



TOWN OF MILLBURY *Office of the Town Manager*

MUNICIPAL OFFICE BUILDING • 127 ELM STREET • MILLBURY, MA 01527 • TEL. 508/865-4710 • FAX 508/865-0843

EMAIL: townmanager@townofmillbury.net

June 25, 2021

ADDENDUM TO RFS #2021-220-1—MILLBURY FIRE HEADQUARTERS

1. **Clarification:** Questions on the project should be submitted to the Town Manager at shendricks@townofmillbury.net by the close of business on June 25, 2021.
2. **Clarification:** Sealed bids should be submitted no later than 2pm on June 30, 2021.
3. **Supplemental RFS documents available:** Construction documents and drawings may be obtained by visiting <https://contextarc.sharefile.com/d-sfe2e726253ca43ee800ae4aa17689647>
4. **Attached supplemental RFS documents:**
 - a. Millbury Fire Final Report Combined
 - b. 2021.04.09 Consultants Specs Volume 2

MILLBURY FIRE STATION FEASIBILITY STUDY

Millbury, Massachusetts

FINAL REPORT

DECEMBER 2019

Contents



01. Introduction	06
02. Executive Summary	07
03. Space Needs Summary	09
04. Site Analysis Summary	15
05. Proposed Schematic Design	17
FLOOR PLANS AND SITE PLAN	
06. Preliminary Project Budget	19
07. Conclusions & Recommendations	23
08. Appendices	26
A. DETAILED SPACE NEEDS STUDY	
B. GEO-TECH REPORT	
C. HAZMAT INSPECTION REPORT	
D. EXISITING CONDITIONS SURVEY	
E. STRUCTUAL AND MEP EXIST. CONDITIONS REPORTS	
F. NEW FIRE STATION SITE PLAN	
G. NEW FIRE STATION FIRST FLOOR PLAN	
H. NEW FIRE STATION SECOND FLOOR PLAN	
I. BUILDING COMMITTEE MEETING NOTES	

Introduction

Context Architecture was retained by the Town of Millbury in February 2019 to prepare an architectural feasibility study for the proposed Police and Fire Station Buildings. This report follows reviews and meetings with the Building Committee. Over the course of more than six months, Context produced a space needs program, performed site investigations, developed schematic design options, and attended meetings with the Committee, with the ultimate goal of developing a plan for the proposed new facilities that will best satisfy the Town's Police and Fire Department's needs and requirements. This report is the culmination of that process and represents our best effort to create a document that the Town can utilize for their needs to move the project forward.

Many people assisted us in the work and we are very appreciative of their advice and counsel. We want especially to thank the Building Committee who provided valuable guidance and with whom we met numerous times.

- Donald P. Desorcy, Millbury Chief of Police - Chairman
- Richard P. Hamilton, Millbury Fire Chief - Vice Chairman, Secretary
- Sergeant Kimberly Cadrin, Millbury Police
- Officer Daniel Daly, Millbury Police
- Officer Kevin Woods, Millbury Police, Retired
- David Rudge, Assistant Fire Chief
- Brian Gasco, Assistant Fire Chief
- Paul Concemi, Private Citizen
- Maxine Mann, Private Citizen
- Gregory Meyers, Millbury Superintendent of Schools

Although our work with the committee involved both the Police and Fire stations simultaneously, this report will focus on our findings and recommendations relative to the Fire Station project. Please refer to the separate for the findings and recommendations relative to the Police Station.

We found it a pleasure working with the Town on this assignment.



Jeff Shaw, AIA, LEED AP BC+D
Principal + President



Zeljko Tonic, AIA, LEED AP BC+D
Project Manager

SUMMARY

Executive Summary

The assignment given to Context was to provide the Fire Station Building Committee a comprehensive space needs analysis and schematic design for a proposed new facility. The study involved an examination of the sites that have been selected by the Town, to be considered for locating the proposed facilities. The two sites are both public property, and were previously public schools. This report is the end result of that assignment. It documents the process undertaken and includes thorough site analysis, a detailed space needs analysis, schematic building and site plans, a probable cost statement, conclusion and recommendations.

Beginning in March of 2019 we kicked off a series of working meetings with the Building Committee, which was led by the Committee chair, Police Chief Donald Decorcy. The Committee was made up of members of the Police and Fire departments, including the Fire Chief, as well as private citizens. Starting with in-depth Police and Fire Chief interviews, we drafted an initial space needs analysis. After several reviews and revisions, narrowing the program requirements, the Committee approved a Final Draft to be used as the basis of the proposed schematic design.

Concurrently, we conducted a site assessment and investigations process. Both of the Town's pre-selected project sites, the former High School at 125 Elm Street and the former Elementary School at 153 Millbury Ave. were surveyed and analyzed, including Geo-technical explorations and engineering reviews of the existing buildings on site.

Over a number of Study Committee meetings we developed the preferred site configuration, concept floor plans and project cost estimate. Our Civil, Structural, Mechanical, Plumbing and Electrical Engineering Consultants, prepared detailed reports outlining the conditions of structural and Mechanical, Plumbing and Electrical conditions in the existing buildings. Geotechnical explorations were made to verify existing subsurface conditions.

Utilizing the researched data, Context developed several options and subsequent iterations of possible floor plans and site plans for consideration by the Committee. After extensive review, discussions and revisions, the final schematic plans were approved.

Finally, based on the current and projected average square foot costs for similar public safety buildings, an estimated project budget was developed for each proposed building, which includes hard construction costs, so-called 'soft' costs including A&E fees, FF&E costs and a project contingency.

This report is focused on the proposed Police Station project and the following plans and data presented will focus exclusively on the Police Department needs..

SPACE NEEDS

Fire Department Space Needs Summary

The existing Fire Department Headquarters, located at 126 Elm Street, is an old and outdated facility that no longer serves the needs of the department. Our first step in the Space Needs process was to interview the fire chief to discuss department needs, staffing, functions for the proposed new headquarters, and particularly their space and equipment requirements. The following is the result of the interviews which is used to establish the building program.

SPACE NEEDS

STAFFING

Position	Current Per Shift	Current Total	Future to 2035	
			Single Shift	Total All Shifts
Administration				
Chief	0	1 on Call	1	1
Captains	0	1 on Call	1	1
Lieutenants	0	3 on Call	1	3
Administrative Assistant	0	1	1	1
Deputy Chief	0	1 on Call	1	1
Assistant Chief	0	3 on Call	1	3
Call FF (FT+PT)	0	14-24	12	12
Career FF	0	0	3	12
Paramedics	0	2 (Contract)	2	8
TOTAL STAFF	0	26-36	23	42

SPACE NEEDS

PARKING NEEDS SUMMARY

Department		Present	Future
Garaged			
	Ladder Trucks / Snorkel	1	1
	Engine	2	2
	Brush Truck	1	1
	Rescue Truck	1	1
	Hazmat Trailer	0	1
	Gator (w/ trailer) [UTV]	0	1
	Ambulance	1	2
	Fire Chief	0	1
	Fire Alarm Bucket Truck	1	1
	Inspector's Vehicles	0	1
	Boats	0	1
	TOTAL	7	13
Parking			
	Personal Vehicles	7	27
	Public Vehicles	0	5
	TOTAL	7	32
Site Features			
	50' Radio Tower		
	Training Tower (see Dayville Fire Company)		

SPACE NEEDS

Prgm No.	Space Type Description	Needed Space Size			Tot. Needed		Floor	
		Qty	Length	Width	NASF	NASF	1st	2nd
FIRE DEPARTMENT								
1.0	Public							
1.1	Vestibule	1	6	7	42	42	42	
1.2	Lobby	1	12	12	144	144	144	
1.3	Public Toilets	2	7.5	6	45	90	90	
1.4	Training Room	1	31	24	744	744		744
1.5	Training Room Storage	1	10	8	80	80		80
2.0	Administration							
2.1	Fire Chief's Office	1	12	16	192	192	192	
2.2	Fire Prevention / Public Education	1	14	14	196	196	196	
2.3	Administrative Office	1	20	14	280	280	280	
2.4	Work Room / Office Supplies	1	9	9	81	81	81	
2.4	Conference Room	1	19	12	228	228	228	
2.6	Administrative Toilet	2	6.5	8.5	55	111	111	
2.7	Record Files	1	13	10	130	130	130	
2.8	Public Education Storage	1	8	8	64	64	64	
3.0	Apparatus & Support							
3.1	Watch Room	1	12	10	120	120	120	
3.2	Apparatus Room	1	94	95	8,930	8,930	8,930	
3.3	Turnout Gear	1	16	15	240	240	240	
3.4	Biohazard - Decon Room	1	9.5	10	95	95	95	
3.5	EMS Supplies	1	9	12	108	108	108	
3.6	Air Supply	1	12	12	144	144	144	
3.7	Extractor & Dryer/Shower	1	14.5	10	145	145	145	
3.8	Firefighter's Toilet	1	8	6	48	48	48	
3.9	Gear Supply Storage	1	12	12	144	144	144	
3.10	Fire Evidence	1	10	10	100	100	100	
3.11	EMS Day Room	1	11	10	110	110	110	
3.12	EMS Dorm Room	1	9	10	90	90	90	
3.13	Fire Alarm Room	1	8	10	80	80	80	
3.14	Womens Auxiliary Storage	1	10	10	100	100	100	

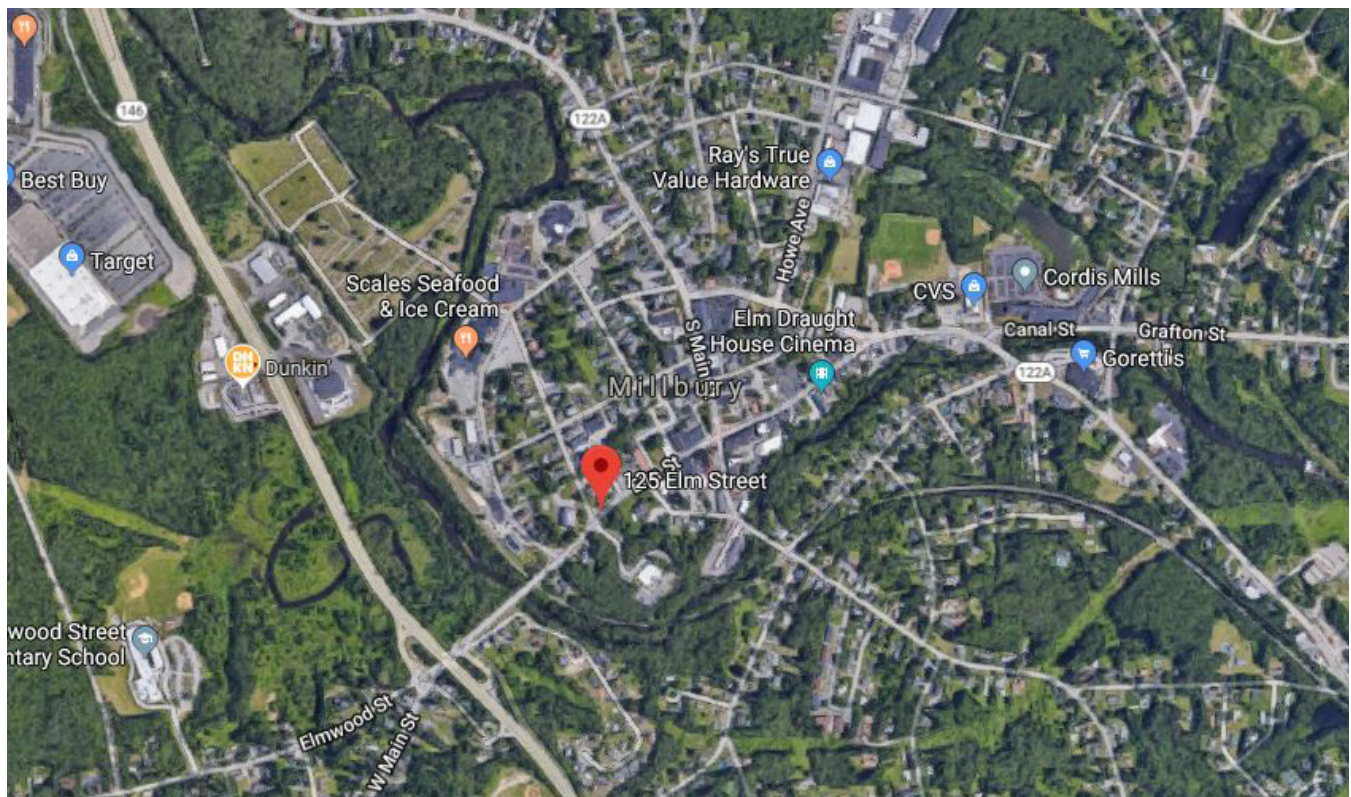
SPACE NEEDS

Prgm No.	Space Type Description	Needed Space Size			Tot. Needed		Floor	
		Qty	Length	Width	NASF	NASF	1st	2nd
4.0	Firefighter's Quarters							
4.1	Kitchen	1	16	9	144	144		144
4.2	Day / Dining Room	1	20	18	360	360		360
4.3	Study / Report Writing	1	8	10	80	80		80
4.4	Shower Room	2	6.5	9.5	62	124		124
4.5	Firefighter Dorm Room	5	10	11	110	550		550
4.6	Washer/Dryer Closet	1	4	6	24	24		24
4.7	Fitness Room	1	20	24	480	480		480
4.8	Office	1	20	14	280	280		280
5.0	Building Support							
5.1	Passenger Elevator	1	8	10	80	160	80	80
5.2	Elevator Machine Room	1	8	10	80	80	80	
5.3	Boiler Room	1	16	12	192		192	
5.4	Electrical Room	1	12	10	120	120	120	
5.5	Emergency Generator Transfer Switch	1	4	8	32	32	32	
5.6	Janitor's Closet	2	4	5	20	40	20	20
5.7	General Storage	1	20	15	300	300	300	
5.8	Building / Grounds Equipment Storage	1	12	16	192	192	192	
Subtotal (Net Square Footage)						15,801	13,028	2,966
Grossing Factor (walls, corridors, chases, etc.)			@	35%		5,530	4,560	1,038
TOTAL SQUARE FOOTAGE						21,331	17,588	4,004

SITE SELECTION

Site Analysis Summary

The site selection process for the proposed new Fire Station had been determined prior to Context initiating this feasibility study. The Town owned property is located just down the street from the current Millbury Fire Station at 125 Elm Street. The location is the former home of the Millbury High School Building which has not been in use for many years. The site is a steeply sloping hill which presents certain specific challenges that were addressed by our existing conditions review and site analysis.



PROPOSED FIRE STATION SITE

The following steps were taken to have a comprehensive review of the existing site conditions:

- Context coordinated the Existing Conditions Survey of the property for the Town done by a Registered Surveying Company;
- Our Geo-Technical Engineer conducted sub surface explorations and issued their report of their findings;
- Our Mechanical, Electrical and Plumbing engineers conducted survey's of the existing building and issued their reports;
- Our Strucural Engineer conducted his survey and issued his report;
- Based on our review and our engineer's reports it was determined that there is no possibility of reusing the existing building for the proposed new Fire Station Faciily and that the existing building would need to be razed as part of the new project.
- In addition, due to the steep grade change from the top of the site to the adjacent street grade, a segnificat protion of the top of the site would need to be excavated and removed, in order to reduce the slopes of access drives for accomodating the Fire Station apparatus
- Due to the presence of bedrock, encountered below the surface at some locations of the site, Context has proposed that additional sub surface exploration be perofmed to further identify and describe the potential quantities of ledge on site.

SCHEMATIC DESIGN

Proposed Schematic Design

Following several design iterations, utilizing the data from the approved space needs study and comments from the Fire Chief and the Building Committee, Context finalized the site plan for the approved schematic design of the proposed building.

The Apparatus Bays, the largest portion of the building, are centrally located at the top of the sloping site. The prime response for apparatus is South to Elm Street, utilizing a wide apron and access drive. There is a secondary access drive from Water Street that serves some apparatus as well as the public and staff parking areas on site. The public access to the one-story Administration Wing, located East of the Apparatus Bays is from the parking area on the NE portion of the site. The firefighters and EMS staff parking area is at the NW corner adjacent to the 2-story portion of the Fire Station that contains most of the firefighting and EMS functions, including dormitory and training spaces.

The final proposed floor plans follow and can be viewed in larger size in Appendix C?

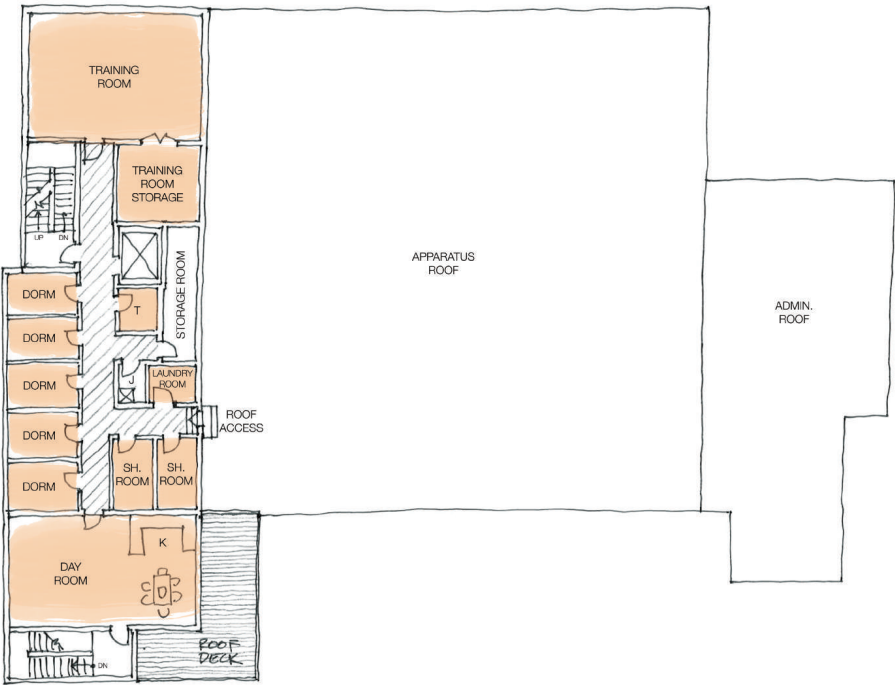


PROPOSED POICE STATION SITE PLAN

SCHEMATIC DESIGN



PROPOSED FIRE STATION FIRST FLOOR PLAN



PROPOSED FIRE STATION SECOND FLOOR PLAN

BUDGET

Preliminary Project Budget

The following is our preliminary project cost estimate, based on current conditions and assumptions, including construction costs as well as related project “soft” costs. We used currently available data from our professional cost estimator for this building type in order to generate an accurate cost/SF.

The following estimate is preliminary, and should not be solely relied upon for final project budgeting. Additional information from further design and engineering will be required to provide a more accurate picture of probable construction cost. Escalation costs have been included through the Summer of 2020. Any delay to the project should anticipate escalation will occur across all line items.

In addition we have compiled a listing of historical cost data for Fire Stations recently bid or constructed, provided by our cost estimator. They can be found in Appendix F.

BUDGET

MILLBURY FIRE STATION PROJECT ESTIMATED PROJECT BUDGET

Millbury Fire Station

Estimate of Probable Cost, September 2019

	<i>Fire Station Size</i>	<i>[21,712 SF]</i>
CONSTRUCTION COSTS		
Fire Station New Construction		\$12,490,000 (\$575/sf)
Escalation (5%)		\$625,000 <i>bid Fall 2020</i>
Total Construction Costs		\$13,115,000
SOFT COSTS		
Design & Engineering		
Architectural and Engineering fees		\$1,115,000
Allowance for extra services and Owner changes		\$56,000
Reimbursable expenses		\$7,500
Furnishing Design fee		\$0 <i>by Owner</i>
Tel/Data & Security Consultant		\$20,000 <i>Allowance</i>
Total Design & Engineering		\$1,198,500
Professional Services		
Owners Project Manager & Clerk of the Works		\$460,000
Geotechnical Engineering & Borings		\$25,000 <i>Allowance</i>
MEP Commissioning		\$40,000 <i>Allowance</i>
Construction Testing		\$30,000 <i>Allowance</i>
Total Professional Services		\$555,000
Fixtures, Furnishings & Equipment		
Furnishings & Equipment (incl HD storage)		\$196,000 <i>Allowance @ \$9/sf</i>
Allowance for Computer Equip. & Network		\$150,000 <i>Allowance</i>
Allowance for Fire Alerting Equipment		\$100,000 <i>Allowance</i>
Allowance for Telephone System & Equip.		\$50,000 <i>Allowance</i>
Allowance for Security & CCTV System		\$304,000 <i>Allowance @ \$14/sf</i>
Total Fixtures, Furnishings & Equipment		\$800,000
Project Related Expenses		
Topographic and Utility Survey		\$0 <i>Incl in A/E Fees</i>
Printing bid sets & advertising		\$5,000 <i>Assumes online bidding</i>
Moving Expenses		\$40,000 <i>Allowance</i>
Utility Fees & Backcharges		\$100,000 <i>Allowance</i>
Total Project Related Expenses		\$145,000
Total Soft Costs		\$2,698,500
Project Contingency		\$1,582,000 <i>10.0%</i>
PROJECT TOTAL		\$17,395,500

RECOMMENDATIONS

Conclusion & Recommendations

To address the needs of the Millbury Fire Department, the following is recommended:

- Based on our analysis of the Space Needs and the program and staffing projections we recommend a facility of approx. 21,712 GSF.
- The chosen site for the new proposed Fire Station Headquarters is well situated and large enough to meet program needs. However, due to the geological make up of the site, in our opinion it should be studied further to get a better picture of the sub-surface conditions and the location, extents and depth of existing ledge.
- We recommend that a new station be constructed of materials commonly used for this type of facility. Structural steel frame, concrete slab on grade and decks, brick masonry exterior wall and concrete masonry interior walls at the apparatus bays
- We recommend a project budget of approximately \$17.4 M based upon the approved space needs and other equipment requirements of the Fire Department.
- The final estimated project cost would need to be developed by using Design Development Drawings and Construction Documents in order to have a complete picture of the detailed construction costs involved
- The next step in this process is to proceed with the design stage of the project, to have the documentation needed for accurate estimating purposes as well as for generating support and approvals for the project.

APPENDICES

Appendices

- A DETAILED SPACE NEEDS STUDY
- B GEO-TECH REPORT
- C HAZMAT INSPECTION REPORT
- D EXISTING CONDITIONS SURVEY
- E. STRUCTURAL AND MEP EXIST. CONDITIONS REPORTS
- F. NEW FIRE STATION SITE PLAN
- G. NEW FIRE STATION FIRST FLOOR PLAN
- H. NEW FIRE STATION SECOND FLOOR PLAN
- I. BUILDING COMMITTEE MEETING NOTES

APPENDICES

A. Detailed Space Needs Study

Contents



Staffing	
FIRE DEPARTMENT	4
Parking Needs Summary	6
Space Needs Summary	7
Fire Department Space Needs	9

STAFFING

Position	Current Per Shift	Current Total	Future to 2035	
			Single Shift	Total All Shifts
Administration				
Chief	0	1 on Call	1	1
Captains	0	1 on Call	1	1
Lieutenants	0	3 on Call	1	3
Administrative Assistant	0	1	1	1
Deputy Chief	0	1 on Call	1	1
Assistant Chief	0	3 on Call	1	3
Call FF (FT+PT)	0	14-24	12	12
Career FF	0	0	3	12
Paramedics	0	2 (Contract)	2	8
TOTAL STAFF				
	0	26-36	23	42

PARKING NEEDS SUMMARY

Department		Present	Future
Garaged			
	Ladder Trucks / Snorkel	1	1
	Engine	2	2
	Brush Truck	1	1
	Rescue Truck	1	1
	Hazmat Trailer	0	1
	Gator (w/ trailer) [UTV]	0	1
	Ambulance	1	2
	Fire Chief	0	1
	Fire Alarm Bucket Truck	1	1
	Inspector's Vehicles	0	1
	Boats	0	1
	TOTAL	7	13
Parking			
	Personal Vehicles	7	27
	Public Vehicles	0	5
	TOTAL	7	32
Site Features			
	50' Radio Tower		
	Training Tower (see Dayville Fire Company)		

SPACE NEEDS SUMMARY

Prgm No.	Space Type Description	Needed Space Size			Tot. Needed		Floor	
		Qty	Length	Width	NASF	NASF	1st	2nd
FIRE DEPARTMENT								
1.0	Public							
1.1	Vestibule	1	6	7	42	42	42	
1.2	Lobby	1	12	12	144	144	144	
1.3	Public Toilets	2	7.5	6	45	90	90	
1.4	Training Room	1	31	24	744	744		744
1.5	Training Room Storage	1	10	8	80	80		80
2.0	Administration							
2.1	Fire Chief's Office	1	12	16	192	192	192	
2.2	Fire Prevention / Public Education	1	14	14	196	196	196	
2.3	Administrative Office	1	20	14	280	280	280	
2.4	Work Room / Office Supplies	1	9	9	81	81	81	
2.4	Conference Room	1	19	12	228	228	228	
2.6	Administrative Toilet	2	6.5	8.5	55	111	111	
2.7	Record Files	1	13	10	130	130	130	
2.8	Public Education Storage	1	8	8	64	64	64	
3.0	Apparatus & Support							
3.1	Watch Room	1	12	10	120	120	120	
3.2	Apparatus Room	1	94	95	8,930	8,930	8,930	
3.3	Turnout Gear	1	16	15	240	240	240	
3.4	Biohazard - Decon Room	1	9.5	10	95	95	95	
3.5	EMS Supplies	1	9	12	108	108	108	
3.6	Air Supply	1	12	12	144	144	144	
3.7	Extractor & Dryer/Shower	1	14.5	10	145	145	145	
3.8	Firefighter's Toilet	1	8	6	48	48	48	
3.9	Gear Supply Storage	1	12	12	144	144	144	
3.10	Fire Evidence	1	10	10	100	100	100	
3.11	EMS Day Room	1	11	10	110	110	110	
3.12	EMS Dorm Room	1	9	10	90	90	90	
3.13	Fire Alarm Room	1	8	10	80	80	80	
3.14	Womens Auxiliary Storage	1	10	10	100	100	100	

SPACE NEEDS SUMMARY

Prgm No.	Space Type Description	Needed Space Size			Tot. Needed		Floor	
		Qty	Length	Width	NASF	NASF	1st	2nd
4.0	Firefighter's Quarters							
4.1	Kitchen	1	16	9	144	144		144
4.2	Day / Dining Room	1	20	18	360	360		360
4.3	Study / Report Writing	1	8	10	80	80		80
4.4	Shower Room	2	6.5	9.5	62	124		124
4.5	Firefighter Dorm Room	5	10	11	110	550		550
4.6	Washer/Dryer Closet	1	4	6	24	24		24
4.7	Fitness Room	1	20	24	480	480		480
4.8	Office	1	20	14	280	280		280
5.0	Building Support							
5.1	Passenger Elevator	1	8	10	80	160	80	80
5.2	Elevator Machine Room	1	8	10	80	80	80	
5.3	Boiler Room	1	16	12	192		192	
5.4	Electrical Room	1	12	10	120	120	120	
5.5	Emergency Generator Transfer Switch	1	4	8	32	32	32	
5.6	Janitor's Closet	2	4	5	20	40	20	20
5.7	General Storage	1	20	15	300	300	300	
5.8	Building / Grounds Equipment Storage	1	12	16	192	192	192	
Subtotal (Net Square Footage)						15,801	13,028	2,966
Grossing Factor (walls, corridors, chases, etc.)			@	35%		5,530	4,560	1,038
TOTAL SQUARE FOOTAGE						21,331	17,588	4,004

SPACE NEEDS SUMMARY

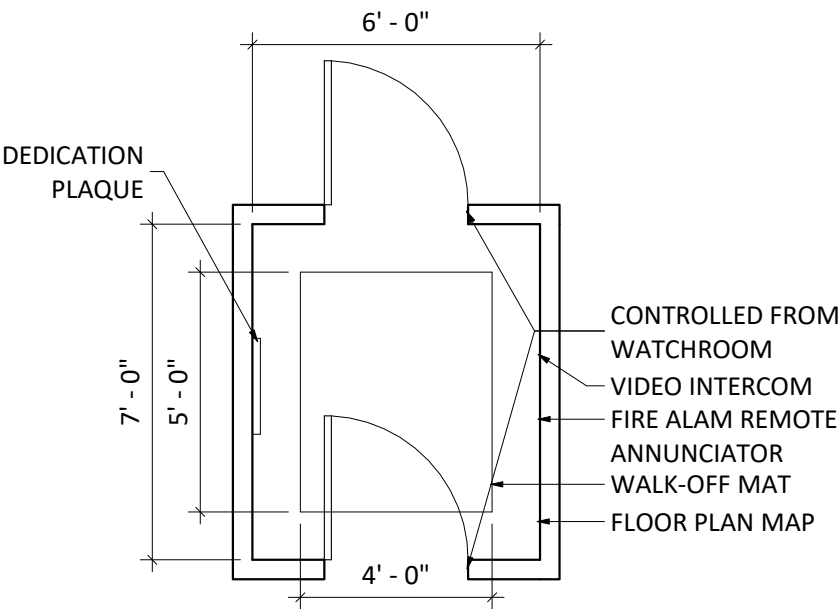
Fire Space Needs

MILBURY FIRE DEPARTMENT

FIRE

1.1 VESTIBULE

Adjacency Requirement	Adjacent to Public Lobby & Exterior.
Public Access	High
Security Requirements	Controlled from Watch Room.
Contract Millwork / Equipment	None
Floor	Epoxy terrazzo, stone or other durable material.
Walls	GWB, painted & glazing
Ceiling	GWB, painted
Lighting / Electrical	Bright, direct
HVAC / Plumbing	A/C
Special Needs	Walk-off mat (Recessed)
Owner supplied Furn. / Equip.	None

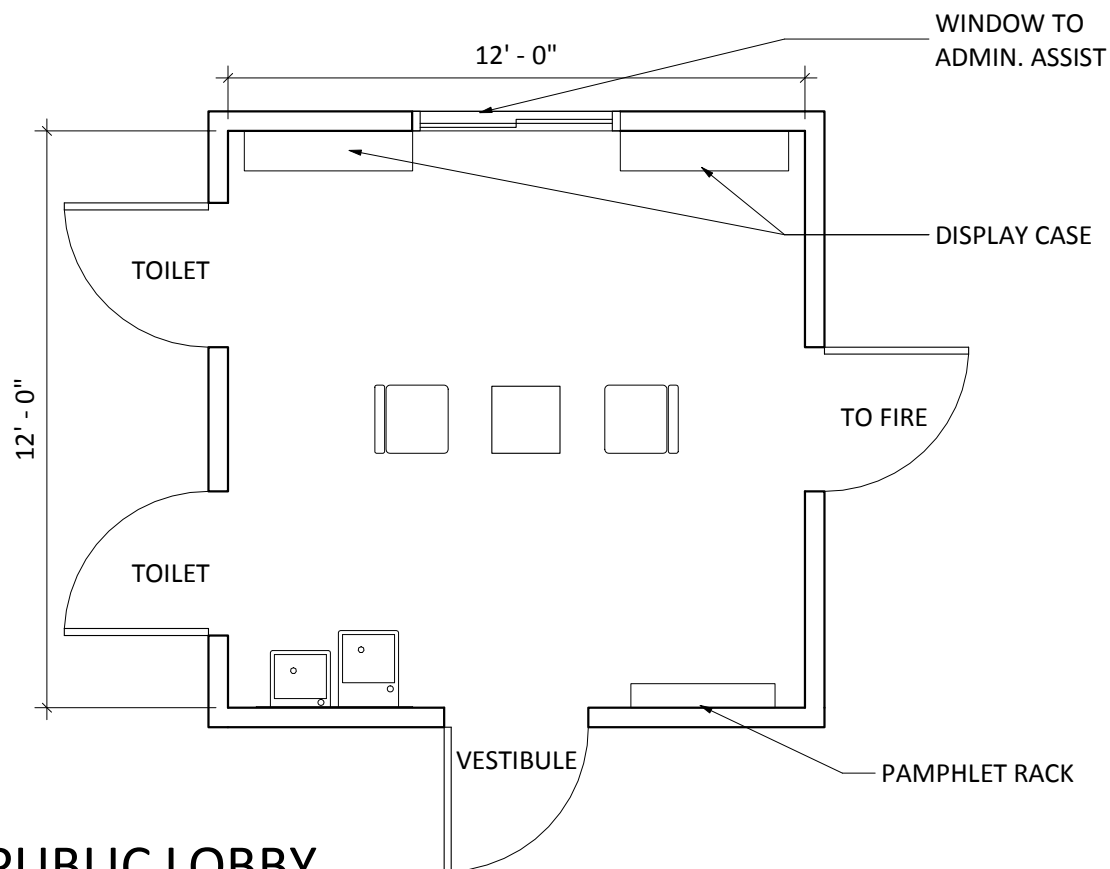


○ VESTIBULE
1/4" = 1'-0"

FIRE

1.2 LOBBY

Adjacency Requirement	Adjacent to Watch Room + Admin. Assistant, near administration area.
Public Access	High
Security Requirements	Controlled exit from lobby to the rest of the building.
Contract Millwork / Equipment	Built-in display case for firefighter memorabilia.
Floor	Epoxy terrazzo, stone or other durable material.
Walls	GWB, painted
Ceiling	GWB, painted /ACT
Lighting / Electrical	Bright, indirect & accent lighting.
HVAC / Plumbing	A/C; two level drinking fountain.
Special Needs	N/A.
Owner supplied Furn. / Equip.	Seating & Table

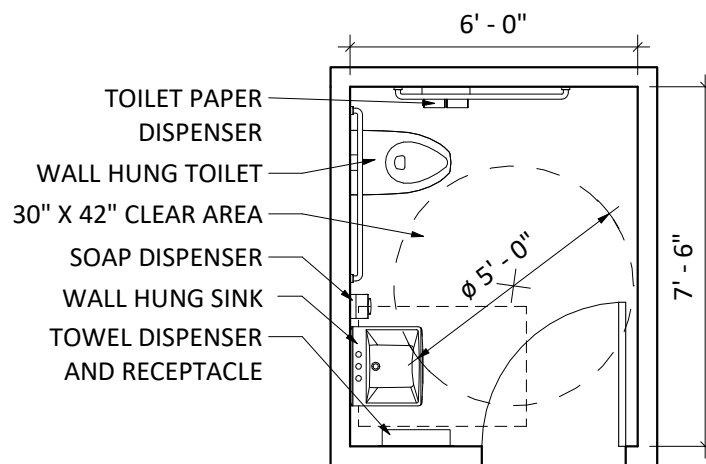


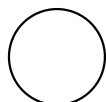
PUBLIC LOBBY
1/4" = 1'-0"

FIRE

1.3 PUBLIC TOILETS

Adjacency Requirement	Public Toilets off the Public Lobby
Public Access	High
Security Requirements	Privacy
Contract Millwork / Equipment	Bathroom accessories, changing table.
Floor	Ceramic tile
Walls	Ceramic tile wainscot, all four walls.
Ceiling	ACT
Lighting / Electrical	Core lighting @ plumbing walls.
HVAC / Plumbing	Good exhaust; wall mounted toilet & sink.
Special Needs	Handicap accessible
Owner supplied Furn. / Equip.	None

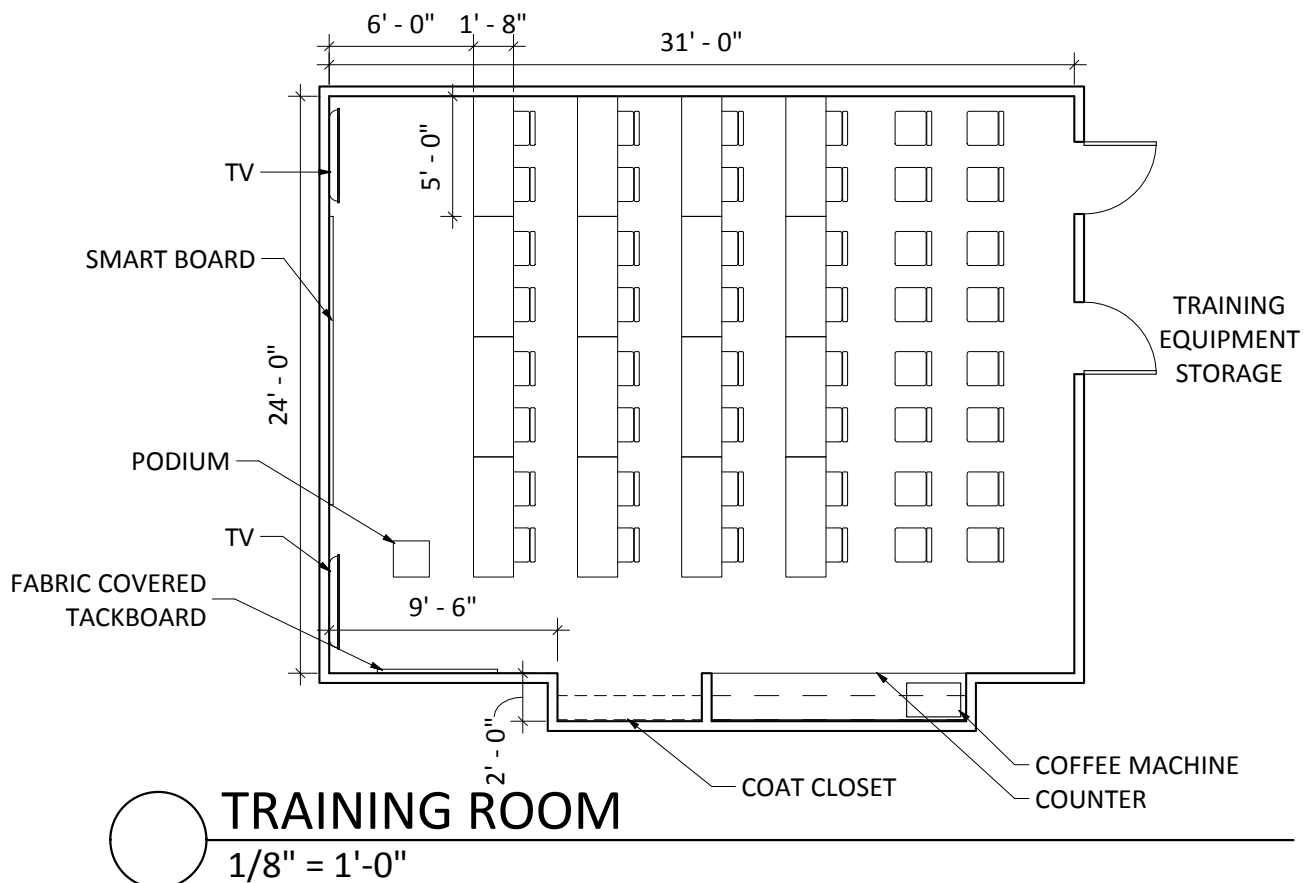


 **PUBLIC TOILET**
1/4" = 1'-0"

FIRE

1.4 TRAINING ROOM

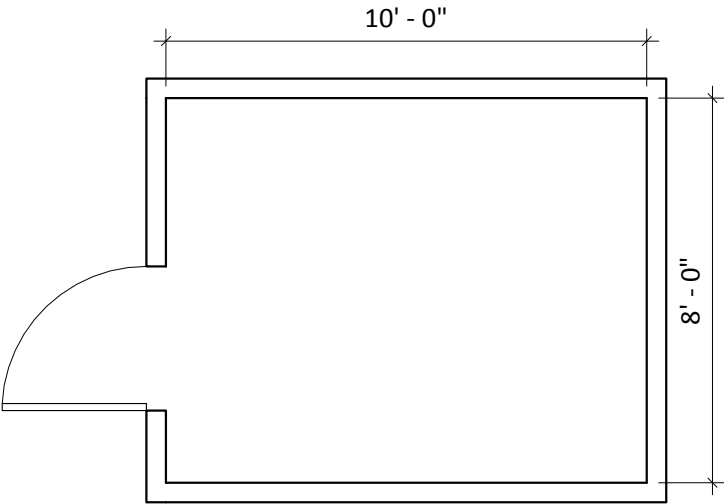
Adjacency Requirement	Easily accessible from Lobby. Adjacent to Storage closet.
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	Fabric covered tackable surfaces; coat rod & shelf. Coffee counter w/ sink.
Floor	Carpet tile
Walls	GWB, painted w/ chair rail.
Ceiling	ACT upgrade
Lighting / Electrical	Power & wireless data outlets. Indirect LED, glare free, dimmable. Speaker system, power outlets under each table. Wireless data system.CATV.
HVAC / Plumbing	A/C w/ good exhaust system.
Special Needs	Space to be adaptable for use as the Emergency Operation Center (EOC).
Owner supplied Furn. / Equip.	Seating for 60 people, (20) training tables, podium, smart board, (2) TV's, coffee machine



FIRE

1.5 TRAINING ROOM STORAGE

Adjacency Requirement	Off Training Room.
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	None
Floor	Rubber or Linoleum
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	LED
HVAC / Plumbing	No A/C
Special Needs	Storage for training tables/
Owner supplied Furn. / Equip.	None

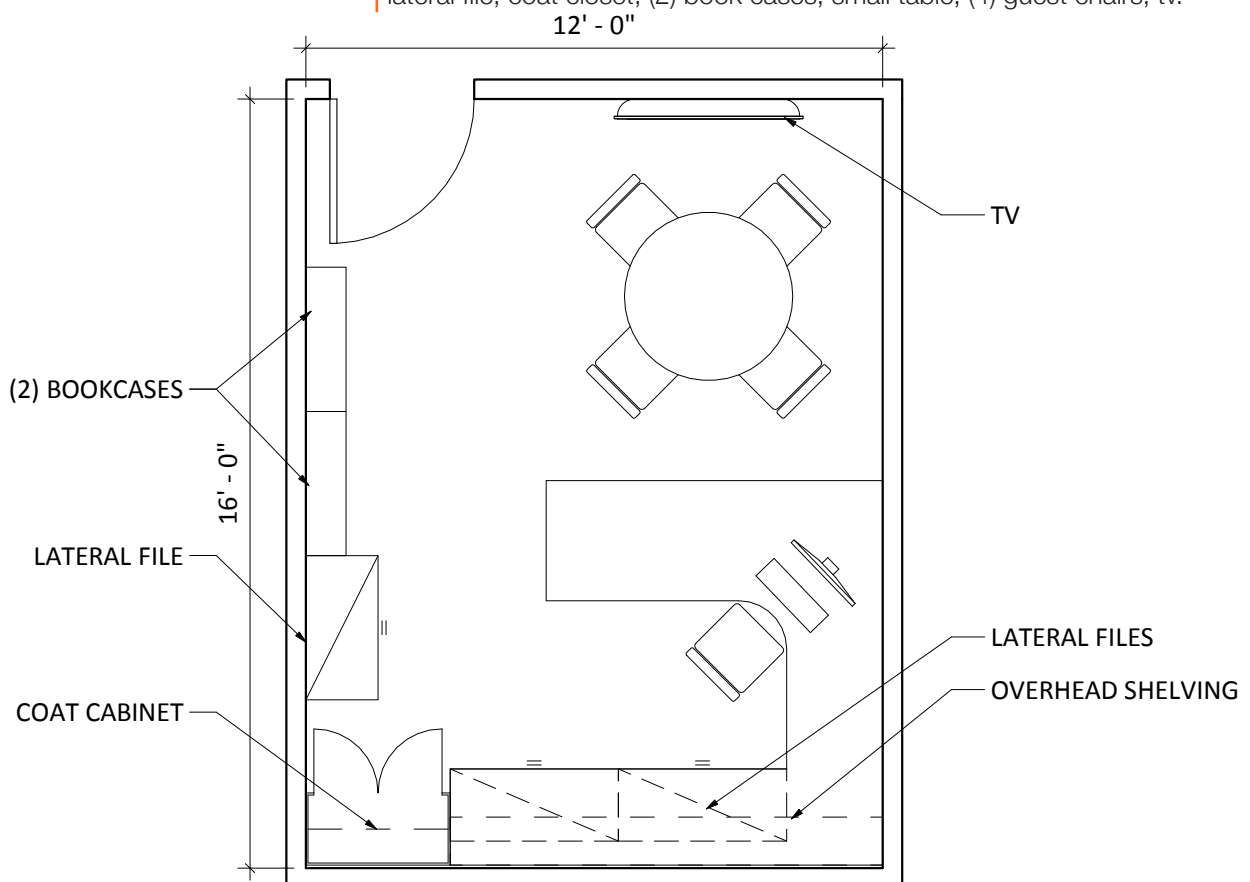


○ TRAINING ROOM STORAGE
1/4" = 1'-0"

FIRE

2.1 FIRE CHIEF'S OFFICE

Adjacency Requirement	Adjacent to Administrative Assistant and Conference Room
Public Access	Moderate
Security Requirements	Office locking
Contract Millwork / Equipment	None
Floor	Carpet tile
Walls	GWB
Ceiling	ACT
Lighting / Electrical	Indirect LED, CATV
HVAC / Plumbing	A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	Workstation w/ credenza, task chair, (2) 2-drawer lateral files, 4-drawer lateral file, coat closet, (2) book cases, small table, (4) guest chairs, tv.

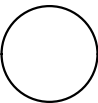
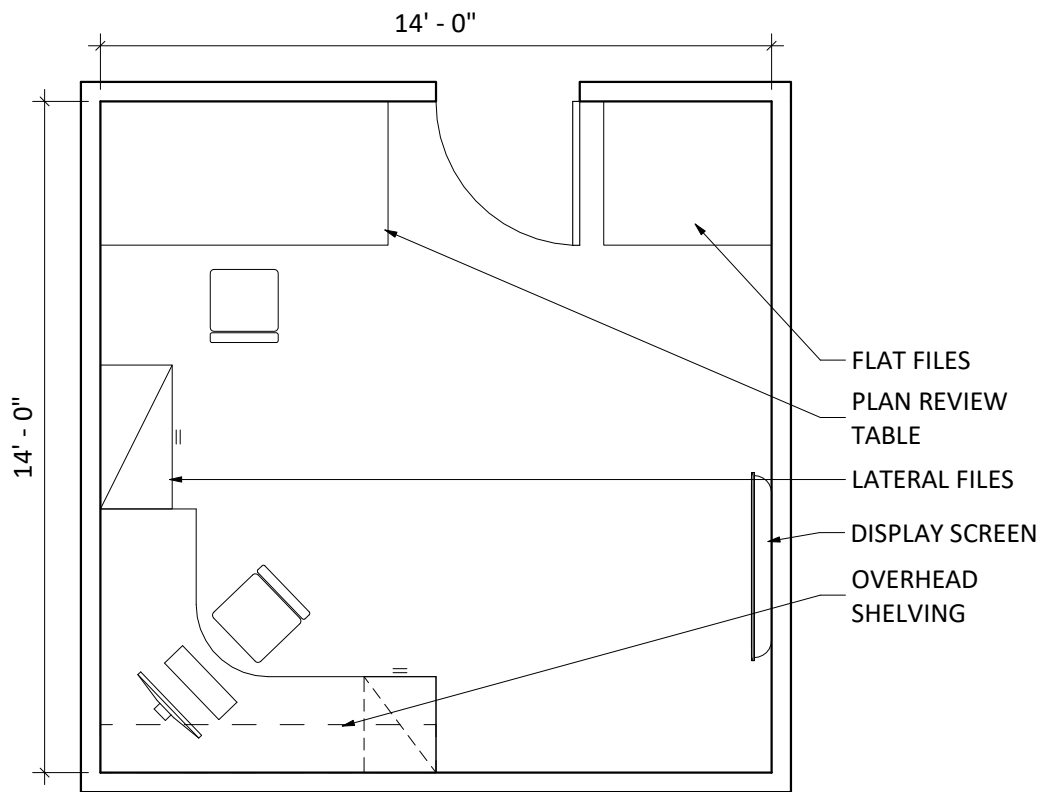


○ CHIEF'S OFFICE
1/4" = 1'-0"

FIRE

2.2 FIRE PREVENTION/PUBLIC EDUCATION

Adjacency Requirement	None
Public Access	High
Security Requirements	Office Locking
Contract Millwork / Equipment	None
Floor	Carpet Tile
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	Indirect LED
HVAC / Plumbing	A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	(1) Workstation, (1) task chair, (1) 4-drawwr lateral files, (1) 40-drawer lateral files, (1) plan review table



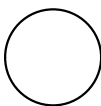
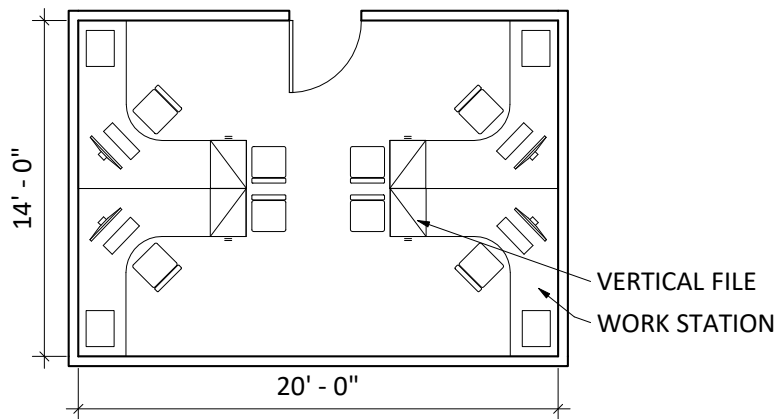
FIRE PREVENTION/PUBLIC EDUCATION

1/4" = 1'-0"

FIRE

2.3 ADMINISTRATIVE OFFICE

Adjacency Requirement	Near work room/office supplies
Public Access	None
Security Requirements	Card Access
Contract Millwork / Equipment	N/A
Floor	Carpet Tile
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	Indirect
HVAC / Plumbing	A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	(4) 24" 2-drawer vertical file, (4) desk chair, (4) work stations, 4 guest chairs

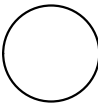
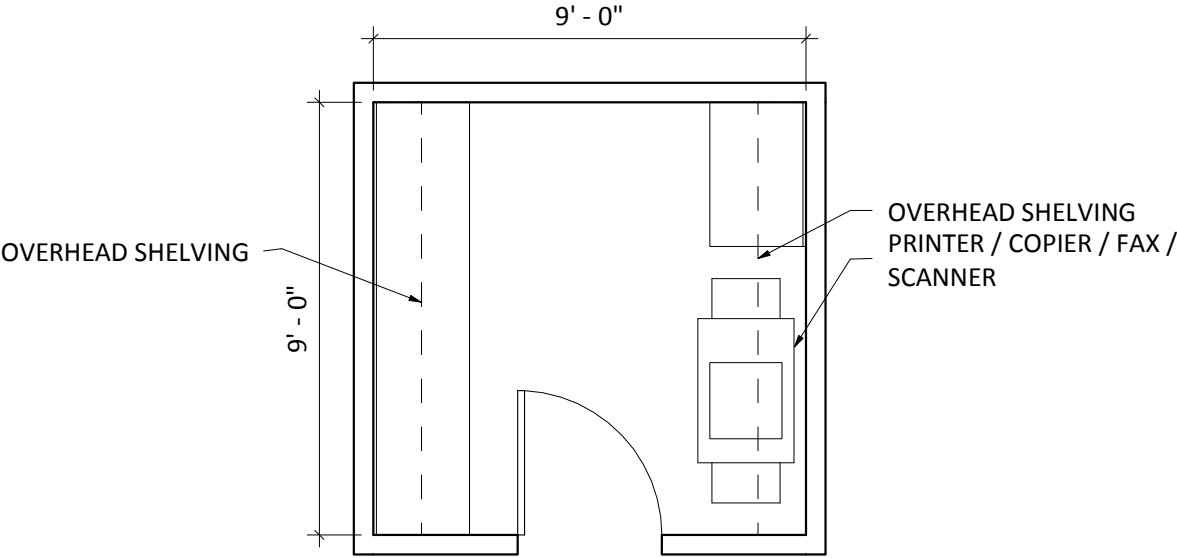


ADMINISTRATIVE OFFICE
1/8" = 1'-0"

FIRE

2.4 WORK ROOM / OFFICE SUPPLIES

Adjacency Requirement	Near Administration offices
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	Base and wall cabinets.
Floor	Rubber or Linoleum
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	LED
HVAC / Plumbing	A/C; sink
Special Needs	N/A
Owner supplied Furn. / Equip.	Multi-functional printer, storage for paper & office supplies.



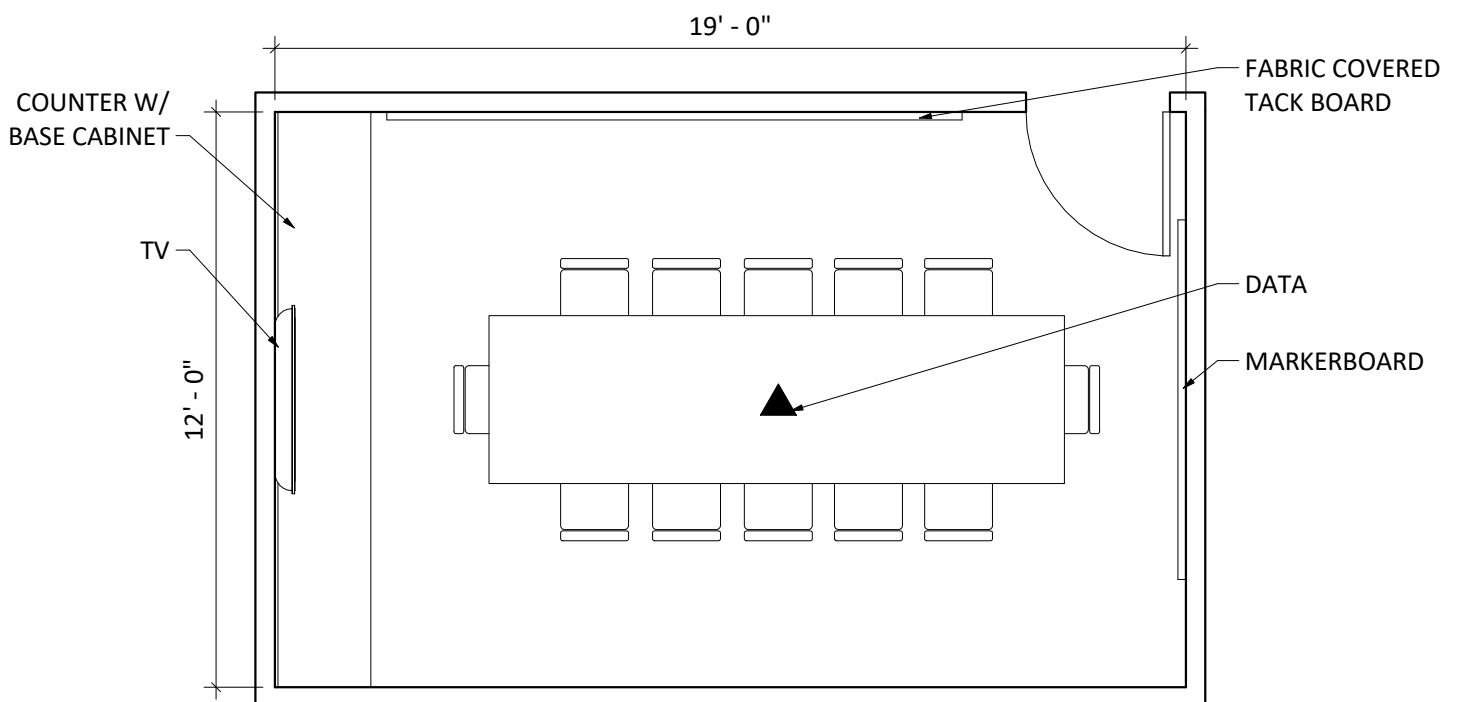
WORKROOM / OFFICE SUPPLIES

1/4" = 1'-0"

FIRE

2.5 CONFERENCE ROOM

Adjacency Requirement	Adjacent to Chief's Office, near Administration Offices.
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	Fabric covered tackboard along (1) wall, full length markerboard, chair rail, solid surface counter w/ base cabinet.
Floor	Carpet Tile
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	Indirect lighting
HVAC / Plumbing	A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	3 1/2' x 12' table w/ 12 chairs, TV

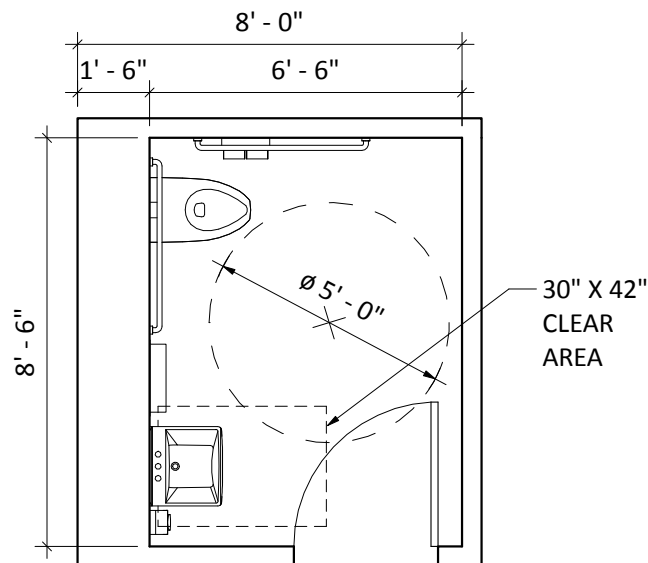


CONFERENCE ROOM
1/4" = 1'-0"

FIRE

2.6 ADMINISTRATIVE TOILET

Adjacency Requirement	Near administrative offices.
Public Access	None
Security Requirements	Privacy
Contract Millwork / Equipment	Toilet Accessories
Floor	Ceramic tile
Walls	Ceramic tile wainscot
Ceiling	GWB, painted
Lighting / Electrical	LED
HVAC / Plumbing	Good exhaust
Special Needs	Handicap accessible
Owner supplied Furn. / Equip.	N/A.

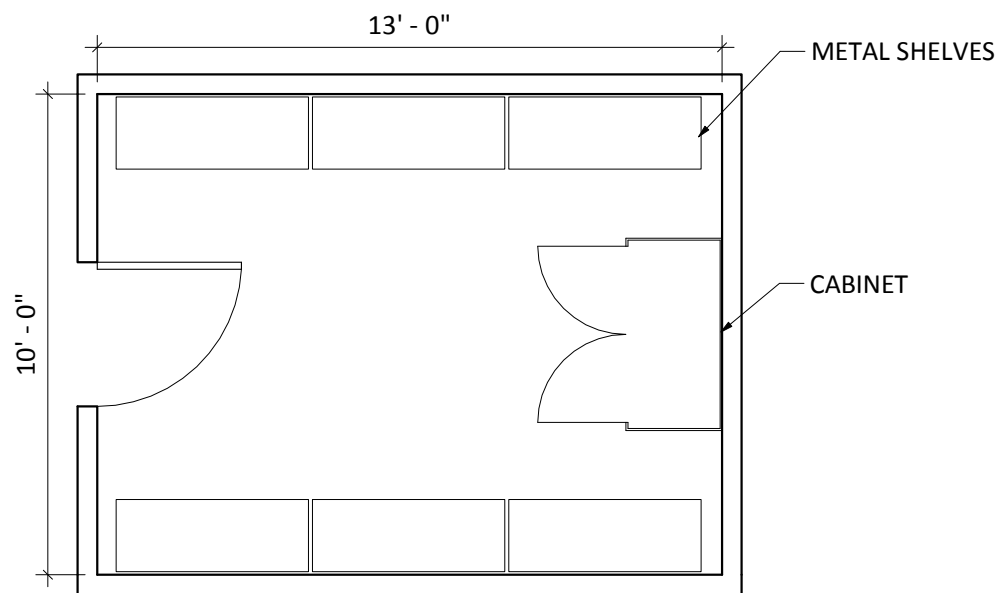


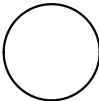
 **ADMINISTRATIVE TOILET**
1/4" = 1'-0"

FIRE

2.7 RECORD FILES

Adjacency Requirement	Near administration offices
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	Metal Shelves
Floor	Rubber or Linoleum
Walls	GWB, painted
Ceiling	GWB, painted
Lighting / Electrical	LED
HVAC / Plumbing	A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A.

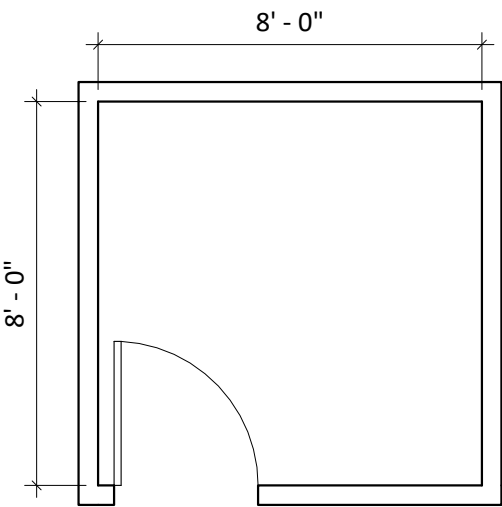


 **RECORD FILES**
1/4" = 1'-0"

FIRE

2.8 PUBLIC EDUCATION STORAGE

Adjacency Requirement	Near administration offices
Public Access	None
Security Requirements	Locking
Contract Millwork / Equipment	N/A
Floor	Rubber or Linoleum
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	LED
HVAC / Plumbing	No A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A.

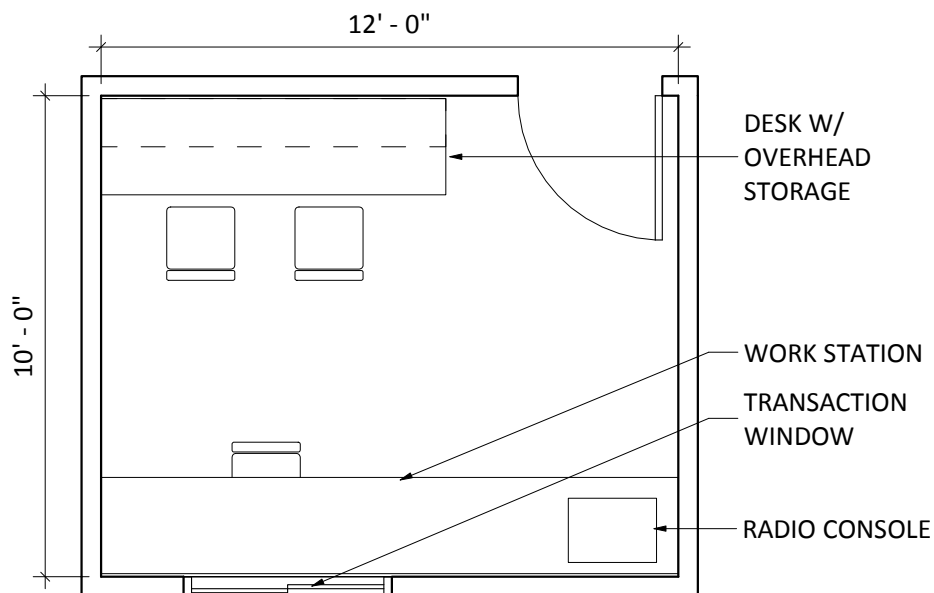


 PUBLIC EDUCATION STORAGE
1/4" = 1'-0"

FIRE

3.1 WATCH ROOM

Adjacency Requirement	Directly next to Lobby, adjacent to Apparatus Room.
Public Access	None
Security Requirements	High
Contract Millwork / Equipment	N/A
Floor	Carpet Tile
Walls	GWB, painted, transaction window
Ceiling	ACT
Lighting / Electrical	Indirect
HVAC / Plumbing	A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	(1) Desk w/ overhead storage, (3) desk chair, (1) work station, (1) radio console

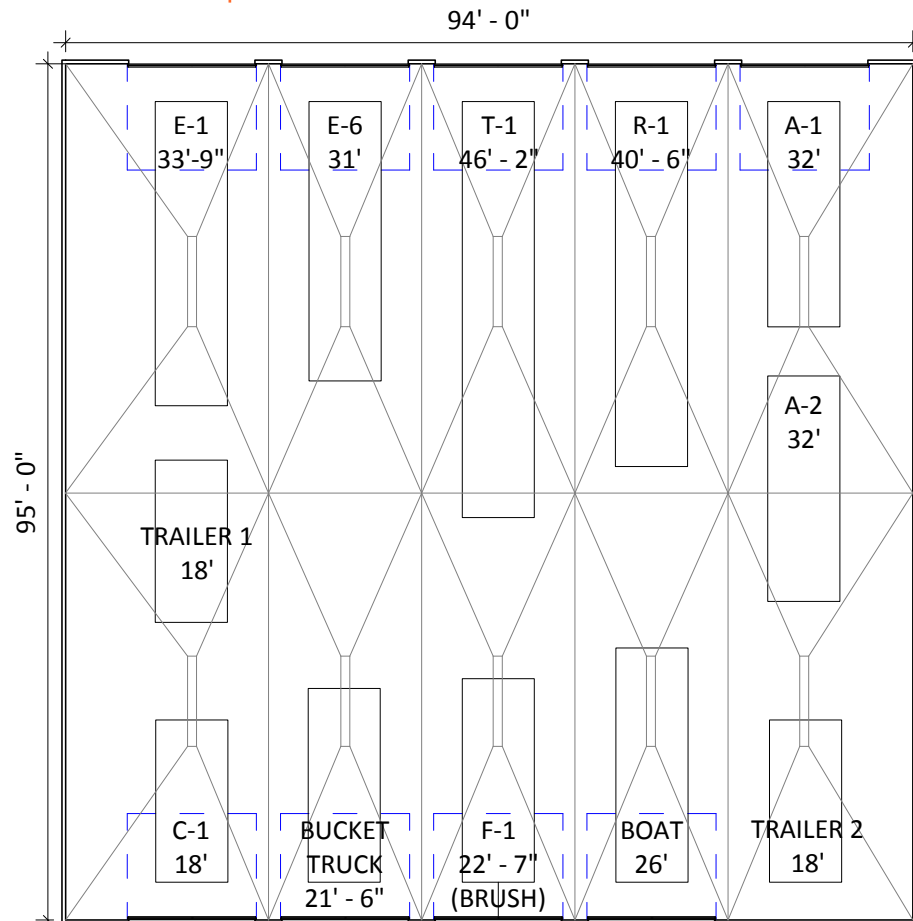


WATCH ROOM
1/4" = 1'-0"

FIRE

3.2 APPARATUS ROOM

Adjacency Requirement	Near Firefighter's Quarters & support spaces.
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	N/A
Floor	Epoxy coat traffic flooring & reflective line stripes.
Walls	CMU w/ epoxy paint.
Ceiling	Painted exposed structure.
Lighting / Electrical	Low level night lighting, rapid-response, electrical cord reel overhead power at each truck. Traffic signals at each door.
HVAC / Plumbing	Heat only, provide vehicle exhaust system, overhead water fill at 2 trucks; compressed air at columns
Special Needs	Over head doors (14'x14'), overhead door operation at door jamb.
Owner supplied Furn. / Equip.	None

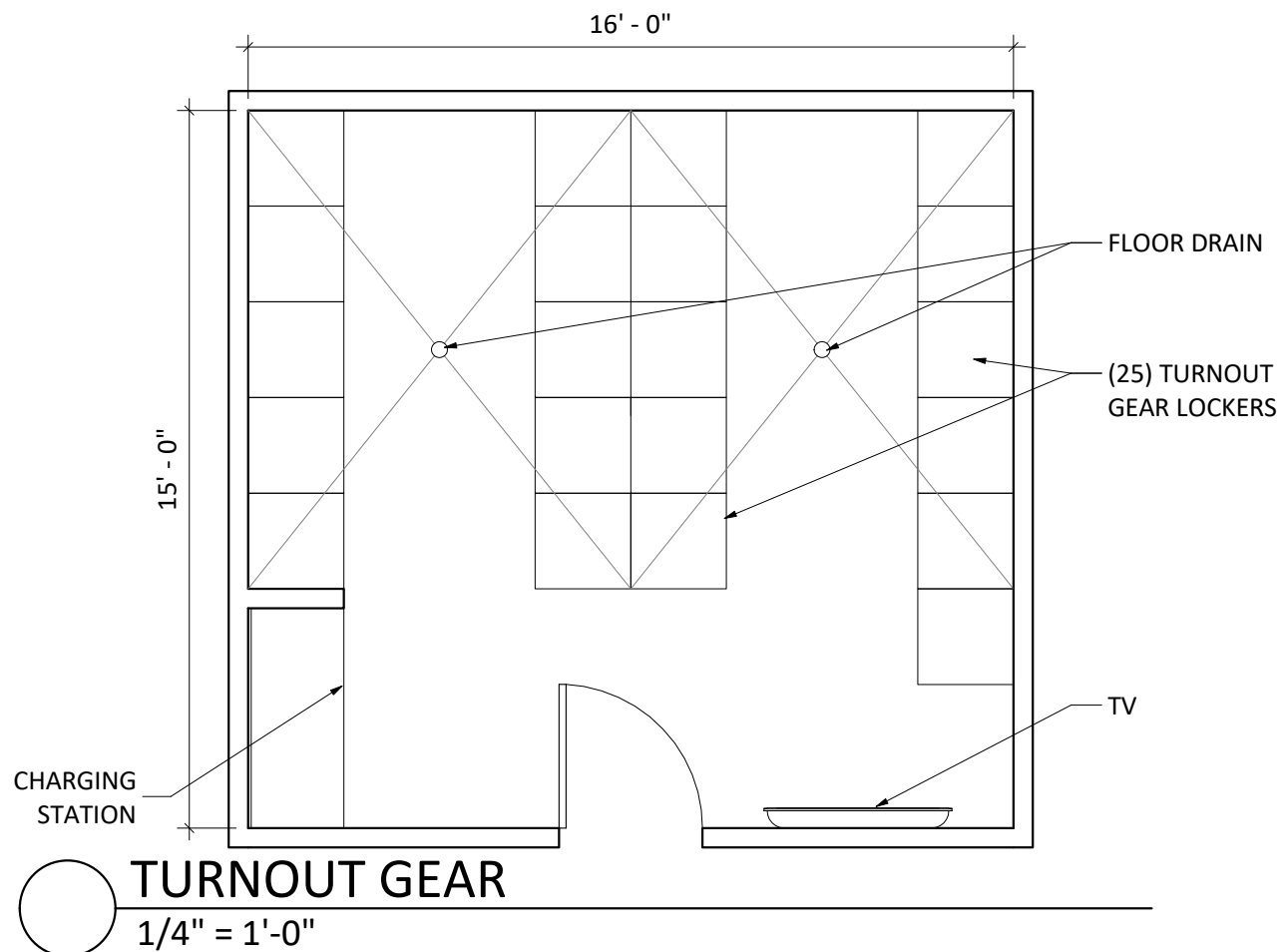


○ APPARATUS ROOM
3/64" = 1'-0"

FIRE

3.3 TURNOUT GEAR

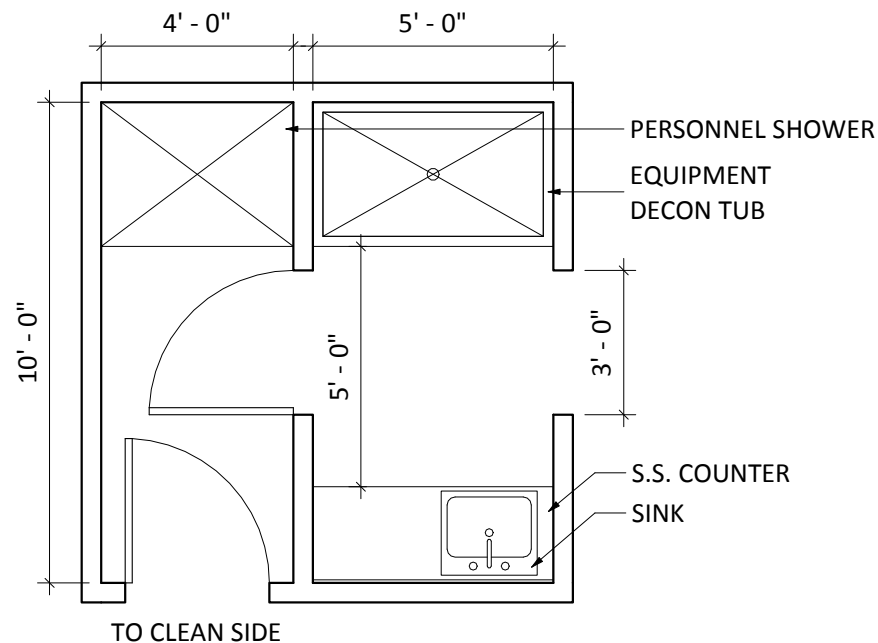
Adjacency Requirement	Adjacent to Apparatus Room
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	(25) steel mesh cucicles (24"x24") w/ top and bottom shelves; wall shelving for charging.
Floor	Hardened concrete or rubber flooring.
Walls	CMU w/ epoxy paint
Ceiling	GWB, painted
Lighting / Electrical	LED
HVAC / Plumbing	Heat only
Special Needs	Floor drains, electrical outlets in each cubicle.
Owner supplied Furn. / Equip.	TV



FIRE

3.4 BIOHAZARD - DECON ROOM

Adjacency Requirement	Adjacent to Apparatus Room and near Extractor
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	24" deep stainless steel counter, S.S. floor tub.
Floor	Epoxy flooring.
Walls	CMU
Ceiling	GWB, painted
Lighting / Electrical	LED
HVAC / Plumbing	Heat only, good ventilation, sink w/ eye wash, hose w/ high temp water spray, prefab shower.
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A



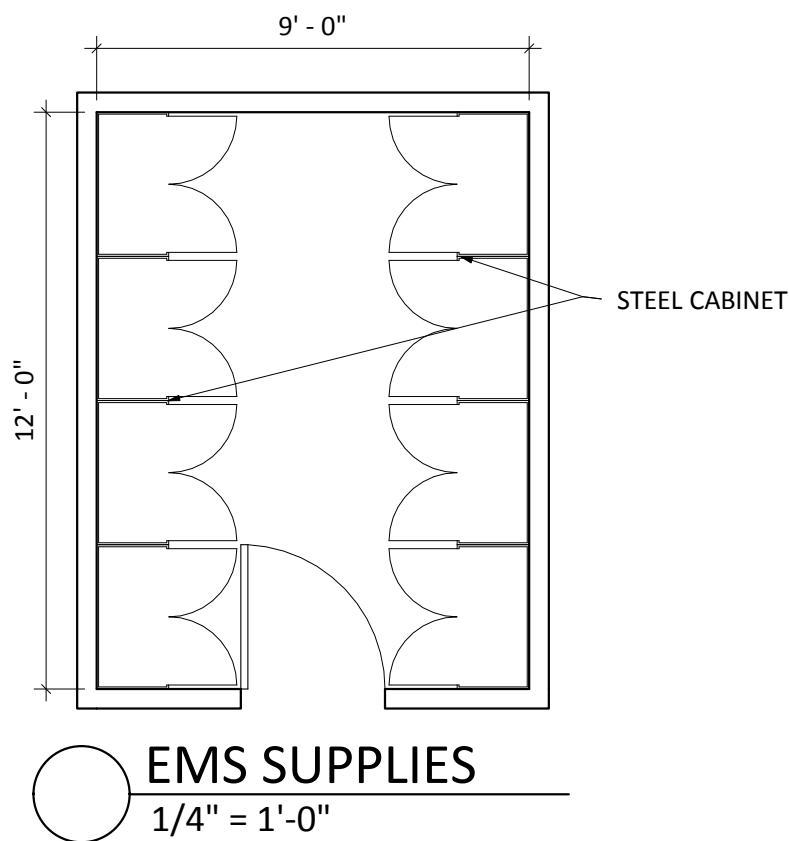
BIOHAZARD / DECON ROOM

1/4" = 1'-0"

FIRE

3.5 EMS SUPPLIES

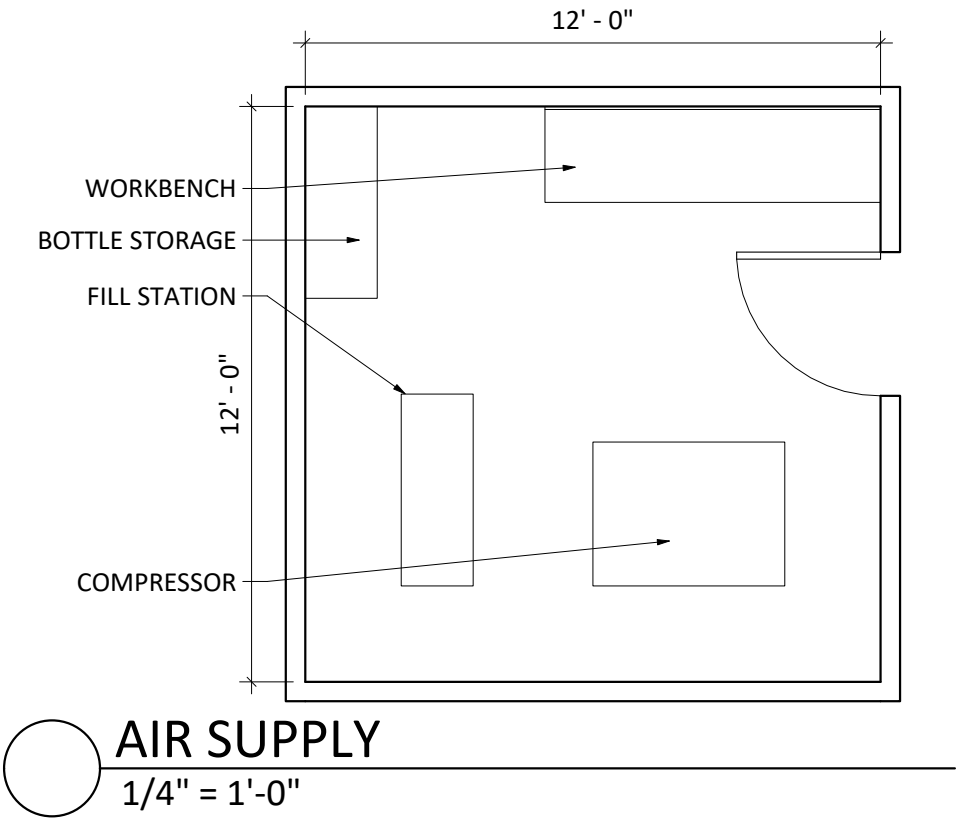
Adjacency Requirement	Near Apparatus Room
Public Access	None
Security Requirements	Card access.
Contract Millwork / Equipment	N/A
Floor	Hardened, sealed concrete.
Walls	CMU, painted
Ceiling	GWB, painted
Lighting / Electrical	LED
HVAC / Plumbing	Heat, A/C, good ventilation
Special Needs	N/A
Owner supplied Furn. / Equip.	Metal cabinets.



FIRE

3.6 AIR SUPPLY

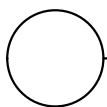
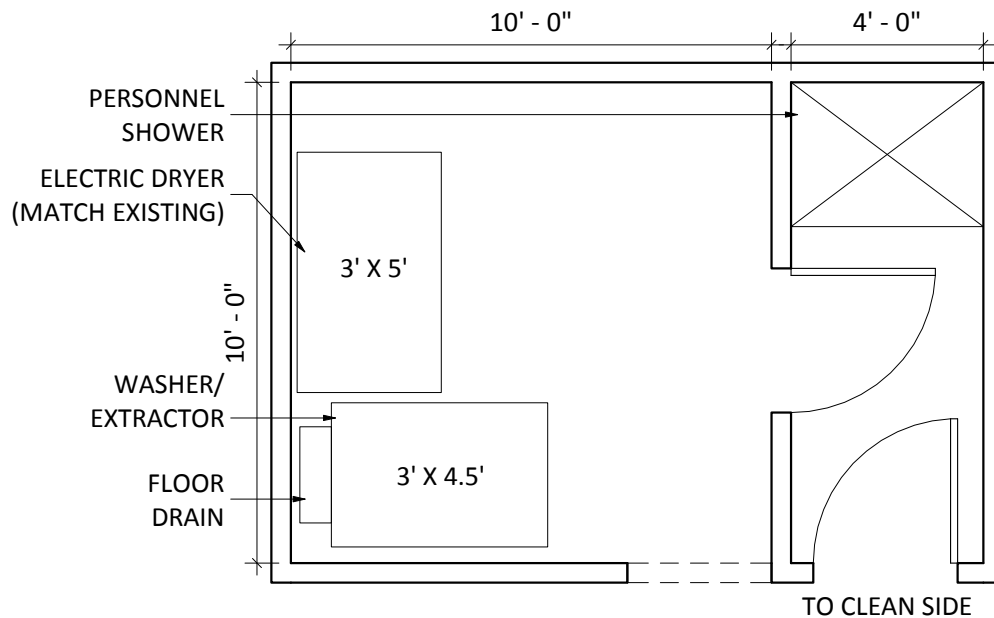
Adjacency Requirement	Adjacent to Apparatus Room
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	Rack storage for air tanks, 6' long work bench, tool storage, new SCBA compressor + fill stations. .
Floor	Hardened, sealed concrete.
Walls	CMU
Ceiling	GWB, painted
Lighting / Electrical	LED
HVAC / Plumbing	Heat only, good ventilation
Special Needs	None
Owner supplied Furn. / Equip.	Tool storage



FIRE

3.7 EXTRACTOR & DRYER/SHOWER

Adjacency Requirement	Adjacent off Apparatus Room, next to Turnout Gear
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	Heavy duty, stainless steel, 60lb capacity (3 sets) washer/extractor, drying rack for (6) sets
Floor	Concrete w/ hardener
Walls	CMU, painted
Ceiling	GWB, painted
Lighting / Electrical	LED lighting
HVAC / Plumbing	No A/C, good ventilation; floor drain, exhaust for dryer.
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A



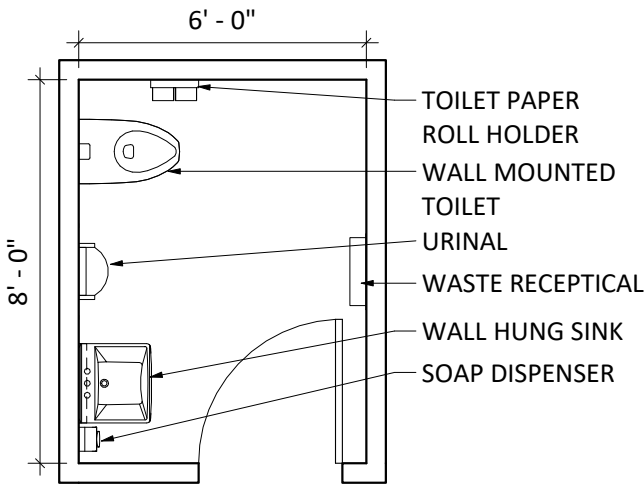
EXTRACTOR & DRYER/SHOWER

1/4" = 1'-0"

FIRE

3.8 FIREFIGHTER’S TOILET

Adjacency Requirement	Off of Apparatus Room
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	Toilet accessories
Floor	Ceramic tile
Walls	Epoxy painted CMU
Ceiling	GWB, painted
Lighting / Electrical	LED lighting
HVAC / Plumbing	No A/C, good ventilation; floor drain, toilet, sink & urinal
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A

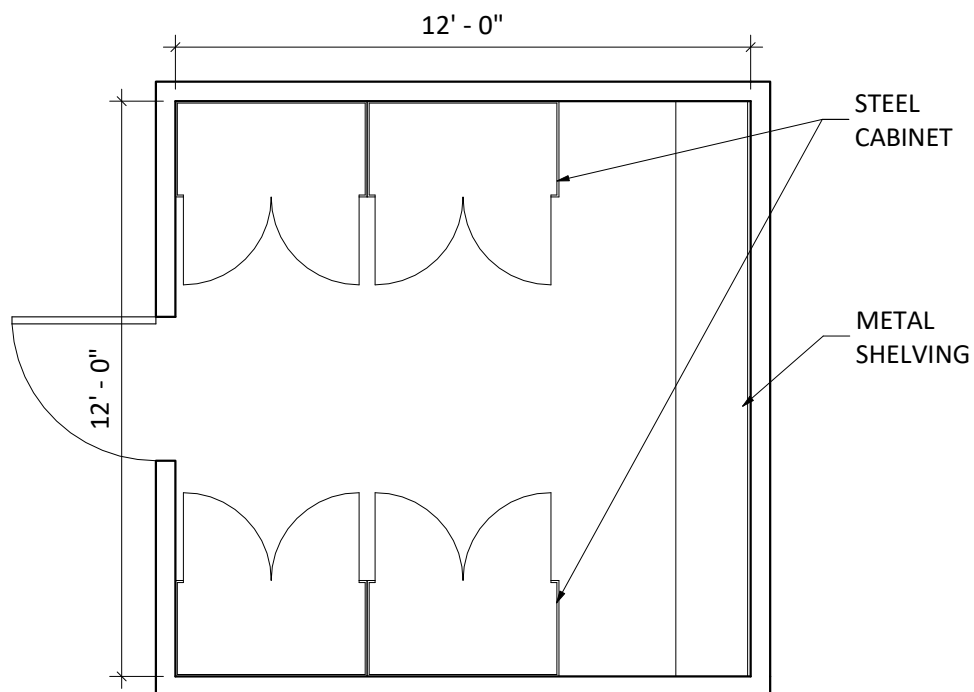


FIREFIGHTER TOILETS
1/4" = 1'-0"

FIRE

3.9 GEAR SUPPLY STORAGE

Adjacency Requirement	Off of Apparatus Room
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	Metal wall shelving
Floor	Concrete w/ hardener
Walls	CMU, painted
Ceiling	GWB, painted
Lighting / Electrical	LED lighting
HVAC / Plumbing	No A/C, good ventilation
Special Needs	N/A
Owner supplied Furn. / Equip.	(4) Metal storage cabinets.

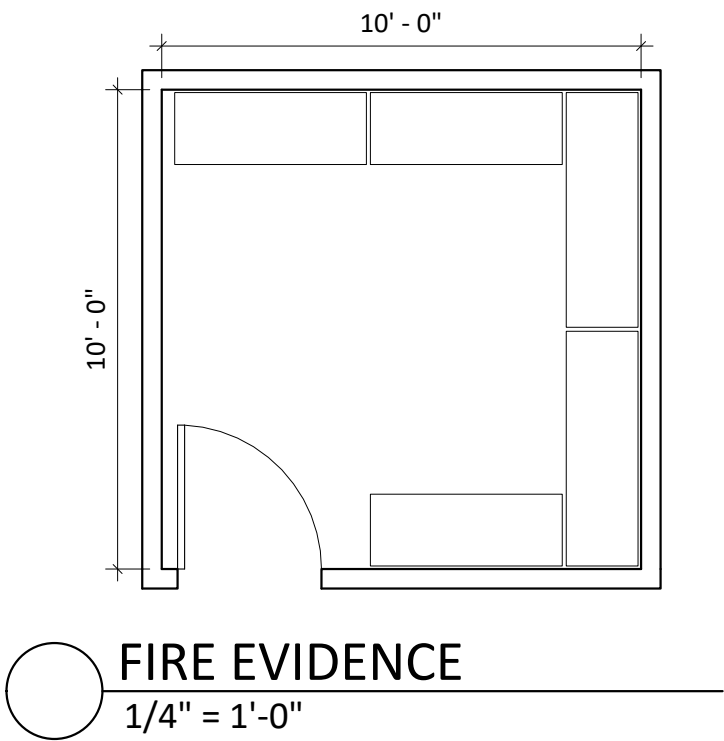


○ GEAR SUPPLY STORAGE
1/4" = 1'-0"

FIRE

3.10 FIRE EVIDENCE

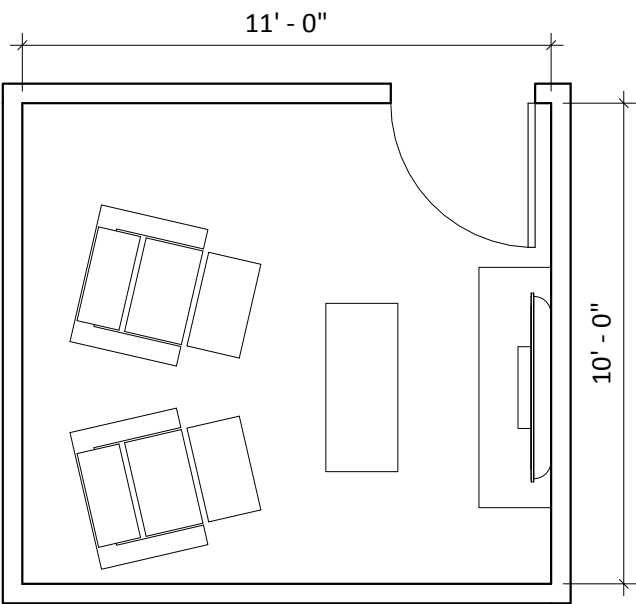
Adjacency Requirement	Adjacent to Apparatus Room.
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	Metal shelving.
Floor	Concrete w/ hardener
Walls	CMU, painted
Ceiling	GWB, painted
Lighting / Electrical	LED lighting
HVAC / Plumbing	No A/C, good ventilation; floor drain.
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A



FIRE

3.11 EMS DAY ROOM

Adjacency Requirement	None
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	N/A
Floor	Rubber or Linoleum
Walls	GWB, painted
Ceiling	GWB, painted
Lighting / Electrical	Indirect LED lighting
HVAC / Plumbing	A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A

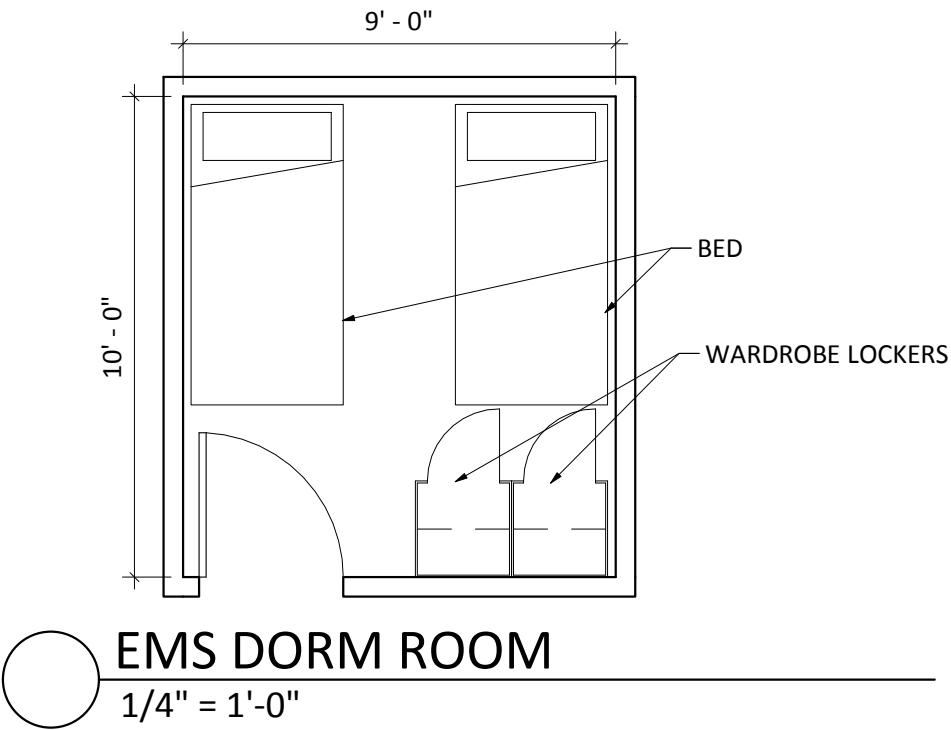


○ EMS DAY ROOM
1/4" = 1'-0"

FIRE

3.12 EMS DORM ROOM

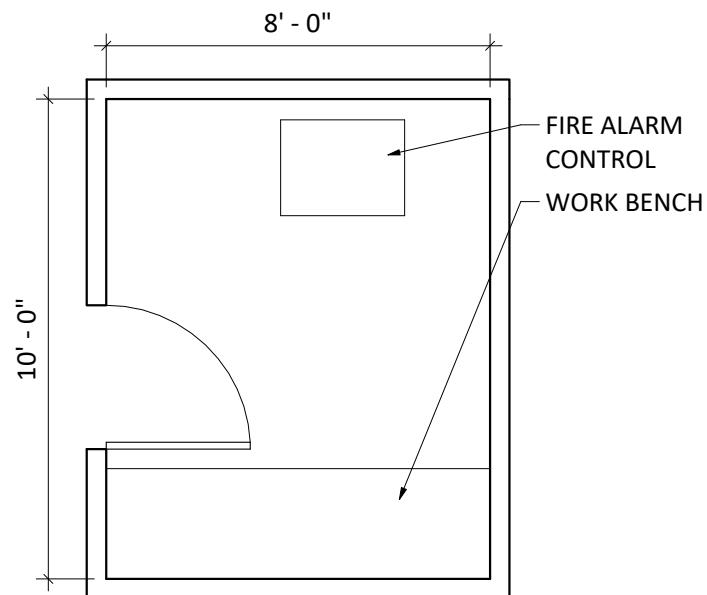
Adjacency Requirement	Near EMS Day Room
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	N/A
Floor	Rubber, Linoleum or Carpet.
Walls	GWB, painted
Ceiling	GWB, painted
Lighting / Electrical	Indirect LED lighting
HVAC / Plumbing	A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A

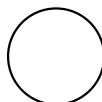


FIRE

3.13 FIRE ALARM ROOM

Adjacency Requirement	Access from the exterior.
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	N/A
Floor	Hardened Concrete
Walls	GWB, painted
Ceiling	GWB, painted
Lighting / Electrical	LED lighting
HVAC / Plumbing	A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A

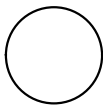
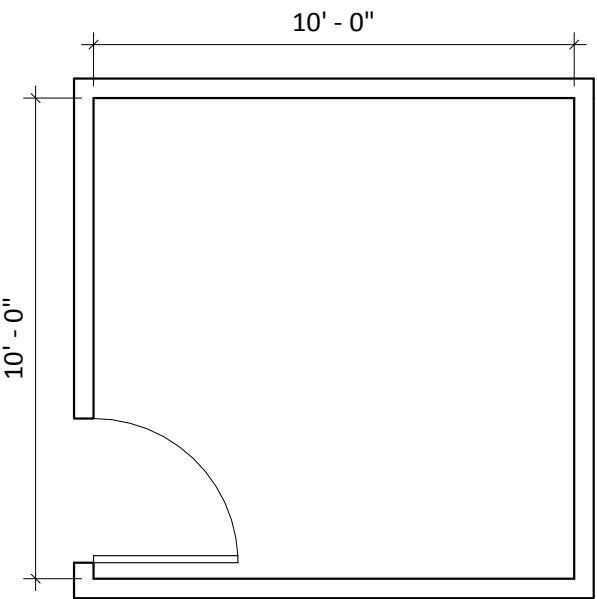


 FIRE ALARM
1/4" = 1'-0"

FIRE

3.14 WOMENS AUXILIARY STORAGE

Adjacency Requirement	Access from the exterior, adjacent to Apparatus Room.
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	N/A
Floor	Hardened Concrete
Walls	GWB, painted
Ceiling	GWB, painted
Lighting / Electrical	LED lighting
HVAC / Plumbing	A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A



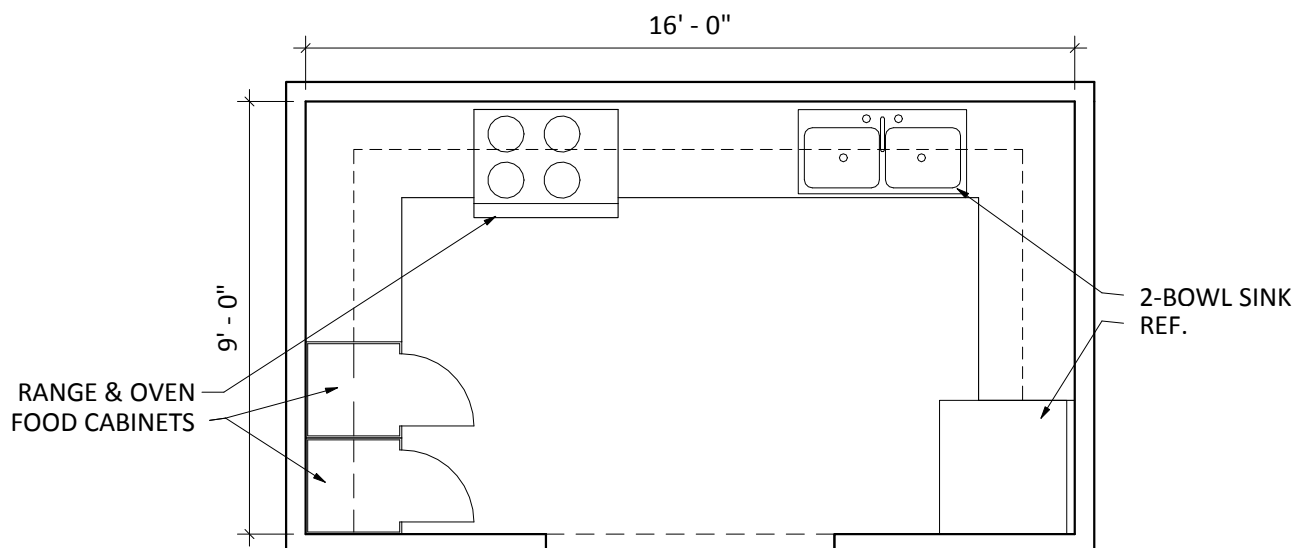
WOMENS AUXILIARY STORAGE

1/4" = 1'-0"

FIRE

4.1 KITCHEN

Adjacency Requirement	Near Day Room
Public Access	None
Security Requirements	Moderate
Contract Millwork / Equipment	Residential kitchen; 4-burner commercial range w/ oven and hood no ansul, microwave, double sink, garbage disposal, grease trap, 30 CF freezer/ refrigerator, stainless steel countertop, plumbed coffeemaker, 2 food cabinets.
Floor	Ceramic tile or Quarry tile
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	LED + under cabinet lighting.
HVAC / Plumbing	Heat, A/C, range exhaust
Special Needs	Zetron speakers
Owner supplied Furn. / Equip.	N/A

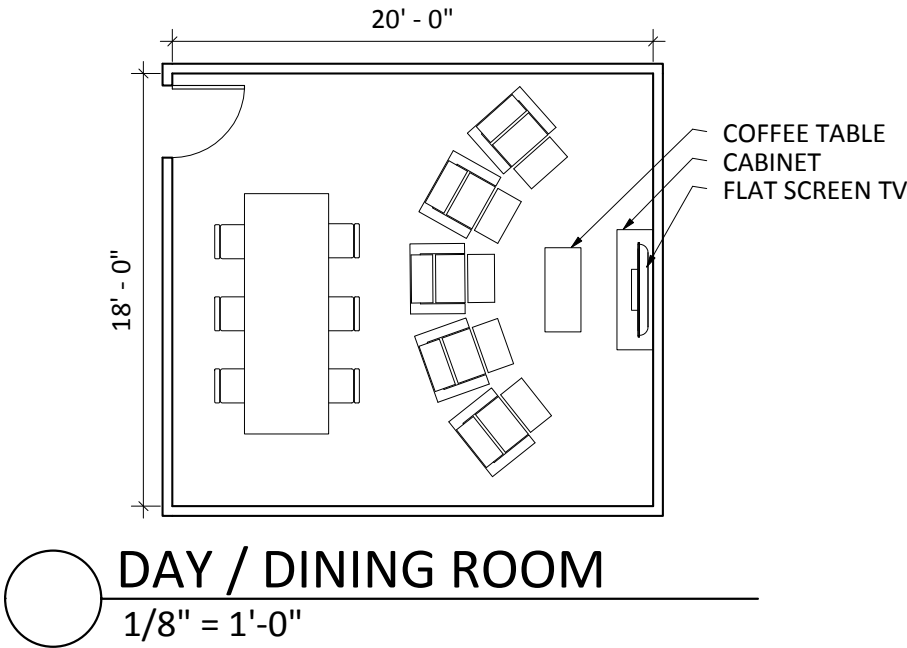


KITCHEN
1/4" = 1'-0"

FIRE

4.2 DAY / DINING ROOM

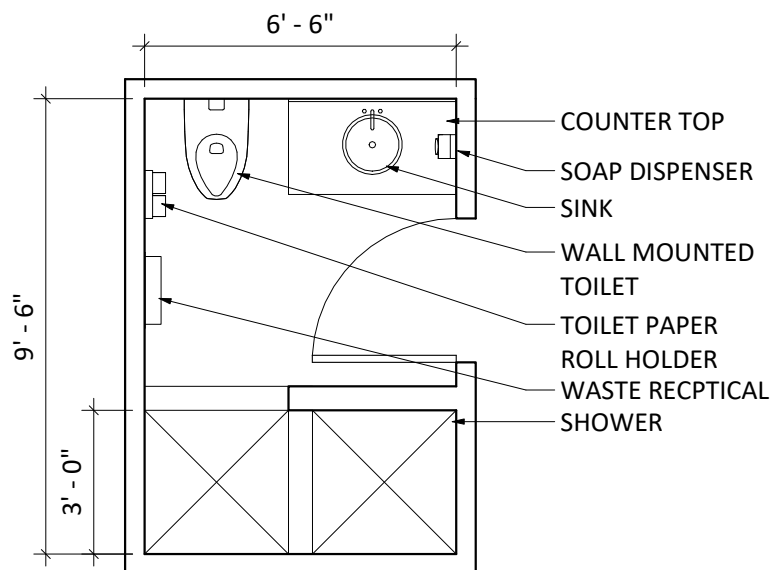
Adjacency Requirement	Open to Kitchen.
Public Access	Good access to Apparatus Room.
Security Requirements	None
Contract Millwork / Equipment	None
Floor	Rubber
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	Indirect lighting, task lighting, power and cable TV outlets on all walls.
HVAC / Plumbing	Heat, A/C
Special Needs	Zetron speakers
Owner supplied Furn. / Equip.	Dining table for (6) Recliners/couch seating for (5).



FIRE

4.3 SHOWER ROOMS

Adjacency Requirement	Near Firefighter Dorm Rooms
Public Access	None
Security Requirements	Privacy
Contract Millwork / Equipment	Solid surface countertop + vanity, continous mirror above countertop, bathroom accessories.
Floor	Ceramic tile
Walls	GWB, ceramic tile wainscot (full height at showers)
Ceiling	GWB, painted
Lighting / Electrical	LED lighting
HVAC / Plumbing	A/C, exhaust; prefab shower, toilet, sink.
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A

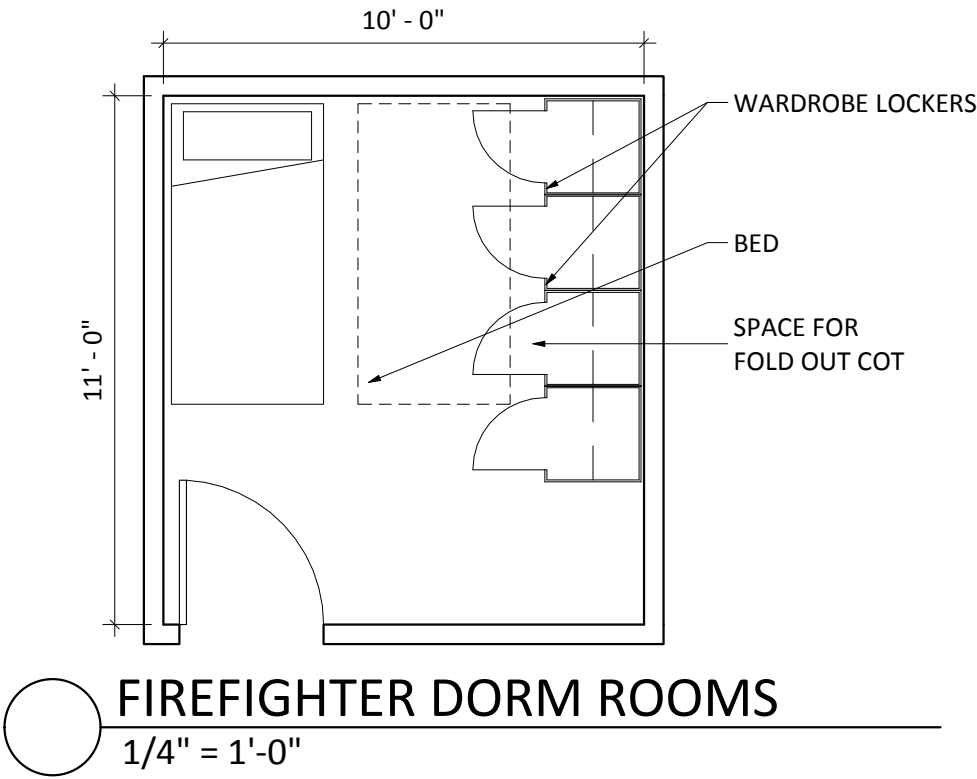


○ **SHOWER ROOM**
1/4" = 1'-0"

FIRE

4.4 FIREFIGHTER DORM ROOM

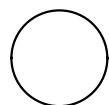
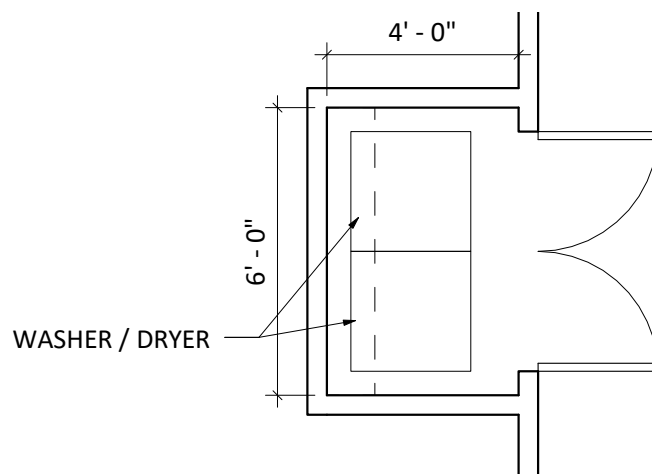
Adjacency Requirement	Good access to Apparatus Room. Adjacent to Toilet Rooms. Near Fire pole.
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	N/A
Floor	Carpet tile
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	2 light levels, task lighting, provide (2) power, (2) data, room darkening shade.
HVAC / Plumbing	Heat, A/C
Special Needs	Alerting system speaker in ceiling.
Owner supplied Furn. / Equip.	Each room to have chair, extra long twin bed, lockers for linens (1) per shift.



FIRE

4.5 WASHER/DRYER CLOSET

Adjacency Requirement	Near Firefighter's quarters.
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	Washer & dryer w/ shelving above.
Floor	Ceramic tile
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	N/A
HVAC / Plumbing	Heat only, good ventilation, dryer vent.
Special Needs	Floor drain and drain pan, zetron speakers
Owner supplied Furn. / Equip.	N/A



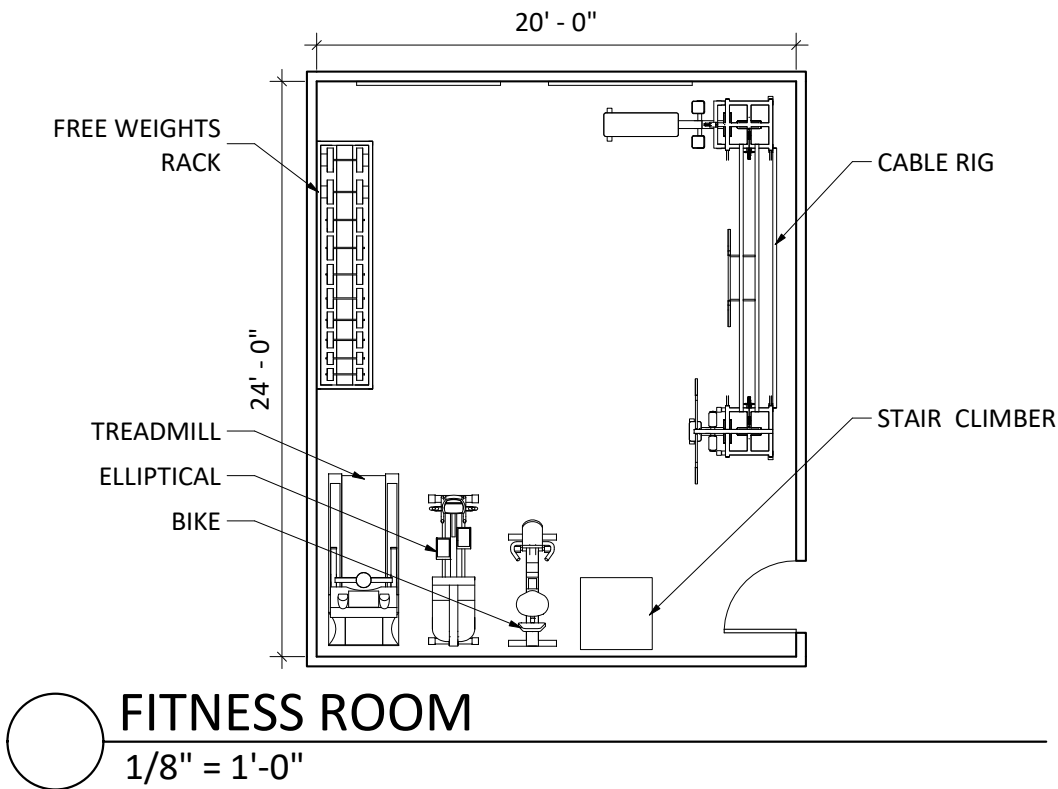
WASHER / DRYER CLOSET

1/4" = 1'-0"

FIRE

4.6 FITNESS ROOM

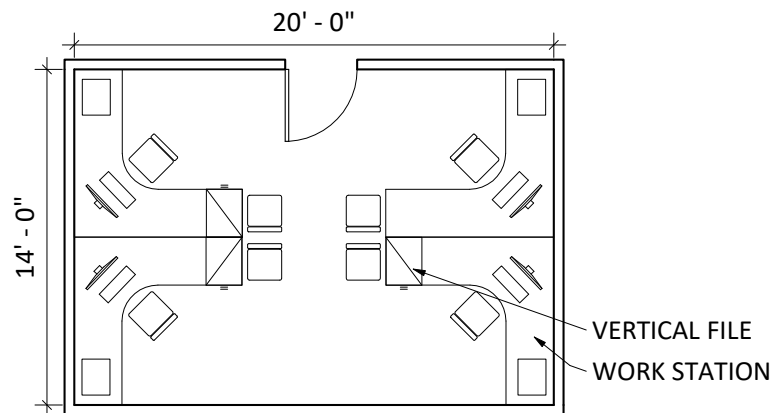
Adjacency Requirement	Direct access to living quarters
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	N/A
Floor	Rubber sport flooring.
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	LED, Zetron speakers
HVAC / Plumbing	Heat, A/C, good ventilation, separate control
Special Needs	N/A
Owner supplied Furn. / Equip.	Treadmill, stationary bike, elliptical, stair climber, free weight rack, cable rig.



FIRE

4.7 OFFICE

Adjacency Requirement	Near Firefighters Quarters
Public Access	None
Security Requirements	Card Access
Contract Millwork / Equipment	N/A
Floor	Carpet Tile
Walls	GWB, painted
Ceiling	ACT
Lighting / Electrical	Indirect
HVAC / Plumbing	A/C
Special Needs	N/A
Owner supplied Furn. / Equip.	(4) 24" 2-drawer vertical file, (4) desk chair, (4) work stations, 4 guest chairs

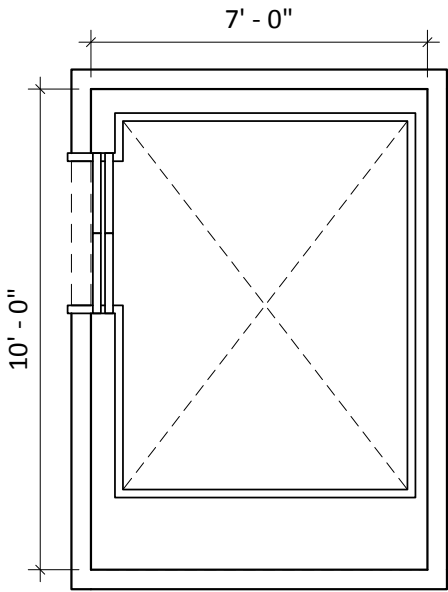


OFFICE
1/8" = 1'-0"

FIRE

5.1 PASSENGER ELEVATOR

Adjacency Requirement	No Access from Lobby
Public Access	Controlled
Security Requirements	High, secured from Lobby - remote release
Contract Millwork / Equipment	N/A
Floor	Rubber or Linoleum
Walls	P.LAM
Ceiling	Luminous panel
Lighting / Electrical	LED
HVAC / Plumbing	Exhaust fan
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A

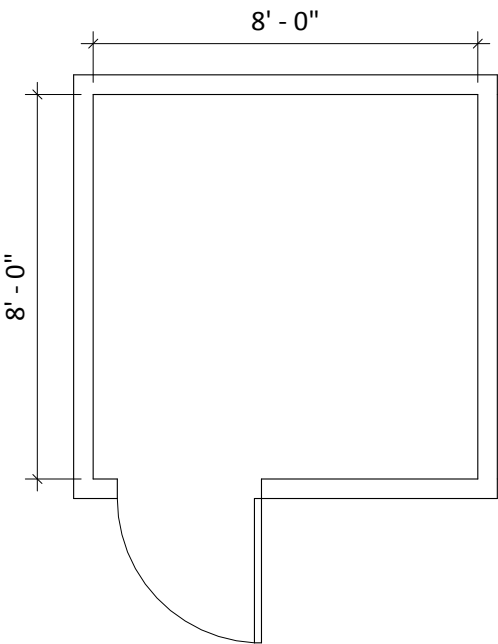


 **PASSENGER ELEVATOR**
1/4" = 1'-0"

FIRE

5.2 ELEVATOR MACHINE ROOM

Adjacency Requirement	Adjacent to elevator.
Public Access	None
Security Requirements	Lockable
Contract Millwork / Equipment	N/A
Floor	Rubber or Linoleum
Walls	GWB, painted
Ceiling	None
Lighting / Electrical	LED, lighting
HVAC / Plumbing	A/C with exhaust
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A

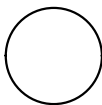
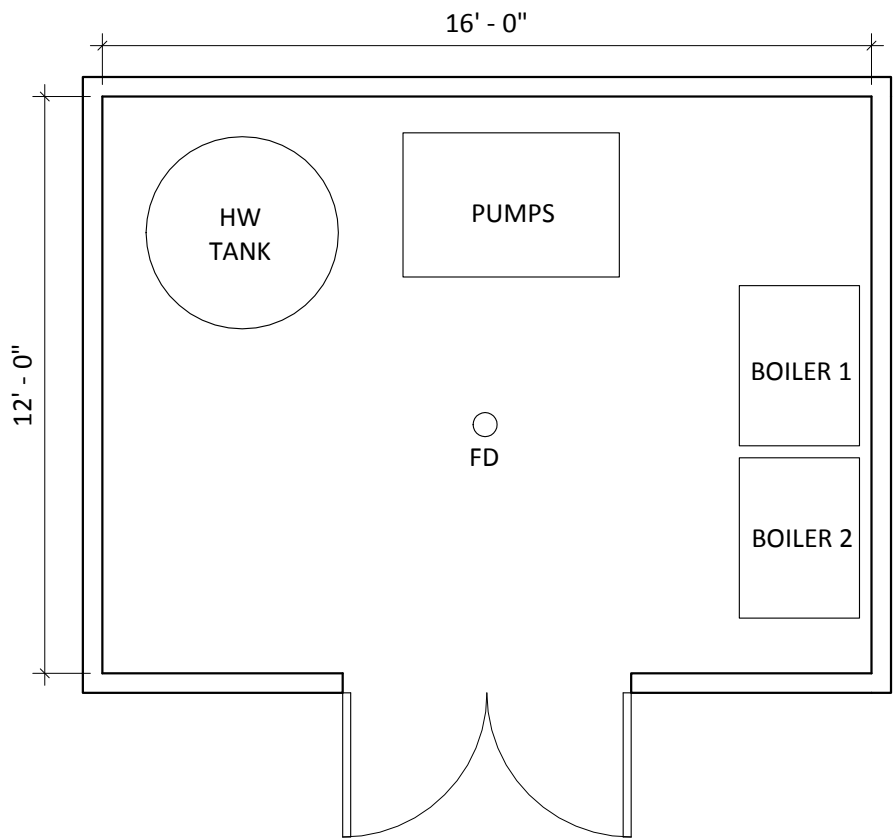


 **ELEVATOR MACHINE ROOM**
1/4" = 1'-0"

FIRE

5.3 CENTRAL BOILER ROOM

Adjacency Requirement	N/A
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	N/A
Floor	Rubber or Linoleum, concrete w/ hardener.
Walls	GWB, painted
Ceiling	None
Lighting / Electrical	LED
HVAC / Plumbing	Exhaust, floor drain
Special Needs	Housekeeping pads below equipment as required by Equipment manufacturer.
Owner supplied Furn. / Equip.	N/A



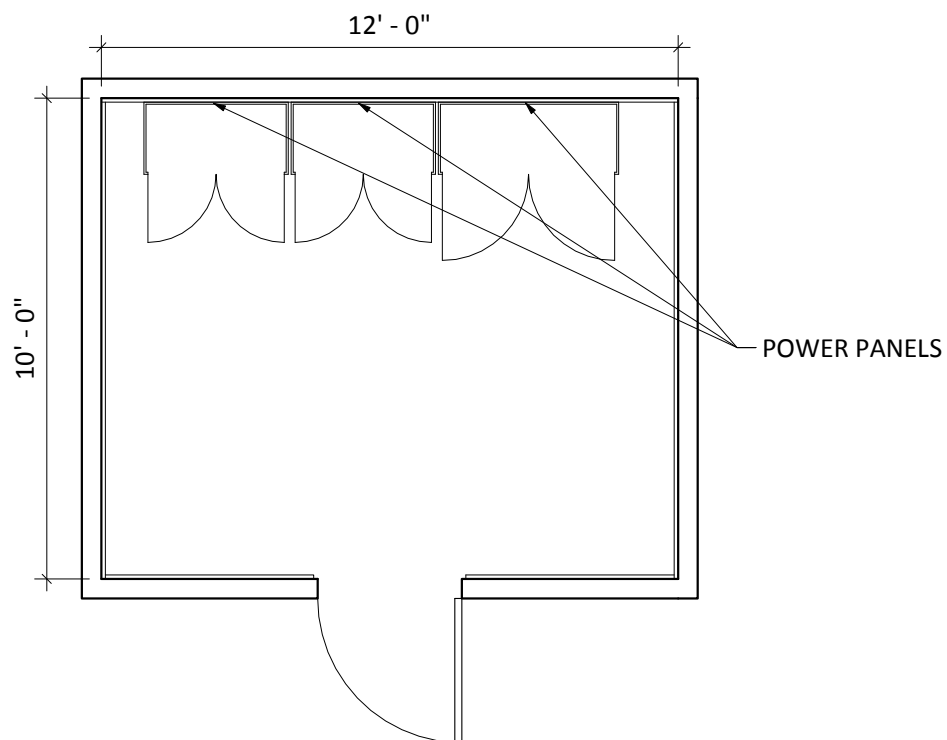
CENTRAL BOILER ROOM

1/4" = 1'-0"

FIRE

5.4 ELECTRICAL ROOM

Adjacency Requirement	None
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	N/A
Floor	Rubber, linoleum or concrete w/ hardener
Walls	GWB, painted w/ F.R. plywood backboards on each wall
Ceiling	ACT
Lighting / Electrical	LED
HVAC / Plumbing	None
Special Needs	None
Owner supplied Furn. / Equip.	N/A

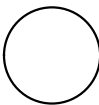
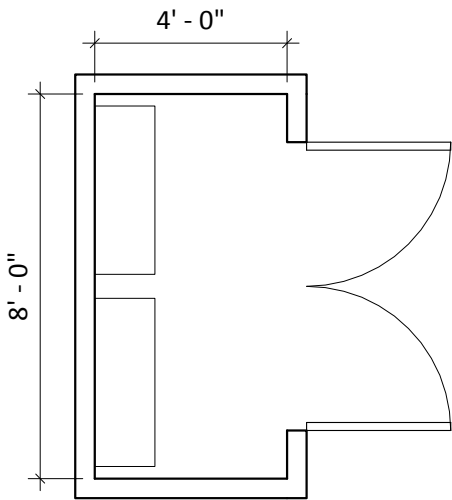


 **ELECTRICAL ROOM**
1/4" = 1'-0"

FIRE

5.5 EMERGENCY GENERATOR TRANSFER SWITCH

Adjacency Requirement	Locate next to Electrical Room
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	N/A
Floor	Concrete w/ hardener
Walls	GWB, painted 3/4" FR plywood panels fixed to walls for mounting of electrical equipment.
Ceiling	Exposed structure, painted
Lighting / Electrical	LED
HVAC / Plumbing	N/A
Special Needs	One hour fire rating..
Owner supplied Furn. / Equip.	N/A



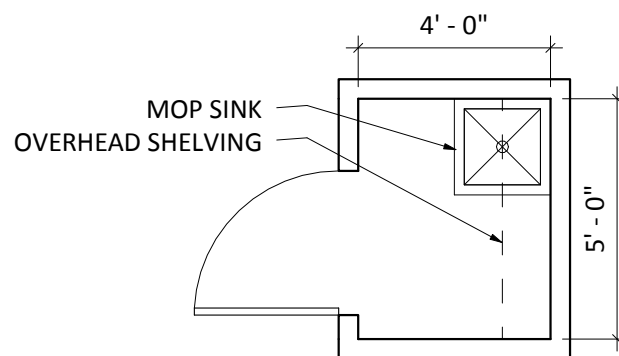
EMERGENCY GENERATOR TRANSFER SWITCH


1/4" = 1'-0"

FIRE

5.6 JANITOR'S CLSOET

Adjacency Requirement	First floor near Aparatus, second floor central.
Public Access	None
Security Requirements	None
Contract Millwork / Equipment	Mop rack & shelf.
Floor	Rubber or linoleum.
Walls	GWB, painted, FRP to 4' high
Ceiling	ACT
Lighting / Electrical	LED
HVAC / Plumbing	Exhaust only, floor sink.
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A

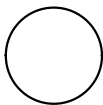
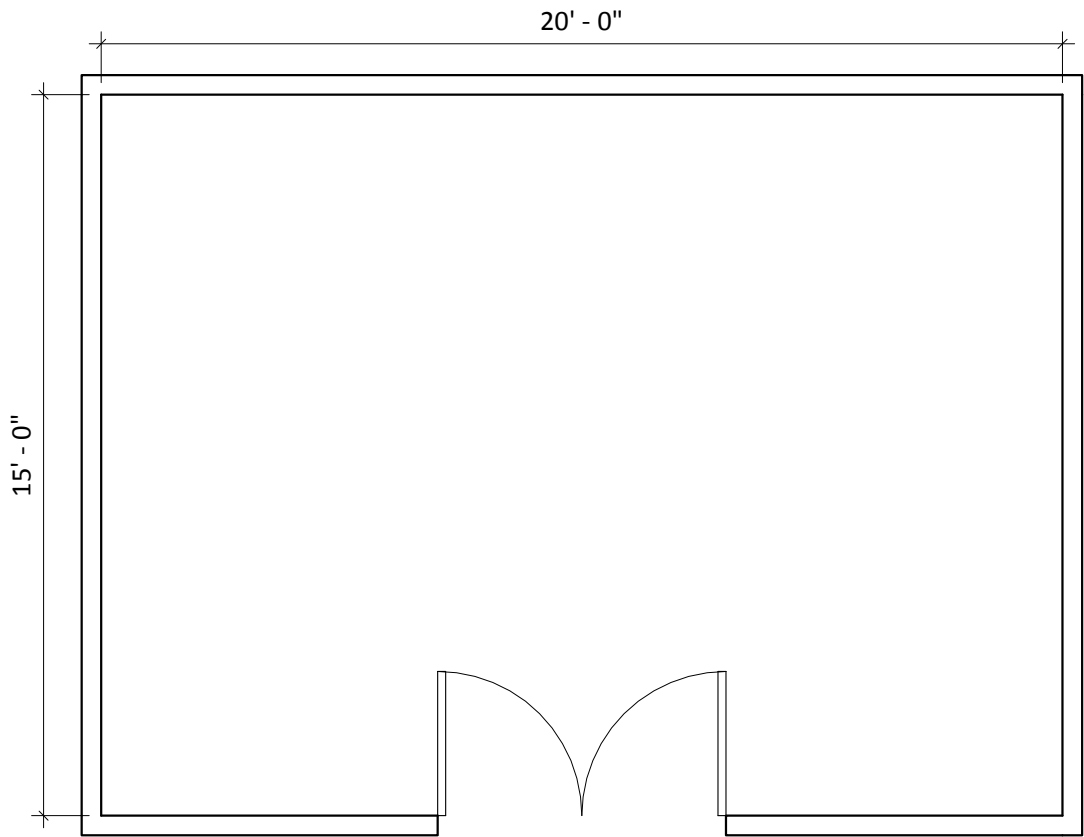


 JANITOR CLOSET
1/4" = 1'-0"

FIRE

5.7 GENERAL STORAGE

Adjacency Requirement	N/A
Public Access	None
Security Requirements	Moderate
Contract Millwork / Equipment	N/A
Floor	Rubber or Linoleum, concrete w/ hardener.
Walls	GWB, painted
Ceiling	None
Lighting / Electrical	LED
HVAC / Plumbing	Exhaust
Special Needs	N/A
Owner supplied Furn. / Equip.	N/A



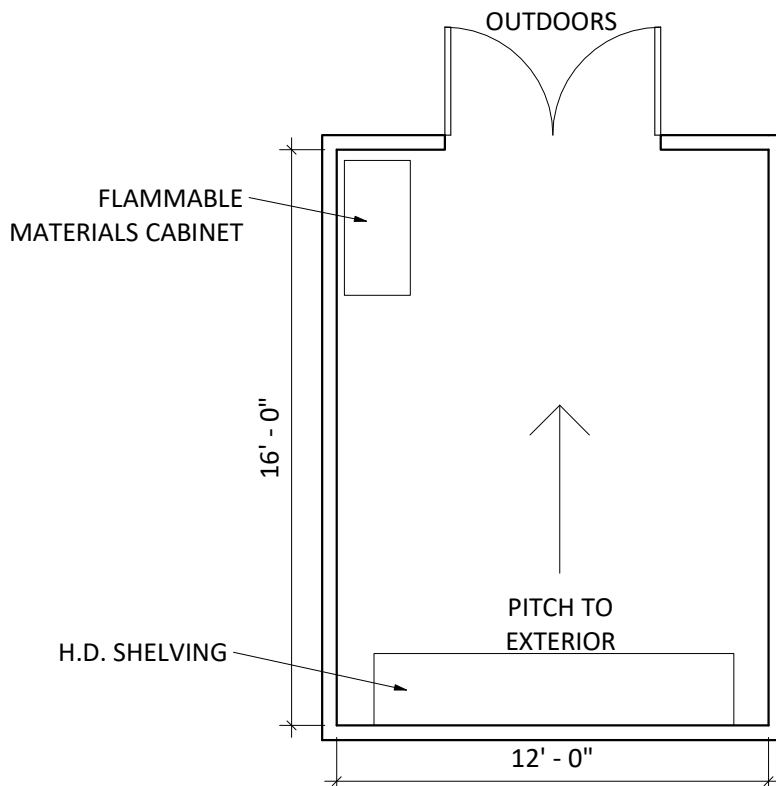
GENERAL STORAGE

1/4" = 1'-0"

FIRE

5.8 BUILDING / GROUNDS EQUIPMENT STORAGE

Adjacency Requirement	Exterior access only
Public Access	None
Security Requirements	Low
Contract Millwork / Equipment	None
Floor	Concrete w/ hardener.
Walls	CMU on GWB W/FRP
Ceiling	None, painted exposed structure
Lighting / Electrical	Utility
HVAC / Plumbing	No A/C, good ventilation; vent for flammables cabinet.
Special Needs	Storage for snow blowers, shovels, leaf blowers, de-icer, B&G equipment. etc.
Owner supplied Furn. / Equip.	Flammable materials cabinet (fluid storage)



BUILDING / GROUNDS EQUIPMENT STORAGE
3/16" = 1'-0"

END OF DOCUMENT

APPENDICES

B. Geo-tech Report



PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

MILLBURY FIRE STATION

MILLBURY, MASSACHUSETTS

MAY 23, 2019

Prepared For:

Context Architecture
68 Harrison Avenue
Boston, MA 02111

2269 Massachusetts Avenue
Cambridge, MA 02140
www.mcphailgeo.com
(617) 868-1420

PROJECT NO. 6775.2.00



May 23, 2019

Context Architecture
68 Harrison Avenue
Boston, MA 02111

Attention: Mr. Zeljko Toncic, AIA, LEED AP

Reference: Proposed Millbury Fire Station; Millbury, Massachusetts
Preliminary Geotechnical Engineering Report

Ladies and Gentlemen:

This report documents our preliminary foundation design study for the proposed Millbury Fire Station to be located at 130 Elm Street in Millbury, Massachusetts.

This letter was prepared in accordance with our proposal dated March 19, 2019, and the subsequent authorization of Context Architecture. These services are subject to the limitations contained in **Appendix A**.

Purpose and Scope

The purpose of our preliminary subsurface exploration program and design study was to assess the subsurface soil, rock and groundwater conditions at the site as they relate to preliminary foundation design, and based on these conditions, to provide safe and economic preliminary foundations design recommendations for the proposed fire station.

Available Information

Information available to McPhail Associates, LLC (McPhail) for use in the preparation of this preliminary report were limited to sketches of the existing conditions and proposed construction provided by the Architect, and printed drawings from the City of Millbury GIS Database maps. It should be noted that these sketches and drawings are not-to-scale.

Based upon information provided to us by the Client, no site survey has yet been performed on the above-referenced site. Therefore, existing site grades were unknown at the time of the preparation of this preliminary report.

Existing Conditions and Proposed Construction

Fronting onto Elm Street to the south, the project site, which is irregularly-shaped and occupies an approximate 85,000 square feet plan area, is bounded by Water Street to the northeast, the intersection of Water Street and Elm Street to the east, residences that fronts onto River Street to the west, and residential properties to the north. The subject site is located about 500 feet to the west of the Millbury Fire Department Headquarters



located at 127 Elm Street. The site is currently occupied by a three-story brick building identified as “McGrath Education Center” surrounded by asphalt-paved parking areas and landscaped areas at the limits of the property. As previously mentioned, existing site grades remain unknown at this time; however, it is understood that the existing grade is at a high point in the middle of the property and slopes slightly downward in all plan directions.

The proposed redevelopment is understood to consist of the demolition of the existing three-story brick building and the construction of a new fire station in the middle of the site. Two (2) building footprint orientations, along the north-south direction (Option 1) or east-west direction (Option 2), are being evaluated. We also understand that the design is still in its preliminary phase and the scheme of the proposed new fire station has yet to be finalized. However, no below-grade space is anticipated to be included as part of the proposed fire station. It is also anticipated that the entry-level floor slab of the proposed fire station will be lowered from the existing grade to provide better access of the fire trucks into the station.

Subsurface Explorations and Conditions

A subsurface exploration program consisting of four (4) borings was conducted at the site on April 19, 2019 by Carr-Dee Corp. of Medford, Massachusetts under contract to McPhail.

The borings were completed utilizing a track-mounted drill-rig and were advanced using 2 ¼-inch I.D. hollow-stem augers and/or HW casing. Standard 1-3/8-inch I.D. split-spoon samples and standard penetration tests were generally obtained at maximum 5-foot intervals of depth in accordance with the standard procedures described in ASTM D1586.

Field locations of the borings were determined by taping from the corners of the existing building indicated on the above-referenced Subsurface Exploration Plan.

A detailed description of the subsurface conditions encountered within the borings is documented on the boring logs contained in **Appendix B**. Approximate locations of the borings are indicated on the enclosed Subsurface Exploration Plans, **Figure 2**.

The following is a description of the generalized subsurface conditions across the site encountered from the ground surface downward.

Borings B-1 and B-2 were performed within the paved parking lot surrounding the existing building to the north and west, respectively, where the surface treatment was observed to consist of a 2-inch thickness of asphalt. Borings B-3 and B-4 were performed in the grassed areas at the northeast and southeast corners of the existing building, respectively, where the surface treatment was observed to consist of a 1-foot thickness of topsoil. The topsoil typically consists of a very loose to compact, dark brown to black, silty sand and gravel.



Directly beneath the asphalt or the topsoil, the borings encountered a fill deposit that extends to depths of approximately 4.5 to 5 feet below the existing ground surface. The fill deposit generally consists of loose to compact, brown to black, silty sand with some gravel varying to sand and gravel with trace silt, with occasional roots, asphalt and brick chips.

Below the fill, the borings encountered a glacial outwash deposit at depths of approximately 4.5 to 5 feet below existing ground surface at the boring locations. The glacial outwash deposit was observed to consist of dense to very dense, brown to gray, silty sand and gravel to sand and gravel with some silt, and some cobbles.

Bedrock was encountered underlying the glacial outwash in boring B-3 at a depth of about 5.8 feet below the existing ground surface. One (1) 5-foot long NX size rock core, RC-1, was obtained from the boring with 80% recovery. The bedrock was observed to be hard to very hard, very slightly to fleshly weathered, slightly to moderately fractured, blended white and gray, fine-grained gneiss, with very close, tight, shallow dipping, smooth to relatively jagged joints, and with thin shallow bedding.

With the exception of boring B-3 which was terminated in the bedrock, the borings were terminated upon roller bit and split-spoon refusals at depths of about 9 to 12.5 feet below existing ground surface, which is likely indicative of cobbles or boulders in the glacial outwash deposit or the underlying bedrock surface.

Groundwater was not encountered in the borings during the subsurface exploration. It is anticipated that future groundwater levels across the project site may vary based on such factors as normal seasonal changes, runoff during or following periods of heavy precipitation, and alterations to existing drainage patterns.

Preliminary Foundation Design Recommendations

Based on the preliminary scope of the proposed construction and the subsurface conditions encountered at the site, for preliminary design purposes it is recommended that foundation support of the proposed fire station consist of a shallow foundation system consisting of footings bearing directly on the glacial outwash deposit, bedrock or on compacted structural fill placed directly over the surface of the undisturbed natural glacial outwash deposit or bedrock following removal of the overlying existing fill and topsoil/loam material.

For preliminary design purposes, it is recommended that the footings be proportioned utilizing a maximum design bearing pressure of three (3) tons per square-foot (tsf). Recommended minimum footing widths for continuous and isolated spread footings are 24 and 36 inches, respectively.

Soil-supported perimeter foundations and soil-supported foundations below unheated areas should be provided with a minimum 4-foot thickness of soil cover as frost protection. Perimeter foundations bearing directly on bedrock should bear a minimum of 2 feet below adjacent exterior grades. Interior footings below heated areas should be located such that



the top of the foundation concrete is a minimum of 6 inches below the underside of the lowest level slab.

The proposed lowest level slab should be designed as conventional slab-on-grade. Preparation of the subgrade for support of the lowest level slab should include the removal of all surface treatments and topsoil/loam from within the footprint of the proposed building.

Depending on the proposed elevation of the lowest level slab, perimeter foundation and underslab drainage systems may be recommended. The proposed development grading plan should be provided to McPhail for review to determine if foundation drainage is required. Recommendations for foundation drainage, if required, would be contained in the Final Foundation Engineering Report (FFER).

Preliminary Foundation Construction Considerations

The preliminary foundation construction considerations that are anticipated to have an impact on the design of the building include the elevation of the proposed lowest level floor slab, preparation of the building pad for support of the footings and slab-on-grade, re-use of excavated on-site soil, and off-site removal of excess excavated soil. Additional foundation construction considerations should be discussed in the FFER.

For preparation of the footing bearing surfaces, all existing site improvements, topsoil/loam and fill should be removed for the placement of structural fill and all soil bearing surfaces should be excavated with a backhoe bucket which has either a smooth, toothless cutting edge or a steel plate welded across the teeth.

Depending on the proposed design bottom of footing and proposed deeper subsurface utility elevations, isolated rock excavation may be required to construct the footings and/or deeper subsurface utilities. It is anticipated that removal of bedrock by mechanical means (i.e. hydraulic hammer) will be feasible and that blasting may not be required for this project, depending on the final grades.

For preparation of the slab-on-grade subgrade soils, the topsoil/loam should be removed and the exposed fill subgrade should be proof-rolled with at least four passes of a double-drum vibratory roller or large vibratory plate compactor.

It is anticipated that portions of the excavated on-site fill material may be re-used on-site as structural fill for support of the proposed building foundations and slab-on-grade. However, laboratory gradation analyses on representative samples of the fill should be performed in order to confirm its re-use on-site as structural fill.

Should excess excavated soil generated from the proposed construction require off-site removal, current Department of Environmental Protection (DEP) policies and regulations for off-site reuse of excess excavated soil require environmental characterization of the excavated soil prior to its off-site reuse. McPhail could perform this as an additional service if required.



Context Architecture
May 23, 2019
Page 5

Final Comments

It is recommended that McPhail be retained to prepare a Final Foundation Engineering Report (FFER) once the details and footprint of the proposed building are finalized. The FFER would provide final foundation recommendations based on the specific project design requirements. Additional subsurface explorations may be required to further delineate the subsurface conditions across the proposed building footprint.

We trust that the above is sufficient for your present requirements. Should you have any questions concerning the recommendations presented herein, please do not hesitate to call us.

Very truly yours,

McPHAIL ASSOCIATES, LLC

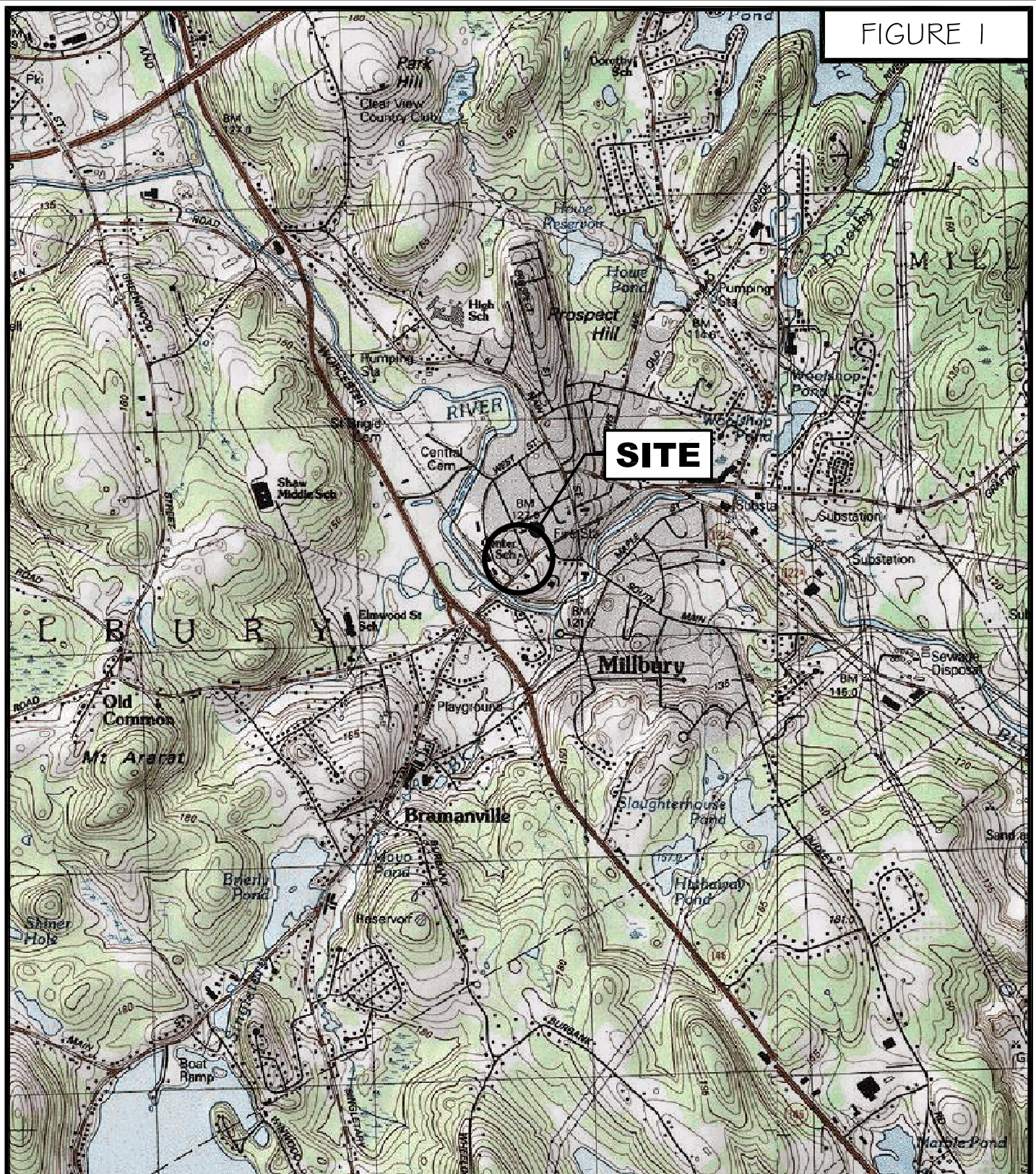
A handwritten signature in blue ink, appearing to read "H. Ghiye", with a stylized flourish extending from the end.

Hassan Ghiye

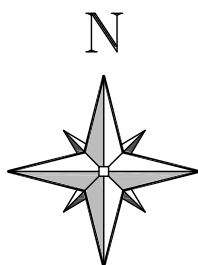
A handwritten signature in blue ink, appearing to read "Chris M. Erikson", written in a cursive style.

Chris M. Erikson, P.E.

FIGURE I



Geotechnical and
Geoenvironmental Engineers
2269 Massachusetts Avenue
Cambridge, MA 02140
617/868-1420
617/868-1423 (Fax)
www.mcphailgeo.com



SCALE 1:25,000

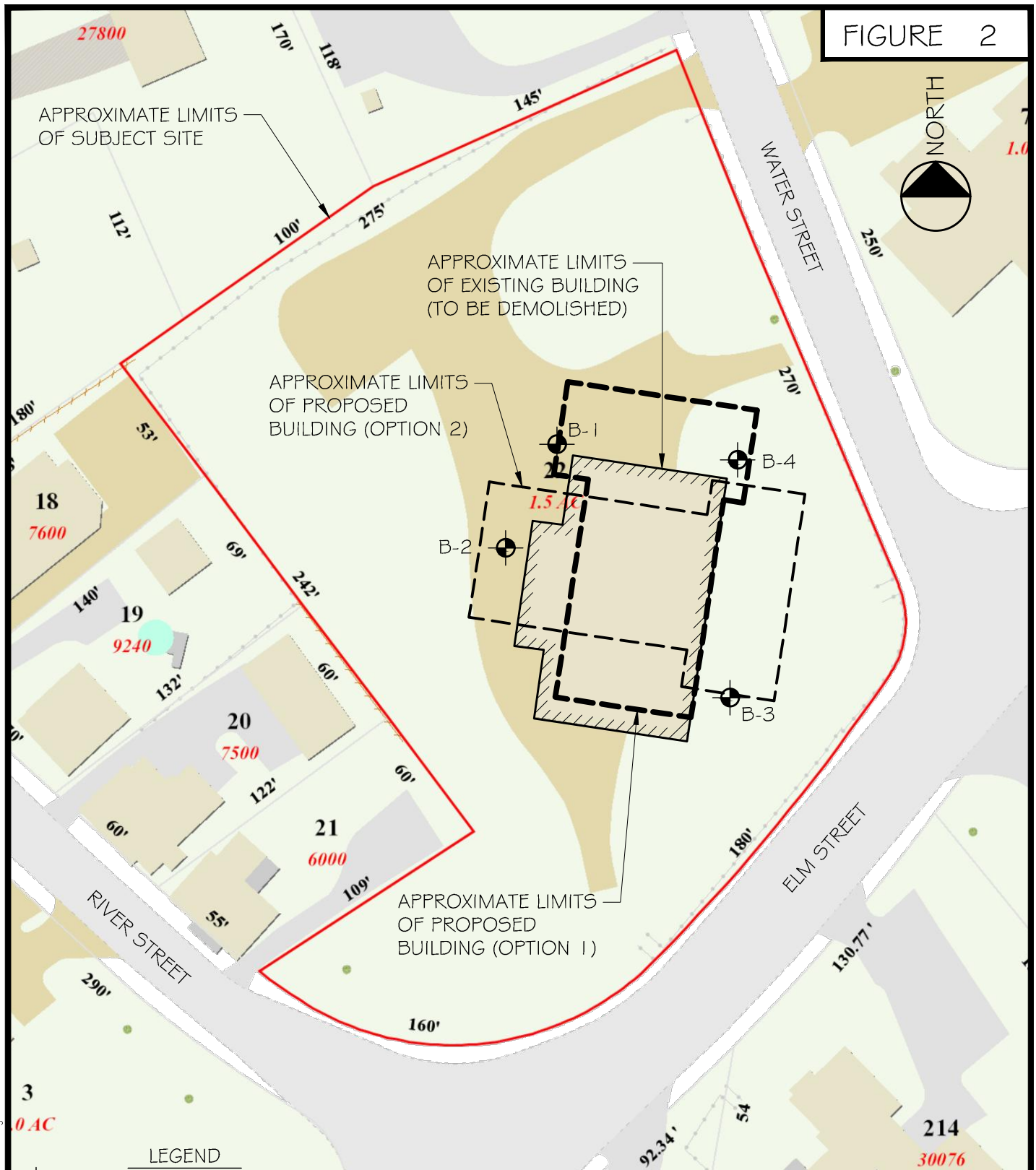
PROJECT LOCATION PLAN

MILLBURY FIRE STATION

MILLBURY

MASSACHUSETTS

FIGURE 2



LEGEND



— APPROXIMATE LOCATION OF BORING PERFORMED BY CARR-DEE CORP. ON APRIL 19, 2019 FOR McPHAIL ASSOCIATES, LLC

REFERENCE: THIS PLAN WAS PREPARED FROM A DRAWING PRINTED FROM THE CITY OF MILLBURY, MA ON MAY 6, 2019



Geotechnical and Geoenvironmental Engineers
2269 Massachusetts Avenue
Cambridge, MA 02140
617/868-1420
617/868-1423 (Fax)
www.mcphailgeo.com

MILLBURY FIRE STATION

MILLBURY

MASSACHUSETTS

SUBSURFACE EXPLORATION PLAN

FOR
CONTEXT ARCHITECTURE

BY
McPHAIL ASSOCIATES, LLC

Date: MAY 2019

Dwn: F.G.P.

Chkd: H.G.

Scale: N.T.S.

Project No:

6775

FILE NAME: N:\Acad\UOB5\6775\6775-F02.dwg



APPENDIX A:

LIMITATIONS



LIMITATIONS

This preliminary report has been prepared on behalf of and for the exclusive use of Context Architecture for specific application to the proposed Millbury Fire Station in Millbury, Massachusetts in accordance with generally accepted soil and geotechnical engineering practices. No other warranty, expressed or implied, is made.

The recommendations contained in this report are for preliminary pricing and design purposes only. Final subsurface exploration program and foundation engineering analyses will be required for the design and construction of the proposed project. In the event that any changes in nature or design of the proposed construction are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and conclusions of this report modified or verified in writing by McPhail Associates, LLC.

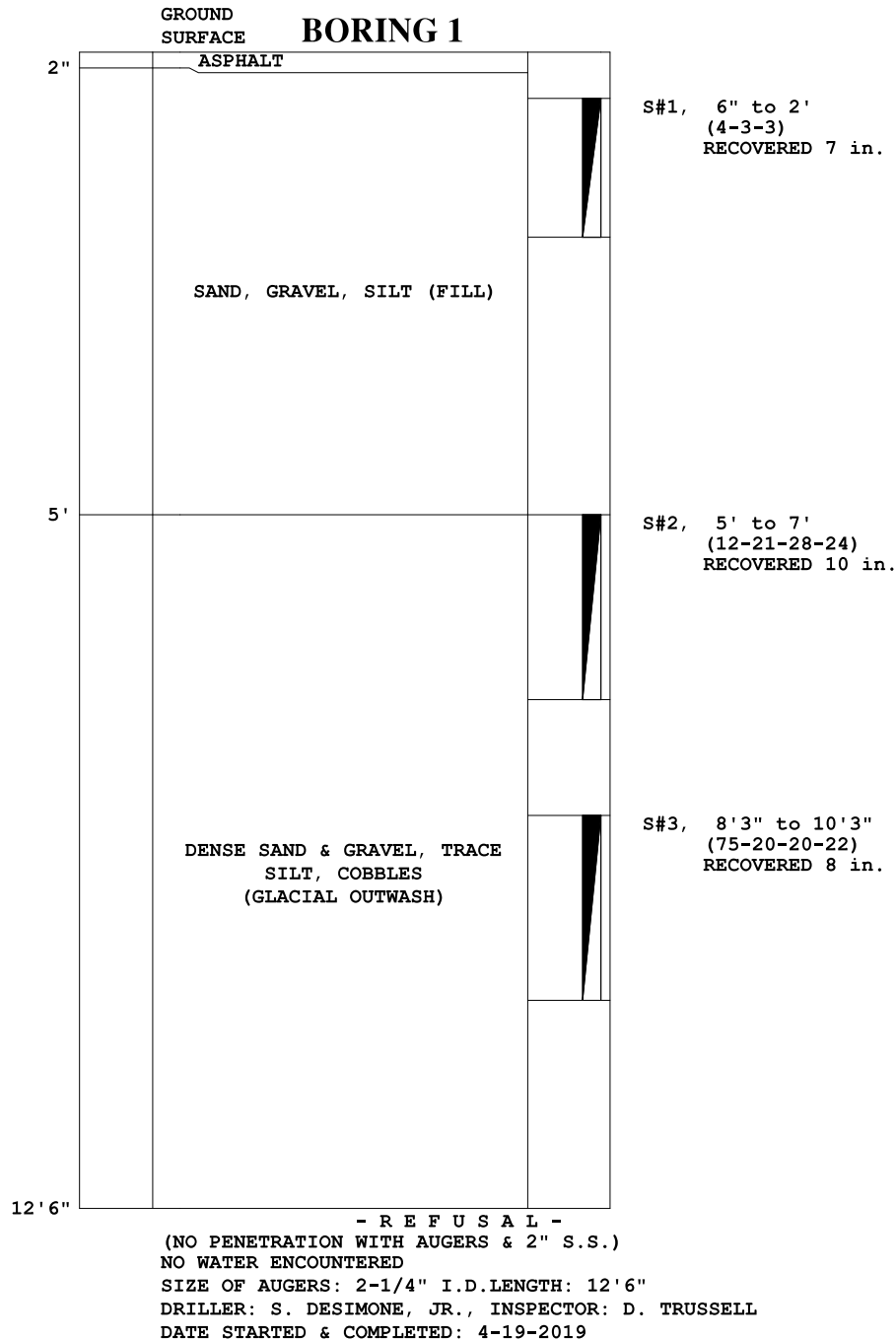
The preliminary analyses and recommendations presented in this report are based upon the data obtained from the subsurface explorations performed at the approximate locations indicated on the enclosed plan. If variations in the nature and extent of subsurface conditions between the widely spaced explorations become evident during the course of construction, it will be necessary for a re-evaluation of the recommendations of this report to be made after performing on-site observations during the construction period and noting the characteristics of any variations.



APPENDIX B:
BORING LOGS PREPARED BY CARR-DEE

CARR-DEE CORP.

37 LINDEN STREET MEDFORD, MA 02155-0001 Telephone (781) 391-4500
 To: MCPHAIL ASSOC., LLC, 2269 MASS. AVE., CAMBRIDGE, MA Date: 4-22-2019 Job No.: 2019-82
 Location: 130 ELM STREET, MILLBURY, MA Scale: 1 in. = 2 ft.



All samples have been visually classified by . Unless otherwise specified, water levels noted were observed at completion of borings, and do not necessarily represent permanent ground water levels. Figures in parenthesis indicate the number of blows required to drive Two-inch Split Sampler 6 inches using 140 lb. weight falling 30 inches(±). Figures in column to left (if noted) indicate number of blows to drive casing one foot, using 300 lb. weight falling 24 inches (±).

CARR-DEE CORP.

37 LINDEN STREET

MEDFORD, MA 02155-0001

Telephone (781) 391-4500

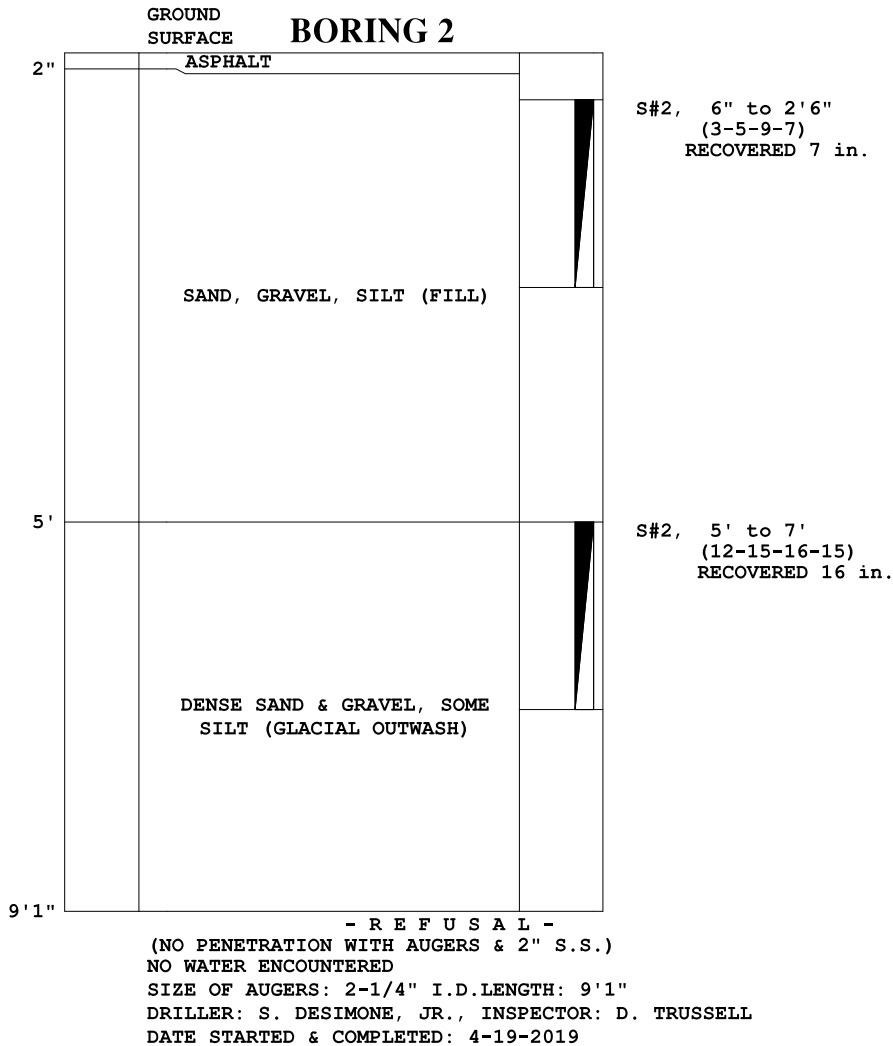
To: MCPHAIL ASSOC., LLC, 2269 MASS. AVE., CAMBRIDGE, MA

Date: 4-22-2019

Job No.: 2019-82

Location: 130 ELM STREET, MILLBURY, MA

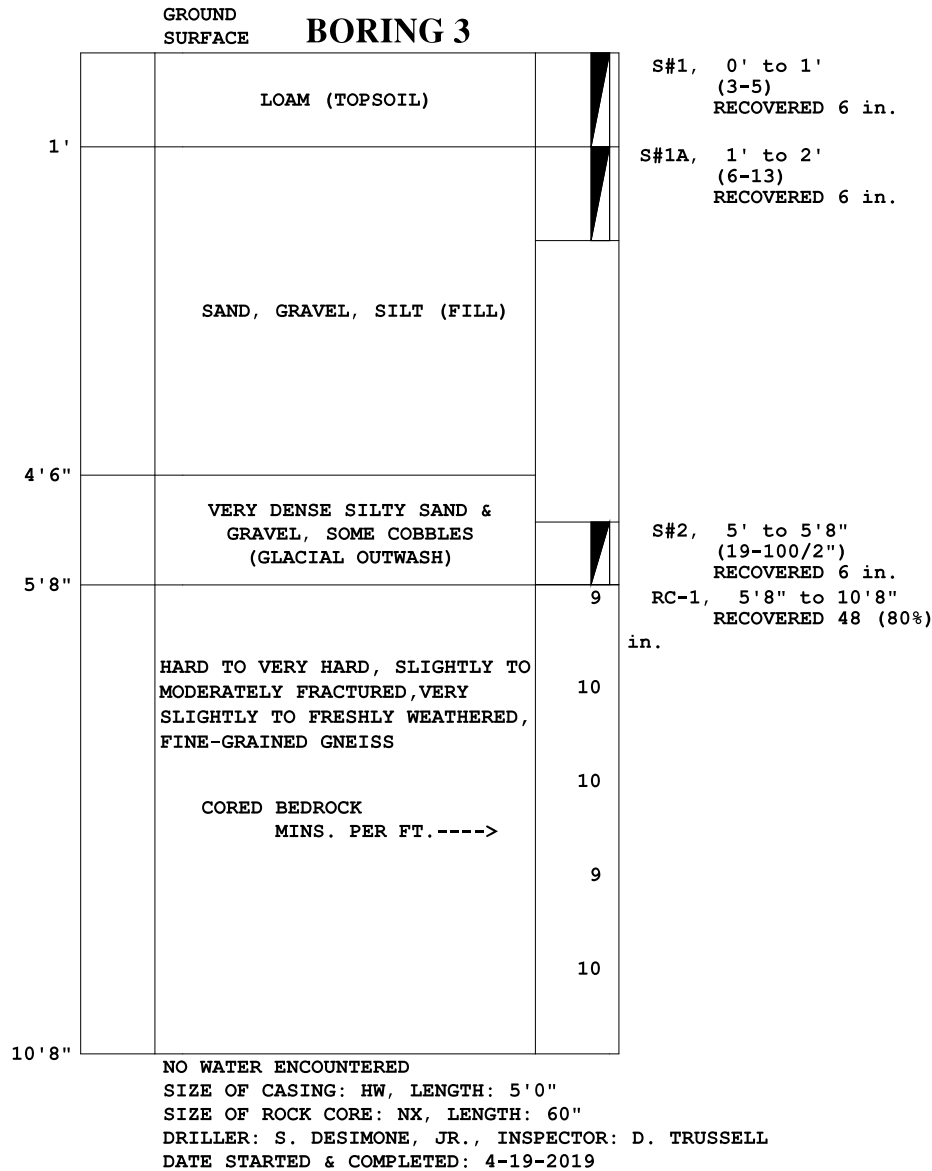
Scale: 1 in. = 2 ft.



All samples have been visually classified by . Unless otherwise specified, water levels noted were observed at completion of borings, and do not necessarily represent permanent ground water levels. Figures in parenthesis indicate the number of blows required to drive Two-inch Split Sampler 6 inches using 140 lb. weight falling 30 inches(±). Figures in column to left (if noted) indicate number of blows to drive casing one foot, using 300 lb. weight falling 24 inches (±).

CARR-DEE CORP.

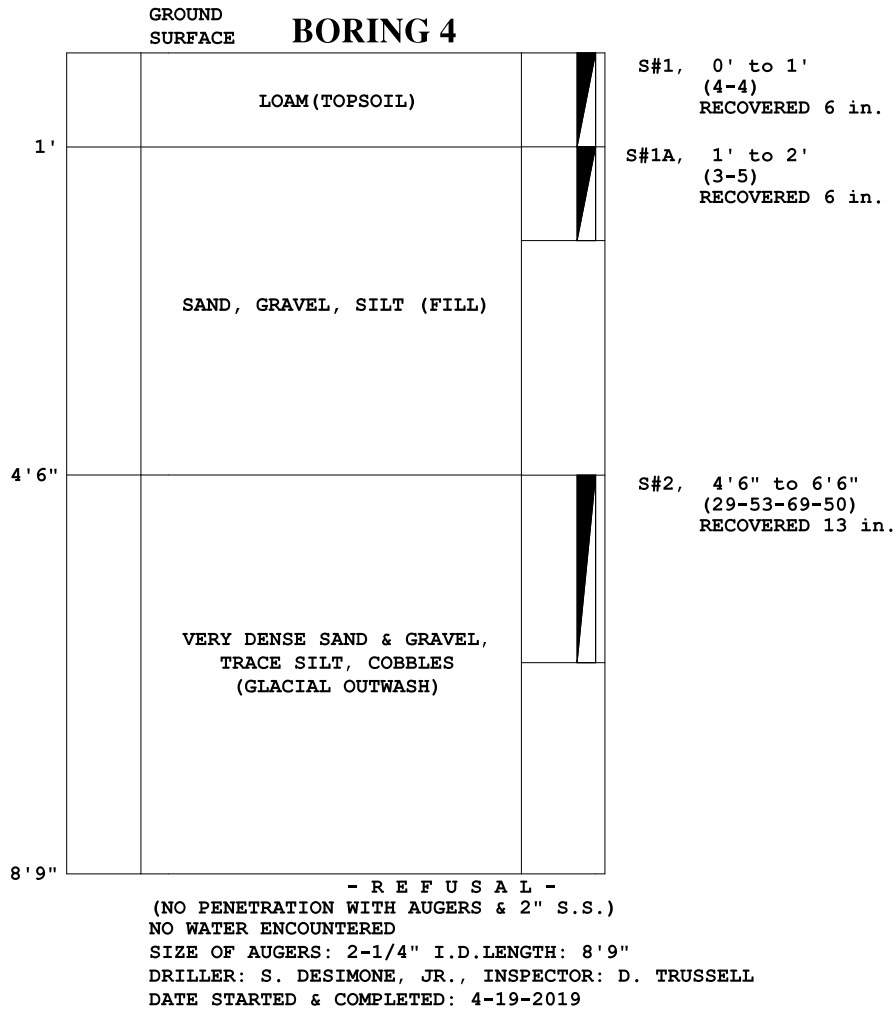
37 LINDEN STREET MEDFORD, MA 02155-0001 Telephone (781) 391-4500
 To: MCPHAIL ASSOC., LLC, 2269 MASS. AVE., CAMBRIDGE, MA Date: 4-22-2019 Job No.: 2019-82
 Location: 130 ELM STREET, MILLBURY, MA Scale: 1 in. = 2 ft.



All samples have been visually classified by . Unless otherwise specified, water levels noted were observed at completion of borings, and do not necessarily represent permanent ground water levels. Figures in parenthesis indicate the number of blows required to drive Two-inch Split Sampler 6 inches using 140 lb. weight falling 30 inches(±). Figures in column to left (if noted) indicate number of blows to drive casing one foot, using 300 lb. weight falling 24 inches (±).

CARR-DEE CORP.

37 LINDEN STREET MEDFORD, MA 02155-0001 Telephone (781) 391-4500
 To: MCPHAIL ASSOC., LLC, 2269 MASS. AVE., CAMBRIDGE, MA Date: 4-22-2019 Job No.: 2019-82
 Location: 130 ELM STREET, MILLBURY, MA Scale: 1 in. = 2 ft.



All samples have been visually classified by . Unless otherwise specified, water levels noted were observed at completion of borings, and do not necessarily represent permanent ground water levels. Figures in parenthesis indicate the number of blows required to drive Two-inch Split Sampler 6 inches using 140 lb. weight falling 30 inches(±). Figures in column to left (if noted) indicate number of blows to drive casing one foot, using 300 lb. weight falling 24 inches (±).

APPENDICES

C. HAZMAT INSPECTION REPORT



April 1, 2019

Context Architecture
68 Harrison Avenue
Boston, Massachusetts 02111

RE: FLI Project #: 19-1311
Inspection for Asbestos Containing Materials at
130 Elm Street
Milbury, Massachusetts

Dear Mr. Tonic,

FLI Environmental, Inc. performed an inspection for asbestos containing materials (ACMs) at the property located at the address noted above. This report outlines the initial visual survey, sample collection and summary of analytical results provided by FLI.

Inspection Summary:

A handwritten signature in blue ink, appearing to read "Jody Freitas", is positioned above a horizontal line.

Asbestos Inspector:	Jody Freitas
License #:	AI900238
Date of Inspection:	March 7, 2019
Total Materials Sampled:	28
Samples Analyzed At:	Asbestos Identification Laboratory, Inc.
NIST/NVLAP Certification#:	200919-0
MassDLS Lab Certification#:	AA000208

Scope and Approach:

FLI provided a state licensed and EPA AHERA accredited asbestos inspector to perform an inspection of the subject area(s). The purpose of the inspection was to identify and sample building materials suspected to contain asbestos. Suspect materials include thermal system insulation, fireproofing, soundproofing, plasters, skimcoating, spray-applied or trowel applied finishes, ceiling & floor tiles, sheet flooring, caulking, glazing, mastics, adhesives, cement board products, roofing materials and numerous other products. Materials having the same function/application, similar color, texture or other observed similar characteristics were grouped together and sampled as one homogeneous material. A minimum of 2 samples of each homogenous material were collected.

Homogeneous materials determined to be non-suspect by the inspector (if observed), include concrete floors, wood flooring/joists, concrete block, black/brown vinyl flexible duct connectors, fiberglass insulation, armaflex (neoprene) insulation, rubber, plastic, ceramic tile, glass and metal.

If present, areas within walls, drywall encased columns and above ceilings were inspected where possible in accessible representative locations. However, each individual enclosed area was not inspected. Accessible areas beneath such surfaces were examined and sampled, and material quantities were estimated based on these observations.

Bulk Sampling:

Bulk samples were collected in a random manner and submitted via chain of custody to the analytical laboratory. The samples were analyzed by Polarized Light Microscopy per EPA Method 600/R-93-116, July 1993. The detection limit of the EPA recommended method is one percent asbestos by weight. Materials containing greater than one percent asbestos are treated as asbestos-containing as required by the EPA. The laboratory is accredited by the National Institute of Standards and Technologies NIST/NVLAP Program and licensed by the Massachusetts Department of Labor Standards (DLS) for asbestos analysis in bulk materials.

Asbestos Containing Materials:

Any homogeneous material having at least one (1) sample analyzed to contain greater than one percent (1%) asbestos is categorized as an asbestos containing material. Any material analyzed to contain any asbestos fibers identified is categorized as an asbestos containing waste material. A summary of materials determined to contain asbestos is provided in Appendix A including approximate location(s) of the material and estimated quantities. Laboratory Analytical Data Sheets for each sample analyzed are included in Appendix C.

Non-Asbestos Containing Materials:

Homogeneous materials where each sample analyzed was determined not to contain asbestos are categorized as non-asbestos. A summary of non-asbestos materials is provided in Appendix B. Laboratory Analytical Data Sheets for each sample analyzed are included in Appendix C.

Remarks and Limitations:

1. Additional suspect materials may be present beneath surfaces (multiple layers) or within chases or crawlspace areas that were unknown or inaccessible at the time of the inspection but may be discovered during demolition, renovation or maintenance activities. Any additional suspect materials not identified in this report that become exposed during building renovation, maintenance or demolition should be sampled and analyzed for asbestos content prior to disturbing.

2. Each identified asbestos containing material must be removed by a licensed asbestos abatement contractor prior to being disturbed by building maintenance, renovation or demolition activities.
3. This report is not meant to be used as an asbestos abatement plan or abatement specification. Material quantities and locations are estimates and approximations and should not be used to obtain pricing from contractors. FLI recommends contracting for abatement after an abatement specification is prepared by a licensed Asbestos Project Designer.
4. Exterior window and roofing materials were not sampled during the survey due to inaccessability. These materials should be sampled and analyzed prior to demilition to determine wether or not they are asbestos containing.

Should you have any questions or need additional information, please contact our office at (781) 251-0040. Thank you for the opportunity to provide you with our services and we look forward to working together in the future.

APPENDIX A

Asbestos Containing Materials Summary Table			
Material	Location	Estimated Quantity	Sample # ('s)
Boiler Insulation	Boiler Room	1 EA	22 A,B,C
Pipe Insulation	Boiler Room	400 LF	23 A,B,C

APPENDIX B

Suspect Materials Found Not to Contain Asbestos				
Sample # ('s)	Material	Sample Location A	Sample Location B	Sample Location C
01 A,B,C	Leveller	Basement	Basement	Basement
02 A,B,C	Carpet Mastic	Basement	Basement	Basement
03 A,B,C	Light Grey Covebase	Basement	Basement	Basement
04 A,B,C	Adhesive with Light Grey Covebase	Basement	Basement	Basement
05 A,B,C	Ceramic Tile Grout	Kitchen	Kitchen	Kitchen
06 A,B,C	Ceramic Tile Adhesive	Kitchen	Kitchen	Kitchen
07 A,B,C	Plaster Base	1st Floor	1st Floor	2nd Floor
08 A,B,C	Plaster Skim	1st Floor	1st Floor	2nd Floor
09 A,B,C	Ceramic Tile Grout	Basement Bath	Basement Bath	1st Floor Bath
10 A,B,C	Ceramic Tile Adhesive	Basement Bath	Basement Bath	1st Floor Bath
11 A,B,C	Adhesive beneath Blackboard Frame	2nd Floor	2nd Floor	2nd Floor
12 A,B,C	Blackboard	1st Floor	1st Floor	2nd Floor
13 A,B,C	Gypsum	2nd Floor	1st Floor	Basement
14 A,B,C	Joint Compound	2nd Floor	1st Floor	Basement
15 A,B,C	Grey Covebase	Basement	Basement	Basement
16 A,B,C	Adhesive with Grey Covebase	Basement	Basement	Basement
17 A,B,C	Black Floor Tile	Basement	Basement	Basement
18 A,B,C	Mastic with Black Floor Tile	Basement	Basement	Basement
19 A,B,C	2' x 4' Fissured Ceiling Tile	Basement	Basement	Basement

APPENDIX B

Suspect Materials Found Not to Contain Asbestos				
Sample # ('s)	Material	Sample Location A	Sample Location B	Sample Location C
20 A,B,C	Mauve Covebase	Basement	Basement	Basement
21 A,B,C	Adhesive with Mauve Covebase	Basement	Basement	Basement
24 A,B,C	Tan Covebase	Boiler Room	Boiler Room	Boiler Room
25 A,B,C	Adhesive with Tan Covebase	1st Floor	1st Floor	1st Floor
26 A,B,C	2' x 4' Grooved Ceiling Tile	2nd Floor	1st Floor	1st Floor
27 A,B,C	Light Grey Covebase	1st Floor	1st Floor	1st Floor
28 A,B,C	Adhesive with Light Grey Covebase	1st Floor	1st Floor	1st Floor

APPENDIX C

BULK SAMPLE LABORATORY DATA SHEETS



Asbestos Identification Laboratory

165 New Boston St., Ste 227

Woburn, MA 01801

781-932-9600

Web: www.asbestosidentificationlab.com

Email: mikemanning@asbestosidentificationlab.com

Batch:

40786



Lab Code: 200919-0

March 18, 2019

Jody Freitas
FLI Environmental
69 Bridge Street
Dedham, MA 02026

Project Number: 19-1311

Project Name: 130 Elm Street, Milbury, MA

Date Sampled: 2019-03-07

Work Received: 2019-03-13

Work Analyzed: 2019-03-15

Analysis Method: BULK PLM ANALYSIS EPA/600/R-93/116

Dear Jody Freitas,

Asbestos Identification Laboratory has completed the analysis of the samples from your office for the above referenced project .

The information and analysis contained in this report have been generated using the EPA /600/R-93/116 Method for the Determination of Asbestos in Bulk Building Materials. Materials or products that contain more than 1% of any kind or combination of asbestos are considered an asbestos containing building material as determined by the EPA. This Polarized Light Microscope (PLM) technique may be performed either by visual estimation or point counting. Point counting provides a determination of the area percentage of asbestos in a sample. If the asbestos is estimated to be less than 10% by visual estimation of friable material, the determination may be repeated using the point counting technique. The results of the point counting supersede visual PLM results. Results in this report only relate to the items tested. This report may not be used by the customer to claim product endorsement by NVLAP or any other U.S. Government Agency.

Laboratory results represent the analysis of samples as submitted by the customer. Information regarding sample location, description, area, volume, etc., was provided by the customer. Asbestos Identification Laboratory is not responsible for sample collection activities or analytical method limitations. Unless notified in writing to return samples, Asbestos Identification Laboratory discards customer samples after 30 days. Samples containing subsamples or layers will be analyzed separately when applicable. Reports are kept at Asbestos Identification Laboratory for three years. This report shall not be reproduced, except in full, without the written consent of Asbestos Identification Laboratory.

- NVLAP Lab Code: 200919-0
- Massachusetts Certification License: AA000208
- State of Connecticut, Department of Public Health Approved Environmental Laboratory Registration Number: PH-0142
- State of Maine, Department of Environmental Protection Asbestos Analytical Laboratory License Number: LB-0078(Bulk) LA-0087(Air)
- State of Rhode Island and Providence Plantations. Department of Health Certification: AAL-121
- State of Vermont, Department of Health Environmental Health License AL934461

Thank you Jody Freitas for your business.

Michael Manning
Owner/Director

March 18, 2019

Jody Freitas
FLI Environmental
69 Bridge Street
Dedham, MA 02026

Project Number: 19-1311

Project Name: 130 Elm Street, Milbury, MA

Date Sampled: 2019-03-07

Work Received: 2019-03-13

Work Analyzed: 2019-03-15

Analysis Method: BULK PLM ANALYSIS EPA/600/R-93/116

FieldID	Material	Location	Color	Non-Asbestos %	Asbestos %
LabID					
01A	Leveller	Basement	white	Non-Fibrous 100	None Detected
451975					
01B	Leveller	Basement	white	Non-Fibrous 100	None Detected
451976					
01C	Leveller	Basement	white	Non-Fibrous 100	None Detected
451977					
02A	Carpet Mawtic	Basement	yellow	Non-Fibrous 100	None Detected
451978					
02B	Carpet Mawtic	Basement	yellow	Non-Fibrous 100	None Detected
451979					
02C	Carpet Mawtic	Basement	yellow	Non-Fibrous 100	None Detected
451980					
03A	Light Grey Covebase	Basement	gray	Non-Fibrous 100	None Detected
451981					
03B	Light Grey Covebase	Basement	gray	Non-Fibrous 100	None Detected
451982					
03C	Light Grey Covebase	Basement	gray	Non-Fibrous 100	None Detected
451983					
04A	Adhesive with Light Grey Covebase	Basement	tan	Non-Fibrous 100	None Detected
451984					
04B	Adhesive with Light Grey Covebase	Basement	tan	Non-Fibrous 100	None Detected
451985					
04C	Adhesive with Light Grey Covebase	Basement	tan	Non-Fibrous 100	None Detected
451986					
05A	Ceramic Tile Grout	Kitchen	gray	Cellulose 2	None Detected
451987				Non-Fibrous 98	
05B	Ceramic Tile Grout	Kitchen	gray	Cellulose 2	None Detected
451988				Non-Fibrous 98	

FieldID	Material	Location	Color	Non-Asbestos %	Asbestos %
LabID					
05C	Ceramic Tile Grout	Kitchen	gray	Non-Fibrous 100	None Detected
451989					
06A	Ceramic Tile Adhesive	Kitchen	gray	Non-Fibrous 100	None Detected
451990					
06B	Ceramic Tile Adhesive	Kitchen	gray	Non-Fibrous 100	None Detected
451991					
06C	Ceramic Tile Adhesive	Kitchen	gray	Non-Fibrous 100	None Detected
451992					
07A	Plaster Base	1st Floor	multi	Hair 2	None Detected
451993				Non-Fibrous 98	
07B	Plaster Base	1st Floor	multi	Hair 2	None Detected
451994				Non-Fibrous 98	
07C	Plaster Base	2nd Floor	multi	Non-Fibrous 100	None Detected
451995					
08A	Plaster Skim	1st Floor	white	Non-Fibrous 100	None Detected
451996					
08B	Plaster Skim	1st Floor	white	Non-Fibrous 100	None Detected
451997					
08C	Plaster Skim	2nd Floor	white	Non-Fibrous 100	None Detected
451998					
09A	Ceramic Tile Grout	Basement Bath	gray	Non-Fibrous 100	None Detected
451999					
09B	Ceramic Tile Grout	Basement Bath	gray	Non-Fibrous 100	None Detected
452000					
09C	Ceramic Tile Grout	1st Floor Bath	gray	Non-Fibrous 100	None Detected
452001					
10A	Ceramic Tile Adhesive	Basement Bath	tan	Cellulose 2	None Detected
452002				Non-Fibrous 98	
10B	Ceramic Tile Adhesive	Basement Bath	tan	Cellulose 2	None Detected
452003				Non-Fibrous 98	
10C	Ceramic Tile Adhesive	1st Floor Bath	tan	Cellulose 2	None Detected
452004				Non-Fibrous 98	
11A	Adhesive Beneath Blackboard Frame	2nd Floor	tan	Cellulose 2	None Detected
452005				Non-Fibrous 98	
11B	Adhesive Beneath Blackboard Frame	2nd Floor	tan	Cellulose 2	None Detected
452006				Non-Fibrous 98	

FieldID	Material	Location	Color	Non-Asbestos %	Asbestos %
LabID					
11C	Adhesive Beneath Blackboard Frame	2nd Floor	tan	Cellulose 2 Non-Fibrous 98	None Detected
452007					
12A	Blackboard	1st Floor	black	Non-Fibrous 100	None Detected
452008					
12B	Blackboard	1st Floor	black	Non-Fibrous 100	None Detected
452009					
12C	Blackboard	2nd Floor	black	Non-Fibrous 100	None Detected
452010					
13A	Gypsum	2nd Floor	multi	Cellulose 20 Non-Fibrous 80	None Detected
452011					
13B	Gypsum	1st Floor	multi	Cellulose 20 Non-Fibrous 80	None Detected
452012					
13C	Gypsum	Basement	multi	Cellulose 25 Non-Fibrous 75	None Detected
452013					
14A	Joint Compound	2nd Floor	white	Non-Fibrous 100	None Detected
452014					
14B	Joint Compound	1st Floor	white	Non-Fibrous 100	None Detected
452015					
14C	Joint Compound	Basement	white	Non-Fibrous 100	None Detected
452016					
15A	Grey Covebase	Basement	gray	Non-Fibrous 100	None Detected
452017					
15B	Grey Covebase	Basement	gray	Non-Fibrous 100	None Detected
452018					
15C	Grey Covebase	Basement	gray	Non-Fibrous 100	None Detected
452019					
16A	Adhesive with Grey Covebase	Basement	tan	Non-Fibrous 100	None Detected
452020					
16B	Adhesive with Grey Covebase	Basement	tan	Non-Fibrous 100	None Detected
452021					
16C	Adhesive with Grey Covebase	Basement	tan	Non-Fibrous 100	None Detected
452022					
17A	Black Floor Tile	Basement	black	Non-Fibrous 100	None Detected
452023					
17B	Black Floor Tile	Basement	black	Non-Fibrous 100	None Detected
452024					

FieldID	Material	Location	Color	Non-Asbestos %	Asbestos %
LabID					
17C	Black Floor Tile	Basement	black	Non-Fibrous 100	None Detected
452025					
18A	Mastic with Black Floor Tile	Basement	black	Cellulose 3 Non-Fibrous 97	None Detected
452026					
18B	Mastic with Black Floor Tile	Basement	black	Cellulose 2 Non-Fibrous 98	None Detected
452027					
18C	Mastic with Black Floor Tile	Basement	black	Cellulose 2 Non-Fibrous 98	None Detected
452028					
19A	2'x4' Fissured Ceiling Tile	Basement	gray	Mineral Wool 30 Cellulose 60 Non-Fibrous 10	None Detected
452029					
19B	2'x4' Fissured Ceiling Tile	Basement	gray	Mineral Wool 30 Cellulose 60 Non-Fibrous 10	None Detected
452030					
19C	2'x4' Fissured Ceiling Tile	Basement	gray	Mineral Wool 30 Cellulose 60 Non-Fibrous 10	None Detected
452031					
20A	Mauve Covebase	Basement	purple	Non-Fibrous 100	None Detected
452032					
20B	Mauve Covebase	Basement	purple	Non-Fibrous 100	None Detected
452033					
20C	Mauve Covebase	Basement	purple	Non-Fibrous 100	None Detected
452034					
21A	Adhesive with Mauve Covebase	Basement	tan	Non-Fibrous 100	None Detected
452035					
21B	Adhesive with Mauve Covebase	Basement	tan	Non-Fibrous 100	None Detected
452036					
21C	Adhesive with Mauve Covebase	Basement	tan	Non-Fibrous 100	None Detected
452037					
22A	Boiler Insulation	Boiler Room	multi	Fiberglass 30 Non-Fibrous 20	Detected Chrysotile 50
452038					
22B	Boiler Insulation	Boiler Room	multi	Fiberglass 30 Non-Fibrous 20	Detected Chrysotile 50
452039					
22C	Boiler Insulation	Boiler Room	multi	Fiberglass 30 Non-Fibrous 20	Detected Chrysotile 50
452040					
23A	Pipe Insulation	Boiler Room	multi	Cellulose 40 Non-Fibrous 10	Detected Chrysotile 50
452041					
23B	Pipe Insulation	Boiler Room	multi	Cellulose 40 Non-Fibrous 10	Detected Chrysotile 50
452042					

FieldID	Material	Location	Color	Non-Asbestos %	Asbestos %
LabID					
23C	Pipe Insulation	Boiler Room	multi	Cellulose 50	Detected Chrysotile 40
452043				Non-Fibrous 10	
24A	Tan Covebase	Boiler Room	tan	Non-Fibrous 100	None Detected
452044					
24B	Tan Covebase	Boiler Room	tan	Non-Fibrous 100	None Detected
452045					
24C	Tan Covebase	Boiler Room	tan	Non-Fibrous 100	None Detected
452046					
25A	Adhesive with Tan Covebase	1st Floor	tan	Non-Fibrous 100	None Detected
452047					
25B	Adhesive with Tan Covebase	1st Floor	tan	Non-Fibrous 100	None Detected
452048					
25C	Adhesive with Tan Covebase	1st Floor	tan	Non-Fibrous 100	None Detected
452049					
26A	2'x4' Grooved Ceiling Tile	2nd Floor	gray	Mineral Wool 30	None Detected
452050				Cellulose 60 Non-Fibrous 10	
26B	2'x4' Grooved Ceiling Tile	1st Floor	gray	Mineral Wool 30	None Detected
452051				Cellulose 60 Non-Fibrous 10	
26C	2'x4' Grooved Ceiling Tile	1st Floor	gray	Mineral Wool 30	None Detected
452052				Cellulose 60 Non-Fibrous 10	
27A	Light Grey Covebase	1st Floor	tan	Non-Fibrous 100	None Detected
452053					
27B	Light Grey Covebase	1st Floor	tan	Non-Fibrous 100	None Detected
452054					
27C	Light Grey Covebase	1st Floor	tan	Non-Fibrous 100	None Detected
452055					
28A	Adhesive with Light Grey Covebase	1st Floor	yellow	Non-Fibrous 100	None Detected
452056					
28B	Adhesive with Light Grey Covebase	1st Floor	yellow	Non-Fibrous 100	None Detected
452057					
28C	Adhesive with Light Grey Covebase	1st Floor	yellow	Non-Fibrous 100	None Detected
452058					

Monday 18 March

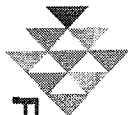
Analyzed by:

Erik Longas

End of Report

Batch: 40786

Page 5 of 5



FLI Environmental

69 Bridge Street • Dedham • MA • 02026 (781) 251-0040 fax (781) 251-0901

ASBESTOS BULK SAMPLE CHAIN OF CUSTODY RECORD

FLI Project #: 19-1311

Client: Context Architecture

Date: 3/7/2019

Site: 130 Elm Street

Sampled by: Jody Freitas

Milbury, Massachusetts

License #: A1900238

Sample # (s)	Material	Location A	Location B	Location C	Asbestos Analysis			Positive (y/n)
					PLM	TEM	Point Count	
01 A,B,C	Leveler	Basement	Basement	Basement	x			
02 A,B,C	Carpet Mastic	Basement	Basement	Basement	x			
03 A,B,C	Light Grey Covebase	Basement	Basement	Basement	x			
04 A,B,C	Adhesive with Light Grey Covebase	Basement	Basement	Basement	x			
05 A,B,C	Ceramic Tile Grout	Kitchen	Kitchen	Kitchen	x			
06 A,B,C	Ceramic Tile Adhesive	Kitchen	Kitchen	Kitchen	x			
07 A,B,C	Plaster Base	1st Floor	1st Floor	2nd Floor	x			
08 A,B,C	Plaster Skim	1st Floor	1st Floor	2nd Floor	x			
09 A,B,C	Ceramic Tile Grout	Basement Bath	Basement Bath	1st Floor Bath	x			
10 A,B,C	Ceramic Tile Adhesive	Basement Bath	Basement Bath	1st Floor Bath	x			
11 A,B,C	Adhesive beneath Blackboard Frame	2nd Floor	2nd Floor	2nd Floor	x			
12 A,B,C	Blackboard	1st Floor	1st Floor	2nd Floor	x			
13 A,B,C	Gypsum	2nd Floor	1st Floor	Basement	x			

Relinquished by:

[Signature] 3/13/19
3/13/19

Date/Time

Turnaround: Rush 24-Hr 48-Hr
3-Day 4-Day 5-Day

Received by:

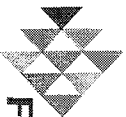
[Signature]

Date Needed

Received by:

[Signature]

Date/Time



FLI Environmental

69 Bridge Street • Dedham • MA • 02026 (781) 251-0040 fax (781) 251-0901

ASBESTOS BULK SAMPLE CHAIN OF CUSTODY RECORD

FLI Project #: 19-1311

Client: Context Architecture

Date: 3/7/2019

Site: 130 Elm Street

Sampled by: Jody Freitas

Milbury, Massachusetts

License #: AI900238

Sample # (s)	Material	Location A	Location B	Location C	Asbestos Analysis			Positive (Y/N)
					PLM	TEM	Point Count	
14 A,B,C	Joint Compound	2nd Floor	1st Floor	Basement	X			
15 A,B,C	Grey Covebase	Basement	Basement	Basement	X			
16 A,B,C	Adhesive with Grey Covebase	Basement	Basement	Basement	X			
17 A,B,C	Black Floor Tile	Basement	Basement	Basement	X			
18 A,B,C	Mastic with Black Floor Tile	Basement	Basement	Basement	X			
19 A,B,C	2' x 4' Fissured Ceiling Tile	Basement	Basement	Basement	X			
20 A,B,C	Mauve Covebase	Basement	Basement	Basement	X			
21 A,B,C	Adhesive with Mauve Covebase	Basement	Basement	Basement	X			
22 A,B,C	Boiler Insulation	Boiler Room	Boiler Room	Boiler Room	X			
23 A,B,C	Pipe Insulation	Boiler Room	Boiler Room	Boiler Room	X			
24 A,B,C	Tan Covebase	Boiler Room	Boiler Room	Boiler Room	X			
25 A,B,C	Adhesive with Tan Covebase	1st Floor	1st Floor	1st Floor	X			
26 A,B,C	2' x 4' Grooved Ceiling Tile	2nd Floor	1st Floor	1st Floor	X			

Relinquished by:

Received by:

Relinquished by:

Received by:

Turnaround: Rush 24-Hr 48-Hr

3-Day 4-Day 5-Day

Date Needed



ASBESTOS BILL K SAMPLE CHAIN OF CUSTODY RECORD

FLI Project #: 19-1311

Client: Context Architecture

Date: 3/7/2019

Site: 130 Elm Street

Sampled by: Jody Freitas

Milbury, Massachusetts

License #: AI900238

[illegible]

Relinquished by:

Turnaround: Rush 24-Hr 48-Hr

Received by:

Date/Time

Relinquished by:

Date/Time

Received by:

Date/Time

3-Day	4-Day	5-Day
Date Needed		

APPENDIX D

LICENSES AND CERTIFICATIONS



THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF LABOR AND WORKFORCE DEVELOPMENT
DEPARTMENT OF LABOR STANDARDS

William D. McKinney,
Director

Asbestos Inspector

JODY FREITAS

Eff. Date 02/11/19

Exp. Date 02/11/20

AI900238

Member of C.O.N.E.S.

BOSR BOS-RENEW

20



THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF LABOR AND WORKFORCE DEVELOPMENT
DEPARTMENT OF LABOR STANDARDS

William D. McKinney,
Director

Asbestos Management Planner

JODY FREITAS

Eff. Date 02/11/19

Exp. Date 02/11/20

AP000051

Member of C.O.N.E.S.

BOSR BOS-RENEW

20





THE COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF LABOR AND WORKFORCE DEVELOPMENT
DEPARTMENT OF LABOR STANDARDS
19 STANIFORD STREET, BOSTON, MASSACHUSETTS 02114

CERTIFICATION FOR ASBESTOS ANALYTICAL SERVICES

ASBESTOS IDENTIFICATION LABORATORY
165 NEW BOSTON STREET
SUITE 227
WOBURN MA 01801

LICENSE: **AA000208**

EXPIRES: **Sunday, June 23, 2019**

IN ACCORDANCE WITH MGL CH. 149 § 6B AND 453 CMR 6.08 THIS CERTIFICATE IS ISSUED BY THE
DEPARTMENT OF LABOR STANDARDS TO THE ABOVE NAMED ENTITIY TO PROVIDE THE ASBESTOS
ANALYTICAL SERVICES SPECIFICALLY LISTED BELOW.

CLASS A CERTIFICATE
CLASS C CERTIFICATE

A handwritten signature in black ink, reading "William D. McKinney".

WILLIAM D. MCKINNEY, DIRECTOR

Mailing Address:

ASBESTOS IDENTIFICATION LABORATORY
165 NEW BOSTON STREET
SUITE 227
WOBURN, MA 01801

United States Department of Commerce
National Institute of Standards and Technology



Certificate of Accreditation to ISO/IEC 17025:2005

NVLAP LAB CODE: 200919-0

Asbestos Identification Laboratory

Woburn, MA

*is accredited by the National Voluntary Laboratory Accreditation Program for specific services,
listed on the Scope of Accreditation, for:*

Asbestos Fiber Analysis

*This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005.
This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality
management system (refer to joint ISO-ILAC-IAF Communiqué dated January 2009).*

2018-07-01 through 2019-06-30

Effective Dates

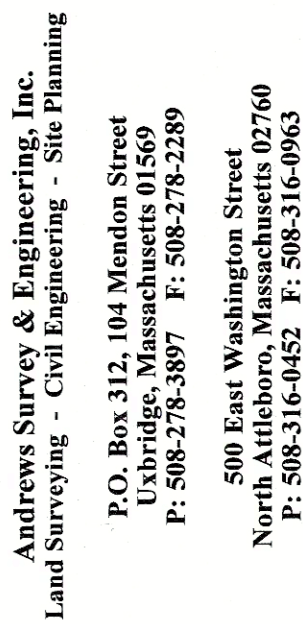


A handwritten signature in blue ink, which appears to read "Peter S. Lander".

For the National Voluntary Laboratory Accreditation Program

APPENDICES

D. Existing Conditions Survey



OWNER OF RECORD:

TOWN OF MILLBURY
1130 ELM STREET
MILLBURY, MA 01527

MILLBURY ASSESSORS INFORMATION:

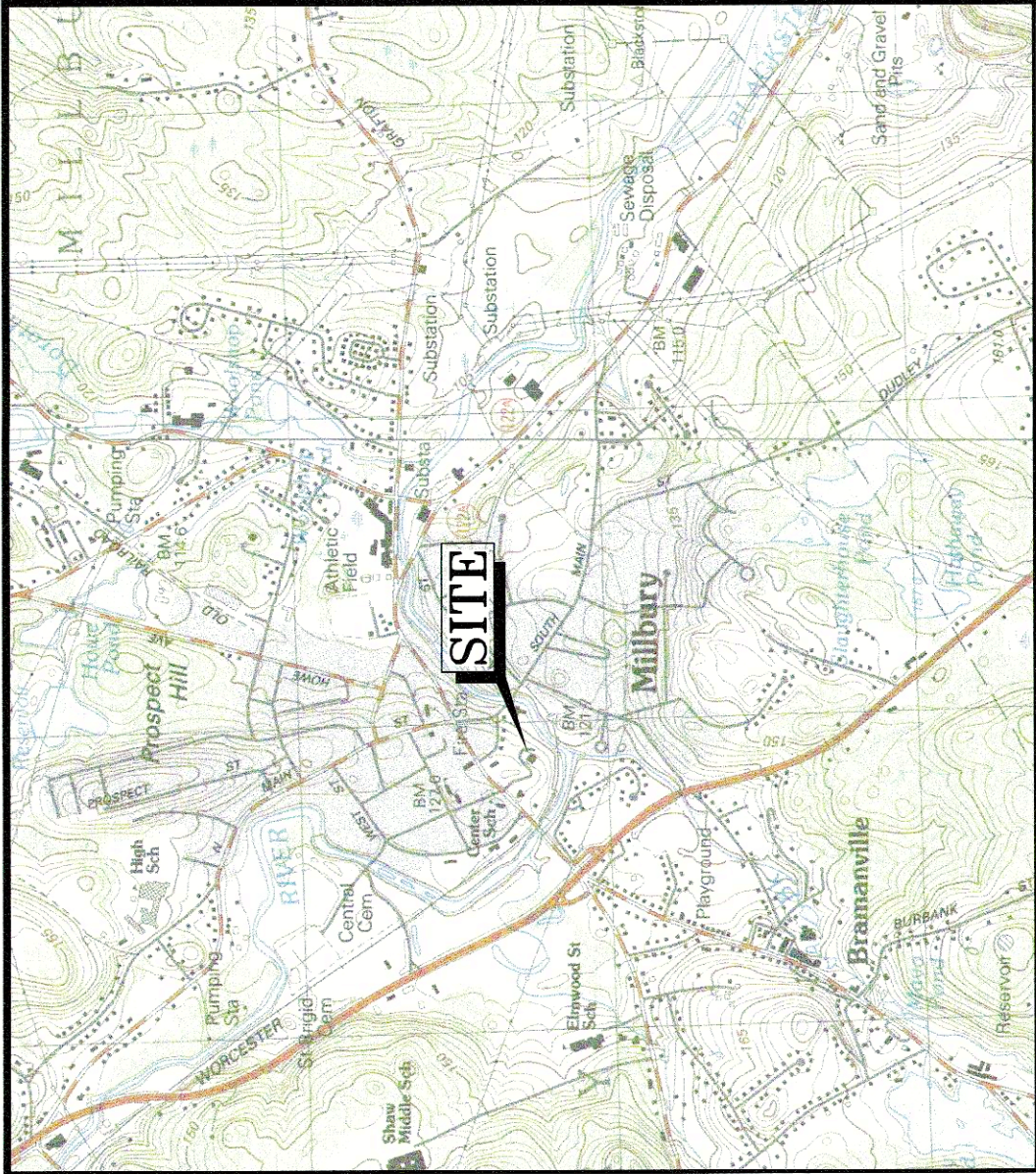
MILLBURY ZONING INFORMATION:

R-1

MINIMUM AREA: 40,000 S.F.

MINIMUM FRONTAGE: 100'

SETBACKS: FRONT 25', SIDE 10', REAR 10'



LOCUS MAP

SCALE: 1" = 2,000'

LEGEND	
NOW OR FORMERLY	N/F
DRILL HOLE	DH
SQUARE FEET	S.F.
FOUND	FND
DRILL HOLE	● DH
ESCUTCHEON PIN LEAD PLUG	● OEP/LP
CHAIN LINK FENCE	— O —

NOTE:

1. PROPERTY LINES ARE THE RESULT OF RECORD INFORMATION AND A PARTIAL ON-THE-GROUND SURVEY AND ARE TO BE CONSIDERED APPROXIMATE ONLY.
2. NOTICE TO CONTRACTOR: THE CONTRACTOR IS SPECIFICALLY CAUTIONED THAT THE LOCATION AND/OR ELEVATION OF EXISTING UTILITIES AND STRUCTURES AS SHOWN ON THESE PLANS IS BASED ON RECORDS OF VARIOUS UTILITY COMPANIES AND WHERE POSSIBLE, MEASUREMENTS TAKEN IN THE FIELD. THIS CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING OR COMPLETE THE LOCATION OF ALL UNDERGROUND UTILITIES AND STRUCTURES SHALL BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO THE START OF CONSTRUCTION. THE CONTRACTOR MUST CONTACT THE APPROPRIATE UTILITY COMPANY, ANY GOVERNING PERMITTING AUTHORITY, AND DISSEMINATE AT LEAST 24 HOURS BEFORE CONSTRUCTION, THE EXACT FIELD LOCATION OF UTILITIES. THE ENGINEER SHALL BE NOTIFIED IN WRITING OF ANY UTILITIES INTERFERING WITH THE PROPOSED CONSTRUCTION AND APPROPRIATE REMEDIAL ACTION SHALL BE TAKEN BEFORE PROCEEDING WITH THE WORK. IT SHALL BE THE OBLIGATION OF THE CONTRACTOR TO RELOCATE ALL EXISTING UTILITIES WHICH CONFLICT WITH THE PROPOSED IMPROVEMENTS SHOWN ON THE PLAN.

3. HORIZONTAL DATUM: NAD 83
VERTICAL DATUM: NGVD 29

EXISTING CONDITIONS

PLAN

Q

130 ELM STREET

IN
MILLBURY, MA

OWNED BY

TOWN OF MILLBURY
CHIEF OF POLICE

APPENDICES

E. STRUCTURAL AND MEP EXIST. CONDITIONS REPORTS

ROOME & GUARRACINO, LLC

Consulting Structural Engineers

48 Grove Street
Tel: 617.628.1700

Somerville, MA 02144
Fax: 617.628.1711

March 25, 2019

Mr. Jeff Shaw A.I.A.
Context Architecture, Inc.
68 Harrison Avenue
Boston, MA 02111

Reference: 130 Elm Street School-Millbury, MA
Existing Conditions Study

Dear Jeff;

This letter summarizes our findings regarding the present condition of the structure of the school building at 130 Elm Street in Millbury, Massachusetts, as well as, our recommendations regarding possible future uses. These observations and recommendation are based on information provided to us by your office, as well as, our field observations of March 5, 2019. There do not appear to be any existing structural drawings for the building, and as such, our comments are based solely on our field observations and experience. Our field observations were only visual surface observations, we have not cut any holes in building finishes, to verify structure, nor have we done any testing to determine the structures underlying condition.

Existing Conditions

On March 5, 2019, I toured the existing school building at 130 Elm Street in Millbury with Mr. Zel Tonic, of your office and the Town of Millbury Police and Fire Chiefs. The existing school building is a three story, rectangular building, that was built in the early 1900's, as a high school for the town, and today is abandoned. The original school building had a gym and mechanical room on the lowest level, a large cafeteria/meeting room and classrooms on the second floor, and classrooms on the upper floor. There is a central corridor on each floor with a stairwell at each end. The building appears to be a reinforced concrete frame building, with reinforced concrete slabs and beams at the floors and roof. Unreinforced CMU was used as the interior partitions and as back-up for the brick masonry veneer on the exterior. The building is presently classified by the Building Code as an "Occupancy Risk Category II Building".

We are not able to determine the allowable gravity loading capacity of the framed floors and roof, as there are no structural drawings that would show us member sizes and reinforcing, but based on their performance over the years, it appears that they were adequately designed. While the structural framing for most of the building is not visible, as ceiling finishes cover the roof and floor framing, there is no evidence of major structural distress. There is no evidence of foundation settlement, (as might be indicted by areas of step cracking in the masonry walls all around the exterior of the building, and especially at corners). There are some minor cracks in the lower level slab-on-grade, but since the slab is cast on earth, they are not a structural concern. The framed floor and roof structure appear to be in relatively good condition with no evidence of structural distress. The

interior masonry non-bearing walls, appear to be in good shape, with no evidence of major cracking or deterioration. There is peeling paint in many locations, probably due to excessive moisture as the building is abandoned and not heated. The exterior, brick masonry walls are in relatively good condition with some areas of cracking, and areas that may need some repointing. Generally, the building appears to be in adequate condition for its age.

Addition/Renovation Feasibility

It is our understanding that the town plans to raze the existing structure in order to build a new fire station. Our review of the existing structure in conjunction with the prevailing codes; The International Existing Building Code-2015 (IEBC2015), The Massachusetts State Building Code-Ninth Edition, Chapter 34-Existing Structures, and Supplements to the IEBC 2015; indicates that this is the correct direction, as this building would be an extremely poor choice for a fire station. Due to the change in use to a higher Risk Category, the existing structure would need to be updated for modern code snow, wind, and seismic loadings. The building would be re-classified as a Category IV-“Essential Facility”, and constructed with “Ordinary Reinforced Concrete Moment Frames”, and based upon Section 34.00-101.10 of the Mass. Code, any renovation where the work area exceeds 50% of the building area, or a “Level 3 Alteration”, as defined by Section 404 of the IEBC; will have to meet the requirements for modern code wind, snow, and seismic loadings. Due to the lack of special reinforcing detailing, which makes the structure non-ductile, and the fact that the existing frames could not withstand the amplified Code mandated wind and seismic loadings for a Category IV building, this building is a very poor choice for an “Essential Facility”. (The Building Code does not allow new construction of “Ordinary Reinforced Concrete Moment Frames” for Risk Category IV- “Essential Facility” buildings.) Similarly, a “Level 2 Alteration” will require meeting modern code loads. Additionally, all of the interior non-bearing CMU partitions would have to be braced at their top to the building structure to keep them from falling over in a seismic event. Further, the area of the present gym, on the lower level where the apparatus bay would be, does not have adequate height or width between the main building columns and beams for a modern-day fire truck.

Based on the above findings, it is our opinion that this building is a poor choice for renovation as a fire station, as the structural deficiencies in the lateral load resisting system are so severe that to make the required structural upgrades would be prohibitively expensive. It is possible to add a new lateral load resisting system by installing new structural steel braced frames throughout the building, but this solution to the lateral loading issue is extremely disruptive, takes up additional space in the building, and is very expensive. Numerous studies have shown that the costs to upgrade lateral systems are generally higher than constructing a new code compliant building. We would strongly recommend against any renovations that would require upgrading this building to a Category IV-“Essential Facility”.

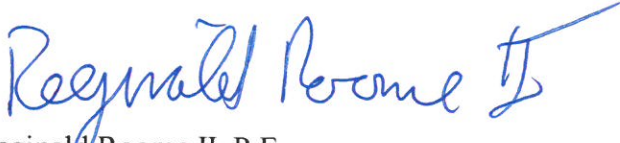
Should a new fire station be built on this site, it is recommended that the existing school structure be razed, and a new building be constructed. Any new structure could then be as large as desired and still be in accordance with the latest codes. For cost and flexibility reasons, we would recommend that any new structure be framed in structural steel, with a slab-on-grade for the lowest level floor, steel beams and concrete on steel deck for all framed floors, and steel beams and steel roof deck for the roof. Braced frames of structural steel would be the least expensive system for providing stability for wind and seismic loadings. Foundations would likely be conventional shallow foundations with spread footings, foundation walls, and slabs-on-grade. Other structural systems and

building types are possible and can be properly vetted once an actual building layout is proposed.

If you have any further questions, or if we can be of any further assistance, please do not hesitate to call.

Very truly yours,

Roome & Guarracino, LLC



Reginald Roome II, P.E.
Partner



Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Plumbing Existing Conditions Systems Report
J#640 053 00.00
L#65910/Page 1/March 27, 2019

PLUMBING

Executive Summary:

Presently, the Plumbing Systems serving the building are cold water, hot water, sanitary, waste and vent system and storm drain piping. Municipal sewer and municipal water service the Building. Natural gas is available at the street.

The majority of the plumbing systems are original to the building. The plumbing systems, while continuing to function, have served their useful life. The building plumbing systems could continue to be used with maintenance and replacement of failed components; however other non-dependent decisions will likely force the plumbing upgrade.

The plumbing fixtures are in fair/poor condition. In terms of the water conservation fixtures, their use is governed by the provisions of the Plumbing and Building Code. Essentially, the code does not require these fixtures to be upgraded, but where new fixtures are installed, as may be required by other codes or concerns, the new fixtures need to be water conserving type fixtures. All new fixtures are recommended.

Fixtures:

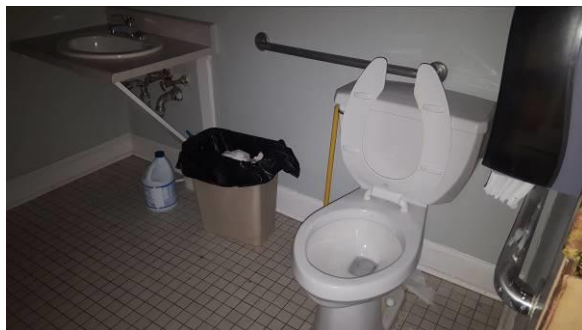
The water closets are predominately floor mounted vitreous china with a mix of tank type and manual operated flush valves.

Urinals are wall hung vitreous china with manually operated flush valves.

Lavatories are a mix of wall hung vitreous china, counter mounted and vanity type. Sink faucets are predominately metering type faucets with single hot and cold water lever.

The 3-compartment pot sink is connected to a passive floor mounted grease interceptor.

Art sink is a stainless steel trough style sink. There is no solids interceptor on the waste piping.



Typical Tank Type Toilet



Typical Urinal

Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Plumbing Existing Conditions Systems Report
J#640 053 00.00
L#65910/Page 2/March 27, 2019



Typical Flush Valve Toilet



Typical Wall Hung Lavatory



3-Compartment Sink



Art Sink

Water Systems:

The main domestic water service is located in Building Basement and appears to have been recently modified. The service is 1 1/4" in size. There is a 3/4" meter and no backflow preventer provided. The majority of the domestic distribution piping is concealed throughout the facility. Piping, where exposed, appears to be copper with sweat joints. The majority of the piping is not insulated.

Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Plumbing Existing Conditions Systems Report
J#640 053 00.00
L#65910/Page 3/March 27, 2019

Domestic hot water in the building is generated through an electric tank type water heater. The hot water system is not recirculated. There is no thermostatic mixing valve on the system to prevent scalding. The water heater has an electrical input of 4.5 kW and a storage capacity of 80 gallons. The circulating pump is seized and abandoned in place. Based on the age of the heater, it appears that the heater is in fair condition.



Domestic Water Service & Meter



Typical Domestic Water Piping



Electric Water Heater

Gas:

There is no natural gas in the building. Natural gas is available at the street for future renovation.

Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Plumbing Existing Conditions Systems Report
J#640 053 00.00
L#65910/Page 4/March 27, 2019

Drainage Systems:

Cast iron is used for sanitary drainage. Where visible, the cast iron pipe appears to be in fair/poor condition. Smaller pipe sizes appear to be copper.



Cast Iron Waste Piping



Grease Interceptor

Recommendations:

- If building is to be renovated all new water and sanitary services will be required.
- Provide all new high efficiency water conserving plumbing fixtures.
- Provide new wall hydrants with vacuum breakers.
- Provide new domestic water distribution piping sized to meet new fixtures.
- Insulate all domestic water piping.
- Provide new high efficiency water heater.
- Provide safe waste pans below water heater.
- Provide mixing valve and circulating pump at water heater.
- Existing buried drainage piping should be video-taped to determine the internal conditional and if any piping needs to be replaced.

Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Fire Protection Existing Conditions Systems Report
J#640 053 00.00
L#65930/Page 1/March 27, 2019

FIRE PROTECTION

Executive Summary

The building does not have an automatic sprinkler system.

In general, Massachusetts General Law M.G.L. c.148, s.26G requires that any existing building over 7,500 square feet that undergoes **major** alterations or building addition must be sprinklered.

Examples of major alterations are demolition or reconstruction of existing ceilings or installation of suspended ceilings; removal of sub flooring; demolition and/or reconstruction of walls, doors, or stairways; or removal or relocation of a significant portion of the building's mechanical or electrical systems. Alterations are considered major when such work affects 33% or more of the building area or when total work (excluding sprinkler installation) is equal to 33% or more of the assessed value of the building.

If the building undergoes a major renovation or if an addition is constructed, an automatic sprinkler system must be installed to protect the entire existing building and any addition.

Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
HVAC Existing Conditions Systems Report
J#640 053 00.00
L#65905/Page 1/March 27, 2019

HEATING, VENTILATION AND AIR CONDITIONING (HVAC)

Executive Summary:

In general, the majority of the Heating, Air Conditioning, Ventilation and Exhaust systems, equipment, and associated ductwork and piping distribution systems appear to be beyond their anticipated life expectancy and is recommended to be replaced. Most of the terminal heating equipment appears to be original to the building, some equipment has been more recently updated such as the boiler. Heating for the building is provided by a Central Boiler Plant and Heating Low Pressure Steam Piping System throughout the building to multiple zones.

Central Boiler Plant:

The Building is served by a single cast iron, standard efficiency sectional boiler. The boiler was manufactured by HB Smith and is oil fired with a Carlin burner. There are four (4) oil tanks in the adjacent room to the Boiler Plant. The boiler is vented with B-Vent Pipe. Combustion is provided to the Boiler Room and does not meet current code. The boiler produces low pressure steam to distribute throughout the building. There is also an abandoned HB Smith oil fired boiler in the building that is no longer in use.

Although the boiler is still considered to have more years of useful expectancy, the Central Boiler Plant is recommended to be upgraded to a high efficiency natural gas condensing Boiler Plant.



Boiler



Oil Tanks

Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
HVAC Existing Conditions Systems Report
J#640 053 00.00
L#65905/Page 2/March 27, 2019

Terminal Heating:

The building is heated by cast iron radiators throughout the building. Each Radiator has an adjustable steam valve to modulate the amount of heat at each unit. The majority of the cast iron radiators are enclosed in a wooden architectural enclosure.



Cast Iron Radiator in Architectural Enclosure

Ventilation:

There are wall mounted grilles in the classroom spaces. These are connected with ductwork to heating and ventilation units in the building that are no longer in use. The only current means of ventilation observed are operable windows in each space.



Wall Grilles

Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
HVAC Existing Conditions Systems Report
J#640 053 00.00
L#65905/Page 3/March 27, 2019

Recommendations:

Overall, the existing HVAC system is in poor condition and is recommended to be completely replaced. A new HVAC system would be recommended to accommodate the architectural renovations and improve thermal comfort and ventilation throughout the building.

Based upon our review and observations of the building HVAC systems, we offer the following system recommendations:

- The Boiler Plant is recommended to be upgraded to two (2) gas fired condensing boilers opposed to a non-condensing boiler. This would produce larger energy savings over the lifetime of the equipment. We would also recommend the building having (2) two boilers rather than a single boiler to allow for redundancy in the event that one of the boilers fail.
- The new Hydronic Heating System should provide room-by-room control as desired by the building occupants.
- Mechanical Ventilation system should operate year-round rather than only during the seasons when operable windows are an option. The Ventilation System should be suitable for any future increased occupancy and provide code compliant ventilation throughout the building.
- We propose a Variable Refrigerant Flow (VRF) System that would provide air conditioning throughout the building and be capable of providing heat through the heat pump system built into the equipment.
- The Apparatus Bay should be served by a New Vehicle Exhaust System, likely two systems; one with hoses to connect to the vehicles and one to monitor CO₂ levels in the space that will energize if a vehicle is running in the Bay not connected to a hose.
- Provisions for make-up air should be provided for any future appliances that exhaust more than 400 CFM, such as the dryer cabinet.
- The building does not currently have a building Management System (BMS) to control, monitor, or alarm for building equipment operation and service requirements. Although this may be a costly upgrade, a BMS System can improve mechanical systems efficiency by diagnosing equipment and systems that are critical in the building operation.

Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Electrical Existing Conditions Systems Report
J#640 053 00.00
L#65915/Page 1/March 27, 2019

ELECTRICAL

Executive Summary:

The existing electrical systems for this facility range from original vintage to some recent upgrades. However, in general, systems do not meet current codes due to the constant code changes, although they probably met code when installed. Systems are marginally sized and would not be suitable for a full renovation/expansion. Furthermore, characteristics such as the main electrical service and generator cannot be expanded as they are not compatible with the requirements of a commercial facility, the fire alarm system is not ADA compliant and is not addressable. In general, there is not much that we would recommend salvaging.

Electrical Distribution:

The secondary distribution system for this facility consists of 400 Amp, 120/208V, 3Ø, 4W service which comes from a pole mounted transformer to a meter socket on the back side of the building. A 400 Amp panel of the circuit breaker type exists with 30 poles of 1, 2 and 3 pole circuit breakers. Branch circuits feed other remote panels, all of the panels are breaker type. Manufacturer of the panel was Siemens and Square D. Equipment is obsolete and some appear original to building and are in very poor condition.

Most remote panels are full and have no space for additional equipment.



Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Electrical Existing Conditions Systems Report
J#640 053 00.00
L#65915/Page 2/March 27, 2019



Emergency Power System:

The emergency power system consists of emergency battery units.

Exit signs offer inadequate coverage.

Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Electrical Existing Conditions Systems Report
J#640 053 00.00
L#65915/Page 3/March 27, 2019



The entire emergency systems should be replaced.

Exterior Lighting:

Exterior lighting consists of wall mounted HID type fixtures. There are pole-mounted light fixtures.

In general exterior lighting is not of cut-off type and is in poor condition and should be replaced.



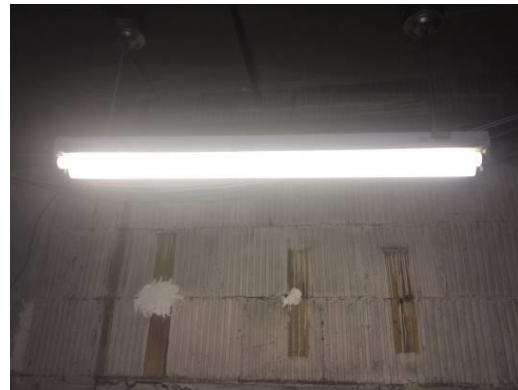
Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Electrical Existing Conditions Systems Report
J#640 053 00.00
L#65915/Page 4/March 27, 2019

Interior Lighting:

Interior lighting consists of open channel fluorescent strips, 2x4 recessed with T8 lamps in various utility and non-utility spaces, as well as some incandescent keyless porcelain fixtures and HID pendant mount fixtures.

Facility has no automated lighting control system. Most spaces have no occupancy sensors.

In general, most lighting is in poor condition and should be replaced.



Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Electrical Existing Conditions Systems Report
J#640 053 00.00
L#65915/Page 5/March 27, 2019

Fire Alarm System:

The fire alarm system consists of smoke detectors, pull stations & horn/strobes.



Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Electrical Existing Conditions Systems Report
J#640 053 00.00
L#65915/Page 6/March 27, 2019

Fire alarm horn/strobes.



Pull station at exterior doors.



System smoke detectors exist in some corridors and stairs.



Millbury Police and Fire Station Study
130 Elm Street – Old Middle High School Building
Millbury, MA
Electrical Existing Conditions Systems Report
J#640 053 00.00
L#65915/Page 7/March 27, 2019

Fire alarm system is not ADA compliant, is obsolete and should be replaced with an addressable system with full coverage.

Miscellaneous:

Incoming communications service runs overhead from a utility pole located on Elm Street.

Facility has no lightning protection system.

Receptacle coverage is inadequate in most spaces.



RECOMMENDATIONS

- Add exit signs where required by code.
- Replace panels and service for service to a 800A, 120/208V, 3Ø, 4W service. Provide new breaker type panel boards and feeders to back feed exiting branch circuits.
- Provide a new emergency generator at 120/208v, 3Ø, 4W output with 2 transfer switches and panels for life safety loads and optional standby loads.
- Provide adequate exterior lighting.
- Replace T8 and HID fixtures with new energy efficient fixtures.
- Provide occupancy sensors.
- Provide new addressable, code compliant fire alarm system with full coverage.

APPENDICES

F. NEW FIRE STATION SITE PLAN



MILLBURY FIRE STATION:
PROPOSED SITE PLAN

APPENDICES

G. NEW FIRE STATION FIRST FLOOR PLAN



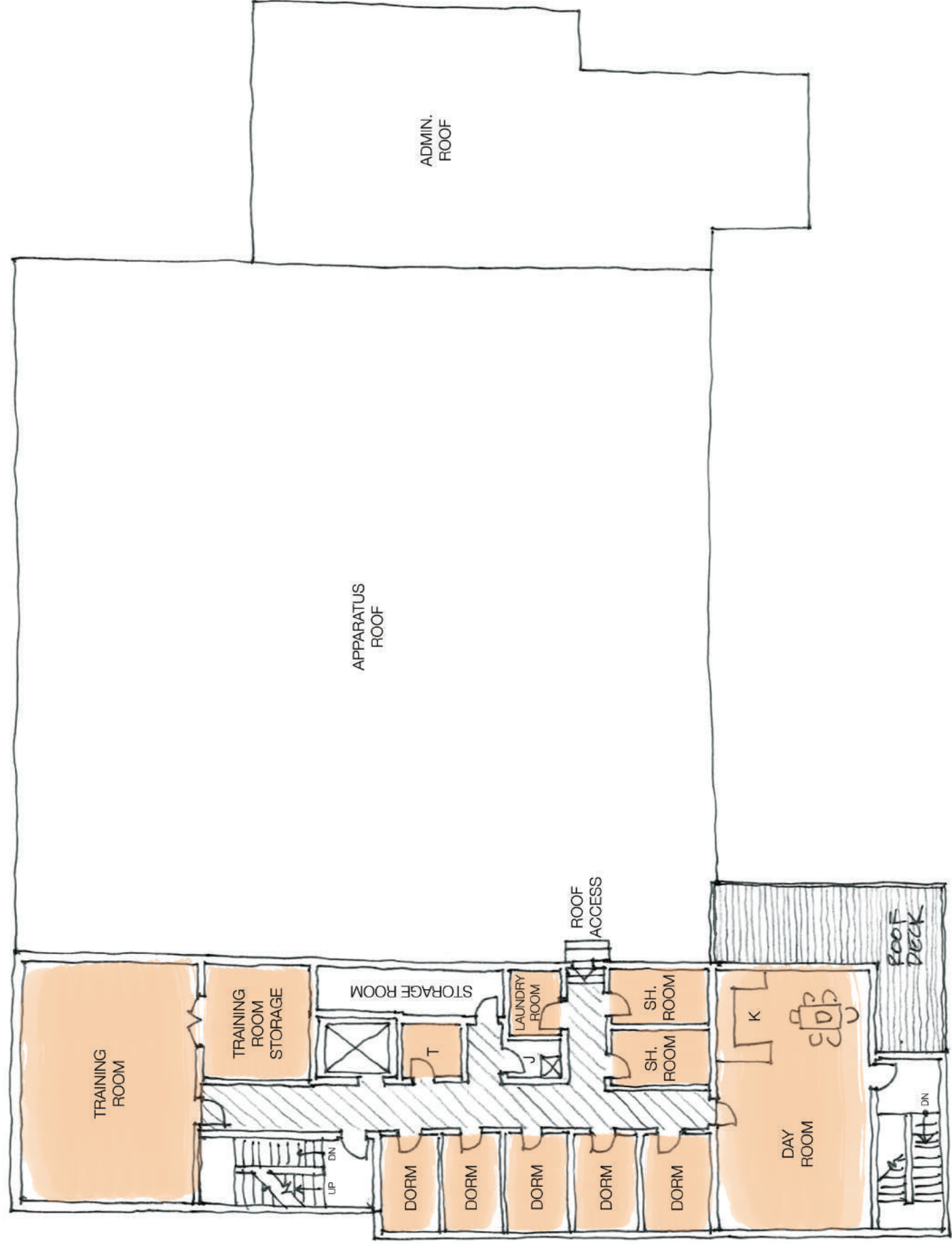
- PUBLIC
- FIRE
- FIRE APPARATUS



MILLBURY FIRE STATION: PROPOSED FIRST FLOOR PLAN

APPENDICES

H. NEW FIRE STATION SECOND FLOOR PLAN



 FIRE

MILLBURY FIRE STATION: PROPOSED SECOND FLOOR PLAN

APPENDICES

I. BUILDING COMMITTEE MEETING NOTES

**MILLBURY POLICE AND FIRE STATION BUILDINGS FEASIBILITY STUDY
MEETING NOTES – Project Kick-Off – 03.14.2019**

Present:

Police Chief Donald Desorcy	Building Committee Chair
Fire Chief Richard Hamilton	Building Committee
Maxine Mann	Building Committee
Paul Concerni	Building Committee
Dan Daly	Building Committee
David Rudge	Building Committee
Brian Gasco	Building Committee
Jeff Shaw	Principal, Context Architecture (CTX)
Zel Tonic	Project Manager, Context Architecture (CTX)

Distribution:

All Present

File: 2019.00: 02: 2.2

The goal of the meeting was for CTX to review the study goals, provide and update of the project status and establish a schedule for future meetings.

1. Project status

- Site walk-throughs by MEP engineers and CTX staff have been performed.
- Hazmat surveys are in progress for both existing structures.
- Geotechnical exploratory survey work to be determined and scheduled.

2. Programming

- CTX presented the first draft of the space needs analysis, to inform the committee on the format and content of the document.
- Jeff will meet with both departments' chiefs and building committee on Wed. 03-19, to review all staffing and programming data and produce a second draft of the report for review.

3. Communications

- CTX will transmit all documents and/or reports to Police Chief Desorcy who will disseminate to the Building Committee and any other Town departments or involved parties.
- Jeff noted that involvement of other Town departments and communities interested and/or involved with this project will be beneficial to the outcome of the process.
- CTX will support the communication and presentations of the project to Town boards and/or residents as needed.

4. Schedule

- Context presented the attached draft schedule for producing the reports and final study. The following items were discussed:
 - Bi-weekly working group meetings will be held on Thursdays at 5:30 at City Hall. Schedule to be updated as needed.



5. Agenda Meetings

- CTX will prepare agenda for Building Committee meetings.

6. Attachments

- 2019.03.14 draft project schedule

**MILLBURY POLICE AND FIRE STATION BUILDINGS FEASIBILITY STUDY
MEETING NOTES – 03.28.2019**

Present:

Police Chief Donald Desorcy	Building Committee Chair
Fire Chief Richard Hamilton	Building Committee
Maxine Mann	Building Committee
Paul Concemi	Building Committee
Dan Daly	Building Committee
Brian Gasco	Building Committee
Jeff Shaw	Principal, Context Architecture (CTX)
Zel Tonic	Project Manager, Context Architecture (CTX)
Capt. Keith Newlands	Guest

Distribution:

All Present

File: 2019.00: 02: 2.2

1. Existing Conditions Reports

- Zel and Jeff presented the findings of the Structural and MEP Engineers Survey Reports.
- In general terms, the structure, although adequate for the current use, would need significant and costly renovation to bring it up to current code compliance.
- Due to the age and condition of the MEP systems, it is recommended that any potential renovation include complete replacement of the plumbing, HVAC and Electrical systems.
- We are still waiting for the Hazmat Report which will be forwarded when received.
- Geotechnical exploratory survey work is scheduled for the week of April 8. We will notify 3 days prior to work taking place.

2. Programming and Space Needs Second Draft Review

- Jeff presented the Second Draft of the Space Needs for both Police and Fire Stations.
- Several specific spaces were reviewed and some potential changes were considered, no final decisions were made.
- The Chiefs and departments will review the documents over the next two weeks.
- They will discuss any potential revisions/reductions in program at the next BC meeting and give CTX their final comments.
- CTX will generate the Final Space Needs Report to be used as basis of schematic design and cost estimate.

3. Preliminary Budget Considerations

- Jeff noted that for general planning purposes, the cost of \$ 550 per Sq Ft. (construction cost) should be used until we have done an actual Schematic Cost Estimate. That number may vary and the Fire Station may be somewhat less due to a large portion, almost ½ the square footage, being the open apparatus bays.



- The committee decided that it would not be prudent to discuss costs with the wider Town community until specific cost estimates are completed which would then allow the committee to provide relevant and specific information.
- CTX will provide a total project budget later in the study.
- Total project cost could run another 30-35% of the construction costs. This would include the design and engineering, furniture, fixtures and equipment (FF&E) and Security and Communications Systems for the buildings.
- The demolition and any potential abatement of the existing structures could be done as separate contracts ahead of the new construction projects. This would be an efficient process to streamline the overall project timeframe.

4. Next Meetings

- CTX will not attend the next Building Committee meeting on April 11th. The Committee will determine the final program and space allocations and issue data to CTX.
- CTX will generate the Final Report which will be used to develop the schematic plan options.
- CTX will attend the meeting on April 25.

MILLBURY POLICE AND FIRE STATION BUILDINGS FEASIBILITY STUDY MEETING NOTES – 04.26.2019

Present:

Police Chief Donald Desorcy	Building Committee Chair
Fire Chief Richard Hamilton	Building Committee
Maxine Mann	Building Committee
Paul Concemi	Building Committee
Dan Daly	Building Committee
Brian Gasco	Building Committee
Jeff Shaw	Principal, Context Architecture (CTX)

Distribution:

All Present, plus	
Zel Tonicic	Project Manager, Context Architecture (CTX)
	File: 2019.00: 02: 2.2

1. Existing Conditions Reports

Jeff noted the status of the geotechnical work to date includes the performance of 2 test pits at the police station site and 4 borings at the fire station site. The borings indicated the presence of bedrock between 5-12 feet below grade depending on location. The test pits observed water 7 feet below grade.

The team discussed the option for a basement at the police station. CTX will obtain information from the Geotechnical engineer to determine what additional testing might be required to be able to know with more certainty if a basement is feasible. The thought currently is that a deeper test pit would be needed.

The team discussed the options for siting the fire station given the elevation of bedrock and the potential for routing driveways and utilities if the site grade was lowered. CTX will inquire with the geotechnical engineer to confirm what additional testing and testing methods could be used to get a better profile of the ledge. JS noted that probes would be a cheaper alternative to borings if we only needed to know where the surface of the ledge was and this might be critical to finalizing the site plan. Maxine questioned whether ground penetrating radar (GPR) could be used.

CTX to provide proposals from the geotechnical engineer for additional testing at both sites and answer the question whether or not alternative methods (GPR) could be employed more cost effectively.

CTX will also solicit proposals for surveys to be conducted at both sites in order to more accurately estimate the project. The survey's will include, boundaries, contours at 1' increments and utilities. CTX noted that this cost is outside the current study fees and considering the possible expense (\$20k) requested contact info be sent to them for any local surveyors that were known to be good as they might be able to provide the best value to the Town.

2. Programming and Space Needs Second Draft Review

Jeff distributed the revised fire department space needs report. The revisions were based on comments provided to CTX prior to the meeting. The Fire Department will review the draft and respond to CTX asap with any follow up comments.



The Police Chief noted his visits to other stations and review of the program. He noted that several spaces would get smaller based upon his further reflection of the needs and likely future staffing of the department. The Chief indicated the program should be able to drop to approx 14,000 SF. The comments would be shared with CTX as soon as he returns from vacation in about a weeks' time.

Both departments space needs programs will be revisited at the next meeting, and a potential vote of acceptance is anticipated.

3. Police Station Examples & Design Options

The Police Chief discussed the results of his visit to other stations including Grafton, Oxford, Sutton & Bellingham. Some of the stations were 2 story and some had basements. In general, the Chief preferred certain aspects of the buildings over others, including the potential for future expansion space that is left unfinished. The decision was made, based on thorough discussion and consideration of the meeting space already available in Town and at the new school, to make the Police Training Room a police-only space, especially if it was located on the second floor.

When the design phase is begun CTX will prepare options for the Police Station to be a 2 story, 1 story with basement and a single story building so that the committee and the department can compare layouts.

4. Next Meetings

The next 2 meetings are scheduled for May 16th & May 30th.

MILLBURY POLICE AND FIRE STATION BUILDINGS FEASIBILITY STUDY MEETING NOTES – 06.13.2019

Present:

Police Chief Donald Desorcy	Building Committee Chair
Fire Chief Richard Hamilton	Building Committee
Maxine Mann	Building Committee
Paul Concemi	Building Committee
Dan Daly	Building Committee
Kevin Woods	Building Committee
Jeff Shaw	Principal, Context Architecture (CTX)
Zel Tonic	Project Manager, Context Architecture (CTX)

Distribution:

Police Chief Donald Desorcy	Building Committee Chair
Jeff Shaw	Principal, Context Architecture (CTX)
Zel Tonic	Project Manager, Context Architecture (CTX)

File: 1902: 2.2

1. Final Geo Technical Report distributed to committee

The Geo-Tech report for each project site was given to the committee members. It is the compilation of the exploratory work data done to date with the Engineer's analysis and recommendations. The general content of the report was discussed at our previous meeting. The Report is labeled as Preliminary due to the Engineer's assumption that there will be additional geo-technical work done on the Elm Street Site and possibly prior to Building Design, should that phase proceed after the Feasibility Study is completed.

2. Additional Geo-Tech exploratory work for Elm Street Site

As discussed previously, CTX has requested that further exploratory work be done, in order to get a better picture of where the bedrock is existing on the site, so that we can have better information to develop potential site plans that will be appropriate and that will inform us of how much bedrock may need to be removed. The proposal from our Geo-Tech is for a day of rock probes as directed by CTX. The approval of the cost (\$8500) to be set aside for the time being, until the Survey work is completed.

3. Existing Conditions Survey Update

Chief Desorcy noted that the town had entered into contract with Andrews Surveying directly, and they are scheduled to start work possibly as soon as next week. It will take some time after the field work is done to have all the data assembled and drawn in CAD for distribution and use. CTX requested to review the preliminary survey plans along with the town prior to final documents being issued.

4. Review of Schematic Layout of Fire Station

Fire Chief Hamilton's comments regarding the building layout include the following:
Maximum separation of the public spaces from the staff and firefighter functions is required. Possibly on the back side of the building. There should be physical separation between the 9-5 portion of the building and the firefighters' spaces and apparatus bays. Second floor program spaces as shown are appropriate. A



direct entrance to access the turnout gear room and apparatus bays is advantageous. Fire Alarm room is missing from the plan.

General comments regarding the Site plan layout include:

The building orientation must be to Elm Street with the apron and driveway directly exiting on to Elm St.

There can be no public parking on the front side apron. Public access off Water Street and parking in the rear of the building. The potential site lay out options will be addressed when we have more specific information regarding the grades and bedrock depths and locations. How the driveway and apron slopes (max. 5%) will be achieved will be determined by a balance of how much rock we can afford to remove to bring the hill down and what the optimum driveway lengths and lay out are. The information provided by the Surveys and the additional geo-tech probes will be crucial to that process.

5. Review of Police Station Schematic Layouts

The plan option of renovating and re-purposing the existing school building for portion of the new police station was not addressed due to the as of yet undetermined magnitude of cost in order to bring that structure in compliance with Category 4 buildings.

The main comments regarding the layout of a new station as shown are as follows:

Chief would like to have a min. of 4 and possibly 5 cells. Proximity of the Dispatch to the cell block is crucial.

Concerns regarding the amount of natural light (windows on exterior wall) should be considered for the Dispatch area. Chief will review with staff. All police day-to-day functions should be located on the first floor. Second floor maybe only for public meeting & training and physical fitness rooms.

Site plan lay out seems appropriate for now. Chief would like to have weather protection canopies, in the rear for cruiser parking. "Police Only" designated driveway from Hayward is needed but no fenced off separation of parking lot areas are necessary.

5. Next Meeting

The next meeting is scheduled for July 11th at 5:30 PM.

New schematic plans and site plans to be developed for review.

MILLBURY POLICE AND FIRE STATION BUILDINGS FEASIBILITY STUDY MEETING NOTES – 05.16.2019

Present:

Police Chief Donald Desorcy	Building Committee Chair
Fire Chief Richard Hamilton	Building Committee
Maxine Mann	Building Committee
Paul Concemi	Building Committee
Dan Daly	Building Committee
Kevin Woods	Building Committee
Jeff Shaw	Principal, Context Architecture (CTX)
Zel Tonic	Project Manager, Context Architecture (CTX)

Distribution:

Police Chief Donald Desorcy	Building Committee Chair
Jeff Shaw	Principal, Context Architecture (CTX)
Zel Tonic	Project Manager, Context Architecture (CTX)

File: 1902: 2.2

1. Final Police and Fire Space Needs Study review and acceptance

Jeff presented the final Police Space Needs Study, incorporating the suggestions and revisions that Chief Desorcy had provided. The goal was to trim and/or consolidate some spaces in order to increase efficiency and reduce overall square footage. The total has been reduced from 16,181 SF to 15,313 SF, a reduction of 868 SF. The total square footage may decrease further during the design phase depending on making the plan layout as efficient as possible.

Maxine initiated some discussion regarding using the Administration Conference room also as Roll Call. Chief Desorcy explained that certain specific functions need to be kept in dedicated spaces due to issues of overlapping activities, privacy and/or security.

Paul inquired if the Dispatch would be provided with standing/positionable work surfaces. JS noted that most manufacturers offer this option, though it comes at an added cost. The Chief explained that these items would be considered during if the project moves past Town Meeting.

The committee voted to approve the Space Needs Study for both the Police Station and Fire Station. The next step in the process will be to develop site plan and building layouts for both sites that will be presented at the next scheduled meeting.

2. Additional Geo-Tech work and site conditions

Zel briefly described the status of the Geo-Technical Report, which will be finalized in the next week or so and submitted for the following meeting. In general both sites indicated similar soil formations with no water encountered (potential bedrock issues aside) and based on the borings and test pits taken the soils will have good bearing capacity for conventional foundation design.



With regard to the potential of ledge being 5'-6' below the surface of the top of the hill at the Fire Station Site, Jeff noted that the Geotechnical engineer is being consulted to determine the most efficient and cost effective way to get more information about the location and extent of the bedrock present on the site. It could be a combination of borings, probes and rock cores. The major concern regarding the location of the bedrock is understanding the potential for reducing the driveway slope by lowering the top elevation of the hill, but not so much as to potentially push the location of foundations and below ground utilities and drainage down into the ledge. CTX expects a proposal soon which will be sent to the Chief for review and approval of the Building Committee. The engineers mentioned they don't believe GPR would be effective for this use.

3. Existing Conditions Survey Proposals

Zel noted that proposals have been received from surveyors. To date 2 companies have submitted and several more are expected in order to have at least 3 or 4 to choose from. CTX will be verifying that the proposals meet the requirements and expectations for scope of work. Based on early results it appears that the total cost for the two sites will not exceed 10K.

4. Next Meeting

The next meeting is scheduled for May 30th at 5:30 PM.

MILLBURY POLICE AND FIRE STATION BUILDINGS FEASIBILITY STUDY MEETING NOTES – 8.1.2019

Present:

Police Chief Donald Desorcy	Building Committee Chair
Fire Chief Richard Hamilton	Building Committee
Maxine Mann	Building Committee
Paul Concemi	Building Committee
Dan Daly	Building Committee
Jeff Shaw	Principal, Context Architecture (CTX)

Distribution:

Police Chief Donald Desorcy	Building Committee Chair
Jeff Shaw	Principal, Context Architecture (CTX)
Zel Tonic	Project Manager, Context Architecture (CTX)
File: 1902: 2.2	

1. Existing Conditions Survey Update

CTX distributed 3 full size copies of the almost complete survey for each site. JS reported that CTX received the digital files for the police site last week and the fire site this week and there are still some minor edits that the surveyor is performing. CTX to advise Chief Desorcy when the survey is considered complete so he may authorize final payment.

2. Review of Fire Station Schematic Layout

JS presented the plans for the proposed station. The Fire representatives indicated that the floor plans are not accurately representing the departments wishes. CTX to review the original diagrams prepared by the department which show the relative location and adjacencies that the Department would like to achieve as well as the specific fire apparatus layout. CTX will prepare revised plans for the Chief to review asap.

The Fire Station site plan was reviewed. JS noted that with a survey performed it is likely that 8 – 10 feet of height would need to be removed from the top of the hill to achieve a maximum 5% slope from the apparatus garage to the street (industry max for apparatus travel). CTX would like to lower that grade if possible. However, it is also known that bedrock (and glacial material) is found between 6' and 12' below ground at the location of the proposed station. CTX will be calculating the cost of removing the bedrock as part of the project budget. The Committee also requested that CTA include a budget scenario where the site is lowered even further to achieve a 2-3% max slope.

3. Review of Police Station Schematic Layouts

JS presented two options for proposed station. Option 1 was for an entirely new station, demolishing the existing school. The Police Chief liked the layout with minimal changes, including:

- Locate the radio tower close to the back of the building, possibly next to the staff entry outside booking. Move the radio room so that it is at the exterior wall and cabling can come directly from the tower
- Move the police break room to the patrol corridor (away from administration) due to noise.



- Move the admin toilet, storage and work room to the interior and the conference room to the exterior wall. From the lobby the progression would go: Conference room, Admin Asst., Lieutenant, Chief.
- Move Guns & Drugs Evidence next to and accessed from the General Evidence Room
- Move the Evidence Lab so that one can move directly from Evidence Processing to General Evidence
- Show corridor access into Report Writing
- Provide access stair (ships ladder) to attic where the mechanical units will likely reside
- Eliminate small hallway into detectives; both public bathrooms will be access from lobby.

Option 2 was for an addition/renovation of the existing school. The Police Chief did not prefer this option, mainly due to the separation of the administration area from the rest of the station. Also, the fitness and locker rooms were too far from staff. However due to the likely significant cost of structurally upgrading the school as well as providing additional elements like stairs and an elevator, the committee did not direct CTX to make any changes to the layout.

4. Next Meetings

The next meeting is scheduled for August 15th at 5:30 PM. Revised schematic plans and site plans to be developed for review.

The following meeting will be held in late August or Early September when CTX will provide budgets and cost estimates for the options. At this meeting the committee will discuss the plan for rolling out the project to the public. Some thought will need to be given to the timing as the school project will be on the Special Town Meeting scheduled for Nov 12, 2019. The Town could consider a Special Town Meeting in January for the Police and Fire project.

MILLBURY POLICE AND FIRE STATION BUILDINGS FEASIBILITY STUDY MEETING NOTES – 9.19.2019

Present:

Police Chief Donald Desorcy	Building Committee Chair
Fire Chief Richard Hamilton	Building Committee
Maxine Mann	Building Committee
Paul Concemi	Building Committee
Dan Daly	Building Committee
David Rudge	Building Committee
Brian Gasco	Building Committee
Jeff Shaw	Principal, Context Architecture (CTX)
Zel Tonic	Project Manager, Context Architecture (CTX)

Distribution:

Police Chief Donald Desorcy	Building Committee Chair
Jeff Shaw	Principal, Context Architecture (CTX)
Zel Tonic	Project Manager, Context Architecture (CTX)

File: 1902: 2.2

Chief Desorcy directed the formal acceptance of meeting minutes by the Building Committee from meetings in July, August and September 12. The Chief then proceeded to review the final CTX Police Station Plan that was revised several times by CTX since the last meeting. The revisions grew the overall footprint and total Square Footage to 18,416 GSF. The estimated cost for the Police Station at the current budget price of \$ 550/SF is \$ 10,130,000. The Fire Station plan consisting of 21,712 GSF that was approved previously and budgeted at \$ 575/SF is estimated at \$ 12,490,000.

Jeff proceeded to walk through all the line items in the Estimates of Probable Costs for both the Police and Fire Station Project Budgets. The current Probable Cost for the Police Station is \$14,686,500 and for the Fire Station is \$17,395,500. Following the descriptions of each item the Committee comments were as follows:

- Each line item needs to be further studied and priced to try to reduce the overall budget.
- The committee will do additional research to see if they can get more precise budgets line item numbers.
- CTX needs to develop a project budget for the original Police Building scheme (Renovation of exist. school building with a two story addition) to see if it would exceed the all new one story scheme.

Chief Desorcy discussed possible next steps to moving the project along to eventually get to Spring Town Meeting:

- Since the Special Fall Town Meeting will have the large School and playfields project to consider, moving this project to the spring makes sense;
- Taking the project schematic design and budget costs numbers to the Finance Committee for their input;



- Put together a package of the proposed projects to present at the Selectmen's Meeting;
- Possibly not discuss the projected budget at initial meeting?
- Look at possible funding sources that may be available to reduce some project costs;
- It's critical for the Building Committee to develop the right approach to pitch the project to town officials and eventually to the Public;
- Need some historical data regarding the cost of these types of buildings and current pricing for similar projects in the same geographical area for comparison;
- CTX will have our Cost Estimator provide as much empirical data as possible;
- Possibly develop several scenarios for presentation to the Spring Town Meeting:
 - Total Project Scope and Costs for a vote prior to Bidding (Design Fees would need to be approved prior to the presentation of the Town)
 - Only the Design Fees to be voted on, in order to proceed with Construction Documents, and Bidding, so that a Real Project Cost (General Bid in hand) could be voted on at a Special or reg. Town Meeting.
- The issue of Cost Escalation to be considered in the project planning for next year;
- The possibility of having CTX generate some schematic design renderings of the proposed Police and Fire Stations for presentation purposes was discussed by the Committee. There were differing opinions on how the visual images of the proposed buildings may affect the public support for the project and decided not to have the rendering done at this time.

Next Meeting

The next meeting is scheduled for October 3rd at 5:30 PM. The Building Committee will be initiating research into possibly reducing some project related costs by getting some real numbers from vendors and/ or utilities. CTX can use those numbers in the proposed project budget as directed. The next meeting with CTX is scheduled for October 17th at 5:30 PM.

MILLBURY POLICE AND FIRE STATION BUILDINGS FEASIBILITY STUDY MEETING NOTES – 10.17.2019

Present:

Police Chief Donald Desorcy	Building Committee Chair
Maxine Mann	Building Committee
Dan Daly	Building Committee
Brian Gasco	Building Committee
Zel Tonic	Project Manager, Context Architecture (CTX)

Distribution:

Police Chief Donald Desorcy	Building Committee Chair
Jeff Shaw	Principal, Context Architecture (CTX)
Zel Tonic	Project Manager, Context Architecture (CTX)

File: 1902: 2.2

Chief Desorcy noted that since there wasn't a Building Committee quorum there would be no votes taken on any specific action item. He also noted that the latest Context Architecture invoice will be approved and processed. The focus of this meeting was to review some of the soft cost items in the Police Station project budget in order to reduce the overall project cost as much as possible. Chief Hamilton was not present so there was no discussion with regards to the Fire Station.

The Chief has done some research by speaking to vendors with regards to the communications systems, security systems and utility charges. For the time being, the following line items will be reduced as follows:

- Furnishings and equipment – Reduce to \$ 175,000.
- Security & CCTV equipment – Reduce to \$200,000.
- Utility Fees & Backcharges – Reduce to \$ 75,000.
- Project Contingency- Reduce to 5% = \$ 668,000.
- Any additional changes will be included in the revised Project Budget.

As requested by the Chief at the last meeting, Zel presented the probable construction cost for the original proposed design scheme of renovating the existing 2 story schoolhouse building and a one story addition: Due to the cost of upgrading the existing structure inside the existing schoolhouse to qualify as a Category 4 building, as well as adding stairs and an elevator, the cost of the renovated portion is projected at \$650/SF and the one story addition at \$550/SF. The total probable cost would be \$11,418,000 vs. the all new one story building estimated at \$10,742,000.

At the request of the Building Committee at our last meeting, CTX provided a listing of recent Police and Fire station projects with the GC Bid prices and SF Costs that our cost consultant had compiled for us for this purpose. As we had discussed, the current trend is for construction related costs to be escalating at a projected rate of 5% per year. Many factors seem to be contributing to this including the cost of labor, materials and availability of qualified contractors bidding projects as well as the volume of public construction projects.



At the request of Chief Desorcy, CTX also provided the actual cost of the Southborough Public Safety Building that our office designed and is currently completing construction. That total cost (GC Bid and all Change Orders) amounted to \$16,170,222 for a 32,289 SF building, which translates to \$500/SF. That project was bid in the beginning of 2018. *It should be pointed out here that the total cost of change orders on this project represents approx. 7.5% of the original Contract Bid Price. The breakdown of the Change Orders is as follows: 4.9% Owner Initiated Changes, 1.5% Errors and Omissions and 1.1% Unforeseen Conditions. While this is higher than average, it does show why an adequate contingency should be included in the project budget and any leftover funding at the end of the job can be returned to the Town.*

In preparation for giving a project update to the Board of Selectmen next week, some strategies were discussed as to how to present the project status, process and schedule for getting to the Town Meeting next spring:

- It was decided that making the case for the Police and Fire Station projects at the Special Fall Town Meeting would not make sense due to the large School project being voted on;
- The Committee wants to get input and guidance from the Finance Committee;
- The decision on how to proceed with the Design Contract to have a full set of Construction Documents, Cost Estimates and/or Bids in hand by next Spring's Town Meeting has to be made;
- How to get approval for funding the design contracts and proceeding with the design for both buildings has to be determined;
- Due to the Cost Escalation currently happening, it would be in the BCs interest to have bids in hand by the Town Meeting in the spring;
- Waiting until spring to authorize design contract funding would delay the bidding of the project until the fall/winter of 2020.

Following the decisions regarding the next steps in the design process, Zel presented the revised proposal from our Geotechnical Engineers regarding the additional rock probes to be done on the proposed Fire Station's Elm Street Site, as has been discussed previously. The proposal was modified in consideration of the Existing Condition Survey, recently completed, and based on the approved schematic building footprint and Site plan. The proposal for this work is estimated to cost \$ 8,500. Chief Desorcy will review and get back to us.

Next Meeting

The next meeting has not been scheduled but it is assumed to be in two weeks on November 1st at 5:30 PM. Chief Desorcy to confirm.

SECTION 01 56 39

TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.
- B. All references to products by manufacturer, trade name or performance Specifications bearing the connotation "or Approved Equal" shall be as determined by the Landscape Architect and the City, per MGL c. 30 s. 39M, part b, criteria 1.

1.2 WORK INCLUDED

- A. Provide all labor, equipment, implements and materials required to furnish, install, construct and perform all site improvements complete as shown on the Drawings and specified herein.
- B. To be included, but not limited to the following:
 - 1. Tree or Plant Protection Fencing as indicated on the Drawings;
 - 2. All other temporary barriers and controls needed for protection of the public during construction.

1.3 REFERENCES

- A. Examine all other Sections of the Specifications and all Drawings for the relationship of the work under this Section and the work of other trades. Cooperate with all trades on the project and all departments of the Municipality and coordinate all work under this Section therewith.
- B. The following related items are included under the Sections listed below:
 - 1. Section 01 57 00 – Environmental Protections;
 - 2. Section 02 41 00 – Site Preparation and Demolition.

1.4 SUBMITTALS

- A. Shop Drawings and Samples
 - 1. Provide complete Shop Drawings and/or samples and catalog cuts for all items called for on the Drawings and as specified and in accordance with applicable requirements under Division 1.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original unopened and undamaged packages with labels legible and intact.
- B. Store materials in unopened packages in a manner to prevent damage from the environment and construction operations.
- C. Handle in accordance with manufacturer's instructions.
- D. The Contractor shall be solely responsible for all materials stored on the site once delivered. Any materials left unsecured at the job site shall be solely at the contractor's own risk.

PART 2 - MATERIALS

2.1 TREE PROTECTION FENCING

- A. Where indicated on the Drawings or as specified elsewhere, tree protection fencing shall be installed to protect existing trees to remain, in accordance with Part 3 below and Section 02 41 00, and with the Details shown on the Drawings.
- B. Wood fencing (if not otherwise specified elsewhere):
 - 1. Posts: 4 inch by 4 inch pressure treated wood.
 - 2. Rails: 2 inch by 4 inch pressure treated wood.
 - 3. Exposed height above grade: 6 feet.

PART 3 - EXECUTION

3.1 PROTECTION OF LANDSCAPE, TREES, AND PLANTINGS

- A. General Information:
 - 1. The Contractor shall not deface, injure, or destroy trees or shrubs nor remove or cut them without written authority from the Owner. No ropes, cables, or guys shall be fastened to or attached to any existing trees for anchorages unless specifically authorized by the Landscape Architect or Owner's Representative. Excavating machinery and cranes shall be of suitable type and be operated with care to prevent injury to trees which are not to be removed, particularly overhanging branches and limbs. The Contractor shall, in any event, be responsible for any damage resulting from such use.
 - 2. Branches, limbs, and roots shall not be cut except by permission of the Landscape Architect or Owner's Representative. All cutting shall be smoothly and neatly done without splitting or crushing. When there is unavoidable injury to branches, limbs and

trunks of trees, the injured portions shall be neatly trimmed and covered with an application of grafting wax or tree healing paint as directed.

3. All trees that may possibly be defaced, bruised, injured, or otherwise damaged by the Contractor's equipment or other operations shall be protected by placing protective measures as described in 2.1 above and 3.2 below. Any trees or landscape feature scarred or damaged by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition at the expense of the Contractor. The Landscape Architect or Owner's Representative will decide what method of restoration shall be used, and whether damaged trees shall be treated and healed or removed, disposed of, and replaced in kind.
4. Cultivated hedges, shrubs, and plants which could be injured by the Contractor's operations shall be protected by suitable means or shall be dug up, balled and temporarily replanted and maintained. After construction operations have been substantially completed, they shall be replanted in their original positions and cared for until growth is re-established. If cultivated hedges, shrubs, and plants are injured to such a degree as to affect their growth or diminish their beauty or usefulness, they shall be replaced by items of a kind and quality at least equal to that existing at the start of the work.

B. Preparation:

1. Verify that existing plant life and features designated to remain are tagged or identified.
2. Identify branches and roots that may interfere with construction.

C. Continuous Protection of Trees and Plants:

1. Protect existing trees scheduled to remain against injury or damage, including cutting, breaking, or skinning of roots, trunks or branches; smothering by stockpiled construction materials, excavated materials or vehicular traffic within branch spread.
2. Protect designated trees with a temporary 6 foot high double rail wood fence enclosure or as otherwise specified on the Drawings:
 - a. The limits of tree protection fencing shall be installed AT THE DRIP LINE of trees wherever feasible, or at the maximum extent practicable where not feasible. At NO POINT shall tree protection fencing be installed at a distance less than 3 times the caliper of the tree from the root flare.
3. Erect temporary fencing before commencing site preparation work.
4. Maintain fencing during entire construction period.
5. See also 3.2 below for further information on tree protection measures.

D. Root System Protection:

1. The Contractor shall not permit the storage of construction materials, debris, or excavated material within the drip line, which is the outer perimeter of branches.

2. The Contractor shall not permit vehicles within the drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems.
3. The Contractor shall protect tree root systems from damage due to noxious materials in solution caused by run-off or spillage during mixing and placement of construction materials or drainage from stored materials.
4. The Contractor shall protect root systems from flooding, erosion, continuous running water or excessive wetting resulting from dewatering operations.

E. Root and Branch Trimming:

1. Consult with Project Consultant to request removal of roots and branches that interfere with construction.
2. Upon Project Consultant's approval of branch or root removal, a qualified Arborist or Landscape Subcontractor trained in pruning and tree work shall:
 - a. Remove branches from trees, which shall remain, if required to clear new construction.
 - b. Carefully and cleanly cut roots and branches of trees indicated to remain, where roots and branches obstruct new construction, with sharp pruning instruments. Sterilize pruning instruments before beginning work on site, and sterilize between plants if disease is observed on site or prevalent in the region. Do not break or chop roots or branches. Use a three-part cut for large limbs. For fastest healing, prune close to the main branch without injuring the bark ridge or branch collar areas.
 - c. Recommend procedures to compensate for loss of roots and perform initial pruning of branches and stimulation of root growth where removed to accommodate new construction.
 - d. Extend pruning operation to restore natural shape of entire tree.

F. Excavation Around Trees:

1. Excavate within drip line of trees only where indicated.
2. Where trenching for utilities is required within the drip line, tunnel around roots by hand digging.
3. Do not cut main lateral roots or tap roots; cut smaller roots, which interfere with installation of new work.
4. Cut roots with sharp pruning instruments: Do not break or chop.
5. Do not allow exposed roots to dry out before permanent backfill is placed:
 - a. Provide temporary earth cover, or pack with peat moss and wrap with burlap.
 - b. Water and maintain in moist condition and temporarily support and protect from damage until permanently relocated and covered with earth.

- c. Landscape sub-contractor shall prune branches to balance loss to root system caused by damage or cutting of root system.

G. Grading and Filling Around Trees:

1. Maintain existing grade within drip line of trees, unless otherwise indicated.
2. Lowering Grades:
 - a. Where existing grade is above new finish grade shown around trees, carefully hand excavate within drip line to new finish grade.
 - b. Cut roots exposed by excavation or provide permanent protections as recommended by Landscape sub-contractor.

H. Raising Grades:

1. Minor Filling:
 - a. Where existing grade is six inches or less below elevation of finish grade shown, use a topsoil fill material.
 - b. Place in single layers and do not compact; hand grade to required finish elevations.
2. Moderate Filling:
 - a. Where existing grade is more than 6 inches, but less than 12 inches, below finish grade elevation, place a layer of drainage fill on existing grade prior to placing topsoil.
 - b. Balance of area within drip line perimeter: Place drainage fill to an elevation six inches below grade and complete fill with a layer of topsoil to finish grade elevation.
 - c. Do not compact stone/gravel or topsoil layers; hand grade to required elevations.

I. Repair and Replacement of Trees:

1. Repair trees damaged by construction operations. Damage shall be assessed with Landscape Architect and Owner prior to repairs. Make repairs promptly after damage occurs to prevent progressive deterioration of damaged trees.
2. Remove and replace dead and damaged trees, which are determined by the Landscape sub-contractor shall be incapable of restoration to normal growth pattern.
3. Provide new trees of same size and species as those replaced, up to 6 inch caliper. For replacement of trees over 6 inches in caliper taken 12 inches above grade, provide new trees of 6 inch caliper, and of the same species as selected by the Project Consultant.

4. Repair and replacement of trees scheduled to remain and damaged by construction operations or lack of adequate protection during construction operations shall be at Contractor's expense.

3.2 SPECIFIC MEASURES FOR TREE PROTECTION

- A. All existing trees not specifically indicated for removal or transplanting on the Drawings shall be protected as identified below.
- B. Tree protection fencing shall be installed and maintained throughout the period of construction as shown on the Drawings; specific attention is directed to the Demolition and Removals Plan.
 1. The limits of tree protection fencing shall be installed AT THE DRIP LINE of trees wherever feasible, or at the maximum extent practicable where not feasible. At NO POINT shall tree protection fencing be installed at a distance less than 3 times the caliper of the tree from the root flare.
 2. Prior to commencing any demolition or removals, the Contractor shall lay out all paving and demolition required within the drip lines of all trees, and shall establish in the field with the Landscape Architect and the Owner's Representative the extents and limits of tree protection fencing to be installed.
 3. IF, AFTER DEMOLITION IS COMPLETE, TREE PROTECTION FENCING CAN BE EXPANDED TO COVER A GREATER AREA, THE CONTRACTOR SHALL REVISE THE FENCING LINE AS DIRECTED BY THE LANDSCAPE ARCHITECT OR OWNER'S REPRESENTATIVE.
 4. Areas within tree protection fencing shall be protected from disturbance, excavation, and compaction.
- C. ALL EXCAVATIONS and ALL REMOVALS within the drip lines of existing trees (NOT limited to areas within tree protection fencing) shall be HAND WORK or AIR SPADE only. Cut no roots without the express permission of Landscape Architect or Owner's Representative.
- D. DO NOT REMOVE any existing drainage fabric, soil separator fabric, or other geotextiles in the vicinity of protected trees without the prior approval of the Landscape Architect or Owner's Representative to avoid damage to feeder roots which often intertwine with the fabric. Where necessary, Contractor shall cut fabric and leave areas entangled by roots in place in the ground.
- E. For all earthwork, excavation, and removals within the driplines of protected trees (not limited to areas within designated tree protection fencing), the Owner's Representative or Landscape Architect must be present on the site or have specifically waived that obligation in writing to the Contractor to ensure tree protection measures are being observed. Provide 48 hours' notice prior to commencement of all such work.

3.3 REMOVAL OF TEMPORARY BARRIERS, ENCLOSURES AND PROTECTIONS

- A. Remove temporary barriers, barricades, fencing, enclosures and protections as warranted by the progress of the Work and prior to Substantial Completion. Tree Protection Fencing shall not be removed except after specific approval by the Landscape Architect or Owner's Representative.
- B. Clean and repair damage caused by installation or use of temporary work.
- C. Restore existing facilities used during construction to original condition at start of work or as specified elsewhere in the Contract Documents.
- D. Restore permanent facilities used during construction to specified condition.

END OF SECTION

THIS PAGE INTENTIONALLY
LEFT BLANK

Section 03 30 00

CAST-IN-PLACE CONCRETE

PART 1- GENERAL

1.1 GENERAL PROVISIONS

- A. All of the Contract Documents, including General and Supplementary General Conditions and Division 1 General Requirements, apply to the work of this Section.

1.2 WORK TO BE PERFORMED

- A. Labor, materials, equipment, services and transportation required to complete cast-in-place concrete work shown on Drawings, as specified herein, or both, including but not limited to items noted below.
1. Furnishing, placing, curing, finishing, and protection of reinforced cast-in-place concrete (normalweight and lightweight) above and below grade.
 2. Furnishing and erection of formwork, shoring and removal of same.
 3. Furnishing and placing of reinforcing steel and related positioning and securing accessories.
 4. Furnishing and installation of admixtures, inserts for connections to steel members, waterstops, flashing reglets, and similar items in conjunction with concrete work.
 5. Installation of anchor bolts.
 6. Furnishing and installation of non-shrink grout at pockets in concrete slabs, walls, or beams left open temporarily, and at other locations as applicable (including baseplates at steel columns).
 7. Furnishing and installation of concrete housekeeping pads, inertia blocks, and foundations for mechanical, plumbing, and electrical equipment.
 8. Installation of items furnished by other sections (such as anchors, sleeves, bolts and plates), and required to be cast into concrete.
 9. Concrete fill in steel stairs.
 10. Make provisions in forms for proper location and installation of pipe sleeves, duct openings, keys, chases, electrical boxes, bolts, anchors, inserts, and similar items, as required by other trades. Notify appropriate trades when items noted are ready for installation.
 11. Patching of concrete floors or walls where concrete is removed by demolition for new work, new equipment or utilities. Filling and patching of existing concrete floors where required to provide for new floor finishes or to close openings remaining from the removal of existing work, equipment or utilities to be removed as part of the work of this contract.
 12. Unless specifically excluded, furnishing and installation of any other items of cast-in-place concrete work indicated on drawings, specified, or obviously needed to make work of this Section complete.

1.3 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
1. Division 31, Earthwork
 2. Section 042000, Unit Masonry
 3. Section 051200, Structural Steel
 4. Section 053100, Steel Deck
 5. Section 055000, Metal Fabrications
 6. Division 7, Thermal and Moisture Protection

1.4 SUBMITTALS

- A. Concrete Constituents:
1. Submit to Architect a detailed list of concrete materials, and corresponding sources, proposed for use in concrete for this project.
 2. See paragraph 2.02.B below for submittal of strength information related to mix design.
 3. If conveying concrete by pump is intended, submit related data regarding concrete materials, pumping device, and methods to Architect. Consider effects of slump loss if lightweight concrete will be pumped; provide HRWR rather than water to maintain workability.
 4. When high-range water reducing admixtures will be used for water-cement ratios equal to or less than 0.45, submit information from manufacturer and batching plant on dosage amounts; timing of dosage(s) (e.g., in plant, at site, repeat dosages, etc.); initial and final slumps; quality control of dosing and mixing.
 5. Tests for approval of concrete mixtures shall be paid for by Contractor.
- B. Methods of Construction: Submit to Architect, prior to starting work, description of methods, sequence of construction, and type of equipment proposed for use for performing cast-in-place concrete work. Submit typical layouts for shoring and reshoring and size and spacing of supports. Provide specific construction loads to be imposed on permanent structure.
- Architect's review is only for the effects of methods on permanent structure. This submission shall not relieve Contractor of his responsibility for providing structural design for methods and equipment, and the necessary methods, equipment, workmanship, and safety precautions.
- C. Shop Drawings: Submit to Architect detailed Shop Drawings, including erection drawings and schedules.
1. Reinforcement Drawings: prepare in accordance with ACI SP-66 Detailing Manual and show following: elevations; dimensions of concrete work with specified

reinforcement clearances; ledges, brackets, openings, sleeves or other items furnished by other Sections, where interference with reinforcement may occur; bending diagrams; assembly diagrams; splices and laps of reinforcement; temperature and shrinkage reinforcement; construction joint reinforcement; and shapes, dimensions, grade designations, and details of reinforcement and accessories. Show dowels with concrete work to be placed first and for connection to existing construction where required.

2. Formwork Drawings: schedules of placement; construction joints and control joints with methods of forming; general arrangement, sizes and grades of lumber and wood panels; alignment and layout of form ties for exposed concrete; location of embedded items and pockets. Submittal is for verification of joint and surface appearance. Comply with ACI 303-91 Guide to Cast-in-Place Architectural Concrete Practice where exposed concrete or special architectural treatment is required on the Drawings. This submission does not relieve Contractor of his responsibility for providing structural design for formwork and the proper methods, equipment, workmanship and safety precautions.
 3. Architect's checking is only a review for conformance with the design concept of the project and compliance with the information given in the contract documents. The Contractor is responsible for: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating this work with that of all other trades; coordinating this work with existing construction; and performing the work in a safe and satisfactory manner.
 4. Do not proceed with fabrication of material or performance of work until corresponding item on Shop Drawing has been reviewed by Architect.
- D. Samples: Submit to Architect samples and/or descriptive literature of materials, products, and methods as noted herein, and as otherwise requested by Architect: concrete constituents including admixtures; form ties (including cones) and spreaders; accessories for reinforcement; reglets; non-shrink cement grout; inserts; form release agents, and waterstops.
1. Do not proceed with fabrication of material/product or performance of work until Sample has been approved by Architect.
- E. Concrete Curing and Protection: Submit to Architect detailed methods proposed for curing and protecting concrete in normal, cold and hot conditions.
- F. Mill Test Certification: Submit to Architect prior to delivery of reinforcing steel or concrete to job site, certified mill test reports of reinforcing steel and cement, (including names and locations of mills and shops, and analyses of chemical and physical properties), properly correlated to concrete to be used in this project. This submittal is for information and file record.
- G. Corrective Work: Submit to Architect drawings showing details of any proposed corrective work prior to performing corrective work.
- H. Affidavit: Submit to Architect, on request by Architect, manufacturer's and/or supplier's and/or installer's affidavit stating that material or product provided complies with Contract Documents.

1.5 REFERENCE STANDARDS, SPECIFICATIONS, AND CODES

- A. Except as otherwise specified herein, perform work in accordance with specifications noted below, including latest editions of applicable specifications, codes, and standards cited therein, and latest applicable addenda and supplements. Keep copies of these items available in shop and field.
1. "The Commonwealth of Massachusetts State Building Code", ninth edition.
 2. "The International Building Code", 2015 edition.
 3. "Building Code Requirements for Reinforced Concrete" (ACI 318-14), American Concrete Institute.
 4. "Specifications for Structural Concrete for Buildings" (ACI 301-14), American Concrete Institute.
 5. "Detailing Manual" (ACI SP-66), 1994, American Concrete Institute.
 6. "Manual of Standard Practice" (MSP-1-96), Concrete Reinforcing Steel Institute (CRSI).
 7. "Structural Welding Code - Reinforcing Steel" (AWS D1.4-92), American Welding Society.
 8. "Manual of Concrete Practice 2005", Volumes 1 through 5, American Concrete Institute for ACI Standards and Recommended Practices referred to in this Section.
 9. American Society for Testing and Materials (ASTM) Standards referenced in this Section.
- B. Any material or operation specified by reference to published specifications of manufacturer or published standard shall comply with said specification or standard. In case of conflict between referenced specifications, most stringent requirement shall govern. In case of conflict between referenced specifications and Project Specifications, Project Specifications shall govern unless otherwise indicated by Architect in writing.

1.6 QUALITY ASSURANCE

- A. Pre-Construction Meeting
1. Adopt a quality control program which will ensure compliance with specified requirements and industry standards. Appoint a person on the construction management team to be responsible for quality issues, and prepare a quality control manual which outlines proposed methods for monitoring reinforcing steel placement and concrete placement consolidation and curing.
 2. Prior to the start of concrete work, a pre-construction meeting shall be held at which representatives of the Owner, Construction Manager, Architect and Testing

Agency and key personnel of the Contractor and Subcontractor shall be present. Key personnel shall include persons who will supply and mix special admixtures such as HRWR; who will place reinforcing and concrete; who will consolidate and cure the concrete. Attendance at the meeting of all parties is mandatory. Discussions at the meeting shall form the basis for the performance and inspection of concrete work.

3. Prior to the start of any item of new work, the specifications and drawings shall be reviewed at a formal meeting at which the Contractor's and Subcontractor's key personnel are present. Key personnel shall include persons actually carrying out the work in the field.

1.7 SUBSTITUTIONS

- A. Substitutions for member sizes, type(s) of concrete, details or any other modifications proposed by Contractor will be considered by Architect only under following conditions:
 1. That request has been made in writing and accepted prior to submission of Shop Drawings.
 2. That there is a substantial cost advantage or time advantage to Owner; or that proposed revision is necessary to obtain required materials or methods at proper times to accomplish work in time scheduled.
 3. That sufficient sketches, engineering calculations, and other data have been submitted to facilitate checking by Architect, including documentation of cost reductions or of savings in time to complete work.

PART 2- PRODUCTS

2.1 CONCRETE CONSTITUENTS

- A. Cement: shall be domestic-made Portland Cement, free from water soluble salts or alkalies which will cause efflorescence on exposed surfaces. Portland Cement shall be Type II, ASTM C150. Do not use air entraining cements. Use only one brand of cement for each type of cement throughout project. No visual variations in color shall result in exposed concrete.
- B. Fly Ash: ASTM C618, Type C of F; fly ash shall not exceed 25% of cement content by weight.
- C. Granulated Blast Furnace Slag: ASTM A989 Grade 120.
- D. Normalweight Fine Aggregate: shall be washed, inert, natural sand conforming to ASTM C33 and following additional requirements:

Sieve	Retained Percent
#4	0 - 5
#16	25 - 40
#50	70 - 87

Sieve	Retained Percent
#100	93 - 97
Fineness Modulus	2.80 (Plus/Minus 0.20)
Organic	Plate 2 maximum
Silt	2.0 percent maximum
Mortar Strength	100 percent minimum compression ratio
Soundness	5 percent max. loss, magnesium sulfate, five cycles

Normalweight Coarse Aggregate: shall be well-graded crushed stone or washed gravel conforming to ASTM C33 and following additional requirements:

Designated Size (inches)							
	3	2	1-1/2	1	3/4	1/2	3/8
FM (+/- 0.2)	7.95	7.45	7.20	6.95	6.70	6.10	5.50
Organic	Plate 1 maximum						
Silt	1.0 percent maximum						
Soundness	5 percent maximum loss, magnesium sulfate, five cycles.						

Maximum designated sizes for normalweight coarse aggregate to be used in concrete sections shall be as noted below, except that sizes shall also be chosen in conjunction with required clearances.

- a. One and one-half inches for sections over ten inches in thickness.
 - b. One inch for sections more than eight and up to ten inches in thickness.
 - c. Three-quarter inch for sections more than three and up to eight inches in thickness.
- F. Lightweight Fine and Coarse Aggregates: shall be a rotary kiln expanded shale and conform to ASTM C330 and as specified herein. Aggregate sizes shall include fine aggregate designated as "sand size", and coarse aggregate designated as graded three-quarter inch size.
- G. Concrete Fill for Steel Stair and Landing Pans: shall be composed of 1:2:2 mix with three-eighths inch maximum size aggregate and shall be placed with a 0 inch to 1 inch slump.
- H. Water: shall be from approved source, potable, clean and free from oils, acids, alkali, organic matter and other deleterious material.

I. Admixtures:

1. Water-reducing admixture: Shall comply with ANSI/ASTM C494, Type A and contain no more than .05% chloride ions.
 - a. "WRDA with Hycol", W.R. Grace & Co.
 - b. "Eucon WR-75", The Euclid Chemical Co.
 - c. "Pozzolith 220N", Master Builder's Co.
 - d. Or approved equivalent conforming to ASTM C494.
2. High-Range Water Reducing (HRWR) admixture (Super Plasticizer): shall comply with ASTM C494, Type F or Type G and contain not more than 0.05% chloride ions:
 - a. "WRDA 19", W.R. Grace & Co.
 - b. "Daracem 100", W.R. Grace & Co.
 - c. "Eucon 37", Euclid Chemical Co.
 - d. "Sikament", Sika Chemical Corp.
 - e. "Rheobuild-1000", Master Builder's Co.
 - f. Or approved equivalent.
3. Air-entraining admixture: shall comply with ANSI/ASTM C 260.
 - a. "Daravair", W.R. Grace & Co.
 - b. "Airmix or Perma-Air", The Euclid Chemical Co.
 - c. "MB-VR", Master Builder's Co.
 - d. Or approved equivalent.
4. Evaporation retarder: use water-based monomolecular film; use one of the following with flatwork containing corrosion inhibitor or silica fume admixture:
 - a. "Confilm"; Master Builders.
 - b. "Euco-bar"; Euclid Chemical Co.
 - c. Or approved equivalent.
5. Water-reducing Set Retarders: shall conform with ASTM C494 Type D and may be used when ambient temperatures exceed 80 degrees F. Use one of the following or equivalent:
 - a. "Daratard-17"; W.R. Grace.

- b. "Eucon Retarder"; Euclid Chemical Co.
- c. Pozzolith 100-XR"; Master Builders.
- 6. Accelerator admixture: Non-chloride and non-corrosive accelerators shall conform to ASTM C494 Type C and may be used when temperatures are below 50 degrees F. Use one of the following or equivalent:
 - a. "Daraset"; W.R. Grace
 - b. "Accelguard 80"; Euclid Chemical Co.
 - c. "Pozzutec 20"; Master Builders.
- 7. Fiber Reinforcement: shall be "Strux 90/40" by the W.R. Grace Co. or approved equal.
- 8. Prohibited admixtures: Calcium chloride, thiocyanates and admixtures containing more than .05% chloride ions are not permitted.

2.2 CONCRETE MIXTURES

- A. Proportion concrete on the basis of previous field experiences or laboratory trial batches with the materials to be employed in the work. However, mixtures shall have the limiting quantities or values listed below for each strength concrete with coarse aggregate less than 1½ inches.

Compressive Strength at 28 days PSI	Maximum Allowable Net Water Content		Min. Cement Factor	
	Gal./Sack	W/C Ratio	Sacks/Cu.Yd	Lbs./Cu.Yd.
Normalweight 4000	5.75	0.51	6.00	564
3000	6.50	0.58	5.00	470
Lightweight 3000	as required		5.50	517

Maximum allowable net water content is the total water in the mix at the time of mixing, including free water on aggregate.

- 2. Consider any fly ash or blast furnace slag as part of the cement content for purposes of establishing cement factor and w/c ratio.
 - a. Fly Ash/ Portland Cement Replacement: Fly ash, in proportions not greater than 25% by weight of the total amount of cementitious materials. Cement content and/or water-cement ratio for mixes containing fly ash shall be

- based on the total weight of cementitious materials (Portland Cement plus fly ash).
- b. Granulated Blast Furnace Slag/ Portland Cement Replacement:
Granulated blast furnace slag may be substituted for Portland Cement in proportions ranging from 25 to 33% by weight of the total amount of cementitious materials. Cement content and/or water-cement ratio for mixes containing blast furnace slag shall be based on the total weight of cementitious materials. (Portland Cement plus blast furnace slag.)
 - c. When combined, the total of fly ash and granulated blast furnace slag substituted for Portland Cement shall not exceed 33% by weight of the total amount of cementitious materials.
3. Consider any fly ash as part of the cement content for purposes of establishing cement factor and w/c ratio.
 4. Use maximum water-cement equal to 0.45 for concrete subject to freezing and thawing, repeated surface wetting or deicers.
 5. Use High-Range Water Reducing admixture for water-cement ratios equal to or less than 0.45.
- B. Field Experience Method: when a concrete production facility has a record of consecutive strength tests that were made within the past 12 months, compute standard deviations and the required average compressive strength in accordance with ACI 301 Paragraph 3.9.1 and 3.9.2.
1. Analysis of standard deviation, average compressive strength and proposed concrete proportions shall be performed by Testing Agency paid by the Contractor. The mix design shall be by the Contractor.
 2. Submit proposed concrete proportions and supporting documentation to Architect.
- C. When an acceptable record of field test results is not available, base concrete proportions on trial mixtures meeting the following restrictions:
1. Use the combination of materials proposed for use in the work.
 2. Make trial mixtures having proportions and consistencies suitable for the proposed work using at least three different water-cement ratios or, for lightweight concrete, cement contents that will produce a range of strengths encompassing those required for the proposed work.
 3. Design trial mixtures to produce a slump within 1 inch of the maximum permitted, and for air-entrained concrete, within 0.5 percent of the maximum allowable air content. Report the temperature of freshly mixed concrete in the trial mixtures.
 4. For each proposed mixture, make and cure at least three compressive test cylinders for each age in accordance with ASTM C192. For normalweight concrete, each change of water-cement ratio shall be considered a new mixture. Test the cylinders for strength in accordance with ASTM C39 at 28 days or at a specified earlier or later age.

5. From the results of these cylinder tests, plot a curve showing the relationship between compressive strength and either the water-cement ratio for normalweight concrete, or cement content for lightweight concrete.
6. From this curve, the water-cement ratio for normalweight concrete, or cement content for lightweight concrete for the concrete to be used in the proposed work, shall be selected to produce an average compressive strength 1200 psi higher than the specified strength. The cement content and mixture proportions to be used shall be such that the selected water-cement ratio or cement content is not exceeded when slump is the maximum permitted. Maintain proper cement content, slump, and air content.

D. Admixtures

1. Use air entrainment admixture in concrete exposed to exterior environment and in accordance with manufacturer's written instructions. Interior protected concrete may be air entrained for improved workability. See ACI 301 Table 3.4.1 for required air content except that minimum for all sizes of aggregate shall be 6 percent in exterior environment. Interior protected slab-on-grade concrete may **not** have air entrainment admixtures.
2. Use water reducing admixture in concrete and in accordance with manufacturer's written recommendations and instructions.
3. Use high-range water reducing (HRWR):
 - a. In concrete with water-cement ratios equal to or less than 0.45, but do not exceed 8 inches slump. In concrete for slab-on-grade, a mid-range water reducer may be used in stead of adding water with a maximum slump of 6 inches.
 - b. In concrete where anticipated slump losses in transit prevent proper pumping, placing and finishing. Use HRWR instead of adding water at the site. Do not exceed 8 inches slump.

E. Slump shall be in accordance with Part 3 of this Section.

F. Normalweight concrete shall have an air dry weight not exceeding 150 lbs. per cubic foot.

1. Design 28 day strengths as shown in the Drawings.

G. Structural lightweight concrete shall have an air dry unit weight from 110 to 115 lbs. per cubic foot and a wet density not exceeding 120 lbs. per cubic foot. Weights shall be determined in accordance with ASTM C567 and C138.

1. Splitting tensile strength determined in accordance with ASTM C330 and C496 shall equal or exceed $6.7 \times \text{square root of } f'_c$, psi.
2. Design 28 day strengths as shown in the Structural Drawings.

H. Any deviation from approved mix design will not be allowed without written approval of

Architect. Cost of any additional testing by Testing Agency associated therewith shall be paid for by Contractor.

2.3 FORM MATERIALS

A. Exposed-to-View Surfaces:

1. Use new and unused Class 1 B-B High Density Overlaid Plyform, exterior grade, not less than five ply, and not less than 5/8 inch thick conforming to U.S. Product Standard P-1-83. Design and maintain forms in accordance with instructions in American Plywood Association (APA) Manual "Concrete Forming" (Form No. V345N/Revised June 87/5000).

B. Not-exposed-to-view Concrete Surfaces: Use forms of wood, metal, or other material subject to approval of Architect.

C. Form Ties and Spreaders: Use products by Richmond Screw Anchor Co.; Superior Concrete Accessories, Inc.; Dayton Sure-Grip and Shore Co.; or equivalent approved by Architect. Wire ties shall not be used. Ties for concrete exposed to public view shall have removable set-back cones. Ties for foundation walls shall have water seal washers on the earth side.

D. Form Release Agent: Use a non-staining and non-emulsifiable type. Form release agent shall not impart any stain to concrete nor interfere with adherence of any material to be applied later to concrete surfaces.

2.4 REINFORCEMENT AND ACCESSORIES

A. Reinforcing Steel Bars: shall be newly rolled billet steel conforming to ASTM A615. (See Structural Drawings for grades.) Bars shall be bent cold.

B. Welded Wire Fabric: shall conform to ASTM A185.

C. Reinforcement Accessories: Reinforcement accessories shall include spacers, chairs, ties, slab bolsters, clips, chair bars, and other devices for properly assembling, placing, spacing, supporting, and fastening reinforcement. Tie wire shall be annealed wire of sufficient strength for intended purpose, but not less than No. 18 gage. Bar supports shall conform to Chapter 3, "Bar Supports" or CRSI Manual of Standard Practice. Supports touching interior formed surfaces exposed to view shall be CRSI Class 1, plastic protected.

2.5 RELATED MATERIALS

A. Vapor Barrier: Provide vapor barrier over prepared base material beneath slabs on ground. Use only materials which have a moisture transmission rate of less than 0.01 grains per square foot per hour and meet the requirements of ASTM E1745 and ASTM E1643. Use polyethylene sheet not less than 10 mils thick or approved equivalent such as the following:

1. "Premoulded Membrane" by WR Meadows
2. "Vapor Guard" by Griffolyn (Reef Industries)

-
3. "15 mil Stego Wrap" by Stego Industries
- B. Non-shrink Grout: Use CRD-C 621, factory pre-mixed grout, Type D, non-metallic, such as one of the following or an approved equivalent:
1. "Masterflow 928"; Master Builders.
 2. "Euco-NS"; Euclid Chemical Co.
 3. "Five Star Grout"; Five Star Products.
- C. Non-slip Aggregate Finish: Use fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40% aluminum oxide and not less than 25% ferric oxide. Use material that is factory-graded, packaged, rust-proof and non-glazing, and is unaffected by freezing, moisture and cleaning materials.
- D. Absorptive Cover: Use burlap cloth weighing approximately 9 oz. per sq. yd., complying with AASHTO M 182, Class 2.
- E. Moisture-retaining Cover: Use one of the following, complying with ANSI/ASTM C 171:
1. Waterproof paper.
 2. Polyethylene film.
 3. Polyethylene-coated burlap.
- F. Curing Compounds: Verify that products listed below meet regulations of jurisdiction for Volatile Organic Compounds (VOC) emissions. Notify Architect if listed products do not comply and submit information about equivalent products that do comply.
1. Curing and Sealing Compound: Use a clear acrylic type conforming to ASTM C309, Type I, Class B. Use one of the following or equivalent where concrete surfaces will remain exposed.
 - a. "Masterkure"; Master Builders.
 - b. "Super Rez Seal"; Euclid Chemical Co.
 - c. "Dress & Seal #30"; L & M
 - d. "Intex"; W.R. Meadows
 2. Curing and Hardening Compound: Use colorless solution containing 35% of a 42 degree Baume sodium silicate solution. Use where shown on drawings. Use one of the following or equivalent:
 - a. "Chem-Hard"; L & M
 - b. "Eucosil"; Euclid Chemical Co.
 - c. "Cure-hard"; W.R. Meadow

3. Dissipating Resin Curing Compound: Use a dissipating resin type compound, conforming to ASTM C309, Type I. The film must chemically break down in a two-to-four week period. Use one of the following or equivalent where concrete surfaces will receive other materials:
 - a. "Kurez DR"; Euclid Chemical Co.
 - b. "3100"; W.R. Meadows
 - c. "Cure Resin"; L & M
- G. Bonding Agent, Patching Mortar: Cementitious slurry containing polymer-modified latex admixture, such as one of the following:
 1. "SikaTop 121, 122 or 123"; Sika Corporation
 2. "Flexcon"; Euclid Chemical Co.
 3. "Everbond"; L & M
- H. Expansion Bolts: Use hot-dipped galvanized bolt conforming to Federal Spec. FF-S-325, Group II, Type 4, Class 1. Allowable pullout and shear values shall be based on ASTM E 488 test methods. See Drawings for diameters, edge distances, embedments and center-to-center spacings. Use one of the following or equivalent approved by Architect:
 1. "Molly Parabolt"; USM Corp.
 2. "Kwik Bolt II"; Hilti Inc.
 3. "Red Head Trubolt Wedge Anchor"; ITW Ramset/Redhead
- I. Waterstops: Provide one of the following types of waterstops where shown on the drawings:
 1. Provide laminate of bentonite and high density polyethylene, such as "Parastop" by Paramount Technical Products, between the contact faces of construction joints. Install in strict accordance with manufacturer's instructions.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine work prepared by other trades to receive work of this Section and report any defects affecting installation to the Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.

3.2 HANDLING, STORAGE, AND PROTECTION OF MATERIALS

- A. Handle and store materials separately in such manner as to prevent intrusion of foreign matter, segregation, or deterioration. Do not use foreign materials or those containing ice. Remove improper and rejected materials immediately from point of use and from

the site. Cover materials, including steel reinforcement and accessories, during construction period. Stockpile concrete constituents properly to assure uniformity throughout project.

3.3 ERECTION OF FORMWORK

- A. Set and maintain formwork to insure complete concrete work within tolerance limits listed in ACI 301, Table 4.3.1.
- B. At construction joints, overlap and clamp forms (using gaskets if necessary) to prevent offsets or loss of mortar at joints.
- C. Before reusing form materials, thoroughly clean surfaces that will be in contact with freshly cast concrete, repair damaged areas and withdraw projecting nails. Recoat form with release agent. Re-use of form material for architecturally exposed concrete shall be subject to approval by Architect.

3.4 PLACING OF REINFORCEMENT

- A. Place reinforcement in accordance with requirements of CRSI "Placing Reinforcing Bars".
- B. Place reinforcement in accordance with ACI 117 (Tolerances) and with Contract Documents and secure firmly in position by wire ties, chairs, spacers, and hangers, each of type approved by Architect.
- C. Do not bend, tackweld or cut reinforcement in field in any manner other than as shown on Drawings unless specific approval for each case is given by Architect.
- D. Continue reinforcement through construction joints unless otherwise indicated on Drawings.
- E. Splice reinforcement only in accordance with requirements of Contract Documents or as otherwise specifically approved by Architect. Do not splice reinforcement at points of maximum stress unless shown on the Drawings. Welded wire fabric shall be lapped six inches or one and one-half spaces, whichever is larger, and shall be wired together.
- F. At time concrete is placed, reinforcement shall be free of excessive rust, scale, or other coatings that will destroy or reduce bond. Paint reinforcement expected to be exposed to weather for a considerable length of time with a heavy coat of cement grout. Protect stored materials so as not to bend or distort bars in any way. Bars that become damaged will be rejected.
- G. Before concrete is cast, check all reinforcement after it is placed to insure that reinforcement conforms to Contract Documents and approved Shop Drawings. Such checking shall be done only by qualified experienced personnel. In addition, notify the Architect at least 36 hours prior to concrete placement so a visit may be made to observe completed reinforcement and formwork before concrete placement.

3.5 JOINTS

- A. Construction and control joints indicated on Drawings are mandatory and shall not be omitted.

1. Slab Control Joints: may be constructed by inserting hardpressed fiberboard or plastic strips into the plastic concrete, or by cutting the concrete with a saw after it has set. Make joints 1/8 inch wide and the depth of 1/4 the slab thickness or the maximum size of the coarse aggregate, whichever is greater.
 - a. Insert fiberboard or plastic strips into a groove tooled into the concrete after the first floating. Use a U-shaped sheet metal device fitted over the top to insert the strips.
 - b. Saw joint early enough to prevent uncontrolled cracking in the slab, but late enough that this can be accomplished without appreciable spalling. Cut joints to true alignment and in sequence of concrete placement. Remove sludge and cutting debris.
- B. Wall Control Joints: Suspend preformed key in center of wall form and directly opposite any vertical reglets on face of form.
- C. Joints not indicated or specified shall be placed to least impair strength of structure and shall be subject to approval of Architect.

3.6 INSTALLATION OF EMBEDDED ITEMS

- A. Conform to requirements of ACI-318, paragraph 6.3, "Conduits and Pipes Embedded in Concrete", and as specified below.
- B. Install steel sleeves, furnished by other trades, at locations shown on the drawings.
- C. Install anchor bolts for column baseplates in accordance with AISC Code of Standard Practice, Paragraph 7.5 and the following: Use setting plate templates. Maintain elevations and plan locations of bolt groups within one-quarter inch of the locations shown on the drawings. Place individual bolts in a bolt group within one-eighth inch of center-to-center dimensions shown on the drawings.

3.7 MIXING, CONSISTENCY, AND DELIVERY OF CONCRETE

- A. Use ready-mixed concrete produced by plant acceptable to Architect. Hand or site mixing shall not be done. Batch constituents, including admixtures, at central plant. Admixtures shall be premixed in solution form and dispensed as recommended by manufacturer.
- B. Concrete shall arrive at the job site at a slump of 2 to 3 inches and at the time of deposit shall be as follows:

Portion of Structure	S L U M P	
	Recommended	Maximum Range
Walls, Columns	4"	3" - 5"
Slabs, Beams	3"	2" - 4"

If high-range water reducing admixture (superplasticizer) is used, it may be added at the job site after verifying that the delivery slump is 2 to 3 inches. Maximum slump after adding HRWR shall be 8 inches.

2. For lightweight concrete, use HRWR to offset slump loss between charging and discharging ends of pumping system.
 3. For normalweight concrete, water may be added at the site only to make up water withheld at the plant. Batching plant shall document on the driver's delivery ticket any water withheld at the plant. When water has not been withheld and slump is too low for proper handling of concrete, use HRWR to bring slump within specified range.
- C. Transport ready mixed concrete to site in watertight agitator or mixer trucks loaded not in excess of rated capacities. Discharge at site within one and one-half hours after cement was first introduced into mix. Do not use concrete with a temperature greater than 85 degrees F. Central mixed concrete shall be plant mixed a minimum of five minutes. Agitation shall begin immediately after premixed concrete is placed in truck and shall continue without interruption until discharged. Transit mixed concrete shall be mixed at mixing speed for at least ten minutes immediately after charging truck followed by agitation without interruption until discharged.
- D. Do not retemper (mixing with or without additional cement, aggregates, or water) concrete which has partially hardened.

3.8 PLACING CONCRETE

- A. If concrete pumping is proposed, refer to "Submittals, Concrete Constituents", in this Section for requirements. If lightweight concrete pumping is proposed, use a pipe diameter of 5 inches. Concrete may be placed into the pump at the maximum but not more than the specified slump.
- B. Remove water and foreign matter from forms and excavations and, except in freezing weather or as otherwise directed, thoroughly soak wood forms just prior to placing concrete. Place no concrete on frozen soil and provide adequate protection against frost action during freezing weather.
- C. To secure bond at construction joints, thoroughly clean concrete surfaces with water jet or compressed air. Before new concrete is deposited, saturate joint surface with water.
- D. Do not place concrete having slump outside of allowable slump range. The loss of slump between pump and discharge end of pipeline shall not exceed two inches.
- E. Transport concrete from mixer to place of final deposit as rapidly as practical by methods which prevent separation of ingredients and displacement of reinforcement, and which avoid rehandling. Deposit no partially hardened concrete. When concrete is conveyed by chutes, equipment shall be of such size and U-shaped design as to insure continuous flow in chute. Do not use flat (coal) chutes. Use metal or metal lined chutes with different portions having approximately the same slope. Slope shall not be less than 25 degrees nor more than 45 degrees from horizontal. Use a baffle or spout at the discharge end of the chute to prevent segregation. If discharge end of chute is more than five feet above surface of concrete in forms, use spout with its lower end at surface of deposit. When operation is intermittent, discharge chute into hopper. Do not

allow concrete to flow horizontally over distances exceeding five feet.

- F. Place concrete in such manner as to prevent segregation and accumulations of hardened concrete on forms or reinforcement above mass of concrete being placed. To achieve this end, use suitable hoppers, spouts with restricted outlets and tremies as required.
- G. During and immediately after depositing, compact concrete in accordance with ACI 309 by means of internal type mechanical vibrators or other tools to produce required quality of finish. Vibration shall be done by experienced operators under close supervision and shall be carried on only enough to produce homogeneity and optimum consolidation without permitting segregation of constituents or "pumping" of air. Vibrators used for normalweight concrete shall operate at speed of not less than 7,000 rpm and be of suitable capacity. Do not use vibrators to move concrete. Keep at least one vibrator on hand for every 10 cubic yards of concrete placed per hour, plus one spare. Vibrators shall be operable and on site prior to starting placement.
- H. Place vertical lifts not to exceed 18 inches. Vibrate through successive lifts to avoid pour lines. Vibrate first lift thoroughly until top of lift glistens to avoid stone pockets, honeycomb, and segregation.
- I. Deposit concrete continuously, and in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause formation of seams and planes of weakness within section. If section cannot be placed continuously between planned construction joints, as specified, introduce a joint and additional reinforcement so as to preserve structural continuity. Notify Architect in any such case.
- J. Cold joints, particularly in exposed concrete, including "honeycomb", are unacceptable. If they occur in concrete surfaces exposed to view, Architect will require that entire section in which blemish occurs be removed and replaced with new materials at Contractor's expense.
- K. When placing exposed concrete walls or columns, strike corners of forms rapidly and repeatedly from outside along full height while depositing concrete and vibrating.
- L. Clean chutes, hoppers, spouts, adjacent work, etc. before and after each run; discharge water and debris outside form.
- M. Place slabs-on-grade in long, alternating strips. Subdivide strips with control joints in accordance with maximum spacing dimensions shown in the Drawings.
- N. Place concrete level on steel deck to elevations shown on drawings but not less than specified thickness at cambered beams. Thickness of concrete at midspans may exceed specified minimum thickness due to steel beams and deck deflecting during placing of concrete.

3.9 CONCRETE FINISHES

A. Finish of Formed Surfaces:

1. Rough Form Finish: For formed concrete surfaces not exposed-to-view in the finish work. This is the concrete surface imparted by stock form facing material used with tie holes and defective areas repaired and patched and fins and other

projections exceeding 1/4" in height rubbed down or chipped off.

2. Smooth Form Finish: For formed concrete surfaces exposed-to-view and surfaces that are to be covered with a coating material applied directly to concrete, such as waterproofing, dampproofing paint. This is the as-cast concrete surface obtained with selected form facing material, arranged orderly and symmetrically with a minimum of joints and with a systematic pattern of ties with set-back cones. Grout tie holes; remove and rub smooth fins or other projections. Surfaces remaining exposed-to-view shall have uniform color and texture acceptable to the Architect.
 3. Related Unformed Surfaces: At tops of walls, horizontal offsets, surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces.
- B. Monolithic Slab Finishes: Floor Flatness (FF) and Levelness (FL) tolerances shall conform to the criteria listed below except Floor Levelness (FL) does not apply to slabs on unshored steel deck. Measure (FL) on shored floor slabs prior to removing shores.
1. Scratch Finish:
 - a. Scratch finish slab surfaces that are to receive concrete floor topping or mortar setting beds for tile, stone and other bonded applied cementitious finish flooring material.
 - b. After placing slabs, plane surface to a tolerance not exceeding 1/2" in 10' when tested with a 10' straightedge. Slope surfaces uniformly to drains where required. After leveling, roughen surface before final set with stiff brushes, brooms or rakes.
 2. Float Finish:
 - a. Apply float finish to monolithic slab surfaces to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing, and as otherwise indicated.
 - b. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently to permit operation of power-driven floats, or both. Consolidate surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level surface plane to a tolerance not exceeding 1/8" in 10' when tested with a 10' straightedge. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
 3. Trowel Finish:
 - a. Apply trowel finish to monolithic slab surfaces to be exposed-to-view, and slab surfaces to be covered with wood flooring, resilient flooring, carpet, thin-set tile and stone, paint or other thin film finish coating system.

- b. After floating, begin first trowel finish operation using a power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over surface. Consolidate concrete surface by final hand-troweling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8" in 10' when tested with a 10' straightedge. Grind smooth surface defects which would telegraph through applied floor covering system.
- 4. Non-slip Broom Finish:
 - a. Apply non-slip broom finish to exterior concrete platforms, steps and ramps, loading dock, and elsewhere as indicated.
 - b. Immediately after trowel finishing, slightly roughen concrete surface by brooming with fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.
- 5. Sealing and Hardener Finishes:
 - a. Apply a coat of the specified Curing and Sealing or Curing and Hardening Compound to exposed interior concrete floors where compound is indicated on the Drawings. Apply the compound in strict accordance with the directions of the manufacturer.
- 6. Non-slip Aggregate Finish:
 - a. Apply non-slip aggregate finish to interior exposed concrete stair treads, platforms, ramps, including cement-filled steel pan stair treads and platforms.
 - b. After completion of float finishing, and before starting trowel finish, uniformly spread 25 lbs. of dampened non-slip aggregate per 100 sq. ft. of surface. Tamp aggregate flush with surface using a steel trowel, but do not force below surface. After broadcasting and tamping, apply trowel finishing as herein specified.
 - c. After curing, lightly work surface with a steel wire brush, or an abrasive stone, and water to expose non-slip aggregate.

3.10 CONCRETE CURING AND PROTECTION

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Start curing before concrete has dried and immediately after placing and finishing. Weather permitting, keep continuously moist for not less than 7 days.
- C. Curing Methods: Keep concrete surface continuously wet by moist curing, by moisture-retaining cover curing, by curing compound, and by combinations thereof, as herein specified.
 - 1. Provide moisture curing by any of the following methods at Contractor's option:

-
- a. Covering with water.
 - b. Continuous water-fog spray.
 - c. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4" lap over adjacent absorptive covers.
2. Provide moisture-cover curing as follows:
 - a. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3" and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 3. Provide curing compound as follows:
 - a. Apply specified curing compound to exterior and exposed interior concrete slabs as soon as final finishing operations are complete (within 2 hours) and to formed surfaces immediately after forms are removed.
 - b. Apply uniformly in two continuous operations at right angles to each other by power-spray or roller in accordance with manufacturer's directions. Recoat areas subjected to heavy rainfall within 3 hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - c. Use dissipating resin type curing compounds on surfaces which are to be covered with finish or coating material applied directly to concrete, such as liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials. If curing compound is not compatible with coating materials, moisture or moisture-cover curing shall be used.
- D. Cold Weather Placing: Protect concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with ACI 306 and as herein specified.
1. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 2. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators, unless otherwise accepted in mix designs.
- E. Hot weather placing: When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
1. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

2. Wet forms thoroughly before placing concrete.

- F. Keep permanent temperature record showing date and outside temperature for concreting operations. Take thermometer readings at start of work in morning, at noon, and again late in afternoon. Record locations of concrete placed during these periods so any effect temperatures may have had on construction can be correlated. Distribute copies of temperature record daily to Architect.

3.11 REMOVAL OF FORMWORK, SHORING AND RESHORING

- A. Contractor shall be responsible for proper removal of formwork shoring, and reshoring. Comply with ACI 347 for shoring and reshoring in multi-story construction.
- B. Remove vertical forms as soon as concrete has attained sufficient strength to support its own weight and their removal can be done without damage to the concrete. Apply curing compound immediately after removing forms.
- C. Keep horizontal forms and supports in place for not less than minimum periods of time noted below or until concrete has reached 60 percent of its specified strength.
1. Soffits of beams or girders shall remain in place until concrete has attained 600 day-degrees.
 2. Forms of floor slabs shall remain in place until concrete has reached 400 day-degrees.
 3. Definition of day-degrees: Total number of days or fractions of days times mean daily air temperature at surfaces of concrete; where concrete surface is protected by insulated blankets or formwork, temperature may be taken under the blankets or formwork. For example, five days at temperature of 60 degrees F. equals 300 day degrees. Days or fractions of days in which temperature is below 50 degrees F. shall not be included in calculation of day-degrees.
- D. When forms are removed, place reshores at same time as stripping operations so that no unshored area is larger than one-fourth of a slab panel. Allow no live load on slab when stripping and shoring are being done.
- E. Field cure test cylinders under same conditions as concrete they represent in order to verify minimum strengths for form removal. Such cylinders and testing shall be at the Contractor's expense.

3.12 ACCEPTANCE AND REPAIRING OF CONCRETE SURFACES

- A. Intent of this Specification is to require forms, mixtures of concrete, and workmanship so that concrete surfaces will require no patching, except for plugging of tie holes.
1. Remove and replace architectural concrete with surface defects exceeding the limitations of ACI 301, Section 13.3.1 or having honeycombs, excessive air voids (bugholes), mismatched coloring, pour lines or sand streaking. The standard of acceptability shall be the surface quality of the approved test panel; or, where no test panel has been made, the standard of unacceptability shall be the photographs shown with paragraphs 7.6 and 7.7 or ACI 309R-87 "Guide for

Consolidation of Concrete".

2. Where patching is acceptable to Architect, procedure shall comply with ACI 301-96, Chapter 9 and Section 13.6 and as described below.
- B. Clean and dampen tie holes and fill solid with patching mortar immediately after form removal.
 - C. Do not patch defective concrete and honeycombed areas unless examined and approval is given by Architect. If such approval is received by contractor, areas involved shall be chipped down square and at least one inch deep to sound concrete by means of cold chisels or pneumatic chipping hammers. If honeycomb exists around reinforcement, chip to provide clear space at least three-quarter inch wide all around steel to ensure proper bond thereto. Repairs thicker than one and one-half inches shall be built-up on successive days, each layer of one and one-half inches being applied as described in ACI 301-96 Chapter 9. Use specified bonding agent.
 - D. Remove and replace patches which become crazed, cracked, or sound hollow upon tapping, at Contractor's expense.

3.13 CLEANING

- A. Clean concrete surfaces of objectionable stains as determined by the Architect. Do not use materials containing acid in any form or methods which will damage "skin" of concrete surfaces. Architect may reject any exposed-to-view concrete with damaged "skin".

3.14 INSPECTION AND TESTING

- A. Inspection and testing of cast-in-place concrete work will be performed by an independent Testing Agency, under a separate contract with the Owner. Materials and workmanship shall be subjected to inspection and testing in mill, shop and/or field by testing Agency and shall be subjected to periodic observation by the Architect. Such inspection and testing shall not relieve Contractor of his responsibility to provide his own inspection, testing, and quality control as necessary to furnish materials and workmanship in accordance with requirements of these Contract Documents.
- B. Requirements of this section are generally written for purpose of securing best workmanship and end result. Certain deviations may be desirable under certain project conditions, however, and may be allowed after examination by and upon written approval of Architect. Any such approved deviation shall not be construed as a waiver of requirements of Specifications.
- C. Notify Construction Manager, Architect and Testing Agency prior to start of any phase of concrete work so as to afford them reasonable opportunity to schedule site visit. Such notification shall be made at least 36 hours in advance.
- D. Facilitate inspection and testing by Testing Agency. Furnish Testing Agency upon request with:
 1. Information as to time and place of shipments of materials to plant and project site.
 2. Free and safe access and assistance for testing materials and proper facilities for

inspection of work in plant and at proper site.

3. Covered box large enough to contain twenty-four standard concrete cylinders. At temperatures below 60 degrees F., box shall be electrically heated to maintain inside temperature of 60 to 80 degrees F. Place cylinders in box immediately after molding and cover with moist burlap until delivery to laboratory, 24 to 72 hours after molding.
 4. Copies of mill test reports of shipments of cement and reinforcing steel.
- E. Promptly replace concrete materials or redo work which has been rejected by Architect and/or Testing Agency, either at plant or at job site, to satisfaction of Architect and/or Testing Agency and at no expense to the Owner.
- F. Correct, or remove and replace concrete work which does not meet requirements of Contract Documents for aesthetic appearance as directed by Architect. Criteria for acceptance shall be based on a mockup preapproved by the Architect. Cost of such correction or removal and replacement shall be at Contractor's expense.
- G. Sampling and testing for quality assurance during placement of concrete may include the following, as directed by Architect. Samples will be made at the point of discharge from the ready-mix truck.
1. Sampling Fresh Concrete: ASTM C172, except modified for slump to comply with ASTM C94.
 - a. Slump: ASTM C143; one test for each concrete load and one test for each set of compressive strength test specimens.
 - b. Air Content: ASTM C173, volumetric method for lightweight or normalweight concrete; ASTM C231 pressure method for normalweight concrete; one for each set of compressive strength test specimens.
 - c. Concrete Temperature: Test hourly when air temperature is 40 degrees F. (4 degrees C.) and below, and when 80 degrees F. (27 degrees C.) and above; and each time a set of compression test specimens made.
 - d. Compression Test Specimen: ASTM C31; one set of 4 standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required. One set of cylinders shall be taken for every 50 cubic yards or fraction thereof.
 2. Compressive Strength Tests: ASTM C39; one set for each 50 cu. yds. or fraction thereof, of each concrete class placed in any one day or for each 5,000 sq. ft. of surface area placed; one specimen tested at 7 days, 2 specimens tested at 28 days, and one specimen retained in reserve for later testing if required.
 - a. When strength of field-cured cylinders is less than 85% of companion laboratory-cured cylinders, Architect may direct Contractor to evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete or to redesign the mix.

- b. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.
 - c. Test results will be reported in writing to Architect, Construction Manager and Contractor on same day that tests are made. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials; compressive breaking strength and type of break for both 7-day tests and 28-day tests.
 - d. Additional Tests: The testing agency will make additional tests of in-place concrete when test results show specified concrete strengths and other characteristics have not been attained in the structure, as directed by Architect or Construction Manager.
 - e. Testing Agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed, including load testing. Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.
- H. Nondestructive Testing of Welded Reinforcing Steel: The Testing Agency will make tests of welded reinforcing in accordance with AWS D1.4-79. Butt welded reinforcing shall be tested by radiographic or magnetic particle methods. Parallel-welded reinforcing shall be visually inspected.
- I. Floor flatness and levelness: The Testing Agency will measure floor surface profiles within 72 hours after concrete placement and calculate Floor Profile Numbers in accordance with ASTM 1155. Floor profilograph or digital readout floor profiler instrument such as a "Dipstick Auto-Read Floor Profiler" (manufactured by FACE Construction Technologies) should be used.

END OF SECTION

SECTION 06 10 00

ROUGH CARPENTRY, TRUSSES AND JOISTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All of the Contract Documents, including General and Supplementary General Conditions and Division 1 General Requirements, apply to the work of this Section.

1.2 WORK INCLUDED

- A. Provide labor, materials, equipment, services and transportation required to complete rough carpentry work shown on the Drawings, as specified herein, or both, including but not limited to items noted below.
 - 1. All sawn lumber joists, rafters, studs, plates, sills, blocking, nailers and curbs, etc.
 - 2. All engineered lumber products, LVL's, etc.
 - 3. All wood roof trusses.
 - 4. All rough hardware, inserts, related metal components, etc. for the work of this Section, except those items specifically specified to be provided by other trades.
 - 5. Wood grounds, furring, strapping for all trades.
 - 6. Plywood backing panels for electrical and telephone equipment.
 - 7. Plywood wall and roof sheathing.
 - 8. Fire retardant wood products.
 - 9. Pressure-treated wood products.
 - 10. Framing for and attachment of temporary dust-proof, fire-proof and/or weather-proof partitions as called for elsewhere in these Specifications.
 - 11. All temporary and/or permanent rough carpentry floors, ladders, ramps, stairs, stair covers, jamb guards, barricades, protective fencing, temporary doors, etc., required for all trades.
 - 12. Building Felts for work of this Section, and protective papers for finished floor.
 - 13. Wood stud reinforcement in partitions around door openings, window openings, fixed lite openings.
 - 14. Other usual items of normal rough carpentry work indicated on the Drawings or necessary for the proper completion of the project, even though not specifically mentioned herein.

1.3 STANDARDS

- A. Except as otherwise specified herein, perform work in accordance with specifications noted below, including latest editions of applicable specifications, codes, and standards cited therein, and latest applicable addenda and supplements. Copies of these items shall be kept available in shop and field.
 - 1. "The Massachusetts State Building Code", ninth edition.
 - 2. "National Design Specification for Wood Construction", National Forest Products Association.
 - 3. "Design Specifications for Metal Plate Connected Wood Trusses", TPI 85, Truss Plate Institute.
 - 4. Applicable Standards of American Plywood Association.

1.4 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01505, Temporary Facilities and Construction
- B. Section 033000, Cast-In-Place Concrete
- C. Section 051200, Structural Steel
- D. Section 055000, Metal Fabrications
- E. Section 062010, Exterior Finish Carpentry
- F. Division 7, Thermal and Moisture Protection
- G. Division 8, Openings
- H. Section 092110, Gypsum Board Assemblies
- I. Section 095100, Acoustic Ceilings

1.5 SUBMITTALS

- A. Certification:
 - 1. Preservative treated wood: Submit certification for water-borne preservative that moisture content was reduced to 19% maximum, after treatment.
 - 2. Fire-retardant treatment: Submit certification by treating plant that fire-retardant treatment materials comply with governing ordinances and that treatment will not bleed through finished surfaces.
- B. Calculations: Submit complete design calculations showing internal layout, member forces and stress control points for all roof trusses. Include ICBO performance standard data. The design shall be stamped and signed by a Registered Professional Engineer in the State of Massachusetts.

- C. Shop Drawings: Submit drawings showing critical dimensions and design loads.

1.6 STORAGE AND PROTECTION OF MATERIALS

- A. Immediately upon delivery to job site, place materials in area protected from weather.
- B. Store materials a minimum of 6 inch above ground on framework of blocking and cover with protective waterproof covering providing for adequate air circulation or ventilation.
- C. Do not store seasoned materials in wet or damp portions of building.
- D. Protect fire-retardant materials against high humidity and moisture during storage and erection.
- E. Protect sheet materials from corners breaking and damaging surfaces, while unloading.

1.7 WOOD PRESERVATIVE TREATMENT

- A. All rough or finish lumber or other finish wood work specified any where in the Contract Documents to be pressure-treated shall be pressure-treated with Wolman salts or Pentachlorophenol with paintable type carrier. The minimum shall be 0.35 pounds of preservative per cubic foot of wood. Standard pressure process shall conform to the following Federal Specifications.
 - 1. For Wolman Salts TT-W-571
 - 2. For Pentachlorophenol TT-W-570a (1)
 - 3. The treating plant shall furnish a notarized certificate that all permanent details of the specifications have been met.
 - 4. Preservative shall be tinted with a color which is easily noticeable.
 - 5. NOTE: Do not use Pentachlorophenol preservative for wood members which will be in contact with bituminous base materials.
- B. Also, brush coat or dip surfaces which are cut after treatment with a heavy brush coat of one of the above preservatives used in pressure treatment. All cut surfaces shall be so treated, not just contact area.

1.8 GRADING AND SEASONING

- A. Grade Marks: Identify all lumber and plywood by official grade mark.
 - 1. Lumber: Grade stamp to contain symbol of grading agency, mill number or name, grade of lumber, species or species grouping or combination designation, rules under which graded, where applicable and condition of seasoning at time of manufacture.
 - a. S-Dry: Maximum 19% moisture content.
 - b. MC-15 or KD: Maximum of 15% moisture content.
 - c. Dense.

2. Softwood Plywood: Appropriate grade trademark of the American Plywood Association.
 - a. Type, grade, class, and Identification Index.
 - b. Inspection and testing agency mark.

PART 2- PRODUCTS

2.1 MATERIALS

A. Lumber

1. Dimensions, unless specifically called out otherwise:
 - a. Specified lumber dimensions are nominal.
 - b. Actual dimensions conform to industry standards established by the American Lumber Standards Committee and the rules-writing agencies.
2. Moisture Content: 19% maximum as specified in the "National Specification for Wood Construction" (1982).
3. Surfacing: Surface four sides (S4S), unless specified otherwise.
4. Lumber, 2 in. to 4 in. thick, 2 in. to 14 in. wide.
 - a. Light framing: any commercial softwood species.
 - i) Supports and nailers for H.M. and finished carpentry: construction grade.
 - ii) Plates, blocking, bracing, and nailers: standard grade.
 - iii) Bracing, blocking, bulk headings, and general utility purposes: utility grade.
 - iv) Furring and grounds: minimum grade, standard.
 - b. Joists, rafters, studs, plates, sills: shall have an allowable extreme fiber stress in bending for single member use of 875 psi and a Modulus of Elasticity of 1,400,000 psi.
 - c. Heavy beams and headers: multiple members face nailed together with staggered splices.
 - i) Allowable stress and modulus of elasticity same as item b above.
 - ii) "LVL" Laminated Veneer Lumber products (E=2,000,000 psi) by Boise Cascade Corporation or equivalent.

- B. Wood Roof Trusses: factory manufactured with structural wood and connector plates.
1. Trusses shall be custom designed to fit the dimensions, load and deflection criteria shown on drawings.
 2. Connector plates - all connector plates shall be a minimum thickness of 0.036" and shall be manufactured from steel meeting the requirements of ASTM A446 Grade A, and shall be hot dipped galvanized according to ASTM A525. Coating Designation G60.
 3. Quality Control - Lumber defects such as wane or knots occurring in the connector plate area must not affect more than ten percent of required plate area or number of effective teeth required for each truss member. Connector plates shall be applied to both faces of truss at each joint, and should provide firm, even contact between the plate and the wood. All wood members shall be accurately cut and fabricated so that all members have good bearing and all completed truss units are uniform. See Truss Plate Institute "Quality Control Manual QCM-77" for tolerances and other special requirements.
 4. Bracing - All trusses must be securely braced both during erection and after permanent installation in a building in accordance with "Bracing Wood Trusses" Commentary and Recommendations (BWT-76)", as published by the truss Plate Institute. Erection bracing shall hold trusses straight and plumb and in safe condition until decking and permanent truss bracing has been fastened forming a structurally sound roof framing system. All erection and permanent bracing shall be installed and all trusses permanently fastened before application of any loads. Permanent structural cross-bracing to ensure overall rigidity of the roof system shall be in accordance with the architectural/engineering plans for building structure. See truss design and shop drawings for any additional special bracing requirements. Materials used in bracing are to be furnished by the erection contractor unless otherwise noted in these specs.
- C. Plywood
1. Plywood for roof sheathing shall be 5/8" exterior groove plywood, APA Structural I and II. (Advantech may be substituted-no OSB)
 2. Plywood for exterior wall sheathing shall and interior walls designated to be "shear walls" shall be 1/2" exterior plywood, APA Structural I and II. (Advantech may be substituted-no OSB)
 3. Plywood for interior work such as electrical and telephone panel boards shall be 3/4" thick and fire-retardant treated.
- D. Fire-Retardant Treated Products: all lumber and plywood where shown on drawings shall be pressure treated with fire retardant chemicals and have a flame spread rating of not higher than equivalent of 25, with no evidence of significant progressive combustion when tested for 30 minutes duration under the Standard Test. Method for Fire Hazard Classification of Building Materials UL 723 NFPA 255, ASTM E84. Fire retardant treatments shall be in the accord with the following:
1. Lumber: AWPA-C20.
 2. Plywood: AWPA-C27

- E. Preservative Treatment: Where lumber or plywood is indicated as "Trt-Wd" or "Treated", or is specified herein to be treated, comply with applicable requirements of SPA Standards C2 (Lumber) and C9 (Plywood) and of AWPB standards listed below. Mark each treated item with AWPB Quality Mark Requirements.
1. Pressure-treat above-ground items with water-borne preservatives complying with AWPB LP-2. After treatment, kiln-dry to a maximum moisture content of 15%. Treat indicated items and the following:
 - a. Wood cants, nailers, curbs, blocking, stripping and similar members in connection with roofing, sheathing, flashing, vapor barriers and waterproofing.
 - b. Wood sills, sleepers, blocking, furring, strapping and similar concealed members in contact with masonry or concrete.
 2. Complete fabrication of treated items prior to treatment, where possible. If cut after treatment, coat cut surfaces with heavy brush coat of same chemical used for treatment. Inspect each piece of lumber or plywood after drying and discard damaged or defective pieces.
- F. Rough Hardware:
1. Provide and install all rough hardware and metal fastenings as shown on the Drawings, specified herein or required for proper installation of carpentry and millwork.
 2. Nails, spikes, screws, bolts and similar items shall be of sizes and types to rigidly secure members in place.
 - a. Minimum fastener size and spacing shall comply with Table 2103-2 (Fastener Schedule for Structure Members) and with Appendix M, (Recommended Nailing Schedule), in the International Building Code.
 - b. Where rough carpentry work is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners and anchorages with a hot-dip zinc coating (ASTM A153).
 - c. Bolts and screws shall penetrate structural substrate at least 1/2 of a wood substrate thickness, at least 3" into concrete and masonry substrates and as shown on the drawings.

PART 3 - EXECUTION

3.1 ROUGH CARPENTRY

- A. Rough Carpentry shall generally conform to the following:
1. Provide all necessary wood framing, blocking, nailing strips, furring strips, nailing inserts, grounds, centers for masonry, rough door bucks, fascia, and usual items of similar nature as required to frame out and to secure and properly install the

work of all trades indicated. Nailing shall be in accordance with Schedules listed in Products, Rough Hardware.

B. Wood blocking, nailers, grounds, furring and strapping:

1. Install all built-in wood blocking, screeds and furring required for all interior finish work.
2. Blocking nailers on masonry or concrete shall be bolted with not less than 5/16" bolts not over 2'-0" o.c. except as otherwise shown. Where finish fits blocking closely, counterbore holes for heads of bolts so that no metal projects beyond the face of the blocking.
3. Provide solid wood blocking, 2 x 6 minimum in frame walls and 3/4" plywood in furred walls, for attachment of toilet partitions grab bars, wall hooks, toilet tissue dispensers, mirrors and all other wall-mounted accessories.
4. Provide solid wood blocking, 2 x 6 minimum in frame walls, and 3/4" plywood in furred walls, for secure attachment of wall cabinets, base cabinets, and wall-supported counter tops, and all other wall-mounted fixtures or accessories.

C. Wood stud reinforcement

1. Provide wood stud reinforcement around all door openings, fixed lite openings, window openings, etc. as shown on the drawings. Securely fasten wood stud reinforcement to adjacent metal studs.

3.2 PLYWOOD WORK

- A. Install plywood with face grain perpendicular to supports; end joints occurring over the supports.
- B. Allow minimum space 1/16 in. between end joints and 1/8 inch at edge joints for expansion and contraction of panels.
- C. Stagger panel end joints.
- D. Support edge joints by use of solid blocking where required on the drawings.
- E. Nail 4 in. o.c. along panel edges, (nail to each member of double sills or plates or other multiple members) and 12" o.c. at intermediate supports.
- F. Use 10d ring-shank, or spiral-thread nails.

3.3 ROOF TRUSSES

- A. Fabrication: Roof trusses shall be manufactured in a plant approved for fabrication by the building code and under the supervision of a third party inspection agency.
- B. Erection and Installation:
 1. Roof trusses shall be stored in a vertical position and protected from the weather. They shall be handled with care so they are not damaged.
 2. Roof trusses shall be erected and installed in accordance with the plans, the

approved shop drawings and written installation suggestions. Temporary construction loads beyond limits shown shall not be permitted. Erection bracing in addition to specified bridging shall be provided as detailed to keep the joists straight and plumb as required and to assure adequate lateral support for the individual trusses and entire system until the sheathing material has been applied. The contractor will give notification prior to enclosing the trusses to provide opportunity for inspection of the installation.

3.4 JOISTS, BEAMS, RAFTERS, STUDS, PLATES, SILLS

- A. Install in accordance with plans and details.
- B. Do not support joists or rafters with toe nails or end grain nails. Use approved joist and beam hangers.

END OF SECTION

Section 05 12 00

STRUCTURAL STEEL

PART 1- GENERAL

1.1 GENERAL PROVISIONS

- A. All of the Contract Documents, including General and Supplementary General Conditions and Division 1 General Requirements, apply to the work of this Section.

1.2 WORK TO BE PERFORMED

- A. Labor, materials, equipment, services and transportation required to complete structural steel work shown on Drawings, as specified herein, or both. Structural steel work is that work defined in AISC "Code of Standard Practice" plus steel work listed below and shown on the structural drawings.
1. Furnishing of anchor bolts, and loose leveling plates.
 2. Furnishing and erection (including bolted and welded connections) of base plates, columns, tubes, channels, struts, beams, hangers, girders, bracing (temporary and permanent), rigid bents, brackets, anchors, angles, stiffeners, plates, bolsters, clips, support angles for metal deck lintels or relieving angles affixed to structure.
 3. Furnishing and installation of openings (unreinforced and reinforced) in structural steel required to accommodate mechanical, plumbing, and electrical work.
 4. Furnishing and installation of non-shrink grout under leveling and base plates.
 5. Furnishing and application of shop paint, including finish coat(s) when required, and field touch-up paint for designated structural steel items.
 6. Furnishing and application of hot-dip galvanizing for masonry lintels, masonry relieving angles, exposed mechanical equipment dunnage beams, and steel so designated on the drawings.
 7. Design of bolted/welded structural connections.
 8. Furnishing and shop-installation of headed shear connectors (excluding shear connectors required for composite beam action) where shown on the drawings.
 9. Furnishing of structural steel items shown in structural drawings required to be built into or from part of work specified under other Sections, to appropriate trade at proper time with complete instructions and templates to facilitate installation. Verify proper installation of same.
 10. Unless specifically excluded, furnishing and installation of any other items of structural steel work indicated on Drawings, specified or obviously needed to make work of this Section complete.

1.3 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
 - 1. Section 033000, Cast-in-place Concrete
 - 2. Section 042000, Unit Masonry
 - 3. Section 053100, Steel Decking
 - 4. Section 054000, Cold Formed Metal Framing
 - 5. Section 055000, Metal Fabrications
 - 6. Section 099000, Painting and Coating (excluding touch-up of prefinished surfaces and shop coats as required)

1.4 SUBMITTALS

- A. Standard Shop Details and Connection Design Calculations: Submit to Architect prior to submitting detailed Shop Drawings, design calculations and details for connections not shown on the Drawings. Calculations shall be prepared under supervision of registered professional engineer.
- B. Joint Welding Procedures: Submit to Architect joint welding procedures and program of welding sequence (for each component and for welding components together) before any welding is done. After return of submittal, welding procedures and sequences shall be followed without deviation. Architect may require requalification of these welding procedures by tests prescribed in AWS "Standard Qualification Procedure".
- C. Quality Control Manual: Submit to Architect, prior to start of fabrication, description of field and plant inspection procedures including titles of responsible personnel, methods and equipment for non-destructive testing of specific typical joints, documentation of inspection results, and procedures for repairing or disposing of nonconforming materials. Results of tests during the course of work shall, upon request by Architect or Construction Manager, be made available for review by Architect and/or Testing Agency.
- D. Methods of Erection: Submit to Architect, in accordance with requirements of Contract Documents, prior to starting work, description of methods, sequence of erection, and type of equipment proposed for use in erecting structural steel work. Provide construction loads imposed on permanent structure.
 - 1. Architect's review is only for effects of methods on permanent structure. This submission shall not relieve Contractor of his responsibility for providing proper methods, equipment, workmanship, and safety precautions.
- E. Shop Drawings: Submit to Architect detailed Shop Drawings, including erection drawings, schedules and index sheets showing: grades of steel; identification mark of members; orientation and relation of members to appropriate grid lines; setting elevations for column bases; framing to support metal deck; location and size of openings, slots, and holes; requirements, such as punched or drilled holes, for attachment of other materials or parts of construction; type, size, and location of shop

and field connections; type, size, and extent of welds; joint welding procedures; welding sequences (use welding symbols adopted by American Welding Society); cleaning requirements prior to painting; type and dry thickness of paint. Members to be galvanized shall be so noted on shop drawings.

1. Architect's checking is a review for conformance with the design concept of the project and compliance with the information given in the Contract Documents. The Contractor is responsible for: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.
 2. Do not proceed with fabrication of material or performance of work until corresponding item on Shop Drawing has been reviewed by Architect.
- F. Samples: Submit to Architect, upon request by Architect, samples and/or descriptive literature of materials, products and methods.
1. Do not proceed with fabrication of material/product or performance of work until Sample has been approved by Architect.
- G. Submit to the Architect complete shop details (keyed to erection layouts) and technical data for all structural bearings specified or shown.
- H. Submit to the Architect drawings and directions for the installation of anchor bolts, high strength bolts, direct tension indicator washers, torque control snap-off bolts, or items to be installed by others. Verify proper installation of same.
- I. Items requiring field measuring shall have all dimensions verified in the field before fabrication. Field dimensions shall be shown on the Shop Drawings and shall be noted as having been verified in the field.

1.5 REFERENCE STANDARDS, SPECIFICATIONS, AND CODES

- A. Except as otherwise specified herein, perform work in accordance with specifications noted below, including latest editions of applicable specifications, codes, and standards cited therein, and latest applicable addenda and supplements. Copies of these items shall be kept available in shop and field.
1. "The Commonwealth of Massachusetts State Building Code", ninth edition.
 2. "The International Building Code", 2015 edition.
 3. "Specification for Structural Steel Buildings", American Institute of Steel Construction (AISC), 2011.
 4. "Code of Standard Practice for Steel Buildings and Bridges", American Institute for Steel Construction, (AISC) 2011 except as modified herein by deletion of the following sentences: Paragraph 4.4 "These drawings shall be returned to the fabricator within fourteen (14) calendar days."
 5. "Structural Welding Code - Steel (AWS D1.1-96)", American Welding Society.

6. "Specifications for Structural Joints Using ASTM A325 or A490 Bolts", Research Council on Structural Connections of the Engineering Foundation (RCSC) 2011.
 7. "Painting Manual, Vol. 1, Good Painting Practice" and "Painting Manual, Vol. 2, Systems and Specifications", Steel Structures Painting Council.
 8. American Society for Testing Materials (ASTM) Standards referenced in this Section.
- B. Any material or operation specified by reference to published specifications of manufacturer or published standard shall comply with said specification or standard. In case of conflict between referenced specifications, most stringent requirement shall govern. In case of conflict between referenced specifications and Project Specifications, Project Specifications shall govern unless otherwise indicated by Architect in writing.

1.6 QUALITY ASSURANCE

- A. Mill Test Certification for Structural Steel: Submit to Architect, prior to delivery of structural steel to job site, certified mill test reports of structural steel (including names and locations of mills and shops, and analyses of chemical and physical properties), properly correlated to structural steel to be used in this project. This submittal is for information and field record.
- B. Mill Test Certifications for Connection Material: Submit to Architect, prior to delivery of structural steel to job site, certified mill test reports of bolts, nuts and washers (including names and locations of mills and shops, and analyses of chemical and physical properties), properly correlated to connections on this project. Submit manufacturer's certifications for filler metal for welding. This submittal is for information and file record.
- C. Painting Certification: Submit to Architect certification stating that requirements pertaining to pre-paint cleaning and painting of steel have been performed in accordance with Contract Documents. This submittal is for information and file record.
- D. Galvanizing Certification: Submit to Architect a copy of certification stating that requirements pertaining to pre-galvanizing cleaning and galvanizing of steel have been performed in accordance with Contract Documents. This submittal is for information and file record.
- E. Corrective Work: Submit to Architect drawings showing details of proposed corrective work prior to performing corrective work.
- F. Affidavit: Submit to Architect, on request by Architect, manufacturer's and/or fabricator's and/or erector's affidavit stating that material or product provided complies with Contract Documents.
- G. Maintain records of shop and field welding procedures and records of welders employed, date of qualification and identification symbol or mark. Maintain records for each impact wrench used in shop and field, showing dates, sizes of bolts tested and the corresponding torque values. Certified copies of the records shall be made available to Contractor, Architect and Owner's testing laboratory.

1.7 SUBSTITUTIONS

- A. Substitutions for member sizes, type(s) of steel, connection details or any other

modifications proposed by Contractor will be considered by Architect only under following conditions:

1. That request has been made and accepted prior to submission of Shop Drawings.
2. That there is a substantial cost advantage or time advantage to Owner; or that proposed revision is necessary to obtain required materials or methods at proper times to accomplish work in time scheduled.
3. That sufficient sketches, engineering calculations, and other data have been submitted to facilitate checking by Architect, including documentation of cost reductions or savings in time to complete work.

PART 2- PRODUCTS

2.1 GENERAL

- A. Provide positive identification for each steel type and tensile strength classification, except A36 steel, by a uniform marking system on each piece. All steel shall be newly rolled steel.

2.2 MATERIALS

- A. High strength low alloy steel: ASTM A992 of grades and to provide yield strengths shown on the drawings. Use A588 or A572 modified for plates over 1½ inch thick where Fy 50 ksi is required.
- B. Carbon steel: shapes, plate and bar shapes, ASTM A36. Tubing, ASTM A500 Grade B; Steel pipe, ASTM A501 or A53, Type E or S, Grade B.
- C. Anchor Bolts: ASTM A307, Grade A. or ASTM F1554 Grade 105.
- D. High Strength Bolts: ASTM A325 or ASTM A490 with ASTM A563, Grade A Hex Style Nuts and compatible washers. Bolts shall be cold-forged with rolled threads. Bolts with Torque Control snap-off ends may be used.
- E. Direct Tension Indicating Compressible Washers: ASTM F959-85, steel alloy washer with 5 to 6 circular protrusions on one side and selected to match bolt strength.
- F. Filler Metal for Welding: E70XX low hydrogen as per Table J2.3 of LRFD Specification or as per Table J2.5 of the Allowable Stress Specification of AISC.
- G. Headed Studs: ASTM A108, Grades 1015 - 1020, minimum yield point of 50,000 psi, and minimum tensile strength of 60,000 psi.
- H. Structural Steel Protective Coatings:
 1. Structural Steel Primer Paint: "Tnemec Series 10" or "88 Series", "Porter 260 FD Shop Primer", P&L Noxide 90".

2. Structural Steel Finish Paints: See Paragraph 3.05C below.
 3. Galvanizing: Hot dip galvanize steel so designated herein and on the drawings and after fabrication in compliance with ASTM A-123. Hot-dip galvanized steel shall be inspected for compliance with ASTM A-123 and shall be marked with a stamp that indicates the name of the galvanizer, the ASTM Number, and the ounces of zinc per square foot of surface. A notarized Certificate of Compliance with all of the above shall be required from the galvanizer. Finish color if required will be specified by the Architect.
- I. Coating for Finished Bearing Surfaces (e.g., columns): "Magnafilm 1043" by Magnus Chemical Co., Garwood, N.J.; "M-2658, Blue Lacquer" by U.S. Steel Corp., Pittsburgh, PA or approved equivalent.
 - J. Bedding mortar for bearing and base plates:
 1. Non-Shrink: CRD-C 621, factory pre-mixed grout, Type D, non-metallic, shall be one of the following or an approved equivalent:
 - a. "Masterflow 713"; Master Builders.
 - b. "SonogROUT"; Sonneborn-Contech.
 - c. "Euco-NS"; Euclid Chemical Co.
 - d. "Five Star Grout"; U.S. Grout Corp.
 - K. Expansion Bolts: 3/4" diameter stainless steel with ultimate capacities in 4000 psi concrete of 16,000 lbs. in shear and 16,000 lbs. in tension; minimum embedment of 6"; shall be one of the following or an approved equivalent:
 1. "Parabolt", ISM Corp.
 2. "Kwik Bolt II", Hilti Corp.
 3. "Red Head Trubolt Wedge Anchor", ITW Ramset/Redhead.

PART 3- EXECUTION

3.1 INSPECTION

- A. Examine work prepared by other trades to receive work of this Section and report any defects affecting installation to Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.

3.2 ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

- A. Fabricate and erect members or components designated as AECS on the drawings in accordance with Section 10 of the AISC Code of Standard Practice.

3.3 HANDLING AND STORAGE

- A. Handle and stack materials carefully to prevent deformation or damage or accidental movement. Use fabric slings to transport finished, prepainted members. Store structural steel carefully on substantial timbers and blocking, so arranged that steel will be free from earth and properly drained, preventing any spattering with dirt or accumulation of water in or about steel. Take care to prevent damage to any shop painted surfaces and to prevent accumulation of mud, dirt, or other foreign matter on steel. Any accumulation shall be completely removed prior to erection.
- B. All bolts shall be kept in dry storage until needed for installation. A325 bolts 1-1/8" and 1-1/4" and A490 bolts 1" and over must first have Johnson's Stick Wax #140 applied to their threads before being assembled in work. If bolts have been left out and have become rusty before use, they shall be rejected and shall not be used until they have been cleaned and waxed with Johnson's Stick Wax.

3.4 SHOP FABRICATION

- A. Except as otherwise indicated on Drawings or specified herein, fabricate structural steel in accordance with References in this Section.
- B. Permissible tolerances for steel members shall conform to ASTM A6. The as-fabricated tolerances shall conform to the cited AISC Specifications, AISC Code and the AWS Code, except where closer tolerances and straightness of members are required for fitting of the work in fabrication or erection.
- C. Provision for attachment of other materials: Punch and drill steel for attachment of other materials indicated on Drawings or noted in Specifications to be attached to steel.
- D. The Contractor shall design and detail all connections required to resist the loads and reactions shown on the drawings and as specified. Fabrication and erection details shall supplement and be consistent with details shown on the drawings. Do not use one-sided or other eccentric connections, except in isolated cases where approval of Architect is obtained.
- E. Welding:
 - 1. Provide quality control and qualification of welders and welding procedures and operations as specified under "Inspection and Testing" in this Section.
 - 2. Shop Welding Process: Use shielded metal-arc, submerged arc, gas metal-arc, and flux cored-arc, or other process approved by Architect.
 - 3. Groove Welds: Provide complete penetration unless otherwise noted on Drawings.
 - 4. Fillet Welds: Where weld symbol is not shown or welds are not dimensioned, provide continuous fillet welds all around and on both sides as appropriate. Minimum dimension shall be as shown in Table J2.5 of LRFD Specification or

Table J2.4 of Allowable Stress Specification of AISC.

5. Base metal shall be checked by Contractor to insure absence of laminations or other defects. Welds shall be sound throughout and have no cracks.
 6. Where structural joints are required to be welded, details of joints, technique of welding employed, appearance and quality of welds made, and methods used in correcting defective work shall conform to applicable requirements noted under References in this Section.
 7. Prepare joint welding procedures and program of welding sequence (for each component and for welding jointing components to each other) and submit to Architect for approval before any welding is done. After approval, welding procedures and sequences shall be followed without deviation unless specific approval for change is obtained from Architect. Architect may require requalifications of these welding procedures by tests prescribed in AWS "Standard Qualification Procedures".
 8. Each welder working on the project shall be assigned an identification symbol or mark. Each welder shall mark or stamp his identification symbol at each weldment completed, whether in shop or field.
- F. Manual oxygen cutting shall be done only with a mechanically guided torch, except as permitted below.
1. Gas cut edges which are not welded and will be free of substantial stresses, as determined by the Architect, may be cut manually with an unguided torch provided that specified AISC edge distances to holes are maintained.
 2. Gas cut edges which will be subjected to substantial stress (over one-half the allowable stress), as determined by the Architect, or which are to be welded may be cut manually with an unguided torch to a line within 1/8 inch of the finished dimension, with final removal of material completed by chipping or grinding to produce a surface quality equal to that of the base metal edges.
- G. Openings in Structural Steel.
1. Cutting of openings differing from or in addition to those shown on approved shop drawings will not be permitted without written approval of Architect.
- H. Corrective Work: Structural steel elements having fabrication errors and/or which do not satisfy tolerance limits shall not be incorporated in finished work. Such elements may be corrected if permitted by Architect and/or Testing Agency. Submit to Architect drawings showing details of proposed corrective work. These drawings shall be approved by Architect prior to performing corrective work. Corrective work shall be performed in accordance with requirements of Contract Documents. Corrective work and any retesting which may be required shall be at the Contractor's expense.
1. Identification: Structural steel members shall have an assigned position and identification mark or symbol, clearly indicated on each piece near one end. Marks shall correspond to those given on Shop Drawings and erection drawings related

to specific members.

3.6 SHOP PAINTING

- A. General: Verify that products listed below meet regulations of jurisdiction for Volatile Organic Compounds (VOC) emissions. Notify Architect if listed products do not comply and submit information about equivalent products that do comply.
- B. Unexposed Steel:
 - 1. Except as otherwise indicated on Drawings or specified herein, paint structural steel work in accordance with Reference Specifications in this Section.
 - 2. Steel to be painted:
 - a. Clean steel surfaces in accordance with SSPC-SP2, Hand Tool Cleaning.
 - b. Unless specifically excluded or modified, apply one shop coat of structural steel primer paint to steel. See Materials above for primer type.
 - c. Apply paint to surfaces requiring paint only to within two inches of any field weld or high strength bolted friction-type connection. If for any reason surface to be field welded or bolted is painted, remove such paint completely to within limits before field welding or bolting.
 - 3. Steel to be left unpainted:
 - a. Surfaces to receive metal deck and/or shear connectors fastened by welding.
 - b. Contact surfaces of high strength bolted connections.
 - c. Finished Bearing Surfaces and Surfaces to be welded in field: Protect surfaces (e.g., bearing surfaces of columns and column base plates) against corrosion by use of rust-inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.
 - d. Surfaces to receive sprayed-on fireproofing.
 - e. Member areas to be embedded in concrete or mortar.
 - 4. Shop Coat Application:
 - a. After steel has been properly prepared as specified above, apply structural steel primer paint to dry steel surfaces by brush, spray, or roller, assuring no running or sagging in accordance with manufacturer's directions as approved by Architect.

- b. Apply 2.0 to 3.0 d.m.t. of shop primer.
 - c. Inspection of shop painting - as specified under "Inspection, Testing and Quality Control" in this Section.
- C. Exposed Steel (Prefinished)
- 1. Except as otherwise indicated on Drawings or specified herein, paint structural steel work in accordance with Reference specification in this Section.
 - 2. Surface preparation:
 - a. Exposed steel within protected environment, such as exposed framing members - SSPC SP-6, Commercial Blast Cleaning.
 - b. Exposed steel subject to corrosive or exterior atmosphere or solutions, such as entry canopy framing, exterior equipment dunnage or supports, relieving angles -- SSPC SP-10 Near-White Blast Cleaning or Galvanizing.
 - 3. Primer Application - SPRAY ONLY
 - a. Exposed steel within protected environment: single package epoxy organic zinc rich material such as "Tnemec 90-97", "Keeler & Long Methane Zinc Rich" or an approved equal at 3.0 to 3.5 d.m.t.
 - b. Exposed steel subject to corrosive or exterior atmosphere or solutions:
 - i) Single package epoxy organic zinc rich material such as "Tnemec 90-97", "Keeler & Long Methane Zinc Rich" or an approved equal at 3.0 to 3.5 d.m.t.
 - 4. Finish Coat - SPRAY ONLY
 - a. Exposed steel within protected environment:
 - i) First Coat: Epoxy-polyamine coating such as "Tnemec 27 Typoxy", "Keeler & Long 3500 Series", or approved equal at 4.0 to 6.0 d.m.t.
 - ii) Second Coat: See Related Work sections.
 - b. Exposed steel subject to corrosive or exterior atmosphere or solutions: Epoxy coating such as "Tnemec 27 Typoxy" or an equal approved at 6 to 8 mils.
 - 5. Surfaces inaccessible to blast cleaning after assembly shall be blast cleaned and coated before assembly. Zinc-rich primers may be applied to friction type connections in accordance with AISC Specifications.
 - 6. Contractor shall include complete details and description of coating operations on shop drawings for approval of the Architect.

7. A pre-production conference shall be arranged by the Contractor with the Architect, Construction Manager, fabricator and representative of the paint manufacturer prior to work.
- D. Notification: Notify Testing Agency five (5) days prior to shipment of any structural steel so paint inspection can be made. At these inspections dry mil thickness of paint film will be checked. Steel containing mill scale that can easily be removed with blade of pocket knife will be subject to recleaning and repainting at no expense to the Owner.

3.7 GALVANIZING

- A. Safeguard against embrittlement in conformance with ASTM A-143.
- B. To safeguard against warpage or distortion of steel members, in conformance with ASTM A-384, steel fabricator shall submit shop drawings of non-standard fabrications, all tubular fabrications, all fabrications involving any dimension which exceeds the size of the galvanizer's kettle, and any fabrication involving materials of different thicknesses. These drawings shall be submitted to the galvanizer prior to fabrication to determine the suitability of the material for galvanizing.

3.8 HEADED STUD WELDING REQUIREMENTS

- A. Testing Agency shall conduct test welding procedure for welding of headed studs.
- B. Headed studs shall be applied in accordance with manufacturer's printed instructions. Use only personnel and equipment authorized by manufacturer.
- C. Check headed studs for indications of insufficient and improper weld:
 1. Less than 360 degree fillet for headed studs.
 2. Burn-off (reduction in length after welding) less than 1/8 inch.
 3. Cold appearance of weld.
- D. If, after welding of any headed stud, visual inspection indicates any imperfections listed above or any other questionable appearance, such shear connector shall be struck hard with three-pound hammer and bent 15 degrees off perpendicular to beam and toward nearest end of beam. Headed studs meeting this test shall be considered acceptable and left in this position. Headed studs failing under this test shall be replaced.
- E. Personnel welding headed studs shall be qualified using elements of above procedure, prior to any production welding of headed studs.

3.9 FIELD ERECTION

- A. Except as otherwise indicated on Drawings or specified herein, erect structural steel in

accordance with Reference Specifications in this Section.

- B. Surveys: Employ an engineer or surveyor for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies to Architect and Construction Manager. Do not proceed with erection until corrections have been made, or until compensating adjustments to structural steel work have been agreed upon with Architect. Establish required leveling and plumbing references with respect to expected service temperatures inside the building; compensate as required for difference between service temperature and erection temperature.
- C. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds. Loads imposed during construction shall be determined by an Engineer employed and paid for by Contractor.
- D. Field Connections: Beams shall have framed connections using 3/4 inch diameter (min.) high strength bolts in accordance with requirements of AISC "Manual of Steel Construction" and Contract Documents. Do not use one-sided or other eccentric connections, except in isolated cases where approval of Architect is obtained. Snug all nuts before applying final torque to any one.

1. High Strength Steel Bolts

- a. Perform installation by using pneumatic powered impact wrenches with sufficient capacity and adequate supply of compressed air. On large bolts (1-1/8" and 1-1/4" A325 and 1" or over A490) wrenches used shall be equivalent in capacity to a Chicago Pneumatic 6120. Air pressure shall be maintained at 100 psi at the wrench.
- b. Perform installation in accordance with turn-of-nut method outlines in RCSC "Specification for Structural Joints Using ASTM A325 or A490 Bolts", with modifications noted below.

Use hardened washer under bolt head or nut, whichever is turned in tightening, unless oversize holes have been approved which require such washer under both head and nut. Use not more than two washers.

Qualification of high strength bolting procedures and operations shall be as specified under "Inspection, Testing and Quality Control", in this Section.

Refer to this bolting installation method as "Modified Turn-of-nut Tightening Method".

- c. In lieu of "modified turn-of-nut" method, direct tension indicator washers or snap-off TC bolts may be used at Contractor's option provided it can be demonstrated by an accurate direct measurement procedure that bolt has been properly tensioned; written approval by Architect is required.

- i) If tension indicator washers are used, place protrusions against bolt head and tighten the nut. Do not tighten at head. All plies must first be brought into firm contact by partially compressing the direct tension indicator bumps. Tightening shall commence from the most rigid part of the connection to its free edges. The part not being turned must be held by a spud wrench, as the bolt must not be allowed to spin.
 - ii) If snap-off bolts are used for friction type connections, snug tight all bolts in connections before proceeding to apply final snap-off torque.
 - d. Make joints without use of erection bolts; high strength bolts required for joint shall serve that purpose.
 - e. Correct poor matching of holes by drilling to next larger size and using larger size bolt, if approved by Architect. Welding or enlarging with drift pins shall not be permitted without Architect's approval.
 - f. If top flange plates are used at girder moment connections, bolts at top flange plate shall be oriented nut-end down.
2. Field Welding: Execute in accordance with requirements under "SHOP FABRICATION" in this Section, excepting those requirements which apply to shop conditions only.
- E. Errors in shop fabrication or deformations resulting from handling and/or transportation that prevent proper assembly and fitting of parts shall be reported immediately to Architect for approval of method of correction. Approved corrections shall be made at Contractor's expense.
 - F. Furnish templates and anchor bolts and instructions for setting of anchor bolts and other items to be embedded in cast-in-place concrete, in ample time so that this work will not be delayed.
 - G. Setting Base and Bearing Plates: Clean bearing surfaces of concrete and masonry and the bottom of the plates. Set plates level to correct elevations and support temporarily on steel wedges, shims, leveling devices, or as shown on Drawings, until corresponding supported member has been positioned, plumbed and anchor-bolted. Entire area under plates shall then be packed solidly with non-shrink bedding grout. Leave protruding leveling devices in place until after grout has attained required strength, and then cut off flush with top or edges of base plates, or both, except as otherwise noted.
 - H. Align, level, and adjust members accurately prior to final fastening. Fasten compression member splices only after abutting surfaces have been brought completely into contact. Splice members only where shown on the Drawings.
 - I. Top flanges of beams to receive shear connectors, shall be free of paint, water, dirt, rust, or any other material detrimental to welding.

J. Openings in structural steel required in field:

1. Make no openings without the specific written approval of the Architect. All re-entrant corners shall be shaped notch-free to a radius of at least 1/2 inch at blocks, copes, cuts and openings.
2. Openings in structural steel shall be cut and/or reinforced only by structural steel Contractor, and only with specific prior written approval of the Architect.
3. Field Oxygen Cutting: Not to be performed without written consent of Architect. Once approval is obtained, execute in accordance with requirements under "FABRICATION" in this Section.

3.10 FIELD PAINTING

A. Field Coat application:

1. Use same type of paint as used for shop coat.
2. After erection, touch-up field welds and connections and other surfaces required to be painted. Do not paint connections until after inspection and approval of Testing Agency.
3. Do not paint when ambient temperature is below 40 degrees F. or when conditions differ from paint manufacturer's recommendations, as approved by Architect.
4. Touch up damaged galvanizing with zinc-rich paint in accordance with ASTM A780.

3.11 INSPECTION AND TESTING

- A. Inspection and testing of structural steel fabrication and erection will be performed by an independent Testing Agency, under a separate contract with the Owner. Materials and workmanship shall be subjected to inspection and testing in mill, shop and/or field by Testing Agency and shall be subjected to periodic observation by the Architect. Such inspection and testing shall not relieve Contractor of his responsibility to provide his own inspection, testing, and quality control as necessary to furnish materials and workmanship in accordance with requirements of Contract Documents.
- B. Requirements of this Section are generally written for purpose of securing best workmanship and end result. Certain deviations may be desirable under certain project conditions, however, and may be allowed after examination by and upon written approval of Architect. Any such approved deviation shall not be construed as waiver of requirements of Specifications.
- C. Contractor shall maintain his own inspection and quality control of shop and field work. Quality control and inspection of welding work shall consist of supervision by Contractor's own welding inspector using non-destructive spot testing, at rate of at least one test per 50 linear feet of weld by each welder, except that full penetration welds shall be tested 100 percent by the ultrasonic method. Results of such tests shall be provided to Architect and/or Testing Agency when requested.

- D. Notify Architect, Construction Manager and Testing Agency prior to start of any fabrication, erection, or other phases of work so as to afford them reasonable opportunity to visit the site. Such notification shall be made at least 36 hours in advance.
- E. Facilitate inspection and testing by Testing Agency. Contractor shall, at his own expense, furnish Testing Agency, upon request, with:
 - 1. Complete sets of approved Shop Drawings and corrective work procedures at fabricating shop(s) and in field.
 - 2. Cutting lists, order lists, material bills, shipping lists, and mill reports.
 - 3. Information as to time and place of all rollings and shipments of material to shops and field.
 - 4. Representative sample pieces requested for testing.
 - 5. Free and safe access and assistance for testing materials, and proper facilities for inspection of work, in mill, shop and field.
- F. Do not remove any marks or tags applied by Testing Agency identifying rejected work.
- G. Any work found deficient shall be corrected or replaced in accordance with these specifications. Deficient welds shall be cut out to sound material and rewelded. Deficient assemblies shall be taken apart, corrected and reassembled, using new materials as required. A490 bolts shall not be reused. A325 bolts may be retightened once only.
- H. Structural steel work which has been rejected by Architect and/or Testing Agency in mill, shop, or field, shall be corrected by Contractor without delay and at no expense to the Owner. Additional tests shall be performed at Contractor's expense to confirm compliance of corrected work.
- I. The acceptance of steel work at the shop shall not prevent its final rejection at the job site, or even after it has been erected, if it is found to be defective in any way.
- J. Qualifications for Welding Work:
 - 1. Qualify welding processes and welding operators in accordance with the latest edition AWS "Standard Qualification Procedure".
 - 2. Provide certificates of welders to be employed in the work showing that they have satisfactorily passed AWS qualification tests for the specific types of welds they will be doing; where certification dates are older than 12 months before start of welding work, certify that affected welder(s) have been continuously employed doing the type(s) of welds since certification.

- K. Sampling and testing for quality assurance of bolted and welded work by the Owner's testing agency may include the following, as directed by the Architect.
1. Shop and Field Bolted Connections:
 - a. Inspect in accordance with RCSC specifications. Calibrate wrenches periodically.
 - b. A minimum of two bolts in each connection shall be tested. If tension indicating washers are used, verify bolt tension in accordance with approved procedure for this project (see paragraph 3.8.D.1) and verify position of washers and method of tightening nut. If snap-off bolts are used, verify that all knurled ends have been snapped off. Periodically verify snap-off torques.
 2. Shop and Field Welding: Inspect and test during fabrication of structural steel assemblies and in accordance with AWS Codes, as follows:
 - a. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
 - b. Perform visual inspection of all welds.
 - c. Perform random verification ultrasonic testing of shop full penetration welds. Perform 100% ultrasonic testing, in accordance with ASTM E-164, on all field full penetration welds.
 3. Camber: Inspect fabricator's procedures and material to ensure specified camber is achieved in accordance with referenced standards.

END OF SECTION

Section 05 31 00

STEEL DECKING

PART I -GENERAL

1.1 GENERAL PROVISIONS

- A. All of the Contract Documents, including General and Supplementary General Conditions and Division 1 General Requirements, apply to the work of this Section.

1.2 WORK TO BE PERFORMED

- B. Provide labor, materials, equipment, services and transportation required to install and complete steel deck work shown on Drawings and as specified herein including but not limited to items noted below.
1. Two inch deep galvanized composite steel floor deck.
 2. One and one half and three inch deep galvanized steel roof deck.
 3. Headed stud "shear connectors" required for structural steel composite beams.
 4. Hanger tabs for suspended ceilings and fixtures as required and/or shown on the reflected ceiling plans.
 5. Drainage and roof sump pans.
 6. Steel deck accessories: closures, transition plates, welding washers, stoppers and cover plates.
 7. Miscellaneous structural framing and connections for support of steel deck where required and not provided under Structural Steel Framing Section.
 8. Cutting of holes and openings in steel deck in accordance with requirements under "Erection" in this Section.
 9. Furnishing and application of approved field touch-up paint for scarred steel deck.
 10. Furnishing of partition/deck closure pieces mated to deck system so chosen.
 11. Furnishing of steel deck items, required to be built into or form part of work specified under other Sections, to appropriate trade at proper time with complete instructions to facilitate installation.
 12. Unless specifically excluded, furnishing and installation of any other items of steel deck work indicated on Drawings, specified, or obviously needed to make work of this Section complete.

1.3 RELATED WORK

- A. Section 033000, Cast-in-Place Concrete
- B. Section 042000, Unit Masonry

-
- C. Section 051200, Structural Steel
 - D. Section 099000, Painting and Coating
 - E. Division 22, Plumbing
 - F. Division 23, Heating, Ventilation, and Air Conditioning

1.4 SUBMITTALS

- A. Fire Rating Certification: Submit to Architect, in accordance with requirements of Section 013300, documentation and certification that composite steel deck as part of proposed structural system will qualify for the fire ratings specified prior to submitting detailed Shop Drawings.
- B. Shop Drawings: Submit to Architect, in accordance with requirements of Section 013300, detailed Shop Drawings, including erection drawings and schedules, properly cross-referenced, showing: steel deck type; gage; finish; layout; identification mark; location; openings; dimensions; anchorages; laps; conditions requiring closures; supplementary framing and special jointing or other accessories; number, size, capacity, and layout of shear connectors; location and size of welding and/or mechanical fastening; and welding data.
 - 1. Architect's checking is a review for conformance with the design concept of the project and compliance with the information given in the Contract Documents. In accordance with Section 014300, the Contractor is responsible for: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.
 - 2. Do not proceed with fabrication of material or performance of work until corresponding item on Shop Drawing has been reviewed by Architect.
 - 3. Get the necessary information from all other trades requiring openings through steel deck and show all such openings, properly dimensioned and drawn to scale on the steel deck shop drawings before the latter are submitted for approval.
- C. Steel Deck Design Calculations: Submit to Architect, in accordance with requirements of Section 013300, and prior to fabrication, complete design calculations for section properties of each type and gage of deck, calculated in conformance with AISI Specification; calculations of load carrying capacity and deflections for each combination of deck type, gage, span, and concrete type and thickness to be used.
- D. Hanger Attachment Devices: Submit to Architect, in accordance with requirements of Section 013300, complete description, including certified load tests, of hanger attachment devices proposed for use of hanging suspended ceiling construction from steel deck system to be used in actual construction.
- E. Samples: Submit to Architect, in accordance with requirements of Section 013300, samples and/or descriptive literature of materials, products, and methods as requested by Architect.
 - 1. Do not proceed with fabrication of material/product or performance of work until Sample has been approved by Architect.
- F. Corrective Work: Submit to Architect, in accordance with requirements of Section 013300, drawings showing details of proposed corrective work prior to performing corrective work.

- G. Affidavit: Submit to Architect, on request by Architect or Construction Manager, manufacturer's and/or fabricator's and/or erector's affidavit stating that material or product provided complies with Contract Documents.

1.5 REFERENCE STANDARDS, SPECIFICATIONS, AND CODES

- A. Except as otherwise specified herein, perform work in accordance with specifications noted below, including latest editions of applicable specifications, codes, and standards cited therein, and latest applicable addenda and supplements. Copies of these items shall be kept available in shop and field.
1. "The Commonwealth of Massachusetts State Building Code", ninth edition.
 2. "The International Building Code", 2015 edition.
 3. "Specification for the Design of Cold-Formed Steel Structural Members, 1986", American Iron and Steel Institute.
 4. "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings", American Institute of Steel Construction, 2005, including addenda.
 5. "Structural Welding Code - Steel" (AWS D1.1-96), American Welding Society.
 6. "Structural Welding Code - Sheet Steel" (AWS D1.3-89), American Welding Society.
 7. "Code of Recommended Standard Practice for Composite Deck, Form Deck, and Roof Deck Construction" (SDI 25), Steel Deck Institute.
 8. "Fire Resistance Directory, January 1996", Underwriters Laboratories Inc.
 9. American Society for Testing Materials (ASTM) Standards referenced in this Section.
 10. Steel Deck Institute Diaphragm Design Manual, Second Edition, 1991.
- B. Any material or operation specified by reference to published specifications of manufacturer or published standard shall comply with said specification or standard. In case of conflict between referenced specifications, most stringent requirement shall govern. In case of conflict between referenced specifications and Project Specifications, Project Specifications shall govern unless otherwise indicated by Architect in writing.

1.6 DESIGN CRITERIA

- A. Contractor is responsible for detailed design of steel deck to safely sustain loadings show on structural drawings and other dead loads indicated on drawings and in specifications.
1. Wherever possible, design deck so as to require no shoring.
 2. Individual steel deck panels shall be continuous over two or more spans except where limited by structural steel layout.
 3. Steel deck sections and calculation of their properties shall conform to "AISI Specification for the Design of Cold-Formed Steel Structural Members".

4. Deflection Requirements relative to supporting members for floor units (L=span): Under initial load of deck plus fresh concrete, deflection shall be less than L/180 or 5/8 inch, whichever is smaller.

a. Under loads applied after concrete has set, deflection shall be less than L/360.

5. Deflection Requirements relative to supporting members for roof units (L=span):

a. Under design live load, deflection shall be less than L/240.

6. Bending strength requirements for floor units:

a. Initial loads (deck acting alone)

Deck + concrete (including ponding + 20 psf live load, maximum allowable deck stress = $0.60F_y$.

Deck + concrete (including ponding + 150 lbs./foot midspan live load, maximum allowable deck stress = $0.80F_y$.

b. Superimposed loads - for composite behavior all spans shall be considered simple spans.

Considering total dead plus superimposed load to be carried by composite action, maximum allowable deck stress = $0.60F_y$ (bottom fiber).

Considering combined stress on steel deck alone due to initial dead load, plus stress on composite section due to superimposed load, maximum allowable deck stress = $0.8F_y$ (bottom fiber).

Considering superimposed load alone, maximum allowable concrete stress = $0.45 f'_c$.

7. Bending strength requirements for roof units:

a. Under total design load, maximum allowable deck stress - 20,000 psi.

8. Other strength requirements:

a. Allowable shear (or shear/bond) and allowable end bearing shall be as recommended by the deck manufacturer if substantiated by tests by an independent Testing Agency. (Alternatively, certification of tests by a registered professional engineer who witnessed and/or supervised the tests will be acceptable.) Factor of safety shall be not less than 2.0.

b. No loads shall be suspended from the deck or from the deck-slab system except for normal ceiling construction not to exceed 10 psf. (Note the load limitation of 100 pounds per hanger, also.) Not more than one hanger shall be suspended from any hanger tab.

B The roof diaphragm is designed based on the values supplied in Reference Standard 1.3.A.9. The deck supplier shall supply certification that deck as supplied, detailed and installed conforms to these values. Contractor is responsible for detailed design of steel deck to safely sustain loadings shown on structural drawings and other dead loads

indicated on drawings and in specifications.

1.7 SUBSTITUTIONS

- A. Substitutions for steel deck sizes, type, connection details or any other modifications proposed by Contractor will be considered by Architect only under following conditions:
1. That request has been made and accepted prior to submission of Shop Drawings.
 2. That there is a substantial cost advantage or time advantage to Owner; or that proposed revision is necessary to obtain required materials or methods at proper times to accomplish work in time scheduled.
 3. That sufficient sketches, engineering calculations, and other data have been submitted to facilitate checking by Architect, including documentation of cost reductions or savings in time to complete work.

PART 2- PRODUCTS

2.1 MATERIALS

- A. Steel deck floor units:
1. Nominal rib height shall not exceed 2 inches.
 2. Sheet thickness shall not be less than 20 gage.
 3. The wr/hr ratio shall not be less than 2.
 4. Sufficient integral locking lugs shall be formed to transfer the horizontal shearing forces between the concrete slab and the floor unit and to prevent vertical separation of the slab from the deck.
 5. Steel deck shall be manufactured from steel conforming to ASTM A653 Structural Quality (SQ) Grade 33 with a minimum yield strength of 33,000 psi.
 6. Deck shall have a galvanized coating conforming to ASTM A653 designation G30 or better.
- B. Steel deck roof units:
1. Sheet thickness shall not be less than 20 gage.
 2. Steel deck shall be manufactured from steel conforming to ASTM A653 Structural Quality (SQ) Grade 33 with a minimum yield strength of 33,000 psi.
 3. Deck shall have a galvanized coating conforming to ASTM A653 designation G60 or better.
- C. Steel deck units shall have U.L. approved fire ratings for the construction assemblies specified.
- D. Deck Accessories:
1. Fabricate deck accessories of 18 gage minimum sheet steel, with galvanized

coating. Provide the following typical accessories and any additional accessories required by deck manufacturer's steel deck system to provide continuous support for the concrete and to prevent loss of any concrete fines through gaps and openings.

- a. Cover plates or flashing plates as required to close panel edge or end conditions and where panels change direction or abut.
 - b. Horizontal flashing to close openings between steel deck and structural steel columns.
 - c. Horizontal flashing to cover gaps between deck and structural steel or between deck units.
 - d. Edge closures and screeds to provide boundary for concrete cast on steel deck. Unless a structural steel member is the edge form, provide edge forms at slab perimeter and at openings in slabs cast on steel deck. Edge closures and forms shall have (or shall be braced to have) sufficient strength and stiffness to retain the concrete with straight edges true to drawing details and dimensions. Edge closures shall not interfere with shear connector installation.
 - e. Drain pans or sumps, flat or recessed to suit drains, formed of 14 gage galvanized steel.
 - f. Welding washers - to be used where specified under PART 3 - INSTALLATION.
 - g. Rust-inhibiting priming paint for touch-up: "TNEMEC-ZINC 92" by Tnemec Co; "Rust-Oleum 7085" by Rust-Oleum Co.; or "Aquapon UC-40059" by P.P.G. Industries.
- E. Welding materials: conform to AWS Code and AWS filler steel specifications.
- F. Auxiliary Structural Steel:
- 1. Steel shapes and plates shall be new steel conforming to ASTM A36.
 - 2. Fabrication shall conform to AISC Specification.
- G. Shear Connectors: Headed steel studs with ceramic arc shield. Studs shall conform to "Specification for Cold-Finished Carbon Steel Bars and Shafting", ASTM A108, grades 1015, 1017, or 1020, minimum yield strength = 50,000 psi and minimum tensile strength = 60,000 psi. See AWS Code D1.1, Section 4, Part F "Stud Welding" for additional material requirements.

PART 3- INSTALLATION

3.1 INSPECTION

- A. Examine all work prepared by others to receive work of this Section and report any defects affecting installation to Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.

3.2 GENERAL

- A. Install all components in accordance with the Contract Documents and the approved Shop Drawings. Erect steel deck only after the supporting structural steel has been

aligned and connected as required by the Structural Drawings and Specifications.

- B. Handle and stack materials carefully in order to prevent deformation or damage. During unloading and hoisting, take care to prevent damage to ends and sides of individual deck panels. Panels stored prior to installation shall be placed on skids and shall be protected and kept dry. Foreign materials on panels shall be completely removed prior to erection.
- C. Replace damaged components with identical new units, unless repair or reinforcement is specifically permitted by the Architect.

3.3 AUXILIARY STEEL SUPPORTS

- A. Erect auxiliary steel supports in accordance with provisions of Section 051200 "Structural Steel" of the Specifications, and in conformance with the approved Shop Drawings.
- B. Bearing surface of each auxiliary support shall be in the plane of the bottom of the deck, as established by adjacent structural steel members on which the deck is to bear.

3.4 STEEL DECK

- A. Steel deck panels shall be shipped to the field cut to the proper length. All notching at columns, bevel cuts, or other similar fabrication shall be done by the steel deck erector.
- B. No opening shall be cut in steel deck unless shown on the approved steel deck Shop Drawings or specifically approved by the Architect in writing. If an opening not shown on the Shop Drawings is required, Contractor shall submit to the Architect a sketch drawn to scale, showing the proposed opening and all other openings and supports in the immediate area. The deck shall not be cut until this sketch has been approved by the Architect. Any additional reinforcement or framing required because of such an opening shall be provided at Contractor's expense.
- C. Holes and openings which are located and dimensioned on the Structural Drawings shall be cut by the steel deck erector. Holes required by other trades shall be shown on the steel deck Shop Drawings but shall be located and cut by the respective trades.
- D. All cutting of steel deck panels shall be done in a workmanlike fashion by power shears, gas-torch, cold chisel or other means approved by the Architect.
- E. Surfaces of structural steel members which are to receive shear connectors, and steel deck support surfaces which are to receive welding or shear connectors, shall be free of paint, ice, water, oil, dirt, rust or any other material detrimental to welding.
- F. No steel deck shall be erected until the corresponding structural steel tier has been fully aligned and connected. If the supporting steel framework or concrete is not in proper alignment, or at the proper level, Contractor shall proceed with corrective action. The steel deck panels shall not be erected until the necessary corrections have been made.
- G. Steel deck panels shall be placed on supporting steel or concrete and accurately aligned to final position before permanently fastened. Deck shall not be stretched or contracted in a transverse direction and shall have a minimum end bearing of 2 inches on the supporting steel or concrete. Steel deck panels shall rest tightly on the top flange of beams or girders, or any other support surfaces. Unless indicated otherwise, all steel beams in floor/roof areas where steel deck is used shall have their top flanges

in direct contact with and welded to the deck, for lateral stability of the beams.

- H. Install sheet steel accessories welded in place, including closures, screeds, filler pieces, or cover plates, as appropriate, to close panel ends, where panels change direction or abut, to bridge from edges of panels to adjacent steel or concrete, at slab edges, and at other locations where shown or otherwise required to support and retain the concrete at each floor level.
- I. Column closures shall be both cut and installed in the field.
- J. All welding of steel deck panels, including accessories, shall be performed by welders who have been qualified by tests, as prescribed in the "Standard Qualification Procedure" of the American Welding Society.
- K. Burning or weakening of the steel deck material around welds shall be cause for rejection. Deficient welds shall either be repaired or entirely removed and rewelded or the steel deck shall be reinforced or replaced, as directed by the Architect.
- L. Steel deck panels shall be arc-welded to the supporting steel in accordance with the following minimum requirements:
 - 1. Welding washers of a type approved by the Architect shall be used in connecting any steel deck material less than 20 gage in thickness.
 - 2. Ends and end laps - 3/4 inch diameter puddle welds at a maximum spacing across the width of the panel, of 12 inches.
 - 3. Intermediate supports - same as (2) above.
 - 4. Where two panels abut, each panel shall be fastened as in (2) above.
 - 5. Longitudinal edges and edge laps supported by steel framework - 3/4 inch diameter puddle welds at a maximum spacing of 2 feet 6 inches along the length of the panel.
 - 6. See Drawings for additional requirements in special areas.
- M. Longitudinal side laps of adjacent panels:
 - 1. Deck shall be welded or mechanically fastened between supports at intervals not exceeding 2 feet 6 inches.
- N. Longitudinal edge closures shall be fastened by tack welding at a maximum spacing of 2 feet 6 inches. Sheet steel screws shall not be used.
- O. Locate drain pans or sumps to suit drain fittings and drain locations. Cut deck to receive drain and weld in pan or sump to reinforce deck openings.
- P. Both welding to bottom of steel deck and field penetration through steel deck for hangers or hanger attachment devices are prohibited, unless specifically approved in advance by the Architect, or shown on the Structural Drawings. The Architect will not consider any hanger or attachment device proposal which in Architect's opinion would impair the local or overall load capacity of the deck-slab system, or would impair the fire resistance of the deck-slab assembly, or would result in a concentrated suspended load on the deck-slab system exceeding 500 pounds in any area of 50 square feet.

3.5 SHEAR CONNECTORS

- A. Headed stud shear connectors shall be installed after erection of the steel deck, in accordance with the AWS Code, by experienced operators using automatic welding equipment, adequate electric power and ceramic shields, in accordance with the recommendations of the stud manufacturer.
- B. Through-deck stud welding shall be used where gage thickness permits proper stud welding to develop required strength. Stud and/or steel deck manufacturer shall provide adequate test results to verify feasibility of through-deck stud welding for particular stud size and gage thickness involved. Stud and/or steel deck manufacturer shall satisfy requirements of stud installer for expeditious and proper installation. Manufacturer's requirements regarding cleanliness of steel and other items shall be met by installer.
- C. If through-deck stud welding is unfeasible, studs shall be installed in prepunched holes in deck. Prepunched holes shall be provided only for studs involved and hole oversize shall be held to a minimum.
- D. All shear connectors shall be headed steel studs. See drawings for spacing and size.
- E. Stud spacing - Shall be in accordance with all spacing requirements of AISC. Space approximately uniformly between center (or designed zero shear point) of beam and each end or designated point, or as otherwise shown.
- F. Horizontal Clearances - Minimum one inch from edge of any stud to face of concrete, deck rib or trench header.
- G. Edge distance - Center of stud to edge of steel beam shall be preferably two inches, but in no case less than 1-1/4 inches.
- H. After stud installation in each area, all ceramic shields shall be broken off and the material removed from the deck and steel surfaces to an area designated by the General Contractor.
- I. Personnel welding shear connectors shall be qualified using elements of above procedure, prior to any production welding of shear connectors.

3.6 INSPECTION, TESTING, AND QUALITY CONTROL

- A. Inspection and testing of steel deck work will be performed by an independent Testing Agency, under a separate contract with the Owner. Materials and workmanship shall be subjected to inspection and testing in shop and field by Architect and/or Testing Agency. Such inspection and testing shall not relieve Contractor of responsibility to provide additional inspection, testing, and quality control as necessary to furnish materials and workmanship in accordance with requirements of Contract Documents.
- B. Notify Architect, Construction Manager and Testing Agency prior to start of any fabrication, erection, or other phases of work so as to afford them reasonable opportunity to visit the site. Such notification shall be made at least 36 hours in advance.

- C. Facilitate inspection and testing by Testing Agency. Contractor shall, at his own expenses, furnish Testing Agency, upon request, with:
 - 1. Complete sets of approved Shop Drawings and corrective work procedures at shop(s) and in field.
 - 2. Cutting lists, order lists, material bills, and shipping lists.
 - 3. Information as to time and place of all rollings and shipments of material to shop(s) and field.
 - 4. Representative sample pieces requested for testing.
 - 5. Full and ample means and assistance for testing materials, and proper facilities for inspection of work, shop and field.
- D. Testing Agency shall inspect and test steel deck and shear connector work as required by Architect.
- E. Maintain records of welders employed and date of qualification. Such records shall be available for examination by Architect and/or Testing Agency, or certified copies submitted upon request to Architect and Testing Agency.
- F. Before any welding of the steel deck is done, two specimens of each type of weld shall be prepared by each operator. These specimens shall be inspected, tested, and approved by the Owner's representative before that operator shall be permitted to weld on the structure.
- G. All headed stud shear connectors shall be checked for the following indications of an insufficient weld:
 - 1. Less than 360 degree fillet, voids, undercuts, or insufficient penetration.
 - 2. Burn-off (reduction in length after welding) less than 1/8 inch.
 - 3. Cold appearance of the weld.
- H. If, after welding of any shear connectors, visual inspection indicates any of the imperfections listed above or any other questionable appearance, such stud shall be struck hard with a three-pound hammer and bent 15 degrees off perpendicular to beam and toward nearest end of beam. Studs which fail this test, as provided in the AWS Code, shall be replaced. Studs which show no sign of failure after this test may be left in bent position if no portion of the stud is less than one inch from a proposed concrete surface.
- I. Do not remove any marks or tags applied by Testing Agency identifying rejected work.
- J. Steel deck work which has been rejected by Architect and/or Testing Agency in shop or field shall be corrected without delay and at no expense to the Owner.
- K. Additional tests shall be performed at Contractor's expense to confirm compliance of corrected work.

END OF SECTION

Section 21 00 00

FIRE PROTECTION
 (FILED SUB-BID REQUIRED)

PART 1 - GENERAL.....	1
1.1 FILING SUB-BIDS.....	1
1.2 GENERAL PROVISIONS.....	1
1.3 DESCRIPTION OF WORK	1
1.4 RELATED WORK	3
1.5 CODES, ORDINANCES, AND PERMITS.....	3
1.6 DISCREPANCIES IN DOCUMENTS.....	3
1.7 MODIFICATIONS IN LAYOUT.....	4
1.8 RECORD DRAWINGS.....	4
1.9 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS	5
1.10 SHOP DRAWINGS AND MATERIAL SCHEDULES	5
1.11 COORDINATION DRAWINGS	6
1.12 GUARANTEE.....	6
1.13 DRAWINGS.....	6
1.14 SYSTEM DESCRIPTION.....	7
1.15 ALARM FACILITIES.....	7
1.16 PIPE MARKER IDENTIFICATION SYSTEM	7
1.17 VALVE TAGS.....	7
1.18 IDENTIFICATION SIGNS	8
1.19 PAINTING	8
1.20 WATER SUPPLY TEST DATA	8
1.21 HOISTING EQUIPMENT AND MACHINERY	8
1.22 STAGING AND SCAFFOLDING.....	8
1.23 COMMISSIONING	9
1.24 BREAKDOWN.....	9
1.25 VISIT TO SITE	9
PART 2 - PRODUCTS.....	9
2.1 GENERAL	9
2.2 PIPE AND FITTINGS	9
2.3 JOINTS.....	10
2.4 VALVES	11
2.5 SPRINKLERS.....	11
2.6 FIRE DEPARTMENT CONNECTION.....	12
2.7 FIRE STANDPIPE EQUIPMENT	12
2.8 SUPPLEMENTARY STEEL, CHANNEL, AND SUPPORTS	12
2.9 HANGERS AND SEISMIC RESTRAINTS	13
2.10 ALARM DEVICES	13
2.11 DOUBLE CHECK VALVE ASSEMBLY.....	13
2.12 ACCESS DOORS	14
2.13 POST INDICATOR VALVE	14
2.14 DUCTILE IRON PIPE.....	15
2.15 EXTERIOR GATE VALVES	15
2.16 TAPPING SLEEVES.....	16
2.17 FIRE HYDRANTS	16
2.18 DETECTABLE UNDERGROUND WARNING TAPE.....	16
2.19 FIRESTOP SYSTEMS.....	16
2.20 SCAFFOLDS AND STAGING.....	17
2.21 HOISTING MACHINERY AND EQUIPMENT	17

PART 3 - EXECUTION..... 17

3.1 WORKMANSHIP AND INSTALLATION METHODS..... 17

3.2 WORK COORDINATION AND JOB OPERATIONS 17

3.3 CUTTING AND CORE DRILLING 18

3.4 CLEANING AND PROTECTION 18

3.5 SLEEVES, INSERTS, AND ESCUTCHEONS 19

3.6 TESTING 19

3.7 FIRESTOP SYSTEMS:..... 20

3.8 SEISMIC RESTRAINTS 20

3.9 SYSTEM SHUTDOWNS 20

Section 21 00 00

FIRE PROTECTION
(FILED SUB-BID REQUIRED)

PART 1 - GENERAL

1.1 FILING SUB-BIDS

- A. Sub-bids for Work under this Section shall be for the complete Work required hereunder and shall be filed in a sealed envelope with the Awarding Authority before the time and date and at the location indicated in the Instructions to Bidders and at that time will be publicly opened and read aloud.
- B. Procedure for filing Sub-Bids shall be as set forth in the Instructions to Bidders contained in this Project Manual and shall conform to all requirements of the Commonwealth of Massachusetts General Laws, Chapter 149, as amended to date.
- C. Every Sub-Bid submitted for Work under this Section shall be on a form furnished by the Awarding Authority as required by Section 44G of Chapter 149, as amended, which form is required to be completely filled in. A sample bid form for Subcontractors is contained in this Project Manual and the bid form to be used in filing a Sub-Bid is available at the office of the Architect.
- D. Every Sub-Bid filed with the Awarding Authority shall be accompanied by bid security in the form and amount stipulated in the Instructions to Bidders.
- E. No sub-sub bids are required for this Section.

1.2 GENERAL PROVISIONS

- A. All the Contract Documents and General Provisions of the Contract including, but not limited to, General and Supplementary Conditions, and Division 1 Specification Sections apply to this Section.
- B. The work of this Section provides and contains general information which is inherently made a part of each Section and applies to all work performed under this Contract.

1.3 DESCRIPTION OF WORK

- A. Provide all labor, materials, equipment, services and accessories necessary to Design, Furnish and Install the work of this Section, complete and functional, as indicated in the Contract Documents and as specified herein. The Design shall conform to the documents and shall be subject to approval by the Architect.
- B. Without limiting the generality thereof, the work to be performed under this Section includes:
 - 1. Fire Service connecting to Municipal water main as shown on the drawings.

2. A hydraulically designed automatic sprinkler system to provide 100% protection for the building as noted on the Drawings. Refer to Fire Protection Criteria on the Drawings. Prepare Working Drawings for approval of the Architect, the local authority having jurisdiction, and the owner's insurance company under stamp of an independent Massachusetts Registered Professional Fire Protection Engineer.
3. Hydrant flow test
4. Backflow Control Device
5. Fire Department Connections.
6. Test Header
7. Pipe and Fittings
8. Valves
9. Hangers
10. Sprinkler Heads
11. Furnishing and installation of Supervisory Switches and Controls
12. Systems Identification
13. Flushing and Testing of the interior and exterior system as provided herein.
14. Drilling, Coring, Cutting & Patching of holes and openings (where the largest dimension thereof does not exceed 12 inches), for Fire Protection Piping and Equipment. All such holes require sleeves.
15. Scaffolding, Rigging, and Staging required for all Fire Protection Work. Comply with Division 1 requirements.
16. Provide Seismic Restraints for all Fire Protection Systems conforming to the requirements of Section 230548 which Section is herein incorporated by reference as work of the Fire Protection Sub Contractor. Seismic Restraints are required in both new and existing building.
17. Furnishing of Access Panels
18. Smoke and Firestopping Seals and sealing of all wall penetrations as detailed on the drawings. Refer to Section 078400 which defines the firestopping materials and methods.
19. When open-flame or spark producing tools such as blower torches, welding equipment, and the like are required in the process of executing the work, the General Contractor shall be notified not less than twenty four hours in advance of the time that the work is to begin and the location where work is to be performed. Provide fire protective covering and maintain constant non-working fire watch through the Local Fire Department where work is being performed and until it is completed.
20. It is the responsibility of this fire protection contractor to provide skilled and properly licensed Sprinklerfitter Foreman, Journeyman, and Apprentices for each project. At any time when an unlicensed labor is found to be on the job, it is the sole responsibility of this fire protection contractor to replace these workers with properly licensed personnel immediately. Any and all work found to be incorrect, defective, installed in contrary to state, local or NFPA standards, regulations or good engineering practices, shall be expeditiously corrected without delay to the project schedule and at no additional cost to the Owner or General Contractor.
21. It shall be the responsibility of this division 210000 to provide all personnel as required to fully coordinate with the commissioning agent. The hours of training and instruction outlined in this division 210000 and the Testing requirements shall be in addition to those tests and requirements outlined in section 018000 and required to fulfill section 018000 commissioning obligations.

1.4 RELATED WORK

- A. The following items of work related to the Fire Protection Work are included under other Sections of the Specifications:
1. Cutting & Patching beyond 1.3B.14 above: SECTION 010450 - CUTTING AND PATCHING.
 2. Installation of Access Panels: Respective finish section.
 3. Excavation and Backfill: DIVISION 31
 4. Finish Painting: SECTION 099000: PAINTING
 5. Wiring for Supervisory Switches, Electrical Alarm, and Flow Switches, and Power Wiring: SECTION 260000 - ELECTRICAL
 6. Temporary Facilities: SECTION 015000 - TEMPORARY FACILITIES
 7. Installation of Hood Suppression System – SECTION 114000 FOOD SERVICE EQUIPMENT

1.5 CODES, ORDINANCES, AND PERMITS

- A. Perform all work in accordance with the following Codes:
1. 780 CMR: The State Building Code.
 2. 527 CMR: The Fire Prevention Regulations.
 3. NFPA-13-2013, NFPA-24-2010, NFPA 25-2014, NFPA-241-2013, and Owner's insurance company requirements.
 4. All applicable Local, State, and Federal Codes, Statutes, or Regulations.
 5. Town of Millbury Fire Department.
 6. Town of Millbury Building Department.
- B. Obtain all permits, inspections, and approvals, from the governing authorities and pay all fees and include cost in the bid, including approvals for the cross connection control device. Provide the Owner with the cross connection permit for the device in the Owner's name.

1.6 DISCREPANCIES IN DOCUMENTS

- A. Where Drawings or Specifications conflict or are unclear, advise Designer in writing before Award of Contract. Otherwise, Designer's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted due to discrepancies or unclarities thus resolved.
- B. Where Drawings or Specifications do not coincide with manufacturers' recommendations, or with applicable codes and standards, alert Designer in writing before installation. Otherwise, make changes in installed work as Designer requires within Contract Price.
- C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specs, this contractor shall provide that material, installation, or work which is of the higher standard.

- D. It is the intent of these contract documents to have the contractor provide systems and components that are fully complete and operational and fully suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component. In cases such as this, where the contractor has failed to notify the Designer of the situation in accordance with the paragraph above, the contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.
- E. In cases covered by the paragraph above, where the contractor believes he needs engineering guidance, he shall submit a sketch identifying his proposed solution and the Designer shall review, note if necessary, and approve the sketch.

1.7 MODIFICATIONS IN LAYOUT

- A. HVAC, Plumbing, Fire Protection, and Electrical Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet architectural requirements.
- B. In all spaces, prior to installation of visible material and equipment, including access panels, review Architectural Drawings for exact locations and where not definitely indicated, request information from Designer.
- C. Check Contract Drawings as well as Shop Drawings of all subcontractors to verify and coordinate spaces in which work of this Section will be installed.
- D. Maintain maximum headroom at all locations. All piping and associated components to be as tight to underside of structure as possible.
- E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades and to coordinate according to Paragraphs A, B, C, D above. Systems shall be run in a rectilinear fashion.
- F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Designer for review and approval.

1.8 RECORD DRAWINGS

- A. General: Refer to DIVISION 01 - GENERAL REQUIREMENTS for general requirements for maintaining as-built drawings and submitting final reproducible record documents.
- B. The General Contractor will provide two sets of black or blue line on white Drawings to the Fire Protection Subcontractor, one set of which shall be maintained at the site and which shall, at all times, be accurate, clear, and complete, showing the actual locations of all equipment and piping as it is being installed. The Record Drawings shall be available to the Architect/Engineer's field representative at all times.

- C. Provide electronic AutoCAD drawings to indicate revisions to piping size and location both exterior and interior; including locations of valves and other equipment requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column line; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located.
- D. Include in the Record Drawings any addenda, sketches, and supplementary Drawings issued during the course of construction.
- E. Non-availability of Record Drawings or inaccuracies therein will postpone the final inspection until they are available.
- F. All valves shown on these Drawings shall be numbered with numbers corresponding to those on the valve charts.
- G. All costs related to the foregoing requirements shall be paid by the Fire Protection Subcontractor.

1.9 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Provide operating instructions to the owner's designated representative with respect to operation functions and maintenance procedures for all equipment and systems installed. At the completion of the project, turn over to the Architect four (4) complete manuals in three-ring, loose-leaf binders, containing the following:
 - 1. Complete Shop Drawings of all equipment.
 - 2. Operation description of all systems.
 - 3. Names, addresses, and telephone numbers of all suppliers of the system.
 - 4. Preventive maintenance instructions for all systems.
 - 5. Spare parts list of all system components.
 - 6. Valve tag chart noting location of any and all valves controlling the fire protection systems including main control, main drain, auxiliary drain, drum drip, inspectors test connections and any low point drains connected to these systems.
 - 7. Copy of NFPA 25, latest edition.
- B. Provide DVD recording of operation and maintenance training sessions and include as part of O & M Manual submittal. Training session video recording and DVDs shall be performed by a professional videographer. Provide indexed table of contents for DVD recording.

1.10 SHOP DRAWINGS AND MATERIAL SCHEDULES

- A. Refer to SECTION 013300 - SUBMITTALS for substitution of equipment and submittal of Shop Drawings. If apparatus or materials are substituted for those specified, and such substitution necessitates changes in or additional connections, piping, supports or construction, same shall be provided as the responsibility, and at the expense, of the Fire Protection Subcontractor.
- B. Fabrication of any material or performing of any work prior to the final approval of the Submittals will be entirely at the risk of the Subcontractor. The Subcontractor is responsible for furnishing and installing materials called for in the Contract Documents, even though these materials may have been omitted from approved Submittals.
- C. Submit Shop Drawings for the following materials and equipment.
 - 1. Coordinated Working Drawings and hydraulic calculations including size, type, length, temperature rating of sprinkler heads, piping and the like. Indicate flow test

- results, design criteria, hydraulic reference points, diffuser and light locations.
- 2. Access Panels and Covers
- 3. Sprinkler Heads
- 4. Hangers and Seismic Restraints
- 5. Pipe, Fittings, and Appurtenances
- 6. Systems Identification
- 7. Valves
- 8. Fire Department Connection
- 9. Cross Connection Devices

1.11 COORDINATION DRAWINGS

- A. Before materials are purchased or Work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces.
- B. Coordination Drawings are for the Contractor's and the Architect's use during Construction and shall not be construed as replacing any Shop or Record Drawings required elsewhere in these Contract Documents.
- C. Detailed procedures for Coordination Drawings are contained in DIVISION 01 of these Contract Documents.

1.12 GUARANTEE

- A. Guarantee all work under this Section free from defects in workmanship or materials for a period of one (1) year from the date of final acceptance of the building, as set forth in the Contract.
- B. Replace any such defective work developing during this period, unless such defects are clearly the result of bad usage of equipment by others. Where such defective work results in damage to work of other Sections of the Specifications, restore such work to its original condition by mechanics skilled in the affected trade.

1.13 DRAWINGS

- A. All work shown on the Drawings is intended to be approximately correct to scale but shall be taken in a sense as diagrammatic. Sizes of pipes and general method of running them are shown, but it is not intended to show every offset and fitting. To carry out the true intent and purpose of the plans, furnish all necessary parts to make a complete working system ready for use.
- B. The Drawings and Specifications are intended to supplement each other so that any details shown on the Drawings and not mentioned in the Specifications, or vice-versa, shall be executed the same as if mentioned in the Specifications and shown on the Drawings.

- C. Refer to the Architectural, Structural, and Other Mechanical and Electrical Drawings which indicate the construction in which this work shall be installed. Locations shown on the plans shall be checked against the general and detailed drawings of the construction proper. All measurements must be taken at the building.

1.14 SYSTEM DESCRIPTION

- A. The building shall be 100% sprinklered with an automatic sprinkler system. The system shall be designed in accordance with NFPA-13-2013
- B. Building is to be 100% sprinklered including all closets and Electric rooms. The elevator machine room and shaft shall not be sprinklered.
- C. Refer to Fire Protection Criteria on the Drawings. Conform to the zoning shown on the plans.
- D. Locations of sprinkler heads are shown in some of the areas to be sprinklered only to establish the patterns and design intent. Major equipment and runs of piping may also be shown. Refer to reflected ceiling plan for location of all sprinkler heads. All sprinkler heads are to be installed dead center of tile.
- E. The documents require that the building be covered 100%. This includes all closets, combustible concealed spaces, and other areas as required under NFPA-13-2013. These areas are to be included in the Sub-contractor's bid whether or not the heads are shown on the sprinkler plans.

1.15 ALARM FACILITIES

- A. Furnish and install all Supervisory Switches, Flow Switches, Pressure Switches, and other Alarm Devices. Install all such devices on the piping and coordinate with the Electrical Subcontractor who shall wire all such devices to the Fire Alarm System. Every shutoff valve installed on this project shall have a supervisory trouble switch wired to the Fire Alarm Panel.

1.16 PIPE MARKER IDENTIFICATION SYSTEM

- A. Mark all piping installed under this Section with a marking system in basic colors conforming to those specified in ANSI/ASME A-13.1. Markings shall indicate pipe content and direction of flow. Apply markers every 20 feet on center on piping which is exposed in mechanical or storage areas and above suspended accessible ceilings. Also, apply at all access panels, valves, tee joints, alarms, and/or controls.
- B. Adhesive system may be used throughout except at the mechanical rooms in which case markings shall be painted on.

1.17 VALVE TAGS

- A. All valves installed in the Fire Protection Contract shall be tagged. Tags shall be secured to valves with chain link and shall be marked with 3/4 inch high letters as to function. All valve tags shall indicate the Fire Zone.

- B. A corresponding framed Valve Tag Chart shall be installed within each Sprinkler Riser or Control Valve Room indicating location of each valve and the section it serves. This chart shall also be included within the Owner's O&M Manual with valve tag locations noted on the As-Built Sprinkler drawings.

1.18 IDENTIFICATION SIGNS

- A. All equipment and systems shall be identified with signs furnished and attached in accordance with NFPA 13.

1.19 PAINTING

- A. All interior exposed piping is to be painted and all painting, except as noted, will be done by the Painting Subcontractor. All uncovered piping and hangers shall be thoroughly cleaned of rust, oil, and other containments by the Fire Protection Subcontractor and left ready to receive primer coat.
- B. Painting for pipe markings shall be done under this Section.

1.20 WATER SUPPLY TEST DATA

- A. The following water supply data is included as information available to bidders.
- B. A hydrant flow test was performed on _____, by _____ at _____.
- C. Flow Test Results:
 - 1. Static Pressure = PSI
 - 2. Residual Pressure = PSI
 - 3. Flow = GPM
 - 4. Estimated Flow at 20 PSI = GPM

1.21 HOISTING EQUIPMENT AND MACHINERY

- A. Unless otherwise specified, all hoisting and rigging equipment and machinery required for the proper and expeditious prosecution and progress of the Work of this Section shall be furnished, installed, operated and maintained in safe condition by each sub-contractor, as specified under Section 015000, TEMPORARY FACILITIES AND CONTROLS.

1.22 STAGING AND SCAFFOLDING

- A. Unless otherwise specified, each sub-contractor shall provide all lifts and man-lifts, and furnish, erect and maintain in safe condition, all staging and scaffolding as specified under Section 015000 Temporary Facilities and Controls, as needed for proper execution of the work of this Section. Staging and scaffolding shall be of adequate design, erected and removed by experienced stage builders having all accident prevention devices required by Federal, state and local laws.

1.23 COMMISSIONING

- A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 018000 – General Commissioning Requirements.
- B. Complete installation and startup checks and functional tests according to Section 018000 – General Commissioning Requirements and manufacturers written instructions.
- C. Operational Test: After plumbing systems have been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the startup procedure.
- D. Verify that equipment is installed and commissioned as per requirements of Section 018000 and manufacturers written instructions/requirements.

1.24 BREAKDOWN

- A. Submit a breakdown of the contract price to aid the Architect in determining the value of the work installed as the job progresses.
- B. No requisition will be approved until the breakdown is delivered to the Architect.

1.25 VISIT TO SITE

- A. Prior to submitting a bid, visit the site of work and become familiar with existing conditions at the site of the work. Any assumptions made are at this Subcontractor's expense.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials and equipment furnished under this Section shall be new, unused, first quality of a manufacturer of established reputation and shall be U.L./F.M. approved. Each valve, fitting, section of pipe, and piece of equipment shall have cast or indelibly stamped thereon the manufacturer's name and pressure rating where applicable. All threads for fire department connection shall conform to the standards of the Local Fire Department.

2.2 PIPE AND FITTINGS

- A. Pipe and fittings shall conform to the latest A.S.A., A.S.T.M., C.A., and F.S. Standards. All grooved products shall be of one manufacturer to conform to NFPA Standards.

- B. All piping installed under this Section shall be in accordance with the following:

<u>Service</u>	<u>Materials</u>
Trim piping around alarm valves, sprinkler piping 1-1/2 inch and smaller	ASTM A-53, Schedule 40 black steel pipe
Sprinkler and standpipe piping 2 inch and larger	Schedule 10, ASTM A-135 U.L./F.M. black steel pipe
Underground service	CL 52 ductile iron pipe

- C. Fittings on fire line piping, 2 inch and larger, shall be Victaulic Fire Lock Ductile Iron Fittings conforming to ASTM A-536 with integral grooved shoulder and back stop lugs and grooved ends for use with Style 009-EZ or Style 005 couplings.
- D. Fittings for standpipes and risers, 2-1/2 inch and larger, and where ever required to conform to Seismic Requirements shall be Victaulic Vic-Flex Style 75 or 77 with Fire Lock Gasket.
- E. Branch line fittings shall be welded or shall be Victaulic 920/920N Mechanical Tees.
- F. Schedule 10 pipe shall be roll grooved. Schedule 40 pipe where used with mechanical couplings shall be rolled groove and shall be threaded where used with screwed fittings.
- G. Fittings for threaded piping shall be malleable iron screwed sprinkler fittings.
- H. All pipe and fittings shall be U.L./F.M. approved for sprinkler and standpipe service. All pipe and fittings shall be galvanized for dry or pre-action system and black for wet system.
- I. Fittings on underground fire service piping shall be 250 psi gray iron fittings with mechanical joint ends. Coordinate with site contractor to assure all joints are properly thrust blocked.
- J. Grooved fittings shall be manufactured by Victaulic, Grinnell, Anvil, or equal.

2.3 JOINTS

- A. Threaded pipe joints shall have an approved thread compound applied on male threads only. Teflon tape shall be used for threads on sprinkler heads.
- B. Joints on piping, 2 inch and larger, shall be made up with Victaulic, or equal, Fire Lock Style 005, rigid coupling of ductile iron and pressure responsive gasket system for wet or dry sprinkler system as recommended by manufacturer. Couplings on dry systems shall be galvanized. Cutting, roll grooving, lubrication, and assembly of all joints shall be made strictly in accordance with manufacturer's recommendations. Exercise particular caution in the use of lubricant to avoid "squeeze out" of lubricant when system is in service.
- C. Grooved joints and fittings shall be manufactured by Victaulic, Grinnell, Anvil, or equal.
- D. Furnish and install where piping crosses building expansion joints a listed expansion joint. Expansion joints shall be Metraflex "Fireloop", or manufactured by Flexonic Company or Hyspan, or equal. Expansion joints shall be UL approved for use for fire sprinkler systems.

- E. All joints on Fire Service under slab shall be restrained up to the service stub flange connection above slab.

2.4 VALVES

- A. All shutoff and control valves shall be U.L./F.M. approved, indicating type valves equipped with a supervised trouble switch wired to the fire alarm system. Shutoffs and zone valves may be either OS&Y indicating gates or butterfly valves.
- B. Gate valves shall be outside screw and yoke indicating type, 175 psi W.P. and U.L./F.M. listed, Jenkins or equal. All such valves shall have supervised trouble switch.
- C. Butterfly valves shall be Victaulic Series 705-W for 2-1/2 inch and larger, and Milwaukee indicating type U.L./F.M. butterfly for threaded service. Coordinate with Electrical Sub-contractor to have factory installed monitor switches compatible with the remainder of the Fire Alarm System.
- D. Check valves shall be iron body bronze mounted U.L./F.M., 175# W.P. or U.L./F.M. wafer checks. Grooved end valves shall be Victaulic Style 717 Fire Lock Check Valve.
- E. Pressure relief valves shall be located on wet systems pressure regulating valves and downstream of check valves per NFPA-13-2013. Pressure relieve valves shall be listed and not less than 1/2 in. in size and shall be by AGF, Watts, Cla-Val or equal.
- F. Ball drips shall be Potter Roemer #5682, 3/4 inch straight design ball drip valve, or by Victaulic, Viking, or equal.
- G. Drains shall be provided in the systems as may be required by field conditions. Provide drains at all low points and wherever necessary to insure that all portions of the sprinkler piping may be completely drained. Test connections shall be provided as required to test all portions of the system. Pipe low point drains and test connections to suitable receptor as determined in field or shown on Drawings.
- H. Install an inspector's test connection at the furthest point of each sprinkler zone. Run discharge back to a suitable receptor. Exterior wall penetration is permitted with test drain but only as approved by the Architect.
- I. Valves shall be manufactured by Victaulic, Nibco, Viking, or equal. Inspector's test stations shall be manufactured by AFG, Tyco, Victaulic, or equal.

2.5 SPRINKLERS

- A. All sprinklers to be used on this project shall be Quick Response type and shall be stamped with date of manufacture and temperature rating. Temperature ratings shall be determined by the location of the heads per NFPA 13-2013, section 8.3.2.5, and shall be minimum 155 degrees F. throughout except in special areas around heat producing equipment, skylights, and attics in which case use temperature rating to conform with hazard as specified in NFPA 13-2013. Orifice diameter and K factor shall be appropriate to meet the hydraulic design criteria, the available water supply, and NFPA Standards.
- B. Furnish spare heads of each type installed located in a cabinet along with special sprinkler wrenches. The number of spares and location of cabinet shall be in complete accord with NFPA 13-2013.
- C. Sprinklers shall be manufactured by Tyco, Victaulic, Viking, or equal.
- D. Upright sprinkler heads in areas with no ceilings shall be Tyco Model "TY-FRB" Quick

Response, upright natural brass finish heads. Include heavy duty sprinkler guards on all upright sprinkler heads.

- E. Sidewall heads shall be Tyco Model "TY-FRB" Quick Response with white polyester head and escutcheon.
- F. Pendent wet sprinkler heads shall be Tyco Model "TY-FRB" Quick Response recessed adjustable escutcheon, white polyester finish.
- G. Concealed heads shall be Tyco Model "RFII" Quick Response concealed type, 1-1/2 inch adjustment white cover plate. In special areas, as may be noted on the Drawings, provide alternate cover plate finishes.
- H. Pendent dry sprinkler heads shall be Tyco Model "DS-1" Quick Response dry type, white polyester finish and escutcheon.
- I. Dry sidewall heads shall be Tyco Model "DS-1" dry horizontal sidewall heads, white polyester finish.
- J. Residential pendent sprinkler heads shall be Tyco Model "LFII" Rapid Response with white polyester coated head and escutcheon.
- K. Residential horizontal sidewall heads shall be Tyco Model "LFII" Rapid Response with white polyester coated head and escutcheon.
- L. Use of flexible stainless steel hose with fittings for fire protection service that connect sprinklers to branch lines in suspended ceilings is acceptable. Flexible hoses shall be UL/FM approved and shall comply with NFPA 13 standards. Hose assemblies shall be type 304 stainless steel with minimum 1-inch true-bore internal hose diameter. Ceiling bracket shall be galvanized steel and include multi-port style self-securing integrated snap-on clip ends that attach directly to the ceiling with tamper resistant screws.

2.6 FIRE DEPARTMENT CONNECTION

- A. Fire Department Inlet Connection shall be Croker #6350 Series; 4 inch Storz inlet x 4 inch outlet, 30 degree elbow, brass plate, and stamped "Sprinkler-Standpipe". Install 1/2" ball drip valve and chrome plated trim wall fitting on bottom of inlet fitting body. Provide access panel for servicing the ball drip.
- B. Fire Department Connection shall be manufactured by Croker, Potter Roemer, Elkhart, or equal.

2.7 FIRE STANDPIPE EQUIPMENT

- A. Fire Department Valves shall be Croker Series 5015 Fire Department Valves fitted with 2-1/2 inch x 1-1/2 inch reducer, caps and chains all conforming to Local Fire Department thread standard. Valves shall be polished chrome plated and shall be mounted in a recessed cabinet as indicated on Drawings.
- B. Valves shall be manufactured by Croker, Potter Roemer, Elkhart, or equal.

2.8 SUPPLEMENTARY STEEL, CHANNEL, AND SUPPORTS

- A. Furnish and install All Supplementary Steel, Channels, and Supports required for the proper installation, mounting, and support of all equipment.

- B. Supplementary Steel and Channels shall be firmly connected to building construction in a manner approved by the Architect.
- C. The type and size of the Supporting Channels and Supplementary Steel shall be determined by the Fire Protection Subcontractor and shall be sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for loading.
- D. All Supplementary Steel and Channel shall be installed in a neat and workmanlike manner parallel to the walls, floor, and ceiling construction. All turns shall be made with 90 degree fittings, as required to suit the construction and installation conditions.

2.9 HANGERS AND SEISMIC RESTRAINTS

- A. Hangers shall be furnished, installed, and supported from the building structure in accordance with NFPA - 13, Section 230548 and Drawing VS-1.
- B. All piping shall be seismic restrained.

2.10 ALARM DEVICES

- A. Flow switches shall be vane type water flow detectors with 0-90 Sec. Adjustable non-accumulative retard device and (2) single pole double throw contacts, Notifier Series WFD Potter, VSR.F or equal. At base of standpipe risers, flow switch shall be a non-water discharge, auto-test vane type water flow detector with 0-90 second adjustable non-accumulative retard device and (2) single pole double throw contacts, Potter VSR.AT or equal. The flow switch shall be paired with either a single gang box test switch, Potter ATC-1 for testing a single device or ATC-4 for testing up to four devices."
- B. Pressure switches shall be adjustable Potter Model PS10A or equal.
- C. High/Low pressure switches shall be adjustable Potter Model PS40A or equal.
- D. Supervisory switches on all O.S. & Y. gate valves shall be Notifier NGV complete with mounting bracket.
- E. The wet system alarm device shall be Reliable Model 'E' alarm valve with "E1" trimmings. Package to include electric bell.
- F. Dry valve shall be Reliable Model "A" or "B" as dictated by Hydraulic Calculations complete with Electric Trim Package.
- G. Refer to Drawings for additional devices. Co-ordinate, prior to ordering devices, with the Electrical Sub-Contractor to assure device compatibility with the Fire Alarm System.
- H. Alarm valves shall be as manufactured by Reliable, Victaulic, Tyco, or equal. Flow, pressure and supervisory switches shall be manufactured by Potter, Notifier, System Sensor, or equal.

2.11 DOUBLE CHECK VALVE ASSEMBLY

- A. Double check valve assembly shall be State approved, U.L./F.M. approved, with iron body bronze mounted construction complete with supervised OS & Y gate valves and test cocks. Furnish two spare sets of gaskets and repair kits.
- B. Double check valve assembly shall be of one of the following:

1. Watts Series 757-OSY
2. Wilkins 350A-OSY
3. Conbraco Series 4S-100
4. Or equal.

- C. In the name of the owner pay for, file for, and obtain required permits from D.E.P. and/or local authority whichever has jurisdiction prior to installation.

2.12 ACCESS DOORS

- A. Furnish Access Doors for access to all concealed control valves, drains, inspector's tests, supervisory devices, and to all other concealed parts of the system that require accessibility for the proper operation and maintenance of the system. These doors shall be installed under the appropriate Section of the Specifications for the surface upon which the panels are mounted.
- B. All Access Doors shall be located in a workmanlike manner in closets, storage rooms, and/or non-public areas, positioned so that the valve or part can be easily reached, and the size shall be sufficient for this purpose (minimum size 12 inch x 16 inch). When access doors are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.
- C. Refer to Section 083100 - Access Doors and Frames, for all product requirements for furnishing access panels.
- D. Coordinate locations and schedule with the work of trades involved with construction in which access panels will be installed.
- E. Access Door Shop Drawings shall be submitted to the Architect for approval.
- F. All access panels shall be keyed alike. Coordinate keying with other trades.

2.13 POST INDICATOR VALVE

- A. Post indicator valves (PIV) shall be Mueller co. UL/FM model A-20806 adjustable type indicator post with supervisory control valve switch model #PCVS-2. Post indicator valve shall be left hand open.
- B. Post Indicator Valve shall be manufactured by Mueller, Clow, American Flow Control, or equal.

2.14 DUCTILE IRON PIPE

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile or gray iron glands, rubber gaskets, and steel bolts.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi.
 - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Gaskets: AWWA C111, rubber.
- C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, round-grooved ends.
 - 1. Grooved-End, Ductile-Iron Pipe Appurtenances: ASTM A47, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions matching pipe, 350 psi.
 - 2. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions, Include ferrous housing sections, gasket suitable for water, and bolts and nuts. Joints shall be Tyton.
 - 3. Gaskets: AWWA C111.
- D. Flanged Ductile Iron Pipe: AWWA C115/A21.11, with factory applied screwed long hub flanges.
 - 1. Flanges: ASME B16.1 250 psi pressure ratings, as necessary.
 - 2. Wall Sleeve Castings, size and types shown on the drawings, shall be hot dipped galvanized per ASTM A123.
- E. Cement Mortar Internal Lining: Cement mortar lining and bituminous seal coat as per AWWA C104.
- F. Exterior Pipe Coating: The exterior of pipe shall have the standard asphaltic coating.

2.15 EXTERIOR GATE VALVES

- A. All gate valves shall conform in design and manufacturing to the latest issue of AWWA Standard C500 "Resilient-Seated Gate Valves for Water Supply", rated at 150 psi working pressure with a minimum 300 psi pressure test
- B. All valves shall have a 2 inch operating nut, mechanical joint hubs (except for wet tapping sleeves).
- C. Coordinate direction of valves opening with the local Water Department.

2.16 TAPPING SLEEVES

- A. Tapping sleeves shall be iron bodied and have a maximum working pressure of 250 psig and certified to ANSI/NSF 61. Outlet flange dimensions and drilling shall comply with ANSI B16.1, class 125 and MSS SP-60.
- B. Couplings to be used in connecting two plain ends of cast, ductile iron, or PVC pipe shall be of cast or ductile iron with bolts and nuts complying with AWWA C111. Couplings shall be Dresser Style 38, Smith-Blair Style 441, Clow Type F12308, or approved equal.

2.17 FIRE HYDRANTS

- A. Hydrants shall conform to the requirements of AWWA C502, and be designed for 150 psi working pressure tested to 300 psi hydrostatic. Hydrants shall be 6 inch mechanical joint show, 4-1/4 inch valve opening, open COUNTER CLOCKWISE with 2-1/2 inch hose nozzles and 4-1/2 inch pumper connection, National Standard Threads, operating nut and nozzle cap with non-kink safety chains. Bury length shall be 5'-0"
- B. Hydrant shall be the compression type, closing with the pressure. They shall be traffic model with safety flange and stem couplings.
- C. Hydrant shall be able to be rotated 360 degrees. They shall have a positive closing, self-cleaning drain valve and drainage area shall be completely bronze or brass lined.

2.18 DETECTABLE UNDERGROUND WARNING TAPE

- A. Detectable warning tape shall be installed 12" directly above all buried utilities. Detectable warning tape shall consist of a nominal 4.5 mil (0.0045") overall thickness and 6" wide, with a solid aluminum foil core. The imprinted warning message is "Buried, or Encased" to prevent rub-off, and is impervious to acids, alkalis and other destructive elements found in soil. The imprint is as such that it allows for total reflectivity. A tape must be visibly seen before it can be read. The tape shall meet the testing requirements of ASTM D-882, Method A.
- B. Legend/Color & Imprint:
 - 1. Tape shall read "CAUTION BURIED WATER LINE BELOW".
 - 2. Tape color coding shall be Blue.

2.19 FIRESTOP SYSTEMS

- A. General: Provide firestopping at all new fire-rated construction where penetrated by the Work of this Section.
- B. Refer to Section 078400 - Firestopping, for all product requirements for maintaining integrity of fire-rated construction at penetrations.

2.20 SCAFFOLDS AND STAGING

- A. General: Trade Contractors shall obtain required permits for, and provide scaffolds, staging, and other similar raised platforms, required to access their Work as specified in Section 01 50 00 - Temporary Facilities and Controls and herein.
 - 1. Scaffolding and staging required for use by this Trade Contractor pursuant to requirements of Section 01 50 00 - Temporary Facilities and Controls shall be furnished, erected, maintained in a safe condition, and dismantled when no longer required, by this Trade Contract requiring such scaffolding.
 - 2. Each Trade Contractor is responsible to provide, maintain and remove at dismantling, all tarpaulins and similar protective measures necessary to cover scaffolding for inclement weather conditions other than those required to be provided, maintained and removed by the General Contractor pursuant to MGL (Refer to Section 01 50 00 - Temporary Facilities and Controls and as additionally required for dust control).
 - 3. General Contractor is responsible to provide enclosures required for temporary heat; refer to Section 01 50 00 - Temporary Facilities and Controls.
 - a. Furnishing portable ladders and mobile platforms of all required heights, which may be necessary to perform the work of this trade, are the responsibility of this Trade Contractor.

2.21 HOISTING MACHINERY AND EQUIPMENT

- A. All hoisting equipment, rigging equipment, crane services and lift machinery required for the work by this Trade Contractor shall be furnished, installed, operated and maintained in safe conditions by this Trade Contractor, as referenced under Section 01 50 00 - Temporary Facilities and Controls.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION METHODS

- A. All work shall be installed in a first-class manner consistent with the best current trade practices. All materials shall be securely installed plumb and/or level, and all flush mounted equipment shall have front edge flush with finished wall surface.
- B. Protect all concealed heads. Coordinate and advise finishing trades so as to prevent painting of sprinkler heads or inadvertent filling with paint or jointing compound of required air spaces in the case of the concealed type sprinkler heads.
- C. Training:
 - 1. Train the Owner's maintenance personnel on troubleshooting procedures, and servicing and preventative maintenance schedules and procedures.
 - 2. Schedule training with Owner through the Architect with at least 7 days prior notice.

3.2 WORK COORDINATION AND JOB OPERATIONS

- A. The equipment shall not be installed in congested and possible problem areas without first coordinating the installation of same.

- B. Before materials are purchased or work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces.
- C. Coordination Drawings are for the Contractor's and the Architect's use during construction and shall not be construed as replacing any Shop or Record Drawings required elsewhere in these Contract Documents.
- D. Detailed procedures for Coordination Drawings are contained in DIVISION 01 - GENERAL REQUIREMENTS of these Contract Documents.
- E. Particular attention shall be directed to the coordination of piping and other equipment installed in the ceiling areas. Coordinate the elevations of all piping in hung ceiling areas to insure adequate space for the installation of recessed lighting fixtures before other mechanical equipment is installed.
- F. Furnish to the General Contractor, and all other Subcontractors, all information relative to the portion of the Fire Protection installation that will affect them, sufficiently in advance so that they may plan their work and installation accordingly.
- G. In case of failure to give proper information as indicated above, sufficiently in advance, pay for all back-charges for the modification, renovation, and relocation of any portion of the work already performed.
- H. Obtain from the other trades, all information relative to the Fire Protection Work to be executed in conjunction with the installation of their respective equipment.

3.3 CUTTING AND CORE DRILLING

- A. Perform all cutting and core drilling operations that are outlined in Part 1 of this SECTION. Throughout the performance of the cutting and coring work, ensure that the structural integrity of the walls, floors, overhead structure, and other structural components is maintained until permanent work is installed. Prior to any coring or cutting, verify all locations of same with the General Contractor. All cutting and coring is to be performed in accordance with approved Coordination Drawings.
- B. Cut all masonry and concrete with an approved diamond blade concrete saw in a neat straight direction, perpendicular to the plane of the wall or floor.
- C. Use a core drilling process which produces clean, sharp edges and the minimum hole size which will accommodate the size of pipe sleeve specified.
- D. Patch all holes up to the sizes indicated in this Section with material and methods as are specified in the Section of the Specifications for the finish trade involved. Holes which are improperly done due to poor materials or method, shall be patched to the satisfaction of the Architect by the finish trade and back-charged to this Subcontractor.

3.4 CLEANING AND PROTECTION

- A. Protect all materials and equipment during shipment and installation and properly handle and store at the job site so as to prevent damage. Assume full responsibility for protection of work until its completion and final acceptance.
- B. Keep the premises reasonable clean at all times and remove rubbish caused by the Fire Protection work as directed by the Architect.

- C. Upon completion of this work, clean all sprinklers, and equipment and replace damaged parts. Failure to fulfill this obligation will result in back-charges for correction of the defective work by others.

3.5 SLEEVES, INSERTS, AND ESCUTCHEONS

- A. All piping passing through slabs, floors, walls, and partitions shall be sleeved and all such sleeves shall be furnished and installed by the Fire Protection Subcontractor as detailed on the Drawings and herein specified. Fire Protection Contractor, shall do his core drilling as approved by the Architect and the cored opening shall have a sleeve caulked and leaded in place. Set sleeves in concrete floors and walls as soon as forms set and before concrete is poured.
- B. All pipes passing through floor, whether slab-on grade or above grade levels shall be sleeved with sleeve extending 1 inch above floor. This includes all piping in toilet room pipe space, stairwells, closets, and partitions.
- C. All sleeves shall be Schedule 40 galvanized steel pipe and shall be reamed. There shall be annular space between the sleeve and pipe per NFPA requirements. Sleeves on drywall, masonry, or concrete walls and partitions shall be flush with wall on both sides.
- D. The space between sleeve and pipe, in all cases, shall be filled with U.L./F.M. approved caulking compound. This includes pipes concealed in chases and/or partitions.
- E. Inserts, where required, shall be furnished and set by the Fire Protection Subcontractor and, where necessary, may be drilled or power driven and shall be sized such that the insert will not exceed a depth of penetration of 1 inch into concrete.
- F. Escutcheons: All exposed pipe, uncovered, passing through walls, or floors, or ceilings, shall be fitted with C.P. brass spun or split type escutcheons with approved clamping device for holding in position. Floor escutcheons shall be deep enough to fit over sleeves, fastened to pipe, and extend down to floor.

3.6 TESTING

- A. Flush the system and test all work in the presence of the Architect and/or Engineer and as required by NFPA and the Insurance Company. The flushing and testing procedures to be followed are specified herein. At the completion of the testing, submit fully executed copies of Contractor's Material and Test Certificate for both above ground and underground piping as contained in NFPA-13.

1. Water Supply:

- a. Flushing: Underground/exterior service entrance shall be flushed at a minimum velocity of 10 fps in accordance with NFPA Standards 13, 14, and 24. The Fire Protection sub-contractor shall coordinate with Division 33 and shall notify the Water and Fire Departments prior to testing of the entire exterior system.

2. Sprinkler System:

- a. Hydrostatic Testing: The interior system shall be hydrostatically tested at 200 psi for 2 hours in accordance with NFPA 13 paragraph 25.2.1.
- b. Operational Testing: Water flow switches and associated alarm systems shall be tested by water flow through the inspectors test assemblies in accordance with NFPA 13, 25.2.3.
- c. Main Drain Test: A flow test shall be performed on the main drain valve and recorded on the Contractor's test certificate in conformance with NFPA 13, 25.2.3.4.
- d. Backflow Preventor Flow Test: The double check valve assembly shall be flow tested in conformance with NFPA 13, 25.2.5. Provide piping and or valving arrangement to preform full flow testing of backflow device.
- e. Dry system shall be trip tested and acceptance tested with recorded results submitted to the owner for their review and record in accordance with NFPA 13 and 25. All dry systems shall be completely drained with all water removed prior to being placed in permanent service.
- f. Underground Piping: Underground piping and fire sprinkler lead in connections to each building shall be hydrostatically tested, flushed and chlorinated in accordance with NFPA 24, the Local DPW, and any other pertinent laws or governing standards. Flushing, Testing and chlorination reports shall be given to the owner for review and included in the O&M Manuals for the fire protection systems.

3.7 FIRESTOP SYSTEMS:

- A. General: Install firestop systems at all new fire-rated construction where penetrated by the Work of this Section.
- B. Refer to Section 078400 - Firestopping, for all installation requirements for maintaining integrity of fire-rated construction at penetrations.

3.8 SEISMIC RESTRAINTS

- A. The independent engineer responsible for design of seismic restraints shall visit the project upon completion of the work to certify the installation is consistent with the approved shop drawings. The certification shall be submitted to the Architect and must precede the closing in of ceilings.

3.9 SYSTEM SHUTDOWNS

- A. Coordinate shutdowns of existing systems with the Owner and submit a written request at least ten working days in advance. Minimize system shut downs as much as possible. Submit a list of all affected areas, the proposed work to be performed, and the expected length of the shut-down including time for retesting.
- B. Provide temporary services to maintain active system during extended shut-downs as required for demolition and construction phasing.

END OF SECTION

SECTION 22 00 00

PLUMBING
 (Filed Sub-Bid Required)

PART 1 - GENERAL.....	1
1.1 FILING SUB-BIDS	1
1.2 GENERAL PROVISIONS	1
1.3 DESCRIPTION OF WORK.....	1
1.4 RELATED WORK.....	3
1.5 CODES, ORDINANCES, AND PERMITS	3
1.6 DISCREPANCIES IN DOCUMENTS	3
1.7 MODIFICATIONS IN LAYOUT	4
1.8 SHOP DRAWING AND MATERIAL SCHEDULES	4
1.9 COORDINATION DRAWINGS.....	5
1.10 RECORD DRAWINGS	5
1.11 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS.....	6
1.12 GUARANTEE	6
1.13 DRAWINGS.....	6
1.14 VALVE TAGS, NAMEPLATES, AND CHARTS	7
1.15 PIPE MARKER IDENTIFICATION SYSTEM	7
1.16 SANITARY, WASTE, VENT, KITCHEN GREASE WASTE AND VENT, GARAGE WASTE AND VENT, AND STORM SYSTEMS	8
1.17 DOMESTIC WATER SYSTEMS	8
1.18 COMPRESSED AIR SYSTEM.....	9
1.19 EMERGENCY TEMPERED WATER SUPPLY	9
1.20 FUEL GAS SYSTEM.....	9
1.21 EQUIPMENT FURNISHED BY OTHERS	10
1.22 PAINTING.....	10
1.23 HOISTING EQUIPMENT AND MACHINERY	10
1.24 STAGING AND SCAFFOLDING	11
1.25 COMMISSIONING.....	11
1.26 BREAKDOWN	11
1.27 VISIT TO SITE.....	11
1.28 ENERGY REBATE PROGRAM	11
1.29 TRADE RESPONSIBILITY FOR INTERCONNECTIONS MATRIX.....	12
PART 2 - PRODUCTS.....	12
2.1 GENERAL.....	12
2.2 PIPE AND FITTINGS	12
2.3 JOINTS.....	14
2.4 VALVES.....	15
2.5 INSULATION	16
2.6 TRAPS.....	16
2.7 DRAIN VALVES	16
2.8 SHOCK ABSORBERS	16
2.9 PIPING ACCESSORIES	17
2.10 HYDRANTS AND HOSE BIBB.....	17
2.11 CLEANOUTS.....	18
2.12 ACCESS DOORS.....	18
2.13 SUPPLEMENTARY STEEL, CHANNEL, AND SUPPORTS	18
2.14 HANGERS, ANCHORS, GUIDES, AND PIERS	19
2.15 DRAINS	20
2.16 PLUMBING FIXTURES.....	20
2.17 BACKFLOW PREVENTERS.....	24

2.18	UNION AND NIPPLES	25
2.19	WATER HEATER (WH-1)	25
2.20	TEMPERING VALVES	26
2.21	RECIRCULATING HOT WATER PUMPS	26
2.22	AIR INTAKE AND EXHAUST BREECHING, CHIMNEYS AND STACKS	26
2.23	CONDENSATE NEUTRALIZING TUBES	27
2.24	WATER METER	27
2.25	EMERGENCY GAS SOLENOID VALVE	27
2.26	ELEVATOR SUMP PUMPS	27
2.27	TRENCH DRAIN	28
2.28	AIR COMPRESSOR (AC-1)	28
2.29	COMPRESSED AIR REGULATORS	28
2.30	MANHOLE AND PRECAST CONCRETE OIL/GAS SEPARATOR STRUCTURE	29
2.31	FIRESTOP SYSTEMS	29
2.32	SCAFFOLDS AND STAGING	30
2.33	HOISTING MACHINERY AND EQUIPMENT	30
PART 3 - EXECUTION		30
3.1	WORKMANSHIP AND INSTALLATION METHODS	30
3.2	WORK COORDINATION AND JOB OPERATIONS	30
3.3	CUTTING AND CORE DRILLING	31
3.4	CLEANING AND PROTECTION	31
3.5	SLEEVES, INSERTS, AND ESCUTCHEONS	32
3.6	TESTING	32
3.7	CHLORINATION	33
3.8	INSTALLATION OF FIRESTOP SYSTEMS	33
3.9	INSTALLATION OF AIR INTAKE AND EXHAUST BREECHING, CHIMNEYS AND STACKS	33
3.10	SEISMIC RESTRAINTS	34
3.11	SYSTEM SHUTDOWNS	34

SECTION 22 00 00

PLUMBING
(Filed Sub-Bid Required)

PART 1 - GENERAL

1.1 FILING SUB-BIDS

- A. Sub-bids for Work under this Section shall be for the complete Work required hereunder and shall be filed in a sealed envelope with the Awarding Authority before the time and date and at the location indicated in the Instructions to Bidders and at that time will be publicly opened and read aloud.
- B. Procedure for filing Sub-Bids shall be as set forth in the Instructions to Bidders contained in this Project Manual and shall conform to all requirements of the Commonwealth of Massachusetts General Laws, Chapter 149, as amended to date.
- C. Every Sub-Bid submitted for Work under this Section shall be on a form furnished by the Awarding Authority as required by Section 44G of Chapter 149, as amended, which form is required to be completely filled in. A sample bid form for Subcontractors is contained in this Project Manual and the bid form to be used in filing a Sub-Bid is available at the office of the Architect.
- D. Every Sub-Bid filed with the Awarding Authority shall be accompanied by bid security in the form and amount stipulated in the Instructions to Bidders.
- E. The Filed Sub-Bidder for the work of this SECTION 220000 shall list, in Paragraph E, of the FORM FOR SUB-BID, the name of each person, firm, or corporation, whom he proposes to use to perform the following classes of work or part thereof, at the bid price therefore:

CLASS OF WORK	PARAGRAPH NUMBERS
Insulation	2.5

1.2 GENERAL PROVISIONS

- A. All the Contract Documents and General Provisions of the Contract including, but not limited to, General and Supplementary Conditions, and Division 1 Specification Sections apply to this Section.
- B. The work of this Section provides and contains general information which is inherently made a part of each Section and applies to all work performed under this Contract.

1.3 DESCRIPTION OF WORK

- A. Provide all labor, materials, equipment, services and accessories necessary to furnish and install the work of this Section, complete and functional, as indicated in the Contract Documents and as specified herein.

- B. The work covered by this Section of the Specifications includes the furnishing of all labor and materials and in performing all operations in connection with the installation of the Plumbing Work.
- C. Without limiting the generality thereof, the work to be performed under this Section includes:
1. Domestic water service to 10 ft. outside building and/or as shown on the Drawings.
 2. Complete Sanitary, Waste & Vent System to 10 ft. outside building and/or as shown on the drawings.
 3. Storm drainage to 10 ft. outside foundation wall.
 4. Garage waste and vent system including precast concrete oil/gas separator structure and access manhole.
 5. Potable Cold, Hot, and Hot Water Re-circulation System.
 6. Non-Potable Cold Water System.
 7. Natural Gas System.
 8. Shop compressed Air System
 9. Furnish and install domestic water heater air intake and exhaust breeching.
 10. Furnish and install boiler air intake and exhaust breeching.
 11. Insulation.
 12. Potable Water Heating Equipment.
 13. Emergency Gas Solenoid Valve
 14. Fixtures and Equipment
 15. Connection to Equipment Furnished by Others
 16. Flushing, Sterilization, and Tests
 17. Furnishing of Access Panels
 18. Drilling, Coring and Cutting & Patching of holes and openings where the largest dimension thereof does not exceed 12 inches for Plumbing Piping and Equipment.
 19. Scaffolding, Rigging, and Staging required for all Plumbing Work. Comply with Division 1 requirements.
 20. Provide Seismic Restraints for all Plumbing Systems conforming to the requirements of Section 230548 which Section is herein incorporated by reference.
 21. Preparation of Co-ordination Drawings.
 22. Smoke and Firestopping Seals and sealing of all wall and floor penetrations as detailed on the drawings. Refer to Section 078400 which defines the firestopping materials and methods.
 23. At Project close out the Plumbing Sub-Contractor shall provide the services of an outside firm who shall run an underground video camera, locating all drainage system lines including depth, preparing a video and identifying & correcting any problem areas. The Plumbing Sub-Contractor shall rod-out and power wash all underground drainage systems. Turn over 4 copies of the video and written report to the owner. Videos are required for all underground sanitary and garage waste systems.
 24. It shall be the responsibility of this division 220000 to provide all personnel as required to fully coordinate with the commissioning agent. The hours of training and instruction outlined in this division 220000 and the Testing requirements shall be in addition to those tests and requirements outlined in section 019113 and required to fulfill section 019113 commissioning obligations.
 25. When open-flame or spark producing tools such as blower torches, welding equipment, and the like are required in the process of executing the work, the General Contractor shall be notified not less than twenty four hours in advance of the time that the work is to begin and the location where work is to be performed. Provide fire protective covering and maintain constant non-working fire watch, paying all fees, where work is being performed and until it is completed. Fee for fire watch shall be included in the bid.

- D. Sustainable Design Intent: Comply with project requirements measured and documented according to LEED v4. Project scores will be verified by a third party certifier.
1. Refer to section 018113 – Sustainable Design Requirements, for material, procedure, and documentation submittal requirements.
 2. Recycled content – for products or materials that contain recycled content, fill out the Materials Submittal Cover Sheet. Show percentage of product that is post-consumer and/or post-industrial recycled content. Provide backup documentation as described in Section 018113. Show installed costs for each line item.

1.4 RELATED WORK

- A. The following Related Work will be performed under the designated Sections:
1. Domestic Water Service to 10 ft. outside – DIVISION 33 – UTILITIES
 2. Cutting and Patching beyond 1.3C.18 above: SECTION 010450 - CUTTING AND PATCHING
 3. Installation Of Roof Drains, Flashing for vents through roof: SECTION 075100 - ROOFING & FLASHING
 4. Electric Power Wiring: SECTION 260000 - ELECTRICAL
 5. HVAC Equipment: SECTION 230000 - HVAC
 6. Excavation and Backfill: DIVISION 31 - EARTHWORK
 7. Sanitary Sewer and storm drains to 10 feet outside the foundation wall: DIVISION 33 - UTILITIES
 8. Finish Painting: SECTION 099000 - PAINTING
 9. Installation of Access Panels: SECTION describing material in which panel is installed.
 10. Toilet Room Accessories: SECTION 108000 - TOILET ACCESSORIES
 11. Temporary Facilities: SECTION 015000 - TEMPORARY FACILITIES
 12. Food Service Equipment: SECTION 114000 FOOD SERVICE EQUIPMENT

1.5 CODES, ORDINANCES, AND PERMITS

- A. Perform all work in accordance with the requirements of the Town of Millbury Building Department, Massachusetts State Plumbing and Fuel Gas Codes, D.E.P., A.D.A., NFPA, The Architectural Barrier Code, and applicable State and Federal Laws. Give all requisite notices, file all requisite plans, and obtain all permits required to perform all Plumbing Work. Where the Contract Documents indicate more stringent requirements than the above Codes and Ordinances, the Contract Documents shall take precedence.
- B. Obtain all permits, inspections, and approvals, from the governing authorities and pay all fees and include cost in the bid, including approvals for the cross connection control device. Provide the Owner with the cross connection permit for the device in the Owner's name.
- C. Owner will pay all related Gas Utility Company back charges.

1.6 DISCREPANCIES IN DOCUMENTS

- A. Where Drawings or Specifications conflict or are unclear, advise Designer in writing before Award of Contract. Otherwise, Designer's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted due to discrepancies or unclarities thus resolved.

- B. Where Drawings or Specifications do not coincide with manufacturers' recommendations, or with applicable codes and standards, alert Designer in writing before installation. Otherwise, make changes in installed work as Designer requires within Contract Price.
- C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specs, this contractor shall provide that material, installation, or work which is of the higher standard.
- D. It is the intent of these contract documents to have the contractor provide systems and components that are fully complete and operational and fully suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component. In cases such as this, where the contractor has failed to notify the Designer of the situation in accordance with the paragraph above, the contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.
- E. In cases covered by the paragraph above, where the contractor believes he needs engineering guidance, he shall submit a sketch identifying his proposed solution and the Designer shall review, note if necessary, and approve the sketch.

1.7 MODIFICATIONS IN LAYOUT

- A. HVAC, Plumbing, Fire Protection, and Electrical Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet architectural requirements.
- B. In all spaces, prior to installation of visible material and equipment, including access panels, review Architectural Drawings for exact locations and where not definitely indicated, request information from Designer.
- C. Check Contract Drawings as well as Shop Drawings of all subcontractors to verify and coordinate spaces in which work of this Section will be installed.
- D. Maintain maximum headroom at all locations. All piping and associated components to be as tight to underside of structure as possible.
- E. Make reasonable modifications in layout and components needed to prevent conflict with work of other trades and to coordinate according to Paragraphs A, B, C, D above. Systems shall be run in a rectilinear fashion.
- F. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Designer for review and approval.

1.8 SHOP DRAWING AND MATERIAL SCHEDULES

- A. Refer to SECTION 013000 - SUBMITTALS for submittal of Shop Drawings. If apparatus or materials are substituted for those specified, and such substitution necessitates changes in or additional connections, piping, supports or construction, same shall be provided as the responsibility, and at the expense, of the Plumbing Subcontractor.

- B. Fabrication of any material or performing of any work prior to the final approval of the Submittals will be entirely at the risk of the Subcontractor. The Subcontractor is responsible for furnishing and installing materials called for in the Contract Documents, even though these materials may have been omitted from approved Submittals.
- C. Submit Shop Drawings for the following materials and equipment.
 - 1. Valves, Piping, couplings and Fittings
 - 2. Fixtures, Drains and Equipment including Supports
 - 3. Backflow Preventers
 - 4. Access Panels and Covers
 - 5. Insulation
 - 6. Drains, and Hydro Mechanical Specialties
 - 7. Hose Bibs, Wall Hydrants
 - 8. Hangers, Anchors, Guides, and Supports including Seismic Restraints
 - 9. Cleanouts
 - 10. Piping Identification System
 - 11. Water Heating Equipment
 - 12. Air Compressors
 - 13. Water heater and boiler air intake and exhaust breeching including coordinated working drawings of installation and backpressure calculations.
 - 14. Precast concrete oil/gas separator and access manhole

1.9 COORDINATION DRAWINGS

- A. Before materials are purchased or Work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces (match lines).
- B. Coordination Drawings are for the Contractor's and the Architect's use during Construction and shall not be construed as replacing any Shop or Record Drawings required elsewhere in these Contract Documents.
- C. Detailed procedures for Coordination Drawings are contained in DIVISION 01 - GENERAL REQUIREMENTS of these Contract Documents.

1.10 RECORD DRAWINGS

- A. General: Refer to DIVISION 01 - GENERAL REQUIREMENTS for general requirements for maintaining as-built drawings and submitting final reproducible record documents.
- B. The General Contractor will provide two sets of Drawings to the Plumbing Subcontractor, one set of which shall be maintained at the site and which shall, at all times, be accurate, clear, and complete, showing the actual locations of all equipment and piping as it is being installed. The Record Drawings shall be available to the Architect/Engineer's field representative at all times.
- C. Provide electronic AutoCAD drawings to indicate revisions to piping size and location both exterior and interior; including locations of valves and other equipment requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column line; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located.

- D. Include in the Record Drawings any addenda, sketches, and supplementary Drawings issued during the course of construction.
- E. Non-availability of Record Drawings or inaccuracies therein will postpone the final inspection until they are available.
- F. All valves shown on these Drawings shall be numbered with numbers corresponding to those on the valve charts.
- G. All costs related to the foregoing requirements shall be paid by the Plumbing Subcontractor.

1.11 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Provide operating instructions to the Owner's designated representative with respect to operation functions and maintenance procedures for all equipment and systems installed. At the completion of the project, turn over to the Architect four (4) complete manuals, in three-ring, loose-leaf binders, containing the following:
 - 1. Complete Shop Drawings of all equipment.
 - 2. Operation description for all systems.
 - 3. Names, addresses, and telephone numbers of all suppliers of the system.
 - 4. Preventative maintenance instructions for all systems.
 - 5. Spare parts lists of all system components.
 - 6. Four copies of video of below slab piping.
 - 7. Valve tag chart.
- B. Provide DVD recording of operation and maintenance training sessions and include as part of O & M Manual submittal. Training session video recording and DVDs shall be performed by a professional videographer. Provide indexed table of contents for DVD recording.

1.12 GUARANTEE

- A. Refer to Division 1 of the Contract. Guarantee all work under this Section free from defects in workmanship and materials for a period of one (1) year from the date of final acceptance of the building, as set forth in the Contract. Replace any such defective work developing during this period, unless such defects are clearly the result of bad usage of equipment by others. Where such defective work results in damage to work of other Sections of the Specifications, restore such work to its original condition by mechanics skilled in the affected trade.

1.13 DRAWINGS

- A. All work shown on the Drawings is intended to be approximately correct to scale, but shall be taken in a sense as diagrammatic. Sizes of pipes and general method of running them are shown, but it is not intended to show every offset and fitting. To carry out the true intent and purpose of the plans, furnish all necessary parts to make complete working systems ready for use. The Plumbing Drawings are intended to show the main stacks and risers and may or may not necessarily show all runout piping particularly in lavatories and gang toilet areas. Contractor shall include all runout piping to all referenced scheduled fixtures and equipment appearing on the Plumbing Drawings.

- B. All floor drains installed on this project, including all kitchen floor drains and trough drains, shall be equipped with trap primers. The trap primer and piping is not shown on the drawings and shall be located in the field by the Contractor as dictated by field piping conditions.
- C. The Plumbing Drawings and Specifications are intended to supplement each other so that any details shown on the Drawings and not mentioned in the Specifications, or vice-versa, shall be executed the same as if mentioned in the Specifications and shown on the Drawings.
- D. Refer to the Architectural, Structural, and other Mechanical and Electrical Drawings, which indicate the construction in which this Work shall be installed. Locations shown on the plans shall be checked against the general and detailed Drawings of the construction proper. All measurements shall be taken at the Building.

1.14 VALVE TAGS, NAMEPLATES, AND CHARTS

- A. All valves on pipes of every description shall have neat circular brass valve tags at least 1-1/2 in. in diameter attached with brass hook to each valve stem. Stamp on these valve tags, in letters as large as practical, the number of the valve and the service, such as "H.W., C.W., GAS", for hot water, cold water, and gas respectively. The numbers for each service shall be consecutive. Where valves are located above ACT ceilings, furnish and install valve finder ceiling tack, tack shall be minimum 7/8 in. diameter with 1/2 in. steel point, color as determined by Owner.
- B. All valves on tanks and pumps shall be numbered by 3 in. red metal discs with white numbers 2 in. high, secured to stem of valves by means of small solid link brass chain, to correspond to numbers indicated for valves on the Record Drawings and on two (2) printed detailed lists. These printed lists shall state the numbers and locations of each valve and the fixture or group of fixtures which it controls, and other necessary information such as requiring the opening or closing of another valve or valves when any one valve is to be opened and closed, and shall be prepared in form to meet approval of the Architect, and shall be framed under glass.
- C. Nameplates, catalog numbers, and rating identifications shall be securely attached to Electrical and Mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.

1.15 PIPE MARKER IDENTIFICATION SYSTEM

- A. Mark all piping installed under this Section and at all Access Panels with a marking system in basic colors conforming to those specified in ANSI/ASME A-13.1. Markings shall indicate pipe content and direction of flow. Markers shall be applied at all valves and tee joints, and on straight runs of pipe at every 20 ft.-0 in. on center.
- B. Markers shall be vinyl snap-around pipe type system. Adhesive markings are not acceptable.
- C. Clearly mark potable and non-potable water system with 4 inch wide colored bands, with arrow for direction of flow, every twenty-five (25) feet on center on all piping installed whether it is concealed or exposed and also on both sides of floor and/or wall penetrations. Mark potable water green and non-potable yellow. Within 6 in. of each band identify with letter "Potable C.W.", Non-Potable H.W." Color of letter shall match banding.

1.16 SANITARY, WASTE, VENT, KITCHEN GREASE WASTE AND VENT, GARAGE WASTE AND VENT, AND STORM SYSTEMS

- A. Furnish and install complete Sanitary, Waste, Vent, and Storm Drainage Systems (all hereinafter called Drainage Systems) to convey wastes from all Soil and Waste Stacks, Fixtures, Equipment, Kitchen Fixtures, and Roof Drains as indicated and/or described in these Plans and Specifications. Urinal waste shall be 2 in. cast iron or sizes indicated on the drawings. Waste piping smaller than 3 in. shall not be used underground. The use of double "Y's" in the horizontal shall not be permitted. All piping shall be installed straight and true and located concealed within building construction.
- B. All horizontal Drainage Systems Piping within the building, 3 in. and smaller, shall be pitched at least 1/4 in. per ft. in the direction of flow. Drainage Piping 4 in. and larger shall be pitched at least 1/8 in. per ft. Make changes in direction of drainage lines with 45 wyes, long turn wyes, or sweep bends.
- C. Furnish and install all cleanouts indicated on the Drawings and/or where required in Drainage Pipes regardless of size so that the distance between cleanouts does not exceed 45 ft. o.c. Cleanouts shall be installed at the base of all risers and at each change of direction.
- D. Refer to drawings for termination points, which generally are connection to existing piping or to 10 feet outside the building.
- E. The Garage Drainage System shall be a complete separate system piped from the interceptor through the roof without interconnection to any other building Drainage System including sanitary waste and vent.

1.17 DOMESTIC WATER SYSTEMS

- A. Furnish, install, sterilize, and test in accordance with the documents and the Plumbing Code, complete potable and non-potable Domestic Cold, Hot, and Hot Water Recirculating Systems including all piping, valves, low point drains, shock absorbers, hangers, insulation, backflow preventers and water heating equipment. Clearly mark the systems as provided above. This work shall start as indicated on the Drawings.
- B. In general, piping shall pitch upward in the direction of flow with each branch and riser separately valved and with 1/2 in. hose end drain on the outlet side of the valve and at all low points in the system. Install shutoff valves for each battery of fixtures and other valves as necessary to isolate any part of each system.
- C. Install shock absorbers on hot and cold water piping to each fixture. Provide shock absorbers at all quick closing valves and as shown on the Drawings and/or specified.
- D. Install a 1/2 inch hose bibb in each toilet room provided with a floor drain. The hose bibb shall be installed under a lavatory.
- E. Install a 1/2 inch hose bibb in each mechanical room.
- F. Furnish and install a ball valve, balancing valve and check valve at each hot water recirculation line before it connects to another hot water recirculation line.

1.18 COMPRESSED AIR SYSTEM

- A. Furnish and install a complete compressed air system as shown on the drawings and herein specified including all valves, piping, fittings, outlets and any incidentals to make a complete and operable system.
- B. This work includes furnishing and installing the shop air compressor as herein specified, provision of air outlets as detailed on drawings.
- C. Piping shall be run straight and true and shall be rigidly supported from the building construction. All turns and offsets shall be made with fittings as specified elsewhere. Bending of pipe shall not be permitted in this installation.

1.19 EMERGENCY TEMPERED WATER SUPPLY

- A. Furnish, Install, Sterilize and Test utilizing the same materials, methods, etc. as specified above in 1.17. A tempered water supply to service all emergency showers and eye wash units. This piping shall be hung and insulated the same as above. Piping shall start at the tempering valve.

1.20 FUEL GAS SYSTEM

- A. Furnish and install a complete Natural Gas Supply System including pipe, fittings, valves, connections to all gas fired equipment requiring gas, and all accessories and incidentals as indicated or specified. Installation shall be made in accordance with the State Gas Code requirements. Piping shall be installed with an 8 in. long sediment leg at the base of all risers. All changes in direction shall be made with plugged tees for cleaning piping out.
- B. All horizontal Gas Piping shall be pitched not less than 1/4 in. in 15 ft. to prevent traps. Pitch piping to risers. Install an 8 in. long sediment leg at the base of all risers. All changes in direction shall be made with plugged tees for cleaning piping out. All horizontal branch outlet pipes shall be taken from the top or side of horizontal mains and not from the bottom. Install shutoff valves for each battery of equipment and other valves as necessary to isolate any part of each system.
- C. Where interior gas vented appliances are provided provide a battery powered, plug-in type, carbon monoxide detector adjacent to the appliance.
- D. Arrange with the Local Gas Company for the installation of the gas meters, services, and gas pressure regulators. Refer to DIVISION 01 - GENERAL REQUIREMENTS for information regarding Utility Company Charges.
- E. Provide seismic restraints for all gas piping per requirements of the Mass. Building Code. Refer also to Section 230548.
- F. Plumbing Sub-Contractor shall furnish and install all gas vents for all knockdown regulators whether furnished by this Section, HVAC, or any other Section.
- G. Gas to the Emergency Generator shall be installed according to the following:
 - 1. A dedicated fuel line shall be installed for the Generator immediately downstream of the meter assembly.
 - 2. The fuel line for the Emergency Power Generator and the fuel line for the remaining appliances shall each have a separate shut off valve installed immediately downstream of the meter to enable each line to operate independently.

3. The fuel line for the Emergency Power Generator shall be labeled at the shut off valve on each side of the wall it penetrates, floor, and every 10 ft. along its run with the following:

WARNING: Emergency Power Generator. Do not shut off without the approval of appropriate authorities.

1.21 EQUIPMENT FURNISHED BY OTHERS

- A. Miscellaneous items, including but not necessarily limited to the following, shall be furnished and set by others as specified in other SECTIONS of the Documents.
 1. Dishwashers
 2. Kitchen Equipment
- B. Verify the extent of the connection requirements from the General, Architectural, and Mechanical Plans and Specifications.
- C. The Plumbing Subcontractor shall be responsible in making final connections to all equipment furnished by others, to ascertain complete cross-connection prevention compliance, and to furnish and install vacuum breaker and backflow preventers which may be required to be Code compliant and are not so furnished with the equipment.
- D. All sinks are intended to be "Accessible" and all drain outlets on all sinks and lavatories where furnished by the Plumbing Subcontractor or the other SECTIONS shall have an off-set drain. Set all roughing tight to wall in all cases to comply with ADA Standards. Provide where required ADA insulation kits to prevent injury where a barrier is not included in the casework. Refer to Equipment Drawings.

1.22 PAINTING

- A. All interior exposed piping is to be painted and all painting, except as noted, will be done by the Painting Subcontractor. All uncovered piping and hangers shall be thoroughly cleaned of rust, oil, and other containments by the Plumbing Subcontractor and left ready to receive primer coat.
- B. Painting for pipe markings shall be done under this Section.
- C. Painting of exterior gas piping at gas meter, generator, on roof, and at rooftop equipment, shall be done under this Section.

1.23 HOISTING EQUIPMENT AND MACHINERY

- A. Unless otherwise specified, all hoisting and rigging equipment and machinery required for the proper and expeditious prosecution and progress of the Work of this Section shall be furnished, installed, operated and maintained in safe condition by each sub-contractor, as specified under Section 015000, TEMPORARY FACILITIES AND CONTROLS.

1.24 STAGING AND SCAFFOLDING

- A. Unless otherwise specified, each sub-contractor shall provide all lifts and man-lifts, and furnish, erect and maintain in safe condition, all staging and scaffolding as specified under Section 015000 Temporary Facilities and Controls, as needed for proper execution of the work of this Section. Staging and scaffolding shall be of adequate design, erected and removed by experienced stage builders having all accident prevention devices required by Federal, state and local laws.

1.25 COMMISSIONING

- A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 018000 – General Commissioning Requirements.
- B. Complete installation and startup checks and functional tests according to Section 018000 – General Commissioning Requirements and manufacturers written instructions.
- C. Operational Test: After plumbing systems have been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the startup procedure.
- D. Verify that equipment is installed and commissioned as per requirements of Section 018000 and manufacturers written instructions/requirements.

1.26 BREAKDOWN

- A. Submit a breakdown of the contract price to aid the Architect in determining the value of the work installed as the job progresses.
- B. No requisition will be approved until the breakdown is delivered to the Architect.

1.27 VISIT TO SITE

- A. Prior to submitting a Bid, visit the site of work and become familiar with existing conditions. Any assumptions made are at this Subcontractor's expense.

1.28 ENERGY REBATE PROGRAM

- A. This project has been designed to incorporate equipment approved for energy rebate such as domestic water heaters. Provide actual equipment purchase price to owner to assist filling out forms for utility company rebates.

1.29 TRADE RESPONSIBILITY FOR INTERCONNECTIONS MATRIX

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring	Notes
Natural Gas Energy Submeters	23 00 00	22 00 00	26 00 00 & 23 00 00 (ATC)	23 00 00 (ATC)	N/A	1
Domestic Water Submeters	23 00 00	22 00 00	26 00 00 & 23 00 00 (ATC)	23 00 00 (ATC)	N/A	1
Boiler and Domestic Water Heater Exhaust Breeching	22 00 00	22 00 00	N/A	N/A	N/A	
Emergency Gas Valve	22 00 00	22 00 00	26 00 00	26 00 00	26 00 00	

Notes:

1. Division 26 00 00 Contractor shall provide all line-voltage power wiring required for meters; Division 23 00 00 (ATC) Contractor shall provide all low-voltage power wiring required for meters.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials and equipment furnished under this SECTION shall be new, unused, first quality of a manufacturer of established reputation. Each valve, fitting, section of pipe, and piece of equipment supplied to project shall have cast or indelibly stamped thereon the manufacturer's name, pressure rating where applicable, type, and any other specific information provided by manufacturer. Materials shall conform to Massachusetts Code as a minimum requirement and shall appear on the Massachusetts Approved Plumbing Products list.

2.2 PIPE AND FITTINGS

- A. Pipe and fittings shall conform to the latest A.S.A., A.S.T.M., C.A., and F.S. standards.
- B. All piping installed under this SECTION shall be in accordance with the following:

<u>Service</u>	<u>Material</u>
Underground Domestic Water Service	Class 52 cement lined ductile iron pipe
Underground Drainage and Vent piping	Service weight cast iron soil pipe-coated bearing collective trademark of the Cast Iron Soil Pipe Institute (CISPI)
Above ground Drainage and Vent, piping 2 in. and larger	No Hub cast iron soil pipe and fittings bearing collective trademark of the CISPI

Above ground drainage, and Vent piping 2 in. and smaller	Type 'L' hard tempered copper tubing
Trap primer piping from Primer to floor drain	Type 'K' soft rolled copper tubing with Swaged ends
Domestic water piping above ground (potable & non-potable) and Pump Force Main Piping	Type 'L' hard tempered copper tubing
Indirect waste piping	Type 'L' hard tempered copper tubing coated with two (2) coats of white epoxy paint
Compress Air Piping & Gas piping above ground	ASTM A-53 Schedule 40 black steel pipe
Gas piping below ground	ASTM A-53 Schedule 40 black steel pipe with fusion bonded epoxy coating Scotchkote 6233 or equal.

- C. Fittings for underground Drainage Piping shall be service weight bell and spigot pattern C.I. soil pipe fittings. Above ground shall be no hub C.I. soil pipe fittings, Massachusetts Standard.
- D. Fittings for sweat drainage piping and force main piping shall be cast bronze or wrought copper of recessed drainage pattern.
- E. Fittings for Type 'L' hard tempered copper tubing for potable and non-potable water piping 2-1/2 inch in size and smaller shall be copper press fittings.
 - 1. Acceptable Manufacturers:
 - a. Viega North America,
 - b. Elkhart Products Corporation
 - c. Victaulic
 - d. Or equal
 - 2. Material:
 - a. ASTM B88 and ANSI/ASME B16.22. O-rings for copper press fittings shall be EPDM.
 - 3. Installation of copper press fittings and installation are to be made in strict accordance with the manufacturers installation instructions. All tubing is to be reamed prior to the installation of the fitting. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool approved by the manufacturer.

- F. Grooved joint piping systems for domestic water piping 3-inch and larger shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved couplings, fittings, valves, and specialties shall be the products of a single domestic manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be supplied by the manufacturer. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A factory trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.
 - 1. Couplings for Copper Grooved Tube: Victaulic Style 607. Installation ready rigid coupling for direct stab installation without field disassembly.
- G. Fittings for compressed air piping shall be threaded malleable iron air pattern fittings for screwed pipe.
- H. Fittings for gas piping 2-inch and smaller shall be threaded malleable iron gas pattern fittings for screwed pipe. All gas piping 2 ½ inch in size and larger shall be welded and shall utilize butt welded steel pipe fittings.
- I. Fittings for underground domestic water service shall be 250 psi gray iron cement lined fittings with mechanical joint ends.

2.3 JOINTS

- A. Joints for underground cast iron bell and spigot soil pipe shall be made up with resilient gaskets. Above ground shall be made up of heavy duty – 4 band stainless steel clamps, and gaskets. Couplings shall be in compliance with CISPI 310 and shall bear the mark of NSF International. Couplings shall be Husky “SD 4000”, Clamp - All HI-TORQ 125, Mission “HW”, or equal.
- B. Copper water tubing and fittings shall be assembled with press or grooved fittings depending on pipe size.
- C. Grooved Joint Lubricants: Lubricate gasket in accordance with the manufacturer's published instructions with lubricant approved for the gasket elastomer and fluid media.
- D. Copper waste and vent tubing and force main tubing with sweat fittings shall be assembled with lead free solder, Silverbrite, Oatey, Harris, or equal, and a non-corrosive flux recommended by the manufacturer.
- E. Joints between copper waste/vent tubing and cast iron shall be made with cast iron threaded fittings and copper thread by sweat fittings.
- F. Joints between copper tubing and ductile iron water pipe or at flanged joints to tanks shall be made with a combination iron and brass flange with composition gasket and iron bolts.
- G. Joints at water heaters or other tanks having threaded connections shall be made up with dielectric unions.
- H. Joints between floor or wall flanges and fixtures shall be made with one-piece special molded neoprene gaskets which shall be furnished by the fixture manufacturer.

- I. Threaded pipe joints including plastics shall be made up with teflon tape.
- J. Joints on screwed gas piping shall be made up with thread compound on male threads only. Welded joints shall be made up by certified welders. All joints on piping 2-1/2 in. and larger, shall be welded.

2.4 VALVES

- A. Furnish and install valves where indicated on the Drawings or where specified and located so that they may be operated, repaired, or replaced with a minimum effort and repacked under pressure.
- B. The following list of valves is intended only as a guide for type and quality. Valves shall be as manufactured by Apollo, Milwaukee, Nibco, Elkhart, Watts, Victaulic, or approved equal.

Shutoff valves	Apollo #94VLF-A lead-free ball valves
Balancing valves	ThermOmegaTech Circuit Solver CS, self-acting thermostatic recirculation balance valve.
Grooved end butterfly valves	Victaulic Series 608N for copper
Gate valves 4 in. and larger	Jenkins 651-A
Stop and waste valves 1 in. and smaller	Apollo #95LF-203 through #95LF-205, lead-free
Check valves	Walworth #406 SJ
Gas service stops, 2 in. and smaller	Apollo #70-102-07 through #70-108-07 with tee handle
Gas service stops, 2-1/2 in. and larger	Rockwell #143 lubricated plug valve
Drain valves	Apollo #77WLF-HC ball valve with cap and chain 1/2 in. x 3/4 in. hose end
Compressed air line Shutoff valves	Apollo #70-100 Series-threaded ends
Compressed air outlet valves	Apollo #70-100 Series with automatic drain
Backwater Valve (Drainage Systems)	Zurn #Z1095. At below grade installations provide with extension to grade Zurn model Z1095-FC, height as required.

2.5 INSULATION

- A. Insulation for all water piping and all horizontal roof leaders whether concealed or exposed shall be 1 in. thick, heavy density, preformed snap-on insulation equal to Johns Manville Micro-Lok HP, 850 degrees snap-on system. Insulation for cold water piping shall have a factory applied vapor barrier with ends and butts sealed with overlapping 4 in. sealing strips.
- B. Valves, fittings, and the underside of roof drain bodies shall be insulated with pre-formed fiberglass fitting insulation cut from dense fiberglass blanket and covered with pre-molded P.V.C. fitting covers. P.V.C. covers shall overlap the adjoining insulation and shall be secured with pressure sensitive vinyl tape over a vapor barrier adhesive seal at the joints. (Note: Staples or tacks are not permitted on covers).
- C. All insulation shall have self-sealing type, all service jacket (ASJ-SSL) factory applied. At all exposed piping, cover jacket with continuous P.V.C. jacket.
- D. Sealers, solvents, tapes, and adhesives, and mastics used in conjunction with the installation of insulation under this Section shall possess the maximum possible fire safe qualities available and shall be NFPA approved.
- E. Covering shall be applied over clean and dry surfaces. No covering shall be applied until after the approval of all pressure and leakage tests.
- F. Insulation shall be as manufactured by Johns Manville, Inc., Owens-Corning Fiberglass Corporation SSL II-ASJ, or Knauf Insulation 1000. Insulation shall be applied by skilled insulation mechanics in a first class manner.

2.6 TRAPS

- A. Furnish and install traps with cleanouts on all fixtures and equipment requiring connection to the sanitary system of the same size and material as the pipe on which they occur. Traps installed on threaded pipe shall be recessed drainage pattern.

2.7 DRAIN VALVES

- A. It shall be possible to drain the water from all sections of the Potable and Non-Potable Hot and Cold Water Piping. Furnish and install 1/2 in. x 3/4 in. hose end ball valves with cap and chain. (see 2.04 for model no.)

2.8 SHOCK ABSORBERS

- A. Furnish and install, where shown on Drawings and where required to prevent water hammer, Zurn Manufacturing Company model 1250-XL lead free shock absorbers, or equal, as manufactured by J.R. Smith Manufacturing Company, Watts Manufacturing Company, or equal.
- B. Installation of absorbers shall be as per manufacturer's recommendations.

2.9 PIPING ACCESSORIES

- A. Pressure and Temperature Relief Valves shall be A.S.M.E. rated temperature relief 210 deg. F. double BTU rated, self-closing, as manufactured by Watts Regulator Company or equal by Wilkins, McDonnell and Miller, or equal.
- B. Vacuum reliefs shall be lead free Watts Regulator Company #LFN36 or equal by Wilkins or Lawler.
- C. Temperature gauges shall be 4-1/2 in. diameter dial thermometers, any angle, and range of 30 degrees F. to 240 degrees F. as manufactured by Weiss Instruments, U.S. Gauge, Terice or equal.
- D. Potable and non-potable Water system pressure gauges shall be 4-1/2 in. diameter with a range of 0 to 160 psi as manufactured by Weiss Instruments, U.S. Gauge, Terice or equal.
- E. Natural gas system pressure gauges shall be 4 inch diameter with a range of 0 to 30 inches of water as manufactured by Weiss Instruments, U.S. Gauge, Terice or equal.
- F. Furnish and install where piping crosses building expansion joints on the domestic water piping and gas piping, expansion joints and anchors sized for 1-1/2 in. expansion per one hundred feet. Expansion joints shall be Metraflex "Metraloop", or manufactured by Flexonic Company or Hyspan, or equal. Piping shall be anchored and guided to force the expansion in the proper direction. Domestic water expansion joints shall be NSF approved. Gas expansion joints shall be AGA approved.
- G. Furnish and install where indicated on Drawings, Watts Regulator Company lead free pressure reducing valve and strainer combination size as indicated on the Drawing or equal, as manufactured by Donnelly Products Company or McDonnell and Miller.
- H. Trap primer connections are required on all floor drains to maintain trap seal. The requirement for trap primer connections shall include all floor drains in the kitchen including trough drains furnished by others. Trap primers shall be Precision Plumbing Products, Inc., Model PRO1-500 flow activated prime-pro trap-primer valve or shall, where appropriate, be Zurn, Watts, Smith or equal in-line connections installed on flush valve supply. Electronic trap primer shall be Precision Plumbing Products, Inc. Model MPB-500 mini-prime electronic trap-primer manifold, 120 volt, single phase. Furnish distribution units as required.
- I. At overflow storm drain leader termination points furnish and install vandal proof type 304 stainless steel downspout cover, Zurn model ZS-199-DC-VP, or as manufactured by JR Smith, Watts, or equal. All fasteners shall be stainless steel.

2.10 HYDRANTS AND HOSE BIBB

- A. Wall hydrants shall be Zurn Series Z-1310-PB Ecolotrol cast brass 3/4 in. non-freeze wall hydrant with integral backflow preventer, 3/4 in. hose connections, polished nickel bronze face, loose key handle, brass wall sleeve, and fitted with brass locknut.
- B. Roof hydrants shall be Zurn Series Z-1388-RK exposed non-freeze roof hydrant with dura-coated cast iron head and lift handle with lock option, bronze interior parts, galvanized steel casing, and bronze valve housing with drain port. Complete with dura-coated cast iron roof support sleeve with anchoring flange and clamp collar. Contractor shall run drain to exterior. Coordinate drain location with Architect.

- C. Hose bibb shall be T & S Brass or equal model #B-720 modified, chrome plated, 3/4 in. hose end, integral stop, vacuum breaker, modified with lock shield and loose tee handle.
- D. Hydrants shall be manufactured by Zurn, J.R. Smith, Watts, or equal. Hose bibbs shall be manufactured by T&S Brass, Speakman, Chicago, or equal.

2.11 CLEANOUTS

- A. Cleanout plugs on the Sanitary System shall be of heavy cast brass of the screwed type. Plugs shall be full size up to and including 4 inch.
- B. For piping running under floor slab, cleanouts shall be brought up to just under the floor slab level. Furnish and install access cover for all floor-type cleanouts, Zurn ZN-1400 Series with scoriated nickel bronze or by Watts, J.R. Smith, or equal. In the garage area and at exterior locations use Zurn model #Z-1474 cleanout housing set over brass cleanout plug.

2.12 ACCESS DOORS

- A. Furnish Access Doors for access to all concealed control valves, cleanouts, valves, expansion joints, and to all other concealed parts of the Plumbing System that require accessibility for the proper operation and maintenance of the system. These doors shall be installed under the appropriate SECTION of the Specifications as determined by the surface upon which the panels are mounted.
- B. All Access Doors shall be located in a workmanlike manner in closets, storage rooms, and/or other non-public areas, positioned so that the valve or part can be easily reached, and the size shall be sufficient for this purpose (minimum size 12 in. x 16 in.). Furnish Access Doors for each pipe space to permit thorough inspection of same. When access doors are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.
- C. Refer to Section 083100 - Access Doors and Frames, for all product requirements for furnishing access panels.
- D. Coordinate locations and schedule with the work of trades involved with construction in which access panels will be installed.
- E. Access Door Shop Drawings shall be submitted to the Architect for approval.
- F. All access panels shall be keyed alike. Coordinate keying with other trades.

2.13 SUPPLEMENTARY STEEL, CHANNEL, AND SUPPORTS

- A. Furnish and install all supplementary steel, channels, and supports required for the proper installation, mounting, and support of all equipment.
- B. Supplementary Steel and Channels shall be firmly connected to building construction in a manner approved by the Architect.
- C. The type and size of the Supporting Channels and Supplementary Steel shall be determined by the Plumbing Subcontractor and shall be sufficient strength and size to allow only a minimum deflection in conformance with the manufacturer's requirements for loading.

- D. All Supplementary Steel and Channel shall be installed in a neat and workmanlike manner parallel to the walls, floor, and ceiling construction. All turns shall be made with 90 deg. fittings, as necessary to suit the construction and installation conditions.

2.14 HANGERS, ANCHORS, GUIDES, AND PIERS

- A. All piping shall be supported from the Building Structure by means of approved hangers and supports. Piping shall be supported to maintain required grading and pitching of lines, to prevent vibration, and to secure piping in place, and shall be so arranged as to provide for expansion and contraction.
- B. The spacing for hangers for horizontal piping shall be in accordance with the following:
1. Cast Iron Soil Pipe: 5 ft.-0 in. at the hubs for 5 ft. lengths. For 10 ft. lengths, use one (1) hanger at the hub and one (1) at midpoint of the length. Install cast iron pipe in accordance with CISPI Handbook - latest edition.
 2. Copper Tubing: 6 ft.-0 in. o.c. for 1-1/4 in. and smaller, and 10 ft.-0 in. o.c. for 1-1/2 in. and larger.
 3. Steel Pipe: 10 ft.-0 in. o.c. for 1-1/2 in. and over; 8 ft. - 0 in. for 1-1/4 in.; 6 ft. - 0 in. for 1 in. and smaller.
 4. Polypropylene acid waste: 4 ft.-0 in. o.c.
- C. Hanger rod diameter shall be as follows:

Pipe Size	Rod Diameter
1/2 in. thru 2 in.	3/8 in.
2-1/2 in. and 3 in.	1/2 in.
4 in. and 5 in.	5/8 in.
6 in.	3/4 in.
8 in. and over	7/8 in.

- D. Vertical lines shall be adequately supported at their bases by a suitable hanger placed in the horizontal line near the riser and at every 10 ft. interval.
- E. All Hangers shall be adjustable Clevis Hanger. Hanger rods shall have machine threads. Malleable iron brackets of approved type shall be used along the walls. All Hangers for copper tubing shall be copper plated except where pipe is insulated, in which case, Steel Clevis Hanger and pipe shield shall be used.
- F. Piping shall not be hung from the hangers of other trades.
- G. Provide seismic restraints for all piping per requirements of the MA Building Code and Section 230548. All gas piping shall be seismically restrained.
- H. Hangers shall be manufactured by Grinnell, Carpenter and Paterson, Fee and Mason, or equal.
- I. Wire and strap hangers will not be permitted in this installation.
- J. Install a 14 gauge metal pipe shield between pipe insulation and all pipe hangers. Hangers shall be sized so that the pipe insulation passes through the hanger and is supported on the shield.

2.15 DRAINS

- A. Furnish and install all floor drains and roof drains where shown on the Drawings.
- B. All floor drains in flooring systems without waterproofing membranes shall have galvanized iron clamping rings with 6-pound lead flashing to bond 9 in. in all directions. All drains shall be checked with Architect's Drawings to determine depth of the flashing collar. Brass extension pieces shall be provided if necessary.
- C. All floor drains installed on this project shall be fitted with Automatic Trap Primer Connections. Field determine appropriate location for Trap Primer valve and drain piping.
- D. Drain Schedule:
 - 1. Type "A" – (General) Zurn #ZN-415-5BZ-P dura coated cast iron body with bottom outlet, combination invertible membrane clamp, adjustable collar, seepage slots, type BZ polished nickel bronze, light-duty, leveling strainer, trap primer connection.
 - 2. Type "B" – (Mechanical Room) Zurn #Z-550-Y-P, 9 in. diameter top, dura coated cast iron body bottom outlet, seepage pan, combination membrane flashing clamp, frame for medium-duty, cast iron, heel-proof slotted grate, sediment bucket, cast iron grate, trap primer connection
 - 3. Type "C" - Zurn #ZC-100-DP-EA-G, galvanized cast iron body roof drain, under-deck clamp, galvanized cast iron dome secured, cast iron extension, roof sump receiver. Refer to Architect's Drawings for height of insulation.
- E. Drains shall be of one manufacturer, by Zurn, J.R. Smith, Watts, or equal.
- F. In bathrooms, coordinate all floor drain locations in field with Architect. Drain locations shall not conflict with toilet partition walls.

2.16 PLUMBING FIXTURES

- A. Furnish and install all fixtures and equipment, including supports, connections, fittings, and any incidentals, to make a complete installation in accordance with the Drawings and as specified.
- B. The Architect shall be final judge as to whether fixtures and trim fulfill the requirements of the Specifications and as to whether they are of suitable quality.
- C. All fixtures requiring hot and cold water shall have the cold water faucet on the right hand side of the fixture and the hot water faucet on the left hand side of the fixture.
- D. Escutcheons shall be furnished and installed on all supplies and traps. Escutcheons shall be one (1) piece chrome plated brass with set screws.
- E. All fixtures shall have the manufacturer's guaranteed label or trademark indicating first quality. All acid resisting enameled ware shall bear the manufacturer's symbol signifying acid resisting material.
- F. Unless otherwise specified, faucets and all exposed fittings shall be chromium plated.
- G. All supply pipes shall run in a reasonable straight vertical line from the stops to faucets. Traps shall be installed perpendicular to walls.

- H. Vitreous china and acid resisting enameled fixtures shall be of one manufacturer by Sloan, American Standard, Toto, or equal. Trim shall be Symmons, Speakman, Chicago, T & S Brass, or equal. Flush valves shall be Sloan, Toto, Zurn, or equal. Water coolers and drinking fountains shall be manufactured by Elkay, Just, Filtrine, or equal. Stainless steel sinks shall be Elkay, Just, Kindred, or equal.
- I. Note: All fixtures and fittings shall be vandal proof mounted, unless specifically noted otherwise.
- J. Carefully coordinate roughing for flush valves so that the dimension from top of fixture to C-L of flush valve is a minimum of 6 in..
- K. Fixture Schedule:
1. P-1 Water Closet, Accessible:

Sloan 2450-1401, complete 1.28 gallon per flush bowl, vitreous china, wall hung, elongated, siphon jet bowl, 1-1/2 in. top spud, and G2 8111 sensor operated flush valve.

Olsonite #95-C Lustra solid plastic white open front seat with check hinge.

Zurn 300-pound carrier as required to suit. Carefully coordinate with Architect's plans to fit wall. Use Z-1209 where dictated by conditions.

Mounting height shall conform to Accessibility Standards. Refer to Architect's Drawings for the exact location of fixture and mounting height and re-verify during construction with the Field Architect.
 2. P-2 Wall Hung Lavatory:

Kohler K-2054 "Soho", wall mounted, 20 in. x 18 in., white vitreous china lavatory, 4-inch centers, punched for concealed arm chair carrier.

Chicago 420-ABCP deck mounted, 4 inch centers, single lever handle, 1.5 GPM non-aerating outlet, Powers LFG480 tempering valve.

McGuire Model 155 WC offset drain with open grid strainer;

McGuire H167 LK (pair) C.P., 3/8 IPS angle supply with loose key stop.

McGuire B-8902 C.P., 1-1/4 in. x 1-1/2 in. cast brass adjustable 'P' trap with cleanout and 17 GA tubing outlet to wall.

Zurn #ZR-1231 floor mounted concealed arm chair carrier.

Provide roughing insulation kit on waste outlet, p-trap, and water supplies.

3. P-2A Wall Hung Lavatory:

Kohler K-2054 "Soho", wall mounted, 20 in. x 18 in., white vitreous china lavatory, 4-inch centers, punched for concealed arm chair carrier.

Chicago EQ-A12C-23ABCP, 4-inch centers, self-generating with battery backup sensor faucet with 0.35 GPM laminar flow outlet and integral thermostatic mixing valve with checks on each supply.

McGuire Model 155 WC offset drain with open grid strainer;

McGuire H167 LK (pair) C.P., 3/8 IPS angle supply with loose key stop.

McGuire B-8902 C.P., 1-1/4 in. x 1-1/2 in. cast brass adjustable 'P' trap with cleanout and 17 GA tubing outlet to wall.

Zurn #ZR-1231 floor mounted concealed arm chair carrier.

Provide roughing insulation kit on waste outlet, p-trap, and water supplies.

4. P-3 Drinking Fountain:

Elkay LZSTL8WSLK Bi-level Barrier Free Electric Water Cooler with bottle filling station, 8 GPH capacity, #4 satin finish stainless steel bowl, flexi-guard bubbler, push button actuator, ADA compliant, vinyl cabinet, and cane apron.

1-1/4 in. x 1-1/2 in. rough p-trap with cleanout; 1/2 in. ball valve stop.

Mounting height shall conform to MAAB Accessibility Standards. Refer to Architect's Drawings for the exact location of fixture and mounting height and re-verify during construction with the Field Architect.

5. P-4 Mop Receptor:

Stern-Williams MTB-2424-BP, 24 in. x 24 in. x 10 in. molded stone mop service basin with stainless steel rim guard on exposed sides, 3 in. caulk connection, stainless steel strainer, splash guard. Plumbing Subcontractor to include caulking and sealant to seal between unit, finished wall and floor.

T&S Brass model B-0665-BSTP service sink fitting, polished chrome, brace to wall, integral screwdriver stops, vacuum breaker, 3/4 in. hose end, 2 in. lever handles, provide 1/2 in. check valve on each supply to fitting with access panel.

Furnish and install 1/2" hot and cold reduced pressure backflow preventer capped for future soap dispenser.

6. P-5 Decon Sink:

Advance Tabco 94-41-24-24RL, 12" deep standard series, single compartment stainless steel sink, 11" backsplash, 14 ga. type 304 stainless steel sink, 1-5/8" galvanized legs with 1" adjustment, 24" drainboard on right and left.

Advance Tabco pre-rinse faucet, model K-116, splash mounted faucet, 8 in. centers, spring action flexible swing gooseneck, 2-3/8 inch blade handles, K-114 hand spray.

Crumb cup strainer with 1-1/2 in. tailpiece and stainless steel ground seat stopper.

1-1/2 in. x 2 in. chrome plated P-trap with cleanout, waste outlet with escutcheon.

Pair of 1/2 in. x 3/8 in. supplies with stops and escutcheons.

7. P-6 Shower:

Symmons 1-100-X Safetymix Pressure Balancing Mixing Valve with level handle, factory pre-set temperature limit stops, Integral Service Stops with 2.5 GPM flow restrictor, adjustable spray showerhead, with arm and flange.

Aquarius model AB3636, cast acrylic, 36 in. x 36 in. shower base. Center drain location, slip resistant, textured bottom, curtain rod and 6" threshold. Less seat and grab bars.

8. P-7 Clothes Washer:

Symmons No. W-602-X Laundry-Mate Supply and Drain Fixture, recessed mounting box 1/2 in. hot and cold water connections, 2 in. waste connection, integral stops and check valves on supplies.

9. P-9 Decon Shower:

Symmons 1-25-FSB-E-VB Safetymix Pressure Balancing Mixing valve with lever handle, factory pre-set temperature limit stops, FS hand spray unit with 2.5 GPM flow restrictor, in-line vacuum breaker, 60 in. flexible hose, 30 in. wall mounted slide bracket rod with heavy duty (250 lb) anchors.

Stern Williams Model WDA-3605-RDM, solid surface shower base, 40" x 38", roll in, with collapsible dam.

10. P-9 Decon Shower:

Symmons 1-25-FSB-E-VB Safetymix Pressure Balancing Mixing valve with lever handle, factory pre-set temperature limit stops, FS hand spray unit with 2.5 GPM flow restrictor, in-line vacuum breaker, 60 in. flexible hose, 30 in. wall mounted slide bracket rod with heavy duty (250 lb) anchors.

Stern Williams Model WDA-3630-RDM, solid surface shower base, 64" x 32", roll in, with collapsible dam.

11. P-10 Kitchen Sink:

Elkay ELUH-361710, under mount, double bowl sink, 10" deep, 18 ga. type 304 stainless steel sink with rear center outlet.

Chicago Faucet 200A-GN8AE3-369 concealed deck faucet with 8" swing gooseneck spout, 2-3/8" blade handles, and vegetable spray.

Just J-35 crumb cup strainer with 1-1/2" tailpiece and stainless steel ground seat stopper.

1-1/2" x 2" chrome plated P-trap with cleanout, waste outlet with escutcheon.

Pair of 1/2" x 3/8" supplies with stops and escutcheons.

12. P-11 Air Hose Reel:

Reelcraft Model 7850 OLP ceiling mounted hose reel with 50-foot hose. Refer to drawings for installation details.

13. P-12 Truck Fill Valve:

In Apparatus Bay furnish and install 2-inch ball where shown on drawing. Valve shall be Watts B6400, bronze two-piece, standard port, threaded end, or equal by Apollo, Milwaukee, Nibco.

Furnish and install a brass, pin lug swivel female to male connection at each fill valve. Coordinate thread type with Owner prior to ordering.

14. P-13 Emergency Eye/Face Wash:

Guardian model G-1724, wide area Emergency Eye/Face Wash including stainless steel drain pan. Recess barrier free eye/face spray head with stainless steel panic bar and stay open C.P. brass ball valve. Provide waste to discharge to piping in wall.

Provide Guardian Model G3602LF thermostatic mixing valve with recessed stainless steel cabinet.

2.17 BACKFLOW PREVENTERS

- A. Backflow preventers shall be reduced pressure type furnished complete with shutoff valves, Massachusetts Approved. Backflow preventers 2-1/2 inch and smaller shall be Watts #LF009-QT-S. Backflow preventers 3 inch and larger shall be Watts 957-QT. Backflow preventers shall be lead free, all bronze, complete with strainer and soft seated check valve. Size shall be as indicated on Drawings.
- B. Mount backflow preventer 3 ft.(+/-) above finished floor. Provide indirect waste funnel and run pipe to an air gapped discharge at sink or floor drain. Furnish a spare parts kit and parts list mounted in the vicinity of the device.
- C. Prior to the installation of devices in the name of the Owner file for, pay for, and obtain all required permits and approvals for cross connection control devices from the Authority having Jurisdiction.
- D. Backflow preventers shall be of one manufacturer, by Watts, Wilkins, Beeco, or equal.

2.18 UNION AND NIPPLES

- A. All connections between copper tubing and galvanized piping or between copper tubing and all tanks (such as water heaters, chillers, and similar equipment) shall be made with dielectric unions and nipples.
- B. All connection to Water Heaters, Meters, Pumps, and other equipment requiring maintenance or alteration shall be made up with unions. Unions on brass piping, 2 in. and smaller, shall be brass composition "E" in strict accordance with Federal Specification WW-U-516. On plastic piping, use unions of the same material as the piping.
- C. All close and shoulder nipples shall be corresponding materials as the pipe and shall be extra heavy.

2.19 WATER HEATER (WH-1)

- A. The potable domestic water heater shall be by PVI, State, AO Smith, or approved equal.
- B. The water heater shall be PVI Conquest condensing water heater with AquaPLEX storage tank. Water heater shall have an input rating of 199,900 Btu/Hour, a recovery capacity of 233 gallons per hour at a 100°F rise and shall be operated on natural gas.
- C. The water heater will be a vertical fire tube, design that is constructed and stamped in accordance with Section IV, Part HLW of the ASME code. Water heater will be National Board Registered for a working pressure of 150 psi and will be pressure tested at 1-1/2 times working pressure.
- D. The water heater shall be certified and listed by C.S.A. International under the latest edition of the harmonized ANSI Z21.10.3 test standard for the US. The water heater shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The water heaters shall operate at a minimum of 95% thermal efficiency. The water heaters shall be certified for indoor installation.
- E. The water heater shall be installed and vented with a Vertical Vent with vertical Air system with a vertical rooftop termination of the vent with the combustion air being drawn from the sidewall. The flue shall terminate at the roof top with the manufacturers specified vent termination. A separate pipe shall supply combustion air directly to the water heater from the outside.
- F. Water heater shall have direct spark ignition with electronic supervision firing control system.
- G. Furnish and install condensate neutralizing kit with water heater. Run condensate piping, after neutralized, to the nearest floor drain.
- H. Storage tank, heating surfaces, and combustion chamber will have a manufacturer's 15-year warranty (8 years non-prorated, 7 years prorated) covering manufacturing or material defects, waterside or fire side corrosion, leaks, and/or the production of rusty water.
- I. Expansion Tank: Furnish and install as shown on plans a 35 gallon (12 gallon acceptance volume), 16" diameter x 45" (high) pre-charged steel thermal expansion tank with a fixed FDA approved butyl bladder. The tank shall have a top NPT stainless steel system connection and a .301" - 32 charging valve connection (standard tire valve) to facilitate the on-site charging of the tank to meet system requirements. The tank must be constructed in accordance with Section VIII of the ASME Boiler and Pressure Vessel Code and stamped 150 psi working pressure. Tank shall be Wessels model number TTA-80 or by Amtrol, Taco, or approved equal

2.20 TEMPERING VALVES

- A. Tempering valves shall be as manufactured by Powers, Acorn Controls, Heat Timer Corp, or equal.
- B. Furnish and install where shown for temperature control at all domestic water heating systems, Powers Intellistation Jr., model LFIS075VL, digital mixing valve. In case of power failure valve shall flow full cold for safety. Provide inlet check-stops, outlet volume/shutoff valve, dial thermometer, and test connection. Valves are to be factory assembled and tested.
- C. Furnish and install a 4 in. diameter thermometer on the outlet side of each tempering valve as manufactured by U.S. Gauge Company, Powers Regulator Company, and/or Trerice Company.

2.21 RECIRCULATING HOT WATER PUMPS

- A. Circulators shall be all-bronze booster type, Grundfos Magna3 40-80 or equal by Bell & Gossett, Taco or approved equal.
- B. Circulators shall be connected to the Building Management System by Division 23.

2.22 AIR INTAKE AND EXHAUST BREECHING, CHIMNEYS AND STACKS

- A. The air intake and exhaust vents shall be double-wall stainless steel, factory-built type for use on condensing appliances.
- B. Maximum temperature shall not exceed 550°F.
- C. Vent shall be listed for an internal static pressure of 6 in. w.g. and tested to 15 in. w.g.
- D. Vent shall be constructed with an inner and outer wall, with a 1 in. annular insulating air space.
 - 1. The inner wall (vent) shall be constructed of AL29-4C superferritic stainless steel, .015 thickness for 4 in.-12 in. diameters and .024 thickness for 14 in.-24 in. diameters.
 - 2. The outer wall (casing) shall be constructed of type 430 stainless steel, .018 thickness for 4 in.-12 in. diameters and .024 thickness for 14 in.-24 in. diameters.
 - 3. Inner and outer walls shall be connected by means of spacer clips that maintain the concentricity of the annular space and allow unobstructed differential thermal expansion of the inner and outer walls.
- E. All parts exposed to the weather shall be stainless steel.
- F. All supports, roof or wall penetrations, terminations, appliance connectors and drain fittings, required to install the vent system shall be included.
- G. Roof penetration pieces shall be UL listed and provided by the vent manufacturer.
- H. All inner vent connections shall be secured by means of profiled connector bands with gear clamp tighteners. Joints shall be sealed with waterproof sealant. Where exposed to weather, the outer closure band shall be sealed to prevent rainwater from entering the space between inner and outer walls.

- I. Vent shall terminate in accordance with installation instructions and local codes.
- J. Manufacturers: Subject to compliance with requirements, provide all steel, insulated, positive pressure double wall vents of one of the following:
 - 1. Metal-Fab, Corr/Guard Model CG
 - 2. Selkirk Heat-Fab Saf-T Vent CI
 - 3. Schebler eVENTplus
 - 4. or equal

2.23 CONDENSATE NEUTRALIZING TUBES

- A. Contractor shall furnish and install condensate neutralizing tubes for new boilers and domestic water heater condensate drains and flue pipe condensate drains.
- B. Neutralizer tubes shall be as manufactured by JJM Boiler Works, Neutra-Safe, Fireside Condensate Neutralizers, or approved equal, and sized according to input rating of each piece of equipment.
- C. The boiler/water heater and flue condensate drains shall not be combined, Provide separate neutralizing tubes for boiler/water heater and flue condensates. All piping shall be per manufacturer's piping diagrams and directions. Secure neutralizing tubes to the floor.

2.24 WATER METER

- A. Furnish and install water meter with inlet strainer in accordance with the standards of the Local Water Department. Coordinate the installation with the water department and include in the Plumbing Bid the cost of the meter. Refer to Part 1 of this section regarding assessments, and the like.

2.25 EMERGENCY GAS SOLENOID VALVE

- A. Emergency gas solenoid valve shall be normally closed FM approved gas solenoid valve ASCO "Red-Hat" Series 8040/8215. Valve shall operate on 120volt power and shall close the gas flow on the main gas feed to the Kitchen cooking equipment. This solenoid valve is furnished and installed by Section 220000.
- B. Gas solenoid valves shall be manufactured by ASCO, QMI, ISIMET, or equal.

2.26 ELEVATOR SUMP PUMPS

- A. Furnish and install in each elevator pit a simplex Stancor Traction Minder Elevator System, 2" submersible sewage pump. Pump shall be Stancor WES-50 submersible. Pump shall be rated to provide 50 GPM @ 22' TDH. Pump motors shall be submersible and not less than 0.5 HP, 115Volt, 1phase, 3,450 RPM and 60 HZ.
- B. Controls shall include Stancor Series CB1000-1 single phase simplex controller, three float switches mounted to the discharge pipe with 20' cord, NEMA 4X enclosure, High Water Alarm, Test and Silence selector switch, high water alarm horn with silencer, and one set of isolated dry contacts for remote alarm.

- C. At each installation furnish and install oil separator as detailed. Oil Separator shall be Striem model #OS-50-SS, made in USA of seamless, rotationally-molded polyethylene. Interceptor shall be furnished for below grade installation. Interceptor flow rate shall be 50 GPM. Interceptor oil capacity shall be 40 gallons. Cover shall provide water/gas-tight seal and have maximum 2,000 lbs. load capacity. Unit shall have a lifetime guaranteed.
- D. Provide complete Striem Slick Stick monitoring system including interface float, alarm panel, and all control wiring and conduit from separator to control panel. Monitoring system shall provide warning of high oil level conditions with interface float. Alarm panel shall be NEMA 4X corrosion resistant, weatherproof enclosure. The single phase, 120 volt, 60 hertz power shall be provided to the panel by Division 26. Panel shall include audible alarm buzzer, 95db pulsing horn with no timeout, high oil light, power on light inside enclosure visible from the outside, horn off button that silences the audible alarm, and test button. Panel shall be supplied with extra dry contact for connection to a building management system.

2.27 TRENCH DRAIN

- A. Furnish and install as shown on the Plumbing Drawings, Zurn Z882-E1-DGE, 12" wide pre-sloped trench drainage system. Glass filled polyester fiberglass drain channel with 1/8" per foot bottom slope with interlocking ends complete with anchor studs at surface, combination anchor tabs/leveling devices at appropriate locations and extra heavy-duty ductile iron (Class E) grate with lockdowns.

2.28 AIR COMPRESSOR (AC-1)

- A. Furnish and install a tank mounted air compressor with all required accessories to provide an automatic supply of shop air to serve station outlets
- B. Air compressor shall be Quincy Model QT-5, 15.2 CFM, 5-HP, 208V, 3 phase 60 HZ motor, 60 gallon vertical ASME receiver, compressor-mounted full-function motor starter with a 120 volt control voltage transformer with on-off switches and manual resets, automatic condensate drain, tank mounted pressure gage, service valve and safety valve. Compressor to include QMF-75 coalescing filter.
- C. Run auto-drain discharge to nearest floor drain.
- D. Compressor to include Quincy QPNC-25 dryer with dedicated 120 volt, single phase power supply.
- E. Compressor to be furnished with MA Code Riser kit to elevate tank 12" above housekeeping pad.

2.29 COMPRESSED AIR REGULATORS

- A. At all compressed air connections furnish and install Parker, series C105/C255, Ingersoll Rand, Control Air, or equal combination air filter and pressure regulator.

2.30 MANHOLE AND PRECAST CONCRETE OIL/GAS SEPARATOR STRUCTURE

- A. Manholes and precast concrete structures shall be constructed as shown on Drawings. Conform accurately to indicated dimensions.
 - 1. Precast concrete manhole barrel, base, and cone sections shall conform to ASTM C-478 and shall be furnished complete with integral cast aluminum polymer coated steel steps. Sections shall be assembled with Kentseal #2 gaskets, or equal.
 - 2. Brick for constructing channels and adjustments to grade shall be waterstruck sewer brick, Grade 'A' concrete brick conforming to ASTM C-55, or precast concrete grade rings mortared in place.
 - 3. Cement mortar for parging and for joining brick shall be made of one (1) part portland cement and two (2) parts sand mixed to the proper consistency. Add approximately twenty (20) pounds of hydrated lime for each sack of cement.
 - 4. Precast concrete structures for oil/gas separator shall be as manufactured by A. Rotondo & Sons, Inc. or equal by Scituate Concrete pipe or Shea precast. Structures shall conform to the form and dimensions shown, be reinforced with ASTM A-615-79 Grade 60 reinforcing steel having a minimum 1" cover, and constructed of 5,000 PSI concrete. All field joints shall be sealed with rubber gasket and shall be grouted with hydraulic cement for watertightness. Design loading for all structures shall meet H-20 wheel loading design
- B. Conform to the Concrete Section of the specification for 4,000 PSI 6% air entrained concrete for all concrete structures for the work of this section. Including reinforcing steel where detailed.
- C. Cast iron manholes, frames, and covers, shall be of the form, dimensions, and manufacture shown on the Contract Drawings. Manhole extensions shall be neatly and accurately brought to dimensions of the base of the frame. Casting shall be of tough gray iron, free from cracks, holes, and cold shuts. All castings shall be made accurately to dimensions and shall be machined to provide even bearing surfaces. Covers must fit the frames in any position and, if found to rattle under traffic, shall be replaced. Filling to obtain tight covers will not be permitted. No plugging, burning-in, or filling will be allowed. All castings shall be carefully coated inside and out with coal tar pitch varnish of approved quality.
- D. Castings shall be as detailed on drawings or castings that appear on the Massachusetts Highway Department approval list for manhole frame & cover castings. Castings shall be by LeBaron Foundry, Neenah Foundry, or Campbell Foundry.

2.31 FIRESTOP SYSTEMS

- A. General: Provide firestopping at all new fire-rated construction where penetrated by the Work of this Section.
- B. Refer to Section 078400 - Firestopping, for all product requirements for maintaining integrity of fire-rated construction at penetrations.

2.32 SCAFFOLDS AND STAGING

- A. General: Trade Contractors shall obtain required permits for, and provide scaffolds, staging, and other similar raised platforms, required to access their Work as specified in Section 01 50 00 - Temporary Facilities and Controls and herein.
 - 1. Scaffolding and staging required for use by this Trade Contractor pursuant to requirements of Section 01 50 00 - Temporary Facilities and Controls shall be furnished, erected, maintained in a safe condition, and dismantled when no longer required, by this Trade Contract requiring such scaffolding.
 - 2. Each Trade Contractor is responsible to provide, maintain and remove at dismantling, all tarpaulins and similar protective measures necessary to cover scaffolding for inclement weather conditions other than those required to be provided, maintained and removed by the General Contractor pursuant to MGL (Refer to Section 01 50 00 - Temporary Facilities and Controls and as additionally required for dust control).
 - 3. General Contractor is responsible to provide enclosures required for temporary heat; refer to Section 01 50 00 - Temporary Facilities and Controls.
 - a. Furnishing portable ladders and mobile platforms of all required heights, which may be necessary to perform the work of this trade, are the responsibility of this Trade Contractor.

2.33 HOISTING MACHINERY AND EQUIPMENT

- A. All hoisting equipment, rigging equipment, crane services and lift machinery required for the work by this Trade Contractor shall be furnished, installed, operated and maintained in safe conditions by this Trade Contractor, as referenced under Section 01 50 00 - Temporary Facilities and Controls.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION METHODS

- A. All work shall be installed in a first-class manner consistent with the best current practices. All materials shall be securely installed plumb and/or level, and all flush mounted equipment shall have front edge flush with finished wall surface.
- B. All piping shall be installed true to line and grade in the case of underground piping. All piping above ceilings or exposed shall be grouped together, be parallel to each other, and be either parallel or perpendicular to the structure. Utilize gang hangers wherever feasible. Group all valves together where feasible.
- C. Training:
 - 1. Train the Owner's maintenance personnel on troubleshooting procedures, and servicing and preventative maintenance schedules and procedures.
 - 2. Schedule training with Owner through the Architect with at least 7 days prior notice.

3.2 WORK COORDINATION AND JOB OPERATIONS

- A. The equipment shall not be installed in congested and possible problem areas without first coordinating the installation of same.

- B. Particular attention shall be directed to the coordination of piping and other equipment installed in the ceiling areas. Coordinate the elevations of all piping in hung ceiling areas to insure adequate space for the installation of recessed lighting fixtures before other mechanical equipment is installed.
- C. Furnish to the General Contractor, and all other Subcontractors, all information relative to the portion of the Plumbing installation that will affect them, sufficiently in advance so that they may plan their work and installation accordingly.
- D. In case of failure to give proper information as indicated above sufficiently in advance, pay for all back-charges for the modification, renovation, and relocation of any portion of the work already performed.
- E. Obtain from the other trades, all information relative to the Plumbing Work to be executed in conjunction with the installation of their respective equipment.

3.3 CUTTING AND CORE DRILLING

- A. Perform all cutting and core drilling operations that are outlined in Part 1 of this SECTION. Throughout the performance of the cutting and coring work, ensure that the structural integrity of the walls, floors, overhead structure, and other structural components, which are to remain, is maintained until permanent work is installed. Prior to any coring or cutting, verify all locations of same with the General Contractor. All cutting and coring is to be performed in accordance with approved Coordination Drawings
- B. Cut all masonry and concrete with an approved diamond blade concrete saw in a neat straight direction, perpendicular to the plane of the wall or floor.
- C. Use a core drilling process which produces clean, sharp edges and the minimum hole size which will accommodate the size of pipe sleeve specified. Submit procedures for cutting thru existing steel beams to Architect for review.
- D. The patching of holes shall be performed by Plumbing Sub-contractor utilizing methods outlined for the finish trade involved. Holes shall be patched to the satisfaction of the Architect.

3.4 CLEANING AND PROTECTION

- A. Protect all materials and equipment during shipment and so as to prevent damage. Water closets, lavatories, and sinks shall be boarded over and all other fixtures shall be protected with pasted on paper. Post notice prohibiting the use of the fixtures prior to completion. Assume full responsibility for protection of work until its completion and final acceptance.
- B. Keep the premises reasonably clean at all times and remove rubbish caused by the Plumbing Work as directed by the Architect.
- C. Upon completion of this work, clean all fixtures and equipment installed herein and replace damaged parts. Failure to fulfill this obligation will result in back-charges for correction of the defective work.

3.5 SLEEVES, INSERTS, AND ESCUTCHEONS

- A. All piping passing through slabs, floors, walls, partitions, foundation walls and grade beams, shall be sleeved and all such sleeves shall be furnished and installed by the Plumbing Subcontractor as detailed on the Drawings and herein specified. Set sleeves in concrete floors and walls as soon as forms are set and before concrete is poured. Core drilling openings shall have a sleeve caulked and grouted in place.
- B. All pipes passing through floor, whether slab-on grade or above grade levels, shall be sleeved with sleeve extending 1 in. above floor. This includes all piping in toilet room pipe space, stairwells, closets, partitions and pre-cast planks.
- C. All sleeves shall be Schedule 40 galvanized steel and shall be reamed. There shall be a minimum of 1 in. annular space between the sleeve and pipe provide greater clearance where seismic requirements dictate. Sleeves on insulated pipe shall be large enough to allow insulation to pass through sleeve. Sleeves on drywall, masonry, or concrete walls and partitions, shall be flush with wall on both sides.
- D. The space between sleeve and pipe in all cases shall be filled with a U.L./F.M. approved caulking compound. This includes pipes concealed in chases and/or partitions.
- E. Inserts where required shall be furnished and set by the Plumbing Subcontractor and where necessary may be drilled or power driven and shall be sized such that the insert will not exceed a depth of penetration of 1 in. into concrete.
- F. Escutcheons: All exposed pipe, uncovered, passing through walls or floors or ceilings shall be fitted with C.P. brass spun or split type escutcheons with approved clamping device for holding in position. Floor escutcheons shall be deep enough to fit over sleeves, fastened to pipe, and extend down to floor.

3.6 TESTING

- A. Test all Work in the presence of the Architect and/or Engineer and as required by Local Codes.
- B. After Soil, Storm, and Vent Piping is in place and before being buried or furred in, plug lower ends and fill the system with water up to the top of stacks. Piping is to be left tight under these conditions and water level shall be maintained intact for the period of at least four (4) hours.
- C. Test all water piping by applying a hydrostatic pressure of 150 PSIG using a pump for this purpose. Make sure that all lines are properly plugged or capped and that air has been vented before applying pressure which shall remain constant without pumping for two (2) hours at least.
- D. Test gas piping per State Gas Code.
- E. Any leaks in joints or evidence of defective pipe on fittings disclosed by test shall be immediately corrected by replacing defective parts with new joints or materials. No makeshift repair effected by caulking threaded pipe with lead wool, application or Wilky or patented compounds will be permitted.

F. Gas/Oil Separator Manhole Exfiltration Test:

1. Plug pipes in manhole; remove water in manhole; observe plugs over period of not less than 2 hours to ensure there is no leakage into manhole.
2. Fill manhole with water to within 4 inches of top of cover frame. Prior to test, allow manhole to soak from minimum of 4 hours to maximum of 72 hours; after soak period, adjust water level inside manhole to within 4 inches of top of cover frame.
3. Measure water level from top of manhole frame; at end of 4 hour test period, again measure water level from top of manhole frame; there shall be no drop in water level during test period.
4. When unsatisfactory test results are achieved, repair manhole and retest until result meets criteria; repair visible leaks regardless of quantity of leakage.

G. Provide testing report for all systems tested.

3.7 CHLORINATION

- A. Upon completion of the Plumbing Work, thoroughly chlorinate the entire domestic water system before putting same in service. Chlorinate all work in the presence of the Architect and/or Engineer. The chlorinating agent shall be as a solution of sodium hypochlorite. Water shall be fed slowly into the new line with chlorine in the proper amount to produce a dosage of 50 PPM. Open and close all valves while system is being chlorinated.
- B. After the sterilization agent has been applied for 24 hours, pay for an independent testing agency to test for residual chlorine and for presence of bacteria. A residual of not more than 5 PPM shall be required in all parts of the line.
- C. If test show 5 PPM or greater of residual chlorine, flush out system until all traces of the chemical used are removed.
- D. Provide testing report from independent testing agency.

3.8 INSTALLATION OF FIRESTOP SYSTEMS

- A. General: Install firestop systems at all fire-rated construction where penetrated by the Work of this Section.
- B. Refer to Section 078400 - Firestopping, for all installation requirements for maintaining integrity of fire-rated construction at penetrations.

3.9 INSTALLATION OF AIR INTAKE AND EXHAUST BREECHING, CHIMNEYS AND STACKS

- A. VIBRATION CONTROL AND SEISMIC RESTRAINT: Refer to section 230548 and drawing VS-1 for the appropriate support of each piece of equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawing VS-1.
- B. Install all gas vents/intakes in accordance with manufacturer's installation instructions and UL listing. Maintain minimum clearances from combustibles specified in UL listing.
- C. Seal joints between sections of positive pressure vents in accordance with manufacturer's installation instructions, and using only sealants recommended by manufacturer.

- D. Support vents at intervals recommended by the manufacturer to support the weight of the vent and all accessories, without exceeding loading of appliances. Provide guys wires on all vents which terminate through the roof. Typical provide three (3) guy wires for each air intake or exhaust vent penetrating the roof.
- E. Install barometric and thermostatically operated dampers in accordance with manufacturer's instructions. Locate as close to draft hood collar as possible.
- F. Clean breechings internally during installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth.
- G. Temporary Closure: At ends of breechings and chimneys which are not completed or connected to equipment, provide temporary closure which will prevent entrance of dust and debris until installations are completed.

3.10 SEISMIC RESTRAINTS

- A. The independent engineer responsible for design of seismic restraints shall visit the project upon completion of the work to certify the installation is consistent with the approved shop drawings. The certification shall be submitted to the Architect and must precede the closing in of ceilings.

3.11 SYSTEM SHUTDOWNS

- A. Coordinate shutdowns of existing systems with the Owner and submit a written request at least ten working days in advance. Minimize system shut downs as much as possible. Submit a list of all affected areas, the proposed work to be performed, and the expected length of the shut-down including time for retesting.
- B. Provide temporary services to maintain active system during extended shut-downs as required for demolition and construction phasing.

END OF SECTION

SECTION 23 00 00

HVAC
 (FILED SUB-BID REQUIRED)

PART 1 - GENERAL	1
1.1 GENERAL PROVISIONS	1
1.2 EXAMINATION OF SITE AND DOCUMENTS	2
1.3 PRE-INSTALLATION CONFERENCE	2
1.4 SEQUENCING	2
1.5 REFERENCES	2
1.6 DEFINITIONS	2
1.7 DESCRIPTION OF WORK	3
1.8 RELATED WORK	3
1.9 CODES, ORDINANCES, AND PERMITS	4
1.10 QUALITY ASSURANCE	4
1.11 DISCREPANCIES IN DOCUMENTS	5
1.12 PHASING	6
1.13 CONTRACT DRAWINGS	6
1.14 ACCESSIBILITY	6
1.15 ROUGH IN	6
1.16 NOTIFICATION OF RELATED TRADES	6
1.17 MECHANICAL INSTALLATIONS	7
1.18 CUTTING AND PATCHING	7
1.19 SUBMITTALS	7
1.20 SUBSTITUTIONS	8
1.21 PRODUCT LISTING	8
1.22 NAMEPLATE DATA	9
1.23 DELIVERY, STORAGE AND HANDLING	9
1.24 RECORD DOCUMENTS	9
1.25 COORDINATION DRAWINGS	9
1.26 OPERATION AND MAINTENANCE DATA	10
1.27 ENERGY REBATE PROGRAM	11
1.28 WARRANTIES	11
1.29 WELDING QUALIFICATIONS	11
1.30 COMMISSIONING	11
1.31 ALTERNATES	12
1.32 TRADE RESPONSIBILITY FOR INTERCONNECTIONS MATRIX	12
PART 2 PRODUCTS	13
2.1 ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT	13
2.2 HANGERS & ATTACHMENTS	16
2.3 MECHANICAL IDENTIFICATION	19
2.4 MECHANICAL INSULATION	20
2.5 HYDRONIC PIPING AND ACCESSORIES	21
2.6 REFRIGERANT PIPING	26
2.7 DUCTLESS COOLING UNITS	27
2.8 HIGH EFFICIENCY CONDENSING BOILERS	37
2.9 HYDRONIC PUMPS	39
2.10 RADIANT FLOOR AND SNOW MELT SYSTEM	39
2.11 TERMINAL HEATING UNITS (HYDRONIC)	41
2.12 POWER AND GRAVITY VENTILATORS	44

2.13	METAL DUCTWORK.....	45
2.14	DUCTWORK ACCESSORIES.....	47
2.15	AIR OUTLETS AND INLETS.....	49
2.16	WALL AND CEILING ACCESS DOORS.....	51
2.17	ARCHITECTURAL LOUVERS AND VENTS.....	52
2.18	CO/CO2/NO2 DETECTION AND CONTROL UNIT.....	52
2.19	GAS DETECTION SENSORS & MONITORING SYSTEM.....	53
2.20	PLATE AND FRAME HEAT EXCHANGERS.....	55
2.21	AUTOMATIC TEMPERATURE CONTROLS (DDC).....	56
PART 3 EXECUTION		80
3.1	INSTALLATION OF HANGERS AND ATTACHMENTS.....	80
3.2	INSTALLATION OF MECHANICAL IDENTIFICATION.....	82
3.3	INSTALLATION OF MECHANICAL INSULATION.....	82
3.4	INSTALLATION OF HYDRONIC PIPING AND ACCESSORIES.....	83
3.5	INSTALLATION OF REFRIGERANT PIPING AND ACCESSORIES.....	87
3.6	INSTALLATION OF DUCTLESS COOLING UNIT SYSTEMS.....	87
3.7	INSTALLATION OF HIGH EFFICIENCY CONDENSING BOILERS.....	88
3.8	INSTALLATION OF HYDRONIC PUMPS AND ACCESSORIES.....	89
3.9	INSTALLATION OF RADIANT FLOOR AND SNOW MELT SYSTEM.....	89
3.10	INSTALLATION OF TERMINAL HEATING UNITS (HYDRONIC).....	90
3.11	INSTALLATION OF POWER AND GRAVITY VENTILATORS.....	91
3.12	INSTALLATION OF METAL DUCTWORK.....	92
3.13	INSTALLATION OF DUCTWORK ACCESSORIES.....	93
3.14	INSTALLATION OF AIR OUTLETS AND INLETS.....	93
3.15	INSTALLATION OF WALL AND CEILING ACCESS DOORS.....	94
3.16	INSTALLATION OF ARCHITECTURAL LOUVERS AND VENTS.....	94
3.17	INSTALLATION OF CARBON MONOXIDE/CARBON DIOXIDE EXHAUST SYSTEM.....	95
3.18	INSTALLATION OF GAS DETECTION & MONITORING SYSTEM.....	95
3.19	INSTALLATION OF HEAT EXCHANGERS.....	95
3.20	INSTALLATION OF AUTOMATIC TEMPERATURE CONTROLS (DDC):.....	96
3.21	TESTING, ADJUSTING, AND BALANCING.....	98

END OF INDEX

SECTION 23 00 00

HVAC
(FILED SUB-BID REQUIRED)

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. The BIDDING REQUIREMENTS, CONTRACT FORMS, and CONTRACT CONDITIONS as listed in the Table of Contents, and applicable parts of Division 1 - GENERAL REQUIREMENTS, shall be included in and made a part of this Section.
- B. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law - Chapter 149, Sections 44A to 44J inclusive, as amended, and applicable Sections of the MGL, Public Contract Law – Chapter 30.
- C. The work to be completed by the Filed Subcontractor for the work of this Section is shown on the following listed Drawings, not just those pertaining particularly to this Sub-Trade, unless specifically called out otherwise, regardless of where among the Drawings it appears:
 - Mechanical: M0.0, M1.1M M1.2, M1.3, M1.4, M2.1, M2.2,M2.3, M3.0.
 - Seismic: TBD
- D. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the Work of this Filed Subcontract.
- E. This project is being Electronically Bid. Sub-Bids for work under this Section shall be for the complete work and shall be filed in strict accordance with requirements outlined in Section 00 11 13, Invitation to Bid, and Section 00 21 13, Instruction to Bidders.
- F. Sub Sub-Bid Requirements

CLASS OF WORK	PARAGRAPH NUMBER
Insulation	2.4, 3.3
Sheetmetal & Accessories	2.13, 2.14, 2.15, 3.12, 3.13, 3.14
Automatic Temperature Control	2.21, 3.20
Testing, Adjusting, and Balancing	3.21

1.2 EXAMINATION OF SITE AND DOCUMENTS

- A. Bidders are expected to examine and to be thoroughly familiar with all contract documents and with the conditions under which work will be carried out. There will be a Pre-Bid Site Conference. It is the responsibility of each Bidders to visit the site for the Fire Station if she or her chooses to inspect it prior to submitting their Bid. The Awarding Authority (Owner) will not be responsible for errors, omissions and/or charges for extra work arising from General Contractor's or Filed Subcontractor's failure to familiarize themselves with the Contract Documents or existing conditions. By submitting a bid, the Bidder agrees and warrants that he has had the opportunity to examine the site and the Contract Documents, that he is familiar with the conditions and requirements of both and where they require, in any part of the work a given result to be produced, that the Contract Documents are adequate and that he will produce the required results.

1.3 PRE-INSTALLATION CONFERENCE

- A. Installer of the Work of this trade is required to attend pre-installation conference. Conference shall include guidelines for installing masonry, insulation and AVB. It is recommended that manufacturer's representatives be present at pre-installation conference to review installation procedures and compatibility issues.

1.4 SEQUENCING

- A. Coordinate work of this Filed Subcontract with that of other trades, affecting or affected by this work, and cooperate with the other trades as is necessary to assure the steady progress of work.
- B. Do not order or deliver any materials until all submittals, required in the listed Specification Sections included as part of this Filed Subcontract, have been received and approved by the Architect.
- C. Before proceeding with installation work, inspect all project conditions and all work of other trades to assure that all such conditions and work are suitable to satisfactorily receive the work of this Section and notify the Architect in writing of any which are not. Do not proceed further until corrective work has been completed or waived.

1.5 REFERENCES

- A. General provisions of Contract, including General and Supplementary Conditions and Division I, General Requirements, apply to work specified in this Section.

1.6 DEFINITIONS

- A. Most terms used within the documents are industry standard. Certain words or phrases shall be understood to have specific meanings as follows:
 - 1. Provide: Furnish and install completely connected up and in operable condition.
 - 2. Furnish: Purchase and deliver to a specific location within the building or site.
 - 3. Install: With respect to equipment furnished by others, install means to receive, unpack, move into position, mount and connect, including removal of packaging materials.
 - 4. Conduit: Raceways of the metallic type which are not flexible.
 - 5. Connect: To duct, pipe or wire up, including all branch ductwork, piping, and/or circuitry, control and disconnection devices so item is complete and ready for operation.

6. Subject to Mechanical Damage: Equipment, ductwork, piping and raceways installed exposed and less than eight feet above finished floor in mechanical rooms or other areas where heavy equipment may be in use or moved.
7. General Contractor and Construction Manager are one in the same.

1.7 DESCRIPTION OF WORK

- A. The work described herein shall be interpreted as work to be done by the HVAC Subcontractor. Work to be performed by other trades will always be specifically referenced to that trade.
- B. Furnish all staging, rigging, temporary support, labor, materials, and perform all operations in connection with the installation of the HVAC work.
- C. Without limiting the generality thereof, the work to be performed under this Section includes complete new HVAC systems with the following major sub systems:
 1. High Efficiency Boiler
 2. Energy Recovery Units
 3. Exhaust Fans
 4. Ductwork with Insulation, Diffusers, Registers and Grilles
 5. Ductless Cooling Units and Air Cooled Condensing Units
 6. Terminal Heating Units
 7. Automatic temperature controls
 8. Valves
 9. Meters and Gauges
 10. Hangers and Attachments
 11. Mechanical Identification
 12. Mechanical Insulation
 13. Hydronic Piping
 14. Pumps and Accessories
 15. Metal Ductwork
 16. Ductwork Accessories
 17. Air Outlets & Inlets
 18. Testing, Adjusting, Balancing, and Commissioning

1.8 RELATED WORK

- A. Cutting beyond the requirements as stated herein, and patching of all openings regardless of size, is specified in the respective Sections of the trade responsible for furnishing and installing similar new materials.
- B. For temporary controls, coordinate with General Contractor and/or Construction Manager.
- C. For flashing of vents through roof and setting of roof curbs and flashing of such, refer to SECTION 07 62 00 - SHEET METAL FLASHING & TRIM.
- D. For power wiring of mechanical equipment refer to SECTION 26 00 00 - ELECTRICAL.
- E. For excavation and backfill of below grade mechanical and related systems refer to Division 31.
- F. For firestopping not called for in this Section refer to Section 07 84 00.

- G. For finished painting of mechanical systems not called for in this Section refer to SECTION 09 91 00 - PAINTING.
- H. For interior concrete work relating to this Section refer to SECTION 03 30 00 – CAST-IN-PLACE CONCRETE.
- I. For exterior concrete work relating to this Section refer to SECTION 03 30 00 – CAST-IN-PLACE CONCRETE.
- J. For Commissioning, requirements refer to SECTION 01 91 13 – COMMISSIONING REQUIREMENTS.

1.9 CODES, ORDINANCES, AND PERMITS

- A. Perform all work in accordance with the requirements of the Town of Millbury Building Department, State of Massachusetts Building Code, and applicable State and Federal Laws. Give all requisite notices, file all requisite plans, and obtain all permits required to perform HVAC Work. Pay all fees and include in the Bid.

1.10 QUALITY ASSURANCE

- A. Codes and Standards:
 - 1. HI Compliance: Design, manufacture, and install HVAC pumps in accordance with HI Hydraulic Institute Standards".
 - 2. UL Compliance: Design, manufacture, and install HVAC pumps in accordance with UL 779 "Motor Operated Water Pumps".
 - 3. ANSI Standards: Comply with ANSI A13.1 for pipe, valve, and equipment identification.
 - 4. I=B=R Compliance: Provide boilers that have been tested and rated in accordance with Institute of Boiler and Radiator Manufacturers (I=B=R) "Testing and Rating Standard for Cast Iron and Steel Heating Boiler", and bear I=B=R emblem on nameplate affixed to boiler.
 - 5. NFPA Compliance: Install gas fired boilers in accordance with NFPA requirements
 - 6. ASME Compliance: Construct cast iron boilers in accordance with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".
 - 7. UL and NEMA Compliance: Provide cast iron boiler ancillary electrical components, which have been listed and labeled UL, and comply with NEMA Standards.
 - 8. FM Compliance: Provide control devices and control sequences in accordance with requirements of Factory Mutual System (FM).
 - 9. IRI Compliance: Provided control devices and control sequences in accordance with requirements of Industrial Risk Insurance (IRI).
 - 10. AMCA Compliance: Test and rate air handling units in accordance with AMCA standards.
 - 11. AGA Compliance: Provide gas controls and devices in accordance with American Gas Associates.
 - 12. ARI Compliance: Test and rate air handling units in accordance with ARI 430 "Standard for Central-Station Air Handling Units", display certification symbol on units of certified models.
 - 13. ASHRAE Compliance: Construct and install refrigerant coils in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".

14. NFPA Compliance: Provide air handling unit internal insulation having flame spread rating not over 25 and smoke developed rating no higher than 50; and complying with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems".
 15. UL and NEMA Compliance: Provide electrical components required as part of air handling units, which have been listed and labeled by UL and comply with NEMA standards.
 16. NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to installation and electrical connections of ancillary electrical components of air handling units.
- B. MSS Standard Practices: Comply with the following standards for valves:
1. MSS SP-45: Bypass and Drain Connection Standard
 2. MSS SP-67: Butterfly Valves
 3. MSS SP-70: Cast Iron Gate Valves, Flanged and Threaded Ends
 4. MSS SP-71: Cast Iron Swing Check Valves, Flanged
 5. MSS SP-72: Ball Valves with Flanged or Butt-Welding Ends for General Service
 6. MSS SP-78: Cast Iron Plug Valves, Flanged and Threaded Ends
 7. MSS SP-80: Bronze Gate, Globe Angle and Check Valves
 8. MSS SP-84: Steel Valves - Socket Welding and Threaded Ends
 9. MSS SP-85: Cast Iron Globe and Angle Valves, Flanged with Threaded Ends
 10. MSS SP-92: MSS Valve User Guide
- C. Automatic Temperature Control Contractor Qualifications: Firms specializing in manufacturing and installation of control system for not less than 5 years.
1. Codes and Standards:
 - a. Electrical Standards: Provide electrical components of control systems which have been UL-listed and labeled, and comply with NEMA standards.
 - b. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for pneumatic control systems.
 - c. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.

1.11 DISCREPANCIES IN DOCUMENTS

- A. Where Drawings or Specifications conflict or are unclear, advise Architect in writing before Award of Contract. Otherwise, Architect's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted.
- B. Where Drawings or Specifications do not coincide with manufacturer's recommendations, or with applicable codes and standards, alert Architect in writing before installation.
- C. If the required material, installation, or work can be interpreted differently from drawing to drawing, for between drawings and specs, this contractor shall provide that material, installation, or work which is of the more stringent.

- D. It is the intent of these contract documents to have the contractor provide systems and components that are fully complete and operational and fully suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a system. In cases such as this, where the contractor has failed to notify the Architect of the situation in accordance with Paragraph (A) above, the contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner.

1.12 PHASING

- A. The mechanical subcontractor shall construct the subject project in phases as directed by the Architect to suit the project progress schedule, as well as the completion date of the project.
- B. For additional information related to phasing, review the General Conditions and Supplementary Conditions and the Architectural drawings.

1.13 CONTRACT DRAWINGS

- A. All work shown on the Drawings is intended to be approximately correct to scale, but shall be taken in a sense as diagrammatic. Sizes of ductwork and pipes and general method of running them are shown, but it is not intended to show every offset and fitting. To carry out the true intent and purpose of the plans, furnish all necessary parts to make complete working systems ready for use.
- B. The HVAC Drawings and Specifications are intended to supplement each other so that any details shown on the Drawings and not mentioned in the Specifications, or vice-versa, shall be executed the same as if mentioned in the Specifications and shown on the Drawings.
- C. Refer to the Architectural, Structural, and other Mechanical and Electrical Drawings which indicate the construction in which this work shall be installed. Locations shown on the plans shall be checked against the general and detailed Drawings of the construction proper. All measurements must be taken at the building.

1.14 ACCESSIBILITY

- A. Install equipment and materials to provide required access for servicing and maintenance. Coordinate the final location of concealed equipment and devices requiring access with final location of required access panels and doors. Allow ample space for removal of all parts that require replacement or servicing.
- B. Extend all grease fittings to an accessible location.

1.15 ROUGH IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

1.16 NOTIFICATION OF RELATED TRADES

- A. Notify all other trades responsible for installing chases, inserts, sleeves, anchors, louvers, etc. when ready for such installation and for final checking immediately before concrete is placed. Cooperate with such trades to obtain proper installation.
- B. Leave openings in walls for pipes, ducts, etc. for mechanical and electrical work as shown on Drawings or required by layout of mechanical or electrical systems.

1.17 MECHANICAL INSTALLATIONS

- A. Coordinate mechanical equipment and materials installation with other building components.
- B. Verify all dimensions by field measurements.
- C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.
- F. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.
- G. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.
- H. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
- I. Coordinate connection of mechanical system with overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

1.18 CUTTING AND PATCHING

- A. Drilling, coring, and cutting of new and existing structures (through walls, floors, ceiling, etc.) where the largest dimension does not exceed 12" shall be by this Contractor.
- B. Throughout the performance of the cutting and coring work, ensure that the structural integrity of the existing walls, floors, overhead structure, and other structural components, which are to remain, is maintained until permanent work is installed. Prior to any coring or cutting verify all locations of same with the General Contractor. All cutting and coring is to be performed in accordance with approved coordination drawings. All cutting or coring of structural must receive approval of the Architect prior to proceeding.
- C. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.
- D. Patching of surfaces shall be by the trade responsible for the surface penetrated.
- E. Refer to various architectural sections for additional reference.

1.19 SUBMITTALS

- A. Refer to Section 01 33 00 – SUBMITTAL PROCEDURES for submittal definitions, requirements, and procedures. The following paragraphs supplement the requirements of Section 01 33 00.

- B. Submittal of Shop Drawings, product data, and samples will be accepted only when submitted by the General Contractor. Data submitted by Sub-contractors and material suppliers directly to the Architect/Engineer will not be processed.
- C. Provide submittals for the following equipment:
 - 1. Rooftop Units, Energy Recovery Ventilators
 - 2. Boiler and Accessories
 - 3. Hangers and Attachments
 - 4. Mechanical Identification
 - 5. Mechanical Insulation
 - 6. Ductless Cooling Units
 - 7. Piping, Valves and Accessories
 - 8. Terminal Heating Units
 - 9. Power and Gravity Ventilators
 - 10. Metal Ductwork
 - 11. Ductwork Accessories
 - 12. Air Outlets and Inlets
 - 13. Automatic Temperature Controls
 - 14. Testing, Adjusting, Balancing, and Commissioning
- D. If a Shop Drawing is not accepted after two submissions, a third submission from the same manufacturer will not be considered.
- E. Check Shop Drawings and other submittals to assure compliance with contract documents before submittal to A/E.
- F. Review of Shop Drawings is final and no further changes shall be considered without written application. Shop Drawings review does not apply to quantities, nor relieve this Contractor of his responsibility for furnishing materials or performing his work in full compliance with these Contract Drawings and Specifications. Review of these shop drawings shall not be considered a guarantee of the measurements of this building or the conditions encountered.

1.20 SUBSTITUTIONS

- A. Refer to, Section 01 33 00 – SUBMITTAL PROCEDURES for requirements in requesting substitutions. The following paragraphs supplement the requirements of Section 01 33 00.
- B. If materials or equipment are substituted for specified items that alter the systems shown or its physical characteristics, or which have different operating characteristics, clearly note the alterations or difference and call it to the attention of the a/e. Under no circumstances shall substitutions be made unless material or equipment has been successfully operated for at least three consecutive years.
- C. Any modifications to the design, as a result of approving a substitution, shall be the responsibility of this contractor. Any additional cost to this contractor or any other contractor, directly or indirectly, as a result of such substitutions, shall be the responsibility of this contractor.

1.21 PRODUCT LISTING

- A. Prepare listing of major mechanical equipment and materials for the project.

- B. Provide all necessary information.
- C. Submit to the A/E through the General Contractor, within twenty (20) days of signing contract, this listing indicating all equipment and manufacturers, as a part of the submittal requirement. If the product list is not submitted, it will be the responsibility of the sub-contractor to submit one (1) of the three (3) named equal manufacturers.
- D. When two or more items of same material or equipment are required they shall be of the same manufacturer. Product manufacturer uniformity does not apply to raw materials, bulk materials, pipe, tube, fittings (except flanged and grooved types), sheet metal, wire, steel bar stock, welding rods, solder, fasteners, motors for dissimilar equipment units, and similar items used in work, except as otherwise indicated.
- E. Provide products, which are compatible within systems and other connected items.

1.22 NAMEPLATE DATA

- A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, mode, number, serial number, capacity, operating, and power characteristics labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

1.23 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section General Conditions for delivery, storage, and handling of equipment. The following paragraphs supplement the requirements of Section General Conditions.
- B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- D. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

1.24 RECORD DOCUMENTS

- A. Refer to 01 78 00, the general conditions, and the supplementary conditions for requirements for record documents. The following paragraphs supplement the above.
- B. Mark Drawings to indicate revisions to piping and ductwork, size and location both exterior and interior; including locations of coils, dampers and other control devices, filters, boxes, and similar units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; concealed equipment, dimensioned to column line; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located.

1.25 COORDINATION DRAWINGS

- A. Refer to Division 01 before materials are purchased or work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces.

- B. The General Contractor shall be responsible for the coordination of all mechanical and electrical work. Before materials are fabricated or work begun, he shall submit to the Architect complete Coordination Drawings in the form of reproducible (vellum) transparencies at not less than 1/4 inch scale. Congested areas and sections through shafts shall be prepared at not less than 3/8 inch scale, such areas being as determined by the Architect. The General Contractor may request electronic files, from the Architect, to generate the indication of the building shell background for the Coordination Drawings.
- C. Coordination Drawings shall indicate the necessary offsets for all ductwork, piping, conduit, and other items to clear the work of all other trades and to maintain the required ceiling height and partition layout. Each subcontractor shall indicate both top and bottom elevations of their equipment taking into account hangers, flanges, and other accessories.
- D. Prepare Coordination Drawings as follows:
 - 1. The General Contractor shall require the HVAC Subcontractor to prepare original Drawings showing all his/her equipment, ducts, and piping on these transparencies.
 - 2. The General Contractor shall have trade contractor coordination drawings made therefrom.
 - 3. The General Contractor shall then require the PLUMBING Subcontractor to indicate all Plumbing piping and heating lines.
 - 4. The General Contractor shall then require the FIRE PROTECTION Subcontractor to indicate all his/her equipment and piping on these transparencies.
 - 5. The General Contractor shall then require the ELECTRICAL Subcontractor to indicate all his/her equipment and conduit lines on these transparencies.
 - 6. The General Contractor shall resolve conflicts and then submit these transparencies to the Architect for review.
- E. Coordination Drawings shall bear the signature of all Subcontractors involved indicating that all space conditions have been satisfactorily resolved. In addition, the Drawings shall bear the Contractor's stamp bearing the notation "Drawings Have Been Checked and Coordinated with All Trades". Drawings without these notations will not be accepted by the Architect.
- F. If any space conflicts cannot be resolved by the Contractor, he shall immediately notify the Architect and request disposition of the conflict.
- G. Coordination Drawings are for the Contractor's and Architect's use during construction and shall not be construed as replacing any Shop, "As-Built", or Record Drawings required elsewhere in these Contract Documents.
- H. Architect's review of Coordination Drawings shall not relieve the Contractor from his overall responsibility for coordination of all work performed pursuant to the Contract or from any other requirement of the Contract.

1.26 OPERATION AND MAINTENANCE DATA

- A. Refer to Section 01 78 00 - CLOSEOUT for procedures and requirements for preparation and submittal of maintenance manuals. The following paragraphs supplement the requirements of Section 01 78 00.
- B. In addition to the information required by Section 01 78 00 for maintenance data, include the following information:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.

2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and user summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and trouble-shooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
5. Videotape all demonstrations and training sessions and provide (3) DVD copies to the Owner

1.27 ENERGY REBATE PROGRAM

- A. This project has been designed to incorporate equipment approved for energy rebate such as boilers, high efficiency motors, chillers, etc. Meet with Utility Company prior to submitting shop drawing to ascertain that submittal meets program guidelines.

1.28 WARRANTIES

- A. The contractor shall provide a two (2) year minimum warrantee on all product (unless otherwise stated in the product specification for a specific product) and labor for work under this section.
- B. Refer to Section General Conditions and Section 01 78 00 - CLOSEOUT for additional procedures and submittal requirements for warranties.

1.29 WELDING QUALIFICATIONS

- A. Piping shall be welded in accordance with qualifications procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operations qualified by another employer may be accepted as permitted by ASME B31.1. The Owner's Representative shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The welder or welding operator shall apply his assigned symbol near each weld he makes as a permanent record. Structural members shall be welded in accordance with Division 1.
- B. When open-flame or spark producing tools such as welding equipment, and the like are required in the process of executing the work, the General Contractor shall be notified not less than twenty four hours in advance of the time that the work is to begin and the location where work is to be performed. Provide fire protective covering and maintain constant fire watch/fire detail (by the Local Fire Department) where work is being performed and until it is completed. This Contractor shall be responsible for obtaining required permit and paying all permit fees and fire watch detail expenses.

1.30 COMMISSIONING

- A. Where indicated in the equipment or commissioning specifications, engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 01 910 13 – Commissioning Requirements.
- B. Complete installation and startup checks and functional tests according to Section 01 91 13 – Commissioning Requirements and manufacturers written instructions.
- C. Operational Test: After electrical system has been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the startup procedure.

- D. Verify that equipment is installed and commissioned as per requirements of section 01 91 13 and manufacturers written instructions/requirements.

1.31 ALTERNATES

- A. Refer to Section 012300 for Alternates affecting this section.
- B. Include in your bid a separate price for amounts to be added or deducted from base bid amount for the following areas of HVAC work:
1. None.

1.32 TRADE RESPONSIBILITY FOR INTERCONNECTIONS MATRIX

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring	Notes
Smoke Detectors (Area type)	26 00 00	26 00 00	26 00 00	230000 (ATC)	26 00 00	
Smoke Detectors (Duct mounted)	26 00 00	23 00 00	26 00 00	230000 (ATC)	26 00 00	
Smoke & Fire/Smoke Dampers	23 00 00	23 00 00	N/A	N/A	N/A	
Smoke & Fire/Smoke Damper Actuators	23 00 00	23 00 00	26 00 00 & 230000 (ATC)	230000 (ATC)	26 00 00	2
Fire Dampers	23 00 00	23 00 00	N/A	N/A	N/A	
VAV Boxes	23 00 00	23 00 00	26 00 00	230000 (ATC)	N/A	2
VAV Box Damper Actuator	230000 (ATC)	Box Mfr	230000 (ATC)	230000 (ATC)	N/A	2
VAV Box DDC Controller	230000 (ATC)	Box Mfr	230000 (ATC)	230000 (ATC)	N/A	2
Hydronic Control Valves	230000 (ATC)	23 00 00	N/A	230000 (ATC)	N/A	1
Hydronic Control Valve Actuator	230000 (ATC)	23 09 23	230000 (ATC)	230000 (ATC)	N/A	1
Sheet Metal Damper	23 00 00	23 00 00	N/A	N/A	N/A	1
Sheet Metal Damper Actuators	230000 (ATC)	23 09 23	230000 (ATC)	230000 (ATC)	N/A	1
Outdoor Airflow Measuring Stations	230000 (ATC)	230000 (ATC)	N/A	230000 (ATC)	N/A	
DDC Panels	230000 (ATC)	230000 (ATC)	26 00 00 & 230000 (ATC)	230000 (ATC)	N/A	4

VFDs at RTU	230000 (RTU Mfgr)	230000 (RTU Mfgr)	26 00 00	230000 (ATC/RTU Mfgr)	N/A	
Elevator Hoistway Vent Damper	23 00 00	23 00 00	N/A	N/A	N/A	
Elevator Hoistway Vent Damper Actuator	230000 (ATC)	230000 (ATC)	230000 (ATC)	230000 (ATC)	26 00 00	
Air Handling Units/Domestic Water Heater Air intake and Exhaust Breeching	22 00 00	22 00 00	N/A	N/A	N/A	
Generator Exhaust Breeching	22 00 00 (if gas fired) 23 00 00 (if diesel fired)	22 00 00 (if gas fired) 23 00 00 (if diesel fired)	26 00 00	26 00 00	26 00 00	
Kitchen Emergency Gas Valve	22 00 00	22 00 00	26 00 00	26 00 00	26 00 00	

Notes:

1. Division 23 00 00 and Division 230000 (ATC) Contractors shall fully coordinate all airflow damper and hydronic valves sizes and quantities.
2. Smoke Damper and VAV Box power wiring shall be provided by Division 26 00 00 to junction box locations shown on electrical drawings; Division 230000 (ATC) Contractor shall provide final power wiring from junction box to end device location.
3. Division 26 00 00 Contractor shall provide all line-voltage power wiring required for meters; Division 23 00 00 (ATC) Contractor shall provide all low-voltage power wiring required for meters.
4. Division 26 00 00 shall provide power at main DDC Panel. Division 230000 (ATC) shall provide power to all other DDC Panels.

PART 2 PRODUCTS

2.1 ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT (Refer to Section 019113 – Commissioning Requirements for additional contract requirements)

- A. Pursuant to Massachusetts General Laws Chapter 141, a Massachusetts Licensed electrician shall install all low and line voltage wiring required by this section.
- B. General: The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

1. All motors for all mechanical equipment shall be premium efficiency matching the following:

	HP	RPM	Efficiency
a.	1	1800	85.5%
b.	1.5	1800	86.5%
c.	2	1800	86.5%
d.	3	1800	89.5%
e.	5	1800	89.5%
f.	7.5	1800	91.0%

g.	10	1800	91.7%
h.	15	1800	93.0%
i.	20	1800	93.0%
j.	25	1800	93.6%
k.	30	1800	94.1%
l.	40	1800	94.1%
m.	50	1800	94.5%

2. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
3. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
4. 2-speed motors shall have 2 separate windings on poly-phase motors.
5. Temperature Rating: Rated for 40 deg. C. environment with maximum 50 deg. C temperature rise for continuous duty at full load (Class A Insulation).
6. Starting Capability: Frequency of starts as indicated by automatic control system and not less than 5 evenly time spaced starts per hour for manually controlled motors.
7. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
8. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
9. Frames: NEMA Standard No. 48 or 54; use driven equipment manufacturer's standards to suit specific application.
10. Bearings:
 - a. Ball or roller bearings with inner and outer shaft seals.
 - b. Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
 - c. Designed to resist thrust loading where belt drivers or other drives produce lateral or axial thrust in motor.
 - d. For fractional horsepower, light duty motors, sleeve type bearings are permitted.
11. Enclosure Type:
 - a. Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
 - b. Guarded drip-proof motors where exposed to contact by employees or building occupants.
 - c. Weather protected Type I for outdoor use, Type II where not housed.
12. Overload Protection: Built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
13. Noise Rating: "Quiet".
14. Efficiency: "Energy Efficient" motors shall have a minimum efficiency as scheduled in accordance with IEEE Standard 112, test method B. If efficiency not specified, motors shall have a higher efficiency than "average standard industry motors", in accordance with IEEE Standard 112, Test Method B.
15. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

- C. Starters, Electrical Devices, and Wiring: (Provided by the HVAC Contractor for Each Packaged Piece of HVAC Equipment Requiring Such):
1. Motor Starter Characteristics:
 - a. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R with conduit hubs, or units in hazardous locations which shall have NEC proper class and division.
 - b. Type and size of starter shall be as recommended by motor manufacturer and the driven equipment manufacturer for applicable protection and start-up condition.
 2. Manual Switches shall have:
 - a. Pilot lights and extra position for multi-speed motors.
 - b. Overload Protection: Melting alloy type thermal overload relays.
 3. Magnetic Starters:
 - a. Maintained contact push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
 - b. Trip-free thermal overload relays, each phase.
 - c. Interlocks, switches and similar devices as required for co-ordination with control requirements of Division 23 Controls Sections.
 - d. Built-in 120 volts control circuit transformer, fused from line side, where service exceeds 240 volts.
 - e. Externally operated manual reset.
 - f. Under-voltage release or protection.
 4. Capacitors:
 - a. Individual unit cells.
 - b. All welded steel housing.
 - c. Each capacitor internally fused.
 - d. Non-flammable synthetic liquid impregnant.
 - e. Craft tissue insulation.
 - f. Aluminum foil electrodes.
 - g. KVAR size shall be as required to correct motor power factor to 90% or better and shall be installed on all motors 1 horsepower and larger, that have an uncorrected power factor of less than 85% at rated load.
 5. Disconnect Switches (Those specified under this Section):
 - a. Fusible Switches: Fused, each phase; general duty; horsepower rated; non-teasible quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "OPEN" position; arc quenchers; capacity and characteristics as indicated.
 - b. Non-fusible Switches: For equipment 2 horsepower and smaller, shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment larger than 2 horsepower, switches shall be the same as fusible type.

2.2 HANGERS & ATTACHMENTS

A. Horizontal-Piping Hangers and Supports:

1. General: Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacture for each piping service. Select size of hangers and supports to exactly fit pip size for bare piping, and to insulated piping. Provide copper-plated hangers and supports for copper-piping systems.
 - a. Adjustable Steel Clevises Hangers: MSS Type 1.
 - b. Steel Pipe Clamps: MSS Type 4.
 - c. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:
 1. Plate: Unguided type.
 2. Plate: Guided type.
 3. Plate: Hold-down clamp type.
 - d. Pipe Saddle Supports: MSS Type 36, including steel pipe base-support and cast-iron floor flange.
 - e. Pipe Stanchion Saddles: MSS Tube 37, including steel pip base support and cast-iron floor flange.
 - f. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange.
 - g. Single Pipe Rolls: MSS Type 41.
 - h. Adjustable Roller Hangers: MSS Type 43.
 - i. Pipe Roll Stands: MSS Type 44.
 - j. Pipe Rolls and Plates: MSS Type 45.
 - k. Adjustable Pipe Roll Stands: MSS Type 46.
2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
 - a. Carpenter and Patterson, Inc.
 - b. Corner & Lada Co., Inc.
 - c. Elcen Metal Products Co.
 - d. Fee & Mason Mfg. Co.; Div. Figgie International
 - e. ITT Grinnel Corp.
 - f. Or equal.

B. Vertical-Piping Clamps:

1. General: Except as otherwise indicated, provide factory-fabricated vertical-piping clamps, complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide copper-plated clamps for copper-piping systems.
 - a. Two-Bolt Riser Clamps: MSS Type 8.
 - b. Four-Bolt Riser Clamps: MSS Type 42.

2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
 - a. Carpenter and Patterson, Inc.
 - b. Corner & Lada Co., Inc.
 - c. Elcen Metal Products Co.
 - d. Fee & Mason Mfg. Co.; Div. Figgie International
 - e. ITT Grinnel Corp.
 - f. Or equal.

C. Hanger-Rod Attachments:

1. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-pipe hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods. Provide copper-plated hanger-rod attachments for copper-piping systems.
 - a. Steel Turnbuckles: MSS Type 13.
 - b. Swivel Turnbuckles: MSS Type 15.
 - c. Malleable Iron Sockets: MSS Type 16.
2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
 - a. Carpenter and Patterson, Inc.
 - b. Corner & Lada Co., Inc.
 - c. Elcen Metal Products Co.
 - d. Fee & Mason Mfg. Co.; Div. Figgie International
 - e. ITT Grinnel Corp.
 - f. Or equal.

D. Building Attachments:

1. General: Except as otherwise indicate, provide factory-fabricated building attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of building attachments to suit hanger rods. Provide copper-plated building attachments for copper-piping systems.
 - a. Concrete Inserts: MSS Type 18.
 - b. Top Beam C-Clamp: MSS Type 19.
 - c. Side Beam or Channel Clamps: MSS Type 20.
 - d. Center Beam Clamps: MSS Type 21.
 - e. Welded Beam Attachments: MSS Type 22.
 - f. C-Clamps: MSS Type 23.
 - g. Top Beam Clamps: MSS Type 25.
 - h. Side Beam Clamps: MSS Type 27.
 - i. Steel Beam Clamps W/Eye Nut: MSS Type 28.
 - j. Linked Steel Clamps W/Eye Nut: MSS Type 29.

- k. Malleable Beam Clamps: MSS Type 30.
 - l. Steel Brackets: One of the following for indicated loading:
 - 1. Light Duty: MSS Type 31.
 - 2. Medium Duty: MSS Type 32.
 - 3. Heavy Duty: MSS Type 33.
 - m. Side Beam Brackets: MSS Type 34.
 - n. Plate Lugs: MSS Type 57.
 - o. Horizontal Travelers: MSS Type 58.
 - 2. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:
 - a. Carpenter and Patterson, Inc.
 - b. Corner & Lada Co., Inc.
 - c. Elcen Metal Products Co.
 - d. Fee & Mason Mfg. Co.; Div. Figgie International
 - e. ITT Grinnel Corp.
 - f. Or equal.
- E. Saddles and Shields:
- 1. General: Except as otherwise indicated, provide saddles or shields under piping hangers and supports, factory-fabricated, for all insulated piping. Size saddles and shields for exact fit to mate with pipe insulation.
 - 2. Protection Saddles: MSS Type 39; fill interior voids with segments of insulation matching adjoining insulation.
 - 3. Protection Shields: MSS Type 40; of length recommended by manufacturer to prevent crushing of insulation.
 - 4. Manufacturer: Subject to compliance with requirements, provide thermal hanger shields of one of the following:
 - a. Elcen Metal Products Co.
 - b. Pipe Shields, Inc.
 - c. Carpenter Patterson, Inc.
 - d. ITT Grinnel Corp.
 - e. Or equal.
- F. Miscellaneous Materials:
- 1. Metal Framing: Provide products complying with NEMA STD ML 1.
 - 2. Steel Plates, Shapes, and Bars: Provide products complying with ASTM A 36.
 - 3. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix at a ratio of 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.
 - 4. Heavy Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.
 - 5. Pipe Guides: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of bolted two-section outer cylinder and base with two-section guiding spider bolted tight to pipe. Size guide and spiders to clear pipe and insulation (if any), and cylinder. Provide guides of length recommended by manufacturer to allow indicated travel.

2.3 MECHANICAL IDENTIFICATION (Refer to Section 019113 – Commissioning Requirements for additional contract requirements)

A. Plastic Pipe Markers:

1. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid snap-on, color-coded pipe markers, complying with ANSI A13.1
2. Pressure-Sensitive Type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1
3. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F (52°C) or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
4. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:
 - a. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
 - b. Adhesive lap joint in pipe marker overlap.
 - c. Laminated or bonded application of pipe marker to pipe (or insulation).
 - d. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4" wide; full circle at both ends of pipe marker, tape lapped 1-1/2".

B. Plastic Equipment Markers:

1. General: Provide manufacturer's standard laminated plastic, color-coded equipment markers. Conform to the following color code:
 - a. Green: Cooling equipment and components.
 - b. Yellow: Heating equipment and components.
 - c. Yellow/Green: Combination cooling and heating equipment and components.
 - d. Blue: Equipment and components that do not meet any of the above criteria.
2. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
 - a. Name and plan number.
 - b. Equipment service.
 - c. Design capacity.
 1. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.
3. Size: Provide approximate 2-1/2" x 6" markers for each piece of equipment.
4. Application: Provide equipment labels for the following equipment:
 - a. Rooftop Units
 - b. Exhaust Fans
 - c. Ductless Cooling Units
 - d. Boilers
 - e. Pumps

2.4 MECHANICAL INSULATION

A. Piping Insulation Materials:

1. Fiberglass Piping Insulation: ASTM C 547, Class 45 required.
 - a. Class 1 for use to 450 degrees F; Class 2 for use to 650 degrees F; Class 3 for use to 1200 degrees F.
2. Flexible Unicellular Piping Insulation: ASTM C 534, Type as required.
 - a. Type I - tubular; Type II - sheet. For use between -40 degrees F and 200 degrees F.
3. Jackets for piping Insulation: ASTM C 921, with vapor barrier for piping with temperatures below ambient.
4. Encase pipe fittings insulation with one-piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.
5. Encase straight pipe insulation, where exposed in occupied areas, with one piece 20-mil thick PVC Jacketing. Fasten and seal as per manufacturer's recommendations.
6. Encase exterior piping insulation with aluminum jacket with weather-proof construction.
7. Staples, Bands, Wires and Cement: As recommended by insulation manufacturer for applications indicated.
8. Adhesives, Sealants and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

B. Piping Insulation Application and Thickness:

1. Application: Cold Piping (40 Degrees F to Ambient):
 - a. Insulate the following cold HVAC piping systems:
 1. Air conditioner condensate drain piping.
 2. Refrigerant liquid and suction piping.
 - b. Insulate each piping system specified above with the following type and thicknesses of insulation:
 1. Fiberglass: 1" thick.
2. Application: Hot Water Piping (to 200 Degrees F)
 - a. Insulate the following hot HVAC piping systems:
 1. HVAC hot water supply and return piping.
 - b. Insulate each piping system specified above with the following type and thicknesses of insulation:
 1. Fiberglass: 1-1/2" thick for all pipe sizes up to and including 1 1/4" and 2" thick for all 1 1/2" pipe and larger.
 2. 1- 1/2" and 2" thick up to and including all 2" pipe and large.
 3. Flexible Unicellular: (Refrigerant piping only max. 1 1/2" pipe size) 1" thick.

C. Ductwork Insulation Materials:

1. Rigid Fiberglass Ductwork Insulation: ASTM C 612, Class as required.
CLASS 2 - 400 DEGREES F; 4 LBS./FT3.
CLASS 3 - 850 DEGREES F; 12 LBS./FT3.
CLASS 4 - 1000 DEGREES F; 12 LBS./FT3.
CLASS 5 - 1800 DEGREES F; 20 LBS./FT3.

2. Flexible Fiberglass Ductwork Insulation: ASTM C 512, Class as required.
CLASS 2 - 400 DEGREES F; .75 LBS./FT3.
CLASS 3 - 850 DEGREES F; 1.5 LBS./FT3.
3. Jackets for Ductwork Insulation: ASTM C 921, with vapor barrier.
4. Ductwork Insulation Accessories: Provide staples, bands, wire, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated.
5. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

D. Ductwork Insulation Application and Thickness:

1. Application: Ventilation and AC System Ductwork:
 - a. Insulate the following ductwork:
 1. Outdoor air intake ductwork between air entrance and air handling unit inlet.
 2. HVAC supply ductwork between HVAC unit discharge and room terminal outlet.
 3. Insulate neck and bells of supply diffusers.
 4. HVAC return ductwork between room terminal inlet and HVAC unit inlet; except omit insulation on return ductwork located in return air ceiling plenums.
 5. HVAC plenums and unit housing not pre-insulated at factory or lined.
 6. Exhaust ductwork between in-line exhaust fan and point of exit in building.
 - b. Insulate each ductwork system specified above with the following type and thicknesses of insulation:
 1. Rigid Fiberglass: In machine rooms, fan rooms, and mechanical spaces insulate all supply air, return air and outside air ductwork with 2" thick rigid. All exposed outdoor ductwork in occupied areas shall be insulated internally with same thickness and material.
2. Flexible Fiberglass: 2 in. thick, minimum R-8 application limited to concealed locations which shall include above ceilings, in chases, shafts etc.
3. All outside air ductwork shall be 2" rigid.

2.5 HYDRONIC PIPING AND ACCESSORIES

- A. Manufacturer: Subject to compliance with requirements, provide piping system products from one of the following:
 1. Grooved Mechanical Joint Pipe, Fittings and Couplings:
 - a. Victaulic Company of America.
 - b. Or equal.
 2. Pump Discharge Valves (Triple-Duty Valve):
 - a. Bell & Gossett ITT; Fluid Handling Div.
 - b. Amtrol, Inc.
 - c. Armstrong Pumps, Inc.
 - d. Taco, Inc.
 - e. Or equal.
 3. Safety Relief Valves:
 - a. Bell & Gossett ITT; Fluid Handling Div.

- b. Amtrol, Inc.
- c. Spirax Sarco.
- d. Watts Regulator Co.
- e. Or equal.
- 4. Pressure Reducing Valves:
 - a. Bell & Gossett ITT; Fluid Handling Div.
 - b. Amtrol, Inc.
 - c. Armstrong Pumps, Inc.
 - d. Taco, Inc.
 - e. Or equal.
- 5. Air Vents (Automatic):
 - a. Bell & Gossett ITT; Fluid Handling Div.
 - b. Armstrong Machine Works.
 - c. Hoffman Specialty ITT; Fluid Handling Div.
 - d. Spirax Sarco.
 - e. Or equal.
- 6. Air Separators:
 - a. Bell & Gossett ITT; Fluid Handling Div.
 - b. Amtrol, Inc.
 - c. Armstrong Pumps, Inc.
 - d. Taco, Inc.
 - e. Or equal.
- 7. Diaphragm-Type Compression Tanks:
 - a. Bell & Gossett ITT; Fluid Handling Div.
 - b. Amtrol, Inc.
 - c. Armstrong Pumps, Inc.
 - d. Or equal.
- 8. Pump Suction Diffusers:
 - a. Bell & Gossett ITT; Fluid Handling Div.
 - b. Amtrol, Inc.
 - c. Armstrong Pumps, Inc.
 - d. Taco, Inc.
 - e. Victaulic (style 731)
 - f. Or equal.
- 9. Chemical Feeder:
 - a. Dearborn USA.
 - b. Vulcan Laboratories, Subsidiary of Clow Corp.
 - c. York-Shipley, Inc.
 - d. Or equal.
- 10. Basket Strainers:
 - a. Crane Co.
 - b. Metraflex Co.

- c. Spirax Sarco.
- d. Victaulic Company of America.
- e. Or equal.

B. PIPE AND TUBING MATERIALS

- 1. Copper Tubing: ASTM grade B 88, Type L hard drawn temper copper tubing.
- 2. Copper Tubing: ASMT grade B 88, Type K, annealed copper tubing.
- 3. Steel Pipe: ASTM A-53 grade B, Schedule 40, seamless, black steel pipe, beveled ends.
- 4. CPVC Plastic Pipe: ASTM D 2846, Chlorinated Poly (Vinyl Chloride) (CPVC) pipe.

C. FITTINGS

- 1. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B2.1.
- 2. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B2.1.
- 3. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.
- 4. Grooved Mechanical Fittings: ASTM A 106, steel fittings with grooves or shoulders designed to accept grooved end couplings.
- 5. Grooved Mechanical Couplings (Zero Flex Only): Consist of ductile or malleable iron housing, a synthetic rubber gasket of a central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- 6. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.
- 7. CPVC Plastic Fittings: ASTM D 2846, Chlorinated Poly Vinyl Chloride (CPVC) socket-type fittings and solvent for solvent cemented joints.
- 8. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125; raised ground face, bolt holes spot faced.
- 9. Cast Bronze Flanges: ANSI B16.24, Class 150; raised ground face, bolt holes spot faced.
- 10. Steel Flanges and Flanged Fittings: ANSI B16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:
 - a. Material Group: 1.1.
 - b. End Connections: Butt Welding.
 - c. Facings: Raised face.
- 11. Solder Filler Metals: ASTM B 32, 50-50, Tin-Lead, for condenser water, chilled water, and make-up water and drain piping.
- 12. Solder Filler Metals: ASTM B 32, 95-5 Tin-Antimony, for heating hot water and low pressure steam piping.
- 13. Brazing Filler Metals: AWS A5.8.

WARNING: Some filler metal contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

- 14. Gasket Material: Thickness, material, and type suitable for fluid to be handled, and design temperatures and pressures.
- 15. Flexible Connectors: Stainless steel bellows with woven flexible bronze wire reinforcing protective jacket; minimum 150 psig working pressure, maximum 250° F. operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected; and shall be capable of 3/4" misalignment.

D. PIPE SLEEVES AND ESCUTCHEONS

1. General: Provide schedule 40 black steel or 18 gage galvanized pipe sleeve large enough to accept pipe along with specified pipe insulation at each point where pipe penetrates a wall or floor. Sleeve shall be large enough to allow for free movement of pipe however minimized to prevent leakage of smoke and fire during a fire emergency. For all piping exposed to view provide a chrome plated escutcheon that will surround insulation where applicable on pipe for a neat finished appearance. Where piping is concealed above ceilings no escutcheons are required.

E. SPECIAL DUTY VALVES

1. General: General duty valves (i.e., gate, check, ball, and butterfly valves) are specified in Division 23 Section "Valves" Special duty valves are specified in this Article by their generic name; refer to the drawings for specific applications of these valves.
2. Pump Discharge Valves (Triple-Duty Valve): 175 PSIG working pressure, 300°F. maximum operating temperature, cast-iron body, bronze disc and seat, stainless steel stem and spring, and "Teflon" packing. Valves shall have flanged connections and straight or angle pattern as indicated. Features shall include non-slam check valve with spring-loaded weighted disc, and calibrated adjustment feature to permit regulation of pump discharge flow and shutoff.
3. Pressure Reducing Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory-set at operating pressure and have the capability for field adjustment.
4. Safety Relief Valves: 125 psig working pressure and 250° F. maximum operating temperature: designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber. Select valve to suit actual system pressure and BTU capacity.

F. HYDRONIC SPECIALTIES:

1. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150 psig working pressure, 240° F. operating temperature; and having 1/4" discharge connection and 1/2" inlet connection.
2. Diaphragm-Type Compression Tanks: Size and number as indicated; construct of welded carbon steel for 125 psig working pressure, 375° F. maximum operating temperature. Separate air charge from flexible diaphragm securely sealed into tank. Provide taps for pressure gage and air charging fitting, and drain fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Tank, with taps and supports, shall be constructed, tested, and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 01.
3. Pump Suction Diffusers: Cast-iron body, with threaded connections for 2" and smaller, flanged connections for 2-1/2" and larger; 175 psig working pressure, 300° F. maximum operating temperature; and complete with the following features:
 - a. Inlet vanes with length 2-1/2 times pump suction diameter or greater.
 - b. Cylinder strainer with 3/16" diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.
 - c. Disposable fine mesh strainer to fit over cylinder strainer.
 - d. Permanent magnet, located in flow stream, removable for cleaning.
 - e. Adjustable foot support, designed to carry weight of suction piping.

- f. Blowdown tapping in bottom; gage tapping in side.
- 4. Chemical Feeder: (Provide one (1) for each piping system). Bypass type chemical feeders of 5 gallon capacity, welded steel construction; 125 psig working pressure; complete with fill funnel and inlet, outlet, and drain valves.
- 5. Chemical Treatment
 - a. Furnish the necessary apparatus to provide water treatment to the hot water system and the boilers as furnished by New England Systems and Supply, Inc., GE Betz Water Technologies, or other fully capable water treatment organization approved by the Engineer.
 - b. A contract agreement satisfactory in form and substance shall be executed between this subcontractor and water treatment company to furnish supervisory service to assure the use of the proper chemical treatment thereof. The water treatment company shall perform the following specified services through its agent:
 - 1. Supervise the cleaning and flushing of all systems and the initial introduction of water treatment chemicals.
 - 2. Furnish all required chemicals for the cleaning and proper initial treatment of all systems hereinafter described, together with all necessary testing equipment and reagents for field analysis of the water.
 - 3. Submit a written report of test results of the field analyses to the Engineer when the systems are cleaned and treated with corrosion inhibitors. Submit certificate of completion for all systems indicating that all treatment systems are properly functioning and that the associated systems are properly treated.
 - c. The hot water systems shall be cleaned with sufficient chemicals to ensure the removal of all cutting oil, compound, etc. These chemicals shall not be harmful to the various materials of the systems. The treatment company representative shall supervise this operation including the flushing of the system and shall test the final rinsed system to ensure that the remnants of the cleaning solution do not impart alkalinity to the water in excess of 300 PPM.
 - d. Hot water systems shall be treated with sufficient amounts of the proper chemicals to conform to the Dianodic method for corrosion protection. Take various samples of water to assure proper level of chemical treatment.
 - e. Each boiler shall be treated with sufficient amounts of the proper chemicals to provide positive protection against corrosion, scale formation and carry over.
 - f. At the end of the first year of the contract agreement, the chemical treatment company shall provide to the owner and copy to Architect, a log of type, quantity and dosage of treatment and test results of treatment performed through the first year.
 - g. Following the first year of service, chemical treatment company shall provide recommended maintenance and treatment schedule to owner and a copy to architect for testing and treating the water. This schedule shall be posted in the boiler room along with the testing and treatment log.
 - h. Upon completion of first year of service, the chemical treatment company shall instruct the owner to the owner's responsibility to test and treat water or to contract with chemical treatment company to perform testing and treatment services.
- 6. Y-Pattern Strainers: Cast-iron body (ASTM A 126, Class B), flanged ends for 2-1/2" and larger, threaded connections for 2" and smaller, bolted cover, perforated Type 304 stainless steel basket, bottom drain connections; 125 psig working pressure.

7. Basket Strainers: High tensile cast-iron body (ASTM A 126, Class B), flanged end connections, bolted cover, perforated Type 304 stainless steel basket, bottom drain connections; 125 psig working pressure.
8. Glycol/Make-up Pump – Provide a glycol fill pump with a capacity of 1.5 gpm @ 100 psi discharge. Pump shall be a bronze gear driven design and shall have a standard 120 volt power electrical cord.

2.6 REFRIGERANT PIPING

- A. General: Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide materials and products complying with ANSI B31.5 Code for refrigeration piping where applicable, base pressure rating on refrigerant piping system maximum design pressures. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in refrigerant piping systems. Where more than one type of materials and products are indicated, selection is Installer's option.
- B. Material: Provide pipes and pipe fittings in accordance with the following listing:
 1. Tube Size 4-1/8" and Smaller: Copper tube; Type ACR, hard-drawn temper; wrought-copper, solder-joint fittings; brazed joints.
- C. Soldered Joints: Solder joints using silver-lead solder, ASTM B32, Grade 96 TS.
- D. Brazed Joints: Braze joints using American Welding Society (AWS) classification BCUO-4 for brazing filler metal.
- E. Piping Specialties: Provide piping specialties complying with Division-23 "Hydronic Piping" in accordance with the following listing:
 1. Pipe escutcheons.
 2. Drip pans.
 3. Sleeves.
 4. Sleeve seals.
- F. Refrigerant Valves: Special valves required for refrigerant piping include the following types.
 1. Globe Shutoff Valves: Forged brass, packed, back seating, winged seal cap, 300 degrees F (149 degrees C) temperature rating, 500 psi working pressure.
 2. Check Valves: Forged brass, accessible internal parts, soft synthetic seat, fully guided piston and stainless steel spring, 250 degrees F (121 degrees C) temperature rating, 500 psi working pressure.
 3. Manufacturer: Subject to compliance with requirements, provide globe and check valves of one of the following:
 - a. Henry Valve CO.
 - b. Parker Hannifin Corp.; Refrigeration & Air Cond. Div.
 - c. Sporlan Valve Co.
 - d. Or equal.
 4. 2-Way Solenoid Valves: Forged brass, designed to conform to ARI 760, normally closed, Teflon valve seat, NEMA 1 solenoid enclosure, 24 volt, 60 Hz., UL-listed, ½" conduit adapter, 250 degrees F (121 degrees C) temperature rating, 400 psi working pressure.

5. Manufacturer: Subject to compliance with requirements, provide solenoid valves of one of the following:
 - a. Alco Controls Div.; Emerson Electric Co.
 - b. Automatic Switch Co.
 - c. Sporland Valve Co.
 - d. Or equal.
 6. Refrigerant Strainers: Brass shell and end connections, brazed joints, monel screen, 100 mesh, UL-listed, 350 psi working pressure.
 7. Moisture-Liquid Indicators: Forged brass, single port, removable cap, polished optical glass, solder connections, UL-listed, 200 degrees F (93 degrees C) temperature rating, 500 psi working pressure.
 8. Refrigerant Filter-Driers: Steel shell, ceramic fired desiccant core, solder connections, UL-listed, 500 psi working pressure.
 9. Refrigerant Filter-Driers: Corrosion-resistant steel shell, steel flange ring and spring, wrought copper fittings, ductile iron coverplate with steel cap screws, replaceable filter-drier core, 500 psi working pressure.
 10. Evaporator Pressure Regulators: Provide corrosion-resistant, spring loaded, stainless steel springs, pressure operated, evaporator pressure regulator, in size and working pressure indicated, with copper connections.
 11. Refrigerant Discharge Line Mufflers: Provide discharge line mufflers as recommended by equipment manufacturer for use in service indicated, UL-listed.
 12. Manufacturer: Subject to compliance with requirements, provide refrigeration accessories of one of the following:
 - a. Alco Controls Div.; Emerson Electric CO.
 - b. Henry Valve CO.
 - c. Parker-Hannifin Corp.; Refrigeration & Air Conditioning Div.
 - d. Sporlan Valve Co.
 - e. Or equal.
- G. Basic Vibration Control: Provide vibration control products as required in accordance with the following listing:
1. Isolation hangers.
 2. Riser isolators.
 3. Riser support isolators.
 4. Flexible pipe connectors.
- 2.7 DUCTLESS COOLING UNITS (Refer to Section 019113 – Commissioning Requirements for additional contract requirements)
- A. The basis of design Heat Recovery Variable Refrigerant Flow system is a three pipe system consisting of a single or multiple outdoor units, multiple indoor units of various types and capacities, and multiple Flow Selector boxes, individual or central indoor unit controls with on/off temperature settings, all connected by fully insulated refrigerant lines utilizing factory supplied, fully insulated, branching kits. Indoor units are connected to condensate piping that shall be terminated to the nearest drain point.
 - B. The system shall be fully capable of simultaneous heating and cooling operation as requested by the individual indoor zones that can consist of single or multiple indoor units. Refer to scheduled performance data for additional information.

C. Evaporator:

1. General: The unit shall be factory assembled, wired and tested. Contained within the unit shall be all factory wiring and internal piping, control circuit board, and fan motor. The unit in conjunction with the wired, wall mounted controller shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be purged with dry nitrogen before shipment from factory.

D. Cabinet: The casing shall be ABS plastic factory finish. Cabinet shall be designed for suspension mounting and horizontal operation. The rear cabinet panel shall have provisions for a field installed filtered outside air intake connection.

E. Fan: The evaporator fan shall have three high performance, double inlet, forward curve fans driven by a single motor. The fans shall be statically and dynamically balanced and run on a motor with permanently lubricated bearings. The indoor fan shall consist of three (3) speeds: low, medium, and high.

F. Vane: There shall be a motorized horizontal vane to automatically direct air flow in a horizontal and downward direction for uniform air distribution. The horizontal vane shall provide a choice of five (5) vertical airflow patterns selected by remote control. There shall also be a set of vertical vanes to provide horizontal swing airflow movement selected by remote control.

G. Filter: Return air shall be filtered by means of an easily removable washable filter.

H. Coil: The evaporator coil shall be of nonferrous construction with pre-coated aluminum strake fins on copper tubing. The multi-angled heat exchanger shall have a modified fin shape that reduces air resistance for a smoother, quieter airflow. All tube joints shall be brazed with PhosCopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil.

I. Control: The control system shall consist of two (2) microprocessors, one on each indoor and outdoor unit, interconnected by a single non-polar two-wire cable. Field wiring shall run directly from the indoor unit to the wall mounted controller with no splices. For A-Control, a three (3) conductor 14 ga. AWG wire with ground shall provide power feed and bi-directional control transmission between the outdoor and indoor units. Where separate power is supplied to the indoor and outdoor units, a two (2) 20 ga. AWG wire shall be run between the units to provide forbid-directional control communication. The system shall be capable of automatic restart when power is restored after power interruption. The system shall have self-diagnostics ability, including total hours of compressor run time. Diagnostics codes for indoor and outdoor units shall be displayed on the wired controller panel.

J. Outdoor Condensing Units:

1. Stand Alone: The outdoor unit shall be equipped with a control board that interfaces with the indoor unit to perform all necessary operation functions. The outdoor unit shall be capable of operating at 0°F, (-18°C) ambient temperature with additional low ambient controls. The outdoor unit shall be able to operate with a maximum height difference of 100 feet and have maximum refrigerant tubing length of 165 feet between indoor and outdoor units without the need for line size changes, traps or additional oil. The outdoor unit shall be completely factory assembled, piped, and wired. Each unit must be test run at the factory.
2. VRF condensing units
 - a. Factory assembled, single piece, air-cooled outdoor unit. Contained within the unit enclosure shall be all factory wiring, piping, controls, and the multiple inverter driven twin rotary compressors.

- b. The maximum sound pressure rating for a single module shall not exceed 63.5dBa sound pressure in cooling and 65.5dBa in heating. For twinned systems the sound pressure numbers should not exceed 66.5 dBa and 68.5 dBa.
 - c. The outdoor unit shall include an oversized accumulator and a liquid tank for proper heating performance while allowing the indoor unit PMV valve (metering device) to shut off completely when a zone is satisfied.
 - d. The outdoor unit shall be protected by a High-pressure switch, High-pressure sensor, Low-pressure sensor, Fusible plug, PC board fuse, and an inverter overload protector.
 - e. The outdoor unit shall be capable of operating in cooling mode down to 14°F ambient air temperature and down to -4°F WB ambient air temperature in heating. For simultaneous heating and cooling the unit shall be capable of operating between 14°F and 60°F ambient air temperature.
 - f. The outdoor unit shall include a total oil management system that balances oil between compressors within a module, replenishes compressor oil to the compressors in a module from the oil separator if required, and allows to move oil and refrigerant between twinned units if required even if one of the units is not running.
- K. Cabinet: The casing shall be constructed from galvanized steel plate, coated with a finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection and have a factory finish. The fan grille shall be of ABS plastic.
- 1. Unit cabinet shall be constructed of pre-coated steel, finished on both inside and outside.
 - 2. Unit access panels shall be removable with minimal screws and shall provide full access to the compressors, fan, and control components.
 - 3. Compressors shall be isolated in a compartment and have an acoustic wrap to assure quiet operation.
 - 4. The outdoor unit control panel shall include a sliding window to access adjustable controls and an LED display for setup and diagnostics.
 - 5. Unit cabinet shall be capable of withstanding 500-hour salt spray test per Federal Test Standard No. 141 (method 6061).
- L. Fan: The fan motor shall be of aerodynamic design for quiet operation, and the fan motor bearings shall be permanently lubricated. The outdoor unit shall have horizontal discharge airflow. The fan shall be mounted in front of the coil, pulling air across it from the rear and discharging it through the front. The fan shall be provided with a raised guard to prevent contact with moving parts.
- 1. Outdoor fan shall discharge air vertically and be driven by a DC inverter variable speed motor with 64 steps that is capable of running down to 60 RPM.
 - 2. Outdoor fan motor shall be totally-enclosed with permanently-lubricated bearings.
 - 3. Motor shall be protected by internal thermal overload protection.
 - 4. Fan blade shall be non-metallic and shall be statically and dynamically balanced.
 - 5. Outdoor fan shall be protected by a raised non-metallic protective grille.
- M. Coil: The L shaped condenser coil shall be of copper tubing with flat aluminum fins to reduce debris build up. The coil shall be protected with an integral metal guard. Refrigerant flow from the condenser shall be controlled by means of linear expansion valve (LEV) metering orifice. The LEV shall be controlled by a microprocessor controlled step motor.
- 1. Coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes, which are cleaned, dehydrated, and sealed.
 - 2. The coil configuration shall be 4 sided and fully separated from the machine compartment for more effective heat transfer and sound isolation.
 - 3. The coil fins shall have a factory applied corrosion resistant blue-fin finish.

- N. Compressor: The compressor shall be a scroll compressor with variable speed inverter technology. The compressor shall be driven by inverter circuit to control compressor speed. The compressor speed shall dynamically vary to match the room load for significantly increasing the efficiency of the system which results in vast energy savings. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be intermittently applied to the compressor motor to maintain enough heat. The outdoor unit shall have an accumulator and high pressure safety switch. The compressor shall be mounted to avoid the transmission of vibration.
1. Each outdoor unit module shall be equipped with two or three inverter driven twin rotary compressors with full range control to a level of 0.1 Hz.
 2. Compressor shall be totally enclosed in the machine compartment.
 3. Compressors shall be equipped with factory mounted crankcase heaters.
 4. Internal overloads shall protect the compressor from over-temperature operation.
 5. Motor shall be suitable for operation in an R-410A refrigerant atmosphere.
 6. Compressor assembly shall be installed on rubber vibration isolators.
 7. To maximize compressor reliability, multiple compressors, within a module, shall be started and operated in variable patterns to ensure equal run time on all compressors.
 8. To ensure maximum efficiency throughout the system operation range, no compressor is required to run at maximum speed under any condition.
- O. Electrical: The electrical power of the unit shall be as indicated on the drawings. The outdoor unit shall be controlled by the microprocessor located in the indoor unit. The control signal between the indoor unit and the outdoor unit shall be pulse signal 24 volts DC. The unit shall have Pulse Amplitude Modulation circuit to utilize 98% of input power supply.
1. All sizes shall utilize 208/230-3-60 or 460-3-60 field power supply.
 2. Twinned systems shall have separate field power supply to each module.
 3. Two core shielded low voltage cable is shall be required for communication between outdoor and indoor unit.
 4. All power and control wiring must be installed per NEC and all local electrical codes.
- P. Variable Refrigerant Flow
1. System Description
 - a. The variable capacity, heating/cooling change-over system shall be a (Variable Refrigerant Flow).
 - b. Each indoor evaporative unit shall be provided with service isolation valves.
 - c. The system shall consist of a outdoor unit, Controller, multiple indoor units (-E models), and DDC (Direct Digital Controls). Each indoor unit or group of indoor units shall be capable of operating in any mode independently of other indoor units or groups. System shall be capable of changing mode (cooling to heating, heating to cooling) with no interruption to system operation. The sum of connected capacity of all indoor air handlers shall range from 80% to 125% of outdoor rated capacity.
 2. Quality Assurance
 - a. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
 - b. All wiring shall be in accordance with the National Electrical Code (N.E.C.).
 - c. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

- d. All units must meet or exceed the 2010 Federal minimum efficiency requirements and the proposed ASHRAE 90.1 efficiency requirements for VRF systems. Efficiency shall be published in accordance with the DOE alternative test procedure, which is based on the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Standards 340/360, 1230 and ISO Standard 13256-1.
- e. A full charge of R-410A for the condensing unit only shall be provided in the condensing unit.
- f. Units shall be listed in the AHRI directory.
- g. All units shall meet the minimum Federal minimum efficiency standards and be tested per AHRI 1230 Standard.
- 3. Delivery, Storage and Handling
 - a. Unit shall be stored and handled according to the manufacturer's recommendation.
 - b. Units shall be shipped in one piece and shall be stored and handled per unit manufacturer's recommendations.
 - c. Units shall be supplied with a base rail that provides openings for moving the unit by fork truck or rigging the unit by crane
- 4. Warranty
 - a. The units shall be covered by the manufacturer's limited warranty for a period of one (1) year from date of installation. If the systems are:
 - 1. Designed by a certified equipment designer
 - 2. Installed by a contractor that has successfully completed the required training by the equipment manufacturer, and
 - 3. Verified with a completed commissioning report submitted to and approved by the equipment manufacturer, then the units shall be covered by an extended manufacturer's limited warranty for a period of five (5) years from date of installation by the equipment manufacturer.

In addition, the compressor shall have a manufacturer's limited warranty for a period of seven (7) years from date of installation.

If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer. This warranty shall not include labor.
 - b. Manufacturer shall have a minimum of five years of HVAC experience in the U.S. market.
 - c. All manufacturer technical and service manuals must be readily available for download by any local contractor should emergency service be required. Registering and sign-in requirements which may delay emergency service reference are not allowed.
 - d. The VRF system shall be installed by a contractor with extensive equipment manufacturer install and service training. The mandatory contractor service and install training should be performed by the manufacturer.

5. Products

a. Outdoor Unit

1. General: The outdoor unit shall be used specifically with same equipment manufacturer's components. The outdoor units shall be equipped with multiple circuit boards that interface to the controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory assembled, piped and wired and run tested at the factory.
 - a. The model nomenclature and unit requirements are shown on plans. All units requiring a factory supplied twinning kits shall be piped together in the field. If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor.

Outdoor Unit Model Nomenclature Basis of Design					
		Twinning Kit	208 Volt		Twinning Kit
Model Number	Units		Model Number		
			Refer to dwgs	Refer to dwgs	

- b. Outdoor unit shall have a sound rating no higher than 66 dB(A) individually or 69 dB(A) twinned. Units shall have a sound rating no higher than 50 dB(A) individually or 53 dB(A) twinned while in night mode operation. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.
- c. All refrigerant lines from the outdoor unit to the indoor units controller shall be insulated.
- d. Outdoor unit shall be able to connect to up to 40 indoor units depending upon model.
- e. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
- f. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
- g. The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet and have total refrigerant tubing length of 985 feet. The greatest length is not to exceed 575 feet between outdoor unit and the indoor units without the need for line size changes or traps.
- h. The outdoor unit shall be capable of operating in heating mode down to -4°F ambient temperature. The outdoor unit shall be capable of operating in cooling mode with required capacity down to -0°F with manufacturer supplied low ambient kit. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.
- i. Manufacturer supplied low ambient kit shall be provided with predesigned control box rated for outdoor installation and capable of controlling kit operation automatically in all outdoor unit operation modes.
- j. Manufacturer supplied low ambient kit shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
- k. Manufacturer supplied low ambient kit shall be factory tested in low ambient temperature chamber to ensure operation. Factory performance testing data shall be available when requested.

- l. Outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
 - m. Unit must defrost all circuits simultaneously in order to resume full heating more quickly. Partial defrost which may extend "no or reduced heating" periods shall not be allowed.
- 6. Unit Cabinet: The casing(s) shall be fabricated of galvanized steel, bonderized and finished. Units cabinets shall be able to withstand 960 hours per ASTM B117 criteria for seacoast protected models.
- 7. Fan: Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed. All fan motors shall be mounted for quiet operation. All fans shall be provided with a raised guard to prevent contact with moving parts. The outdoor unit shall have vertical discharge airflow.
- 8. Refrigerant: R410A refrigerant shall be required for unit systems. Polyolester (POE) oil shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
- 9. Coil: The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing. The coil fins shall have a factory applied corrosion resistant blue-fin finish. The coil shall be protected with an integral metal guard. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.
- 10. Compressor: Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors, which cause inrush current (demand charges) and require larger wire sizing, shall not be allowed. A crankcase heater(s) shall be factory mounted on the compressor(s). The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of 19%-5% of rated capacity, depending upon unit size. The compressor will be equipped with an internal thermal overload. The compressor shall be mounted to avoid the transmission of vibration. Field-installed oil equalization lines between modules are not allowed.
 - a. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.
- 11. Electrical: The outdoor unit electrical power shall be 208 volts, 3-phase, 60 hertz refer to mechanical schedules. The outdoor unit shall be controlled by integral microprocessors. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
- 12. Refrigerant: R410A refrigerant shall be required.
- 13. Refrigerant valves: The unit shall be furnished with multiple branch circuits which can individually accommodate up to 54,000 BTUH and up to three indoor units. Branches may be twinned to allow more than 54,000 BTUH. Each branch shall have multiple two-position valves to control refrigerant flow. Service shut-off valves shall be field-provided/installed for each branch to allow service to any indoor unit without field interruption to overall system operation. Linear electronic expansion valves shall be used to control the variable refrigerant flow.
- 14. Integral Drain Pan: An integral condensate pan and drain shall be provided.

15. Electrical: The unit electrical power shall be 208/230 volts, 1 phase, 60 hertz. The unit shall be capable of satisfactory operation within voltage limits of 187-228 volts.
16. Controls Network: Controls Network consists of remote controllers, schedule timers, system controllers, centralized controllers, and/or integrated web based interface communicating over a high-speed communication bus. The Controls Network shall support operation monitoring, scheduling, error email distribution, personal browsers, tenant billing, online maintenance support, and integration with Building Management Systems (BMS) using BACnet® interfaces. The below figure illustrates a sample control network System Configuration.
17. Remote Controllers: Provide remote wired backlit controllers for all indoor evaporators.
18. Centralized Controller: The Centralized Controller shall be capable of controlling a maximum of 50 indoor units across multiple outdoor units. The Centralized Controller shall be approximately 8-1/2"x10" in size and shall be powered from a built-in power supply to the network transmission line. The Centralized Controller shall support operation superseding that of the remote controllers, system configuration, daily/weekly scheduling, monitoring of operation status, and malfunction monitoring. The Centralized Controller shall have five basic operation controls which can be applied to an individual indoor unit, a group of indoor units (up to 50 indoor units), or all indoor units (collective batch operation). This basic control set of operation controls for the Centralized Controller shall include on/off, operation mode selection (cool, heat, auto, dry, and fan), temperature setting, fan speed setting, and airflow direction setting. Since the GB-50ADA provides centralized control it shall be able to enable or disable operation of local remote controllers. In terms of scheduling, the GB-50ADA Centralized
 - a. Controller shall allow the user to define both daily and weekly schedules with operations consisting of ON/OFF, mode selection, temperature setting, vane, direction, fan speed, and permit/prohibit of remote controllers.

(Suggested Centralized Controller Settings Basis of Design)			
Item	Description	Operation	Display
ON/OFF		Each Block, Group or Collective	Each Group or Collective
Operation Mode	Switches between Cool/Dry Dry/Auto/Fan/Heat.	Each Block, Group or Collective	Each Group
Temperature Setting	Sets the temperature for a single group. Range of temperature setting from 57°F – 87°F dependant on operation mode and indoor unit model.	Each Block, Group or Collective	Each Group
Fan Speed Setting	Models with 5 air flow speed settings: Hi/Mid-2/Mid-1/Low, Auto Models with 4 air flow speed settings: Hi/Mid-2/Mid-1/Low Models with 3 air flow speed settings: Hi/Mid/Low Models with 2 air flow speed settings: Hi/Low * Fan speed setting (including Auto) varies depending on the indoor unit model.	Each Block, Group or Collective	Each Group
Air Flow Direction Setting	Air flow direction angles, 4-angle or 5-angle Swing, Auto *1: Louver cannot be set. *Air flow direction settings vary depending on the indoor unit model.	*1 Each Block, Group or Collective	Each Group

(Suggested Centralized Controller Settings Basis of Design)			
Item	Description	Operation	Display
Schedule Operation	Annual/weekly/today schedule can be set for each group of air conditioning units. Optimized startup setting is also available. *2: The system follows either the current day, annual schedule, or weekly, which are in the descending order of overriding priority. Twenty-four events can be scheduled per day, including ON/OFF, Mode, Temperature Setting, Operation Prohibition, Vane Direction, and Fan Speed. Two types of weekly schedule(Summer/Winter) can be set. Settable items depend on the functions that a given air conditioning unit supports.	*2 Each Block, Group or Collective	Each Group
Optimized Startup	Unit starts 5 - 60 minutes before the scheduled time based on the operation data history in order to reach the scheduled temperature at the scheduled time.	Each Block, Group or Collective	Each Block, Group or Collective
Night Setback Setting	The function helps keep the indoor temperature in the temperature range while the units are stopped and during the time this function is effective.	Each Group	Each Group
Permit / Prohibit Local Operation	Individually prohibit operation of each local remote control function (Start/Stop, Change operation mode, Set temperature, Reset filter). *3: Centrally Controlled is displayed on the remote controller for prohibited functions.	Each Block, Group or Collective	*3 Each Group
Indoor Unit Intake Temp	Measures the intake temperature of the indoor unit when the indoor unit is operating.	N/A	Each Group
Error	When an error is currently occurring on an air conditioner unit, the afflicted unit and the error code are displayed *4 When an error occurs, the LED flashes. The operation monitor screen shows the abnormal unit by flashing it. The error monitor screen shows the abnormal unit address, error code and source of detection. The error log monitor screen shows the time and date, the abnormal unit address, error code and source of detection	N/A	*4 Each Unit or Collective
Ventilation Equipment	This interlocked system settings can be performed by the master system controller. When setting the interlocked system, use the ventilation switch the free plan LOSSNAY settings between "Hi", "Low" and "Stop". When setting a group of only free plan LOSSNAY units, you can switch between "Normal ventilation", "Interchange ventilation" and "Automatic ventilation".	Each Group	Each Group
Interlock	Operation of indoor groups or general equipment can be interlocked by the change of state (ON/OFF, mode, error of indoor groups/general equipment). (GB-50 will execute interlocking control depending on the interlocked setting.)	N/A	N/A
Multiple Language	Other than English, the following language can be chosen. Spanish, French, Japanese, Dutch, Italian, Russian, Chinese, and Portuguese are available.	N/A	N/A

(Suggested Centralized Controller Settings Basis of Design)			
Item	Description	Operation	Display
External Input / Output	By using accessory cables you can set and monitor the following. Input By level: "Batch start/stop", "Batch emergency stop" By pulse: "batch start/stop", "Enable/disable remote controller" Output: "start/stop", "error/Normal" *5: Requires the external I/O cables (PAC-YG10HA-E) sold separately.	*5 Collective	*5 Collective
Collective ON/OFF	All the units can be operated / stopped with a DIP switch.	Collective	Collective (7 SEG)
Data back-up (USB Memory)	The initial setting data, operation data (charge parameter) can be stored to a USB memory. Initial setting data can be read from USB memory.	N/A	N/A

1. All Centralized Controllers shall be equipped with one Ethernet port to support interconnection with a network PC via a closed/direct Local Area Network (LAN). The Centralized Controller shall be capable of performing initial settings via a PC using the Centralized Controller's initial setting browser.
2. Standard software functions shall allow the building manager to securely log into each Centralized Controller via the PC's web browser to support operation monitoring, scheduling, error email, and online maintenance diagnostics. Standard software functions shall not expire.

19. Control Network: System Integration

- a. The Control Network shall be capable of supporting integration with Building Management Systems (BMS) via our LonWorks® and BACnet® interfaces.
- b. BACnet® Interface. The interface, shall be compliant with BACnet® Protocol (ANSI/ASHRAE 135-2004) and be Certified by the (BTL) BACnet® Testing Laboratories. The BACnet® interface shall support a maximum of 50 indoor units. Operation and monitoring points include, but are not limited to, on/off, operation mode, fan speed, prohibit remote controller, filter sign reset, alarm state, error code, and error address. HVAC contractor and ATC Contractor shall coordinate BMS system protocol requirements for integration into existing Automated Logic BMS System.

20. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Mitsubishi CityMulti
- b. Daikin AC
- c. LG
- d. Toshiba/Carrier
- e. Or Equal.

21. Written prior approval required for alternate VRF System Manufacturer.

22. Written prior approved alternate manufacturer is required to coordinate any changes from the basis of design with all associated trades. Any additional costs associated with the alternate equipment shall be covered by the HVAC contractor or equipment manufacturer. No additional costs shall be incurred by the owner.

23. Shop drawings shall be submitted in accordance with 013300. Submittals should include equipment cutsheet information, proposed piping design layout and list of materials. Submittals shall be prepared by an authorized system designer and distributor.

- 2.8 HIGH EFFICIENCY CONDENSING BOILERS (Refer to Section 019113 – Commissioning Requirements for additional contract requirements)
- A. General: Furnish and install in accordance with the instructions of the manufacturer a gas-fired condensing hot water heating boiler complete with accessories and fully-modulating gas train and shall have a steady state efficiency of not less than 89.9 percent for natural gas as published in the I=B=R Ratings of the Hydronics Institute.
- B. Boiler:
1. The boiler shall be designed with a horizontal primary combustion chamber which allows sufficient depth for an unrestricted and clean combustion. A secondary, vertically arranged, corrosion-resistant heat exchanger shall extract energy from the flue gasses via a high rate of flue gas condensation. The primary combustion chamber, the secondary heat exchanger plates, and the flue gas condensate collector shall be constructed of corrosion resistant stainless steel. The outer pressure vessel walls shall be made of carbon steel.
 2. Non-fin heat transfer surfaces shall be designed with wide water passageways in between plates, and a large water volume on a pressure vessel side to enhance heat transfer. Boiler shall not require a flow switch and shall have, at maximum flow rate, a flow restriction of less than three and ½ ft. w.c.
 3. The pressure vessel shall be mounted horizontally on a boiler-skid complete with 4 leveling bolts to ensure proper drainage of all condensate. The front section of the primary heat exchanger shall be removable for easier handling.
 4. Boiler enclosure panels shall be electrostatically powder-coated and encase the boiler shell outside with three in. /76 mm mineral wool insulation wrap-around blanket complete with nylon backing. Wire and cable entry to boiler shall be facilitated by flip-open strain relief to protect the reduce water on cables. The assembled boiler shall have a hinged swing-open combustion chamber door to provide easy access from the boiler front. Water connections shall be on the top and rear of the boiler shell. There shall be two separate boiler return flanges to accommodate different return water temperatures, and shall include a detachable steel supply header as standard equipment.
 5. Minimum operating pressure is 30 psig, and maximum boiler water temperature is 210 percent F. Boiler shall be CGA and AGA approved and shall be built in compliance with ASME Section IV, carrying the "H" stamp, and Canadian Registration Number (CRN) in Canada.
 6. Standard equipment not mentioned above shall include the following items:
 - a. Cast-iron safety header equipped with pressure gauge and air vent.
 - b. Pressure relief valve.
 - c. Boiler drain valve.
 - d. All required safety controls, low-water cut-off, adjustable high limit with manual fixed high limit reset.
 - e. Category IV breeching for each boiler (furnished and installed by Division 22 00 00).
 7. Condensate neutralization system shall be provided by Division 22 00 00.
 8. Control Package:
 - a. General: Provide boiler control for boiler installation as indicated on the plans. The control package must be factory tested to ensure proper operation. The control package shall include the following hardware as standard equipment: boiler control c/w boiler temperature sensor, capillary for adjustable high limit (AHL), capillary for fixed manual reset temperature high limit (FHL), and outdoor temperature sensor.

- b. Construction: Control shall consist of a single housing for mounting on boiler. A digital display located on the face of the boiler control panel shall be used to indicate time, weekday, outdoor temperature, boiler water temperature, operating hours, all to assist in set-back programming and to assist in failure diagnostics. The AHL shall govern the maximum boiler water temperature; it shall be of a tamper-proof, lock-in design and be located behind a flip-down cover. The FHL shall shut down the boiler in the event of boiler or system deficiencies. A TUV test switch shall enable the user to override the AHL to test proper operation of the FHL. The TUV test switch shall be located behind a flip-down cover to discourage tampering. Boiler water temperature shall be modulated by an indoor/outdoor control, and shall utilize a PID (Proportional, Integral, Derivative) – based control algorithm. An integrated failure diagnostic system shall be included. The control shall be pre-wired with low voltage quick-connect plug-in system for integration with boiler.
- c. Provide communication card for seamless communication with DDC system. Coordinate communications protocol requirements with ATC contractor.

C. Burner:

1. Burner housing shall have a removable cover to provide access for service. Housing shall swing left or right interchangeably. Other components shall include a differential air pressure switch, a separate combustion head for simple installation, and an observation port for viewing the flame. A single servomotor with 90 deg. rotation shall be incorporated, controlling both air adjustment cam and gas butterfly valve. The clutch shall enable manual positioning of the servomotor.
2. The air intake shall be single louver located on the suction side of the fan. The air louver is to be controlled by a single linkage from the cam. Air intake housing shall be insulated to reduce noise.
3. Both the combustion head and the diffuser assembly shall be constructed of a stainless steel alloy capable of withstanding 1475 deg. F. Diffuser, ignition electrodes, mixing assembly must be accessible and removable without removing the burner. The gas butterfly valve shall be an integral part mounted directly on the burner housing. The combustion head must be adjustable to maximize mixing pressure for high and low fire. The burner shall be factory-equipped with a low-Nox combustion head.
4. The blower motor to be single-phase and totally enclosed including dynamically balanced squirrel cage fan.
5. The burner shall be standard equipped with electronic spark ignition. A Landis and Gyr, Honeywell or approved equal flame safeguard system with UV scanner flame detection shall be standard equipment.
6. The gas train shall be preassembled and prewired consisting of two Landis and Gyr, Honeywell or approved equal fluid powered gas valves.
7. Burner shall be factory prewired to ensure optimal functionality, compliance with regional requirements, and ease of installation in the field and will include all necessary hardware items such as junction panel, burner power supply and all essential pressure switches, as well as interconnection with conduit between control and burner.

D. Venting System

1. The HVAC Contractor shall be responsible to coordinate with Division 220000 for breeching and combustion air requirements. Breeching and combustion air stacks to be provided by Division 220000.

E. Manufacturer: Subject to compliance with the above, provide high efficiency gas fired condensing boiler of one of the following:

1. Hydrotherm

2. Lochinvar
3. Viessman
4. Aaerco
5. Or equal

2.9 HYDRONIC PUMPS (Refer to Section 019113 – Commissioning Requirements for additional contract requirements)

A. General: Provide factory-tested pumps, thoroughly cleaned, and painted with one coat of machinery enamel prior to shipment. Type, size, and capacity of each pump is listed in pump schedule. Provide pumps of same type by same manufacturer.

B. IN-LINE CIRCULATOR PUMPS:

1. General: Provide in-line circulator pumps where indicated, and of capacities as scheduled.
2. Type: Horizontal mount, vertical split case, oil-lubricated, designed for 125 psi working pressure, and 225° F. (107° C) continuous water temperature.
3. Body: Cast-iron, with suction and discharge gage tapings.
4. Shaft: Hardened alloy steel.
5. Bearings: Oil-lubricated bronze journal bearings.
6. Seal: Mechanical, with carbon seal ring and ceramic seat.
7. Motor: Non-overloading at any point on pump curve, open, drip-proof, oil-lubricated journal bearings, resilient mounted construction, built-in thermal overload protection on single phase motors.
8. Couplings: Self-aligning, flexible coupling.
9. Impeller: Enclosed type hydraulically and dynamically balanced, and keyed to shaft.
10. Manufacturer: Subject to compliance with requirements, provide in-line circulator pumps of one of the following:
 - a. Grunfos
 - b. Bell & Gosset ITT; Fluid Handling Div.
 - c. Taco, Inc.
 - d. Or equal.

2.10 RADIANT FLOOR AND SNOW MELT SYSTEM

A. General

1. The equipment and materials listed in this section shall be provided by the radiant system snowmelt manufacturer. ATC Contractor shall coordinate and interface to Building Management System.

B. PEX Tubing

1. ViegaPEX Barrier: Tubing shall be cross-linked high density polyethylene as per ASTM F876/F877. Tubing shall include an oxygen diffusion barrier in accordance with DIN 4726. Tubing shall also meet the requirements of ANSI/NSF 14 and 61.
2. FostaPEX: Tubing shall be electronically cross-linked high density polyethylene as per ASTM F876/F877. An aluminum layer shall cover the inner PEX core for form stability and serve as an oxygen diffusion barrier. An outer layer of polyethylene shall cover the aluminum for protection against corrosion. Tubing shall also meet the requirements of ANSI/NSF 14 and 61.

3. Tubing shall be rated to the following maximum performance criteria:
 - a. 200 degrees F (93 degrees C) at 80 psi (551 kPa)
 - b. 180 degrees F (82 degrees C) at 100 psi (689 kPa)
 - c. 73 degrees F (23 degrees C) at 160 psi (1102 kPa)

C. Enhanced Mixing Stations

1. Enhanced Mixing Station: Made from brass and copper, this station is included with one Grundfos alpha pump factory attached and tested and provided with BACnet communication for BMS integration. Station also includes a 1" diverting valve made to accept an actuator. Stations are also equipped with two 1" ball valves. And threaded end connections to attach directly to a Viega Manifold. Station is delivered with two 6-5/8" wall mounting brackets.

D. Manifolds

1. Stainless Steel Manifolds
 - a. Shall be 1-1/4" extruded 304 stainless steel manifold as supplied by radiant system manufacturer. Manifold shall have factory installed air bleeder and 1-1/4" Union connection.
 - b. Manifolds can be valveless design or equipped with valves for individual circuit flow and shut off capabilities. Manifolds can be equipped with manufacturer supplied Circuit flow meters with graduated flow settings up to 2 gpm. (Gallons per minute).
 - c. Manifold shall be rated for a maximum continuous operational pressure of 180 degrees Fahrenheit (82 degrees C) and a maximum pressure of 100 psi (689 kPa).
 - d. Manifold shall be rate for flow rate as scheduled per circuit to a maximum manifold flow rate as scheduled.

E. Attachment Methods

1. Climate Trak: Shall be made from extruded aluminum made to be used in conjunction with either ViegaPEX Barrier or Pextron 3/8" and 1/2" tubing. Not to be used with any silicone or other heat transfer material.

F. Valves

1. Diverting Valves: Valve body shall be made of bronze with brass and corrosion resistant steel internal components. Valve shall also include EPDM (ethylene-propylene-dienemonomer) rubber seals. Valve has max working temp of 242°F and max working pressure of 145 psi.
2. Mixing Valves (3/4-1-1/2 inch): Mixing valve shall be grey cast iron with sweat connections with gaskets with a chromium-plated plug. Valve has maximum operating temperature of 230°F with max operating pressure of 125 psi. Angular adjustment shall be 90°. All moving parts shall be treated with special heat resistant grease if they are to come in contact with hot water.
3. Mixing Valves (2-3 inch): Mixing valve shall be grey cast iron with flange connections as per DIN 2531. Valve has max operating temperature of 260°F with max operating pressure of 125 psi. Angular adjustment shall be 90°. All moving parts shall be treated with special heat resistant grease if they are to come in contact with hot water.

G. Controls

1. Controls to be specified by radiant system manufacturer.

2. Basic Heating Control: shall be supplied for radiant heating systems. Basic Heating Control shall be equipped with outdoor reset control, modulating mixing valve control, seasonal pump activation, BMS output, supply temperature high limit and space/slab temperature control.
3. Three Position Actuator: floating actuator controls diverting valves separately or on mixing station from a 24 VAC signal.

H. Fittings & Accessories

1. Compression Fittings: Shall be made of brass and used to connect PEX to manifolds or to repair a damaged tubing line.
2. Press Fittings: Shall be made of brass and shall be used with manufacturer's stainless steel press sleeves and press tools.
3. Press Sleeves: Shall be made of 304 Stainless Steel and shall only be pressed using the Viega Press Tools.

I. Source Quality Control

1. The ViegaPEX Barrier cross-linked polyethylene tubing and fitting manufacturer shall maintain a third party listing of the tubing and fittings. The tubing and fittings shall be marked with ASTM F876/F877 to ensure tubing and fittings are continuously being made to the same required standard. Tubing shall also be marked with the NSF-pw marking to verify this tubing's suitability to transport potable water.

J. Warranty

1. Products shall be subject to manufacturer guidelines and regulations, and subject to such terms as stated by manufacturer.
2. Warranty shall be valid from date of installation for the duration as stated by the product warranty for the installed product.
3. Warranty shall be transferable to subsequent owners.
 - a. PEX tubing shall be warranted against manufacturer defects for 30 years as installed under manufacturer warranty guidelines.
 - b. Fitting connections shall be warranted against manufacturer defects for a period 10 years as installed under manufacturer warranty guidelines.
 - c. Manifolds, stations and valves shall be warranted against manufacturer defect for 5 years 2 years for controls as installed under manufacturer warranty guidelines.
4. Product is subject to product warranty as written on the date of installation.

K. Manufacturer

1. Viega North America
2. Uponor
3. Or equal

2.11 TERMINAL HEATING UNITS (HYDRONIC) (Refer to Section 019113 – Commissioning Requirements for additional contract requirements)

A. BASEBOARD RADIATION:

1. General: Provide baseboard radiation of lengths and in locations as indicated, and of capacities, style, and having accessories as scheduled.
2. Cabinets: Minimum 20-ga cold-rolled steel, one-piece back and top panel, front panel with integral damper. Provide steel brackets, inserted in back/top panel, to support element and front panel. Provide baked enamel finish. Color as selected by the Architect.
3. Elements: Copper tube and aluminum fins, with slide mechanism between element and support brackets to eliminate expansion and contraction noises.

4. Accessories: Provide the following accessories:
 - a. Blank end caps.
 - b. End caps with hinged access panel.
 - c. Trim strips.
5. Manufacturer: Subject to compliance with requirements, provide baseboard radiation of one of the following:
 - a. Slant/Fin Corp.
 - b. Rittling
 - c. Sterling Radiator: Div. of Reed National Corp.
 - d. Trane (The) Co.
 - e. Or equal.

B. FINNED TUBE RADIATION:

1. General: Provide finned tube radiation of lengths and in locations as indicated, and of capacities, style, and having accessories as scheduled.
2. Cabinets: Minimum 18-ga cold rolled steel full backplate, minimum 16-ga front. Brace and reinforce front minimum of 4'-0" o.c. without visible fasteners.
3. Elements: Copper tube and aluminum fins, or steel tube and steel fin (as scheduled) with tube mechanically expanded into fin collars to eliminate noise and insure durability and performance at scheduled ratings.
4. Finish: Flat black heat resisting paint for backplate; factory finished baked enamel on fronts and accessories. Standard manufacturer color as selected by Architect.
5. Accessories:
 - a. End panels, inside and outside corners, and enclosure extension.
 - b. Access panels in front of valves, balancing cocks, and traps.
 - c. Factory mounted dampers.
 - d. Ball bearing hangers.
6. Manufacturer: Subject to compliance with requirements, provide finned tube radiation of one of the following:
 - a. Slant/Fin Corp.
 - b. Rittling
 - c. Sterling Radiator; Div. of Reed National Corp.
 - d. Or equal.

C. HYDRONIC CONVECTORS (C)

1. General: Provide convectors having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled.
2. Cabinets: Minimum 16-ga steel front and top panels, 18-ga side panels, and 20-ga back panels. Phosphatize and galvanize back panels, phosphatize and paint tops, sides, and fronts, with standard manufacturer color as selected by architect. Secure fronts in place with quick opening slide bolts or camlock fasteners.
 - a. Recessed Cabinets: One-piece front panel, with 4-side gasketed overlap.
3. Elements: Aluminum fins, ribbed steel side plates, fin tube supports and copper tubes, cast-iron headers. Factory test each element to 150 PSI air pressure under water.
4. Accessories: Provide the following accessories.
 - a. Factory mounted dampers.

- b. 1/2" insulation on front
- c. Access doors in front for valve access.
- 5. Manufacturer: Subject to compliance with requirements, provide convectors of one of the following:
 - a. Airtherm Mfg. Co.,
 - b. Rittling
 - c. Sterling
 - d. Trane (The) Co.
 - e. Or equal.

D. UNIT HEATERS (UH) (HORIZONTAL TYPE)

- 1. General: Provide horizontal unit heaters in locations as indicated, and of capacities, style, and having accessories as scheduled.
- 2. Construction:
 - a. Casings: Construct of steel, phosphatized inside and out, and finished with baked enamel. Provide adjustable face air diffuser.
 - b. Fans: Construct of aluminum and factory balance. Design so motor and fan assembly is removable through fan outlet panel.
 - c. Coils: Construct of plate type aluminum fins, mechanically bonded to copper tubes. Design coil for use in steam or hot water applications.
 - d. Motors: Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.
- 3. Manufacturer: Subject to compliance with requirements, provide horizontal unit heaters of one of the following:
 - a. Airtherm Mfg. Co.
 - b. Rittling
 - c. Modine Mfg. Co.
 - d. Trane (The) Co.
 - e. Or equal

E. UNIT HEATERS (UH) (CABINET TYPE)

- 1. General: Provide cabinet unit heaters having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coil, fanboard, fan wheels, housings, motor, and insulation.
- 2. Construction:
 - a. Chassis: Galvanized steel wrap-ground structural frame with edges flanged.
 - b. Insulation: Faced, heavy density glass fiber.
 - c. Cabinet: 16-ga removable front panel, 18-ga top and side panels. Insulate behind entire front panel section. Provide access door on coil connection side. Clean cabinet parts, bonderize, phosphatize, and flow-coat with primer and finish paint color as selected by architect.
 - d. Water Coils: Construct of 5/8" seamless copper tubes mechanically bonded to configured aluminum fins. Design for 300 psi and leak test at 300 psi under water. Provide same end connections for supply and return.
 - e. Fans: Provide centrifugal, forward curved double width fan wheels constructed of non-corrosive, molded, fiberglass reinforced thermo-plastic material. Construct fan scrolls of galvanized steel.

- f. Motors: Provide PSC motors with integral thermal over-load protection, and motor cords for plug-in to junction box in unit. Provide three speed switch on fan motor.
 - g. Filters: Provide 1" thick throwaway type filters in fiberboard frames.
- 3. Manufacturer: Subject to compliance with requirements, provide cabinet heaters of one of the following:
 - a. Rittling
 - b. McQuay Inc.
 - c. Sterling
 - d. Trane (The) Co.
 - e. Or equal

2.12 POWER AND GRAVITY VENTILATORS (Refer to Section 019113 – Commissioning Requirements for additional contract requirements)

- A. General: Except as otherwise indicated, provide standard prefabricated power and gravity ventilator units of type and size indicated, modified as necessary to comply with requirements, and as required for complete installation.

- B. Refer to Division-23 automatic temperature control for control sequence.

C. ROOF FANS (EF)

- 1. Type: Centrifugal fan, direct or belt driven as scheduled. Provide aluminum, or galvanized steel, weatherproof housings as scheduled. Provide square base to suit roof curb. Provide permanent split-capacitor type motor for direct driven fans; capacitor-start, induction-run type motor for belt driven fans.
- 2. Electrical: Provide factory-wired non-fusible type disconnect switch at motor in fan housing. Provide thermal overload protection in fan motor. Provide conduit chase within unit for electrical connection.
- 3. Bird Screens: Provide removable bird screens, 1/2" mesh, 16-ga. aluminum or brass wire.
- 4. Gravity Operated Dampers: Provide gravity-actuated, felt edge, louvered dampers in curb bases.
- 5. Motor Operated Dampers: Provide louvered dampers with linkage below curb base (maximum of 6").
- 6. Manufacturer: Subject to compliance with requirements, provide centrifugal roof ventilators of one of the following:
 - a. Carnes Co., Div. of Wehr Corp.
 - b. Cook Co., Loren.
 - c. Greenheck Fan Corp.
 - d. Penn Ventilator Co., Inc.
 - e. Power Line Fans; Div. of Torin Corp.
 - f. Or equal.

D. CENTRIFUGAL CEILING FANS (EF)

- 1. Provide AMCA Certified Ratings Seal.
- 2. Type: Provide galvanized steel housing lined with acoustical insulation, adaptable for ceiling or wall installation. Provide centrifugal fan wheels mounted on motor shaft with fan shrouds, all removable for service. Provide integral backdraft damper fan discharge.

3. Grille: Provide stainless steel or painted aluminum louvered grille with flange on intake with thumbscrew attachment to fan housing.
4. Motor: Provide permanent split-capacitor motor, permanently lubricated, with grounded cord and plug.
5. Electrical: Provide junction box for electrical connection on housing, and receptacle for motor plug-in.
 - a. Furnish built-in fan speed control, for balancing purposes, of the solid state type capable of controlling fan speed from full speed to approximately half speed.
6. Accessories: Provide manufacturer's standard roof jack, wall cap, and transition fittings as indicated on drawings or schedules.
7. Manufacturer: Subject to compliance with requirements, provide centrifugal ceiling exhausters of one of the following:
 - a. Carnes Co.
 - b. Cook Co., Loren.
 - c. ILG Industries.
 - d. Penn Ventilator Co. Inc.
 - e. Power Line Fans.
 - f. Greenheck Fan Corp.
 - g. Or equal.

E. PREFABRICATED ROOF CURBS

1. Manufacturer of ventilating unit shall provide his standard insulated minimum 18" high roof curb compatible with unit being provided. Curb shall be insulated and sloped to allow for level installation of device. Provide all necessary nailers, cants, etc. for a complete installation.

2.13 METAL DUCTWORK (Refer to Section 019113 – Commissioning Requirements for additional contract requirements)

A. Ductwork Materials:

1. Exposed Ductwork Materials: Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections including piping, seam marks, roller marks, stains and discolorations, and other imperfections, including those which would impair painting.
2. Sheet Metal: Except as otherwise indicated, fabricate ductwork from galvanized sheet steel complying with ASTM A 527, lock forming quality, with G 90 zinc coating in accordance with ASTM A 525; and mill phosphatized for exposed locations.

B. Miscellaneous Ductwork Materials:

1. General: Provide miscellaneous materials and products of types and sizes indicated and, where not otherwise indicated, provide type and size required to comply with ductwork system requirements including proper connection of ductwork and equipment.
2. Fittings: Provide radius type fittings fabricated of multiple sections with maximum 15 degree change of direction per section. Unless specifically detailed otherwise, use 45 degree laterals and 45 degree elbows for branch takeoff connections. Where 90 degree branches are indicated, provide conical type tees.
3. Duct Liner: Refer to "Acoustic Duct Lining Section".
4. Duct Liner Adhesive: Comply with ASTM C 916 "Specification for Adhesives for Duct Thermal Insulation".

5. Duct Liner Fasteners: Comply with SMACNA HVAC Duct construction Standards, Article S2.11.
 6. Duct Sealant: Non-hardening, non-migrating mastic or liquid elastic sealant, type applicable for fabrication/installation details, as compounded and recommended by manufacturer specifically for sealing joints and seams in ductwork.
 7. Ductwork Support Materials: Except as otherwise indicated, provide hot-dipped galvanized steel fasteners, anchors, rods, straps, trim and angles for support of ductwork.
 - a. For exposed stainless steel ductwork, provide matching stainless steel support materials.
 - b. For aluminum ductwork, provide aluminum support materials except where materials are electrically separated from ductwork.
 8. Flexible Ducts: Corrugated aluminum complying with UL 181.
 - a. Where installed in unconditioned spaces other than return air plenums, provide 1" thick continuous flexible fiberglass sheath with vinyl vapor barrier jacket.
- C. Fabrication:
1. Shop fabricated ductwork in 4, 8, 10 or 12-ft lengths, unless otherwise indicated or required to complete runs. Pre-assembled work in shop to greatest extent possible, so as to minimize field assembly of systems. Disassemble systems only to extent necessary for shipping and handling. Match-mark sections for reassembly and coordinated installation.
 2. Shop fabricated ductwork of gages and reinforcement complying with SMACNA "HVAC Duct Construction Standards".
 3. Fabricate duct fittings to match adjoining ducts, and to comply with duct requirements as applicable to fittings. Except as otherwise indicated, fabricate elbows with center-line radius equal to 1-1/2 times associated duct width; or squared metered elbows with double thickness turning vanes. Limit angular tapers to 30 degrees for contracting tapers and 20 degrees for expanding tapers.
 4. Fabricate ductwork with accessories installed during fabrication to the greatest extent possible. Refer to section "Ductwork Accessories" for accessory requirements.
 5. Fabricate ductwork with duct liner in each section of duct where indicated. Laminate liner to internal surfaces of duct in accordance with instructions by manufacturers of lining and adhesive, and fasten with mechanical fasteners.
- D. Factory-Fabricated Low Pressure Round And Oval Ductwork:
1. General: Provide factory-fabricated duct and fittings.
 2. Material: Material type shall be as indicated or, galvanized sheet steel complying with ASTM A 527, lock forming quality, with ASTM A 525, G90 zinc coating, mill phosphatized.
 3. Gage: 28-gage minimum for round and oval ducts and fittings, 4" through 24" diameter.
 4. Seams: All seams shall be spiral lockseams.
 5. Elbows: One piece construction for 90 degrees and 45 degree elbows 14" and smaller. Provide multiple gore construction for larger diameters with standing seam circumferential joint.
 6. Divided flow Fittings: 90 degree tees, constructed with saddle tap spot welded and bonded to duct fitting body.

7. Manufacturers: Subject to compliance with requirements, provide factory-fabricated ductwork of one of the following:
 - a. Semco Mfg., Inc.
 - b. United Sheet Metal Div., United McGill Corp.
 - c. Or equal.

2.14 DUCTWORK ACCESSORIES (Refer to Section 019113 – Commissioning Requirements for additional contract requirements)

A. Dampers:

1. Low Pressure Manual Dampers: Provide dampers of single blade type or multiblade type, constructed in accordance with SMACNA "HVAC Duct construction Standards".
2. Automatic Control Dampers: Refer to Division-23 section "Automatic Temperature Control" for control dampers; not work of this section.
3. Backdraft Relief Dampers: Provide dampers with parallel blades, counterbalanced and factory-set to relieve at .05" static pressure. Construct blades of 16-ga. aluminum, provide 1/2" diameter ball bearings, 1/2" diameter steel axles spaced on 9" centers. Construct from 2" x 1/2" x 1/8" steel channel for face areas 25 sq. ft. and under: 4" x 1-1/4" x 16 ga. channel for face areas over 25 sq. ft. Provide galvanized steel finish on frame with aluminum touch-up. Provide felted or rubber trim to assure tight, leak-proof seal when closed.
4. Manufacturer: Subject to compliance with requirements, provide dampers of one of the following:
 - a. Air Balance, Inc.
 - b. Airguarde Corp.
 - c. American Warming & Ventilating, Inc.
 - d. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
 - e. Louvers & Dampers, Inc.
 - f. Penn Ventilator Co.
 - g. Ruskin Mfg. Co.
 - h. Or equal.

B. Fire Dampers:

1. Fire Dampers: Provide fire dampers, of types and sizes indicated. Construct casings of 11-ga. galvanized steel. Provide fusible link rated at 160 to 165 degrees F (71 to 74 degrees C) unless otherwise indicated. Provide out of air stream type damper in open position and with positive lock in closed position, and with the following additional features:
 - a. Damper Blade Assembly: Curtain type.
 - b. Blade Material: Steel, match casing.
 - c. Blade Material: Stainless steel.
2. Manufacturer: Subject to compliance with requirements, provide fire and smoke dampers of one of the following:
 - a. Air Balance, Inc.
 - b. American Warming & Ventilating, Inc.
 - c. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
 - d. Louvers & Dampers, Inc.
 - e. Penn Ventilator Co.

- f. Phillips-Aires
- g. Ruskin Mfg. Co.
- h. Or equal.

C. Turning Vanes:

1. Manufactured Turning Vanes: Provide double thickness airfoil turning vanes constructed of 1-1/2" wide curved blades set at 3/4" o.c., supported with bars perpendicular to blades set at 2" o.c, and set into side strips suitable for mounting in ductwork.
2. Manufacturer: Subject to compliance with requirements, provide turning vanes of one of the following:
 - a. Aero Dyne Co.
 - b. Airsan Corp.
 - c. Anemostat Products Div.; Dynamics Corp. of America.
 - d. Barber-Colman Co.
 - e. Duro Dyne Corp.
 - f. Environmental Elements Corp.; Subs, Koppers Co., Inc.
 - g. Hart & Cooley Mfg. Co.
 - h. Register & Grille Mfg. Co., Inc.
 - i. Souther, Inc.
 - j. Or equal.

D. Duct Hardware:

1. General: Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:
 - a. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
 - b. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12". Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.
2. Manufacturer: Subject to compliance with requirements, provide duct hardware of one of the following:
 - a. Ventbamics, Inc.
 - b. Young Regulator Co.
 - c. Or equal.

E. Duct Access Doors:

1. General: Provide duct access doors of a size as required to service and maintain device in duct. Provide on (1) access door at each control damper, humidifier, coil, fire damper, and any device that requires attention.
2. Construction: Construct of same or greater gage as ductwork served, provide insulated doors for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one handle-type latch for doors 12" high and smaller, 2 handle-type latches for larger doors.

3. Manufacturer: Subject to compliance with requirements, provide duct access doors of one of the following:
 - a. Air Balance, Inc.
 - b. Duro Dyne Corp.
 - c. Register & Grille Mfg. Co., Inc.
 - d. Ruskin Mfg. Co.
 - e. Ventfabrics, Inc.
 - f. Zurn Industries, Inc.; Air Systems Div.
 - g. Or equal.

F. Flexible Connectors:

1. General: Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibration of connected equipment.
2. Manufacturer: Subject to compliance with requirements, provide flexible connections of one of the following:
 - a. American/Elgen Co.; Energy Div.
 - b. Duro Dyne Corp.
 - c. Flexaust (The) Co.
 - d. Ventfabrics, Inc.
 - e. Or equal.

2.15 AIR OUTLETS AND INLETS (Refer to Section 019113 – Commissioning Requirements for additional contract requirements)

A. Ceiling Air Diffusers:

1. General: Except as otherwise indicated, provide manufacturer's standard ceiling air diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation. Stamped face diffusers will not be acceptable.
2. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw, drop and noise criteria ratings for each size device as listed in manufacturer's current data.
3. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

4. Types: Provide ceiling diffusers of type, capacity, throw, blow and with accessories as listed on diffuser schedule.
 - a. Ceiling Diffusers shall be of the restricted multi-orificed jet induction and air mixing type consisting of louver sections with built-in diffusing vanes. The vanes shall be arranged to discharge air from adjacent louvers at an angle of 45 degrees in opposite directions to insure rapid mixing of primary and room air. Diffusing vanes shall be welded and mechanically fastened to the adjacent louver sections to make a rigid unit. The vanes shall extend to the discharge edges of the louvers. Where louver sections join the core frame, the louver ends shall be welded to the core frame. The leading edge of each louver shall be hemmed and the louver ends shall be rounded and hemmed before welding to the core frames.
 - b. Diffusers shall be fabricated of aluminum or steel-welded construction, and shall be provided with a removable core permitting easy access to the neck connection. The diffuser neck shall extend no less than 1" above the core to accommodate an internal duct connection to prevent leakage into the ceiling space.
 - c. Finish shall be baked enamel. Color as selected by A/E.
 5. Diffuser Dampers:
 - a. Opposed Blade: Adjustable opposed blade damper assembly, key operated from face of diffuser. Provide in each ceiling diffuser.
 6. Manufacturer: Subject to compliance with requirements, provide diffusers of one of the following:
 - a. Tuttle & Bailey Agitair Series
 - b. Price
 - c. Nailor
 - d. Or equal
- B. Wall Registers and Grilles:
1. General: Except as otherwise indicated, provide manufacturer's standard registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
 2. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device and listed in manufacturer's current data.
 3. Compatibility: Provide registers and grilles with border styles that are compatible with adjacent systems, and that are specifically manufactured to fit into wall and ceiling construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of construction which will contain each type of register and grille.
 4. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule:
 5. Pattern: Register and grille patterns shall have style as identified on Drawings.
 6. Dampers: Opposed Blade adjustable assembly, key operated from face of register.
 7. Accessories:
 - a. Plaster Frame: Perimeter frame designed to act as plaster stop and register or grille anchor. Provide where required.
 - b. Operating Keys: Tools designed to fit through register or grille face and operate volume control device and/or pattern adjustment.
 8. Finish: Register and Grille Finishes shall be baked enamel color as selected by the Architect.

9. Manufacturer: Subject to compliance with requirements, provide registers and grilles of one the following:
 - a. Agitair (Air Devices)
 - b. Price
 - c. Nailor
 - d. Or equal

C. Ceiling Registers and Grilles:

1. General: Except as otherwise indicated, provide manufacturer's standard "Egg-Crate" type registers and grilles where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.
2. Compatibility: Provide registers and ceiling grilles with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling construction.
3. Types: Provide registers and grilles of type, capacity, and with accessories and finishes as listed on register and grille schedule.
4. Register and Grille Materials:
 - a. Aluminum Construction: Manufacturer's standard extruded aluminum frame and core.
5. Register and Grille Faces:
 - a. 1/2" x 1/2" "Egg-Crate" with 1" border frame.
6. Register and Grille Dampers:
 - a. Opposed Blade: Adjustable opposed blade damper assembly, key operated from face of register (provide for registers only).
7. Register and Grille Finishes shall be baked enamel color as selected by the Architect.
8. Manufacturer: Subject to compliance with requirements, provide registers and grilles of one of the following:
 - a. Agitair (Air Devices)
 - b. Price
 - c. Nailor
 - d. Or equal

2.16 WALL AND CEILING ACCESS DOORS

- A. Furnish access doors for access to all concealed control valves, motor operated dampers, fire doors, etc, and all other concealed parts of the HVAC system that require accessibility for the proper operation and maintenance of the system.
- B. Access doors shall be heavy gage steel with 1" frame. Door shall be fastened to frame with continuous piano hinge. Entire door and frame assembly shall be prime painted and be completed with cylinder lock and two (2) keys. Door and frame shall match fire rating of wall or ceiling installed into.
- C. Manufacturer: Subject to compliance with requirements, provide access doors of one of the following:
 1. Inland Steel Products Company, "Milcor"
 2. Walsh-Hannon-Gladwin Inc., "Way Lector"

2.17 ARCHITECTURAL LOUVERS AND VENTS

A. Manufacturers:

1. Louver: Acceptable Manufacturers: Subject to compliance with the requirements specified herein, manufacturers offering products which may be incorporated in the work include the following, or approved equal:
 - a. Dayton
 - b. Grainger
 - c. Industrial Louvers, Inc.
 - d. Or Equal

B. Architectural Louvers:

1. Louvers: Clear finished fixed aluminum louvers in doors.
 - a. Nominal Louver depth: Fit door width.
2. Louvers in exterior brick wall
 - a. Size: Refer to floor plans for free area requirements.

C. Penthouse Elevator Vent Louver:

1. Manufacturers:
 - a. Greenheck
 - b. Buckley Associates
 - c. United Enertech
2. Model #PELV-100-44 by Buckley Associates or equal
 - a. Enclosure – heavy gage extruded 6063-T5 aluminum 4 in. x 0.081 nominal wall construction.
 - b. Birdscreen: $\frac{3}{4}$ " x 0.051 flattened expanded aluminum in side mounted.
 - c. Finish – enclosure: integral color anodized from manufacturer's standard color range including white.
 - d. Curb: 18 gage cold rolled steel with 2" mounting flange, welded construction.
 - e. Hood: 0.090 formed aluminum with insulation.
 - f. Boxed Corner: 0.090 formed aluminum.
 - g. Glass: 0.125" clear tempered glass.

2.18 CO/CO2/NO2 DETECTION AND CONTROL UNIT (Refer to Section 019113 – Commissioning Requirements for additional contract requirements)

A. GENERAL: Supply, install, and connect an environmental control system for diesel and gasoline fumes detection and control. Equipment shall include the following basic features:

1. Sampling head with high efficiency built-in filter for space mounting, located as shown on drawings.
2. Central Processor Unit with memory for programming, value storage, display and outputs.
3. Output relay contacts with one for the operating and one for the alarm level.
4. Proportional outputs 0-1V DC, 0-10V DC and 4-20 MA DC for CO/CO2/NO2 ranges.

- B. CABINET: Enclosure shall be locking type with no adjustments accessible from the outside. Indicating lights shall display condition of On-Off outputs. Digital display shall indicate concentration of CO/CO₂/NO₂ in ppm values. Mount 5'-0" above floor.
- C. OPERATION:
 - 1. Systems shall operate continuously, updating control panel.
 - 2. CPU continuously acquires the CO/CO₂/NO₂ values as furnished by the analyzer.
 - 3. Each output shall be according to the CO/CO₂/NO₂ concentration when compared to settings on CPU.
- D. OUTPUTS:
 - 1. First "ON/OFF" level for operation.
 - 2. Second (Alarm) ON-OFF level for operation.
 - 3. Flow adjustment on flow meter.
- E. DISPLAY:
 - 1. Analyzer flow indicator confirms air is flowing to analyzer.
 - 2. LED status indicators for the two ON-OFF levels.
 - 3. Digital display indicates concentration of CO/CO₂/NO₂ in ppm values.
- F. Unit shall include calibration check with CO/CO₂/NO₂ by factory trained person two weeks after unit is started up, with written report to Engineer.
- G. Provide remote alarm with silence button installed where shown on drawing.
- H. Manufacturer: Subject to compliance with requirements, provide carbon dioxide control system of one of the following:
 - 1. Car-Mon
 - 2. Tox Alert
 - 3. Vulcain
 - 4. Or equal

2.19 GAS DETECTION SENSORS & MONITORING SYSTEM

- A. DETECTORS E3Point Model E3SM-E3SCO (Carbon Monoxide) & E3SM-E3NO₂ (Nitrogen Dioxide)
 - 1. Transmitter will be powered by the control panel power supply rated at 24 Vac. Fully addressable gas transmitter must be capable of communicating digitally with controller through an RS-485 communication port. Gas transmitters must be installed in a true daisy chain with an end of the line resistor on the last transmitter. The gas transmitter will incorporate an electrochemical cell for toxic gas monitoring and catalytic bead sensor for combustible gases. Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy.
 - 2. When placed in a network configuration the transmitter will be capable of transmitting gas concentrations through the controller. For local activation of fans or louvers (or other equipment) an on-board DPDT relay 5 A, 30 Vdc or 250 Vac (resistive load) will be activated at programmable set points (and programmable time delays) through the control panel. An LCD display will provide gas concentration readings.
 - 3. Transmitter will be capable of operating within relative humidity ranges of 5-95 percent and temperature ranges of -4 deg. F to 104 deg. F (-20 deg. C to 40 deg. C).

4. Unit will be certified to ANSI/UL 61010-1 label and CAN/CSA-C22.2 No. 61010-1. Transmitter must be manufactured in an ISO 9001-2000 production environment.
5. The transmitter should have a plug-in capability for a gas cartridge with a smart sensor capable of self-testing.
6. For local activation of audible alarms, the transmitter shall have an on-board device able to generate an audible output of 85 dBA @ 10 ft (3 m).
7. Detector alarm levels are to be activated and the unit is to be installed in accordance with the following parameters:

TOXIC GASES	1st ALARM SET POINT (TLV-TWA)	2nd ALARM SET POINT (TLV-STEL)	3rd ALARM SET POINT	MOUNTING HEIGHT	COVERAGE RADIUS
Carbon Monoxide (CO)	25 PPM	200 PPM	225 PPM	5 ft (150 cm) above finished floor	50 ft (15 m)
Nitrogen Dioxide (NO ₂)	0.72 PPM	2.0 PPM	9.0 PPM	1 ft (30 cm) from ceiling	50 ft (15 m)

8. Local Building Codes recommendations take precedence over these parameters. Coverage can differ depending on application

B. CONTROLLER VA301C

1. The control panel must be capable of communicating digitally with the networked transmitters and relay modules through three RS-485 Modbus communication buses. Each communication bus must be capable of accepting a combination of up to 32 addressable transmitters, relay modules, or annunciator panels at a maximum distance of 2,000 feet. The power supply shall be of either 24 Vac or 24 Vdc
2. The controller will manage four internal DPDT relays at fully programmable alarm levels (and within programmable time delays) and be capable of activating multiple relay modules of eight relays each. The relay rating will be no lower than 5 A, 30 Vdc or 250 Vac (resistive load).
3. The controller must include a self-test function that allows for the activation/deactivation of all the programmed outputs by simulating a continuous 5 percent increase/decrease value until the maximum/minimum value is reached.
4. The controller must include a real-time clock that enables operation of the outputs for a specific timeframe.
5. The controller must also include an energy saving feature that allows for output operation on alarms set at the max, min or average value of a specific group of transmitters. This feature must also allow for the activation of outputs upon a certain number of a specific group ($\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$) of transmitters reaching their alarm levels. A total of 128 groups can be assigned.
6. The controller will be capable of communicating with an annunciator panel that can serve as a remote display panel in a secondary control room.
7. The controller will indicate the exact concentration of gas, the gas detected, and the location of the sensor by sweeping through the network and displaying the detected levels at each point on a graphic LCD display.
8. BACnet option (For Future Connection):
 - a. The controller must enable BACnet™ communication through its optional BACnet output using BACnet/IP protocol over twisted-pair Ethernet (10BaseT) wires.

C. ACCESSORIES

1. Strobe and Horn type STAS for 24 Vac FHS-240 for 24 Vdc or STACKSTAS for 120 V AC
 - a. Strobe & Horn combo unit will be capable of operating within relative humidity ranges of 0-100 percent and temperature ranges of -30 deg. F to 150 deg. F (-35 deg. C to 66 deg. C). Rating of horn will be no less than 72dB at 10 feet. Intensity of light will be no less than 40W and will flash at a frequency of 1 per second. Unit will be certified by CSA. Honeywell Analytics.
2. Power Transformer type T100VA, T200VA, T300VA or Class 2 devices type T100VAC2, T200VAC2 or T300VAC2
 - a. Transformer shall have an input voltage of 120 V AC and an output voltage of 24 V AC with a VA range of 50-300. Operating frequency shall be 60 Hz. Unit will provide insulation systems up to 130 deg. C (50-1300 VA). Unit will operate at sound levels of less than 40 db. Transformers shall be of fused type.
3. Relay Modules VA301R8
 - a. Relay module will be powered by the control panel's power output or by power transformer rated at 24 Volts AC or DC (always respect minimum voltage requirements at device). Module must be capable of communicating digitally with the Vulcain controller through an RS-485/MODBUS communication port. Relay module will have eight relays rated at no lower than 5A, 30 Vdc or 250 Vac (resistive load). Honeywell Analytics model VA301R8
4. Detector Guards E3PT- GUARD
 - a. The grid is made of a 9-gauge steel wire. The guard must be designed to allow calibration without removing the guards.

D. Acceptable manufacturers:

1. Honeywell
2. Armstrong Monitoring
3. Sensidyne
4. Or equal

2.20 PLATE AND FRAME HEAT EXCHANGERS

- A. FRAME COMPONENTS: Plate Heat exchangers shall be designed, constructed, and tested in accordance with Section VIII, Division 1 of the ASME Pressure Vessel Code, and shall be code stamped. Preference will be given to single pass designs with all connections on the fixed cover. The fixed and movable covers shall be of sufficient thickness for the design pressure and code requirements and shall have no reinforcement or stiffeners. The movable cover shall be provided with a steel roller bearing, for units greater than 50" in height. Carrying and guide bars shall be designed to allow for expansion of at least 25%, and shall be precision manufactured of stainless steel, to prohibit corrosion and facilitate movement of the plates, painted or plated surfaces are not permitted. Entire frames shall be bolted together to allow unit to be field assembled, to permit rigging into place. Welding of frame components is not permitted. Plate and carrying bar designs shall permit the removal and access to any plate in the plate pack, without the need to remove any other plates. Lifting lugs shall be designed to allow lifting of the entire units flooded weight. All steel surfaces shall be thoroughly cleaned and prepared for painting per SSPC-SPI063T, painting over mill scale is not acceptable. All steel components shall be epoxy coated.
- B. CONNECTIONS: Connections equal to or less than 2", shall be stainless steel NPT type. To avoid leakage on port area, studded port design should be provided on heat

exchangers with connections greater than 2". Flanged nozzle connections are not acceptable.

- C. COMPRESSION BOLTS: Compression bolts shall not require special tools and shall be equipped with lock washers at the movable cover, to facilitate opening and closing of the unit from the fixed cover only. Compression bolts shall be equipped with captive nuts at the fixed cover and threaded nuts at the movable cover. Welding of the nut to the closure bolt is prohibited. Bolts with rolled threads to reduce galling, and double width hex nuts, to adequately distribute the load, shall be provided. Ball bearing box washers shall be located at all critical closing bolts on units greater than 50" in height. Bolts, shall be liberally coated with lubrication and rust prevention, and covered with a plastic sleeving for protection from the environment and prevent bodily injury. Zinc plating is prohibited. The bolting system shall be designed so that only (4) compression bolts are required for the opening and closing of a unit.
- D. PLATES: The plate and frame heat exchanger shall consist of pressed type 304 stainless steel plates (or other alloys), to provide the required heat transfer area to meet the operating conditions specified. Individual plates shall be pressed from a homogenous single metal sheet in one step. Each heat transfer plate shall have herringbone corrugations. Corrugations shall be designed to provide support to adjacent plates at evenly distributed support points, allowing pressurization of each circuit to a full differential of 1.5 times the design pressure, for one hour without buckling or deformation of the heat transfer plates. All plates and gaskets shall be permanently marked to identify quality and material. Each heat transfer plate shall have a built-in self aligning system, to accurately locate the plates in the frame assembly, and prevent lateral plate movement, while maintaining maximum gasket contact under pressure. Plates shall be reinforced on the upper and lower mounting slots, to avoid bending of the hangers on the plates. Plates shall be 304 stainless steel with II B finish and tapered gasket grooves. The plate pack shall be covered with an aluminum shroud in accordance with OSHA.
- E. GASKETS: Gaskets shall have relieving grooves to prevent intermixing of fluids and cause leakage to flow to the outside of the unit. One piece molded gaskets are required, and shall fit around both the heat transfer area and port holes.
- F. MANUFACTURER: Subject to compliance provide plate from heat exchanger of one (1) of the following:
 - 1. Bell & Gossett Xylem
 - 2. Alfa Laval
 - 3. Taco Inc.
 - 4. Kelvion

2.21 AUTOMATIC TEMPERATURE CONTROLS (DDC) (Refer to section 01 91 13 Commissioning for additional contract requirements)

- A. A new building management system must have Tridium interface to connect to the Town wide building monitoring systems for the controls to be remotely monitored and adjusted as desired. The Tridium interface shall include JACE controllers and licenses required for town wide interfacing.
- B. Subject to compliance with requirements, provide automatic temperature controls of the following:
 - 1. Johnson Controls
 - 2. Honeywell
 - 3. Siemens
 - 4. Millbury Controls by Schneider Electric
 - 5. Or equal with Tridium Niagara JACE Controller & License

C. Basic Components and Systems:

1. General: Provide control products in sizes and capacities indicated, consisting of dampers, thermostats, clocks, sensors, controllers, and other components as required for completed installation. Except as otherwise indicated, provide manufacturer's standard materials and components as published in their product information, designed and constructed as recommended by manufacturer and as required for application indicated. All equipment and systems shall be installed by factory trained contractors with the following functional and construction features.
2. Install an open-protocol (BACNet) energy management system (EMS) to monitor and control the building HVAC system:
3. The ATC control and building EMS system shall have the following attributes with characteristics and performance as specified within this Specification section, related Electrical and Plumbing section specifications and the Control Diagram drawings:
 - a. Sensors as follows:
 1. Sensors to trend outdoor air temperature
 2. Sensors to monitor and trend equipment status for all equipment with motors greater than ½ hp (and for lower motor hp sizes where indicated in specifications and drawings).
 3. Indication and trending of damper and valve commanded positions.
 4. Sensors to monitor indoor CO2.
 5. Sensors to monitor and trend (create trend logs) controlled variables at the operator interface. Control variables may include air and/or water flow, temperature, pressure, CO2, and pump or fan speed. Relevant multiplexed data from microprocessors located in chillers, boilers, variable speed drives and other equipment with multiplexing capabilities may be used in lieu of specifying separate sensors.
 - b. Points matrix – including all hardwired input and output devices connected to the automation system, all set points, upper and lower control limits.
 - c. Trend capabilities – including a trend point list and preprogrammed sample of point (performed by controls contractor), sample rate, storage interval, upload interval, custom trend abilities, alarms, and automated trend data review and notification (automated diagnostics).
 - d. System architecture – capable of allowing sampling of these points to facilitate building commissioning and diagnostics without significantly affecting system performance.
 - e. Data storage system – with adequate capacity to record trend data for use by building operators. Data export requirements must facilitate user-friendly data access and manipulation.
 - f. Operator interface – designed for remote/web access, monitoring requirements, trend-log reporting and diagnosing building problems through a user-friendly interface. This includes providing a visual (non text based) operations and reporting interface to facilitate rapid system assessment that utilizes color-coding, diagrams of floor plans and graphing capabilities.

4. Electric Wiring: All electric wiring and wiring connections, either line voltage or low voltage, from the main electric panels to the ATC panels, and from the ATC related panels to the individual control devices i.e. rooftop units, exhaust fans, boilers, chillers, valves, dampers, etc. required for the installation of the control system, as herein specified shall be provided by the control contractor unless specifically shown on the electrical drawings or called for in the electrical specifications.
 - a. The wiring installation shall be in accordance with National and Local Codes and with the Electrical portion of these specifications. All wiring shall be run concealed wherever possible. Exposed wiring in occupied areas shall be run in raceways. Raceways shall be Wiremold 200 series with all elbows, raceways, covers, mounting stops, box extensions and wiring for a complete and neat installation. All wiring located in mechanical spaces, boiler rooms, fan rooms, etc. shall be installed in metal conduit
 - b. All wiring above ceilings, in boiler rooms, and all mechanical spaces shall follow routing of piping and where not possible shall be in conduit. All exposed wire shall be bundled and wire tied and shall be supported to adjacent piping. Draped and free floating wire will not be allowed.
 - c. All terminations of wire at control devices shall be looped and supported adequately.
 - d. All wiring shall comply with the requirements of the electrical section of the specification.
- D. Controls Systems Wiring
 1. All conduit raceways, wiring, accessories and wiring connections required for the installation of the Controls Systems shall be provided by the Controls Contractor except as shown on the Electrical Trade documents. All wiring shall comply with the requirements of applicable portions of the Electrical Trade work and all local and national electric codes and the requirements of the AHJ.
 2. All Controls Systems wiring materials and installation methods shall comply with the original equipment manufacturer recommendations and standards.
 3. The sizing type and provision of cable, conduit, cable trays and raceways shall be the design responsibility of the Controls Contractor.
 4. Class 2 Wiring
 - a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
 - b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5ft. from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines.
 5. Class 2 signal wiring and 24VAC power may be run in the same conduit. Power wiring 120VAC and greater shall not share the same conduit with Class 2 signal wiring.
 6. Perform circuit tests using qualified personnel only. Provide necessary instruments and equipment to demonstrate that:
 - a. All circuits are continuous and free from short circuits and grounds.
 - b. All circuits are free from unspecified grounds; that resistance to ground of all circuits is no less than 50 megohms.
 - c. All circuits are free from induced voltages.
 7. Provide complete testing for all cables and wiring. Provide all equipment, tools, and personnel as necessary to conduct these tests.
 8. Provide for complete grounding of all signal and communication cables, panels and equipment so as to ensure integrity of Controls Systems operation. Ground cabling and conduit at panel terminations. Do not create ground loops.

E. Line Voltage Power Sources

1. 120-volt AC circuits for the Controls Systems shall be taken by the Controls Contractor from electrical trade panelboards and circuit breakers as designated on the electrical drawings.
2. Circuits used for the Controls Systems shall be dedicated to these Controls Systems and shall not be used for any other services.
3. Controls DDC terminal unit controllers may use 120-volt AC power from motor power circuits.

F. Controls Systems Raceways

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in the Specification. Minimum conduit size 3/4".
2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.
3. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the supporting surface.
4. UL/ULC Listed Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls and for final connection to equipment.

G. Penetrations

1. Firestopping for all penetrations used by dedicated Controls Systems conduits and raceways shall be by other trades.
2. All openings in fire proofed or fire stopped components shall be closed by other trades using approved fire resistive sealant.
3. All wiring passing through penetrations, including walls, shall be in sleeves, conduit or enclosed raceway.
4. No penetrations through building structural elements, slabs, ceilings and walls shall be made before receipt of written approval from the Architect.

H. Controls Systems Identification Standards

1. Node Identification: All nodes shall be identified by a permanent label fastened to the outside of the enclosure. Labels shall be suitable for the node environmental location.
2. Cable shall be labeled at every termination with cross-referencing to record documentation.
3. Raceway Identification: Exposed covers to junction and pull boxes of the FMS raceways shall be identified at primary points.
4. Wire Identification: All low and line voltage wiring shall be identified by a number, as referenced to the associated shop and record drawing, at each termination.
5. Wires and cabling shall not be spliced between terminations. Cable shields shall be single end grounded – typically at the panel end outside the panel.
6. Suggested color coding, for use at the Contractors option, are:
 - a. Analog Input Cable Yellow
 - b. Analog Output Cable Tan
 - c. Binary Input Cable Orange
 - d. Binary Output Cable Violet
 - e. 24 VAC Cable Gray
 - f. General Purpose Cable Natural
 - g. Tier 1 Comm Cable Purple
 - h. Other Tier Comm Cable Blue
7. Provide permanent identification labels at all valve and damper actuators to indicate open and closed positions.

- I. Field Panel And Device Installations And Locations
 - 1. The Controls Systems panels, enclosures and cabinets shall be located as coordinated with the Architect at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.
 - 2. All field devices shall be installed per the manufacturer recommendation and in accessible locations as coordinated with the Architect.
 - 3. Panels to be located in damp areas or areas subject to condensation shall be mounted with wall standoffs.
 - 4. Conduit configurations entering or leaving panels and devices shall be such as to preclude condensation traps.
- J. Networking Communications
 - 1. The design of the BAS shall network operator workstations and stand-alone DDC Controllers. The network architecture shall consist of multiple levels for communication efficiency, a campus-wide (Management Level Network) Ethernet network based on TCP/IP protocol, high performance peer-to-peer building level network(s) and DDC Controller floor level local area networks with access being totally transparent to the user when accessing data or developing control programs.
 - 2. System shall communicate with a BACnet network over Ethernet (MS/TP) (according to Annex J). The intent is to use the system provided under this contract to communicate with control systems and/or devices provided by other vendors. A PICS must be provided describing the BACnet, ANSI/ASHRAE 135-95, implementation. The product shall be Network Application Engine level 1 controllers with field equipment controller for level 2 controllers no substitutions. Minimum system functionality must include monitoring, commanding, and alarming for daily operator functions from a common workstation.
 - a. System shall have the capability to be an OPC Client and Server for dynamic communication with OPC Clients or Servers over an Ethernet network. At a minimum, the following must be supported:
 - 1. Data Access 1.0 (96), 1.0A (97) and 2.0 (11/98)
 - 2. Alarms & Events 1.0 (1/99)
 - 3. Peer-to-Peer Building Level 1 Network:
 - a. All operator devices either network resident or connected via dial-up modems shall have the ability to access all point status and application report data or execute control functions for any and all other devices via the peer-to-peer network. No hardware or software limits shall be imposed on the number of devices with global access to the network data at any time.
 - b. The peer-to-peer network shall support a minimum of 100 DDC controllers and PC workstations
 - c. Each PC workstation shall support a minimum of 4 peer to peer networks hardwired or dial up.
 - d. The system shall support integration of third party systems (fire alarm, security, lighting, PCL, chiller, boiler) via panel mounted open protocol processor. This processor shall exchange data between the two systems for interprocess control. All exchange points shall have full system functionality as specified herein for hardwired points.
 - e. Field panels must be capable of integration with open standards including Modbus, BACnet, and Lonworks as well as with third party devices via existing vendor protocols.
 - f. The peer-to-peer Building Level Network shall use the TCP/IP over Ethernet. All devices must:
 - 1. Auto-sense 10/100 Mbps networks.
 - 2. Receive an IP Address from a Dynamic Host Configuration Protocol (DHCP) Server or be configured with a Fixed IP Address.

3. Resolve Name to IP Addresses for devices using a Domain Name Service (DNS) Server on the Ethernet network.
4. Allow access using Telnet.
4. Intranet/Internet access
 - a. Web Based Operator Interface
 1. The BAS shall provide a web based graphical interface that allows users to access the BAS data via the Internet, extranet, or Intranet. The interface shall use HTML based ASP pages to send and receive data from the BAS to a web browser.
 2. A web server computer will be supplied. The web server shall use Microsoft's Windows 7, and support browser access via Microsoft Internet Explorer 10 (or higher).
 3. All information exchanged over Internet shall be optionally encrypted and secure via SSL (provided by Owner).
 4. Access to the web interface may be password protected. A users rights and privileges to points and graphics will be the same as those assigned at the BAS workstation. An option will exist to only allow users "read" access via the web browser, while maintaining "command" privileges via the BAS workstation.
 5. Commissioning of the Web interface shall not require modification or creation of HTML or ASP pages. All graphics available at the BAS graphical workstation shall be available to users via a web browser.
 6. The web-based interface shall provide the following functionality to users, based on their access and privilege rights:
 - a. Logon Screen – allows the user to enter their user name, password and Domain name for logging into the web server.
 - b. Alarm Display – a display of current BAS alarms to which the user has access will be displayed. Users will be able to acknowledge and erase active alarms, and link to additional alarm information including alarm messages, and informational and memo text. Any alarm acknowledgements initiated through the web interface will be written to the BAS central workstation activity log.
 - c. Graphic Display – Display of system graphics, including animated motion, available in the BAS workstation will be available for viewing over the web browser. Software that requires creation of dedicated "web" graphics in order to display them via the browser interface will not be acceptable. A graphic selector list will allow users to select any graphics to which they have access. Graphic displays will automatically refresh with the latest change of values. Users will have the ability to command and override points from the graphic display as determined by their user accounts rights.
 - d. Point details – users will have access to point detail information including operational status, operational priority, physical address, and alarm limits, for point objects to which they have access rights.
 - e. Point Commanding – users will be able to override and command points they have access to via the web browser interface. Any commands or overrides initiated via the web browser interface will be written to the BAS central workstation activity log.
5. The web server licensing options will allow concurrent access by a minimum of (10) browser connections.
6. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the web access feature.

- K. DDC Controller Floor Level 2 Network
 - 1. This level communication shall support a family of application specific controllers and shall communicate with the peer-to-peer network through DDC Controllers for transmission of global data.
- L. DDC & HVAC Mechanical Equipment Controllers <TEC>
 - 1. The DDC & HVAC Mechanical Equipment Controllers shall reside on the Building Level Network.
 - 2. DDC & HVAC Mechanical Equipment Controllers shall use the same programming language and tools. DDC & HVAC Mechanical Equipment Controllers which require different programming language or tools on a network are not acceptable.
 - 3. DDC & HVAC Mechanical Equipment Controllers which do not meet the functions specified are not acceptable.
- M. DDC Controller
 - 1. DDC Controllers shall be a 16-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors, communication controllers, power supplies and input/output point modules. Controller size shall be sufficient to fully meet the requirements of this specification and the attached point I/O schedule. Each controller shall support a minimum of three (3) Floor Level Application Specific Controller Device Networks.
 - 2. Each DDC Controller shall have 72 Megabytes of memory to support its own operating system and databases, including:
 - a. Control processes
 - b. Energy management applications
 - c. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
 - d. Historical/trend data for points specified
 - e. Maintenance support applications
 - f. Custom processes
 - g. Operator I/O
 - h. Dial-up communications
 - i. Manual override monitoring
 - 3. Each DDC Controller shall support firmware upgrades without the need to replace hardware.
 - 4. Provide all processors, power supplies and communication controllers so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.
 - 5. DDC Controllers shall provide a RS-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals. DDC Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.
 - 6. As indicated in the point I/O schedule, the operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points.
 - a. Switches shall be mounted either within the DDC Controllers key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.
 - b. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

7. DDC Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Graduated intensity LEDs or analog indication of value shall also be provided for each analog output. Status indication shall be visible without opening the panel door.
 8. Each DDC Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
 9. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
 - a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3 V
 - b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact
 - c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500 V signal, 1 kV power
 - d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max)
 - e. Isolation shall be provided at all peer-to-peer panel's AC input terminals to suppress induced voltage transients consistent with:
 1. IEEE Standard 587-1980
 2. UL 864 Supply Line Transients
 3. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)
 10. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 60 days.
 - a. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.
 - b. Should DDC Controller memory be lost for any reason, the user shall have the capability of reloading the DDC Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.
 11. Provide a separate DDC Controller for each RTU or other HVAC system as indicated on the control diagram drawing. It is intended that each unique system be provided with its own point resident DDC Controller.
 12. Radiant floor and Snow Melt system shall integrate to the building management system utilizing a controller similar to Tekmar model 680.
- N. HVAC Mechanical Equipment Controllers
1. HVAC Mechanical Equipment Controllers shall be a 12-bit stand-alone, multi-tasking, multi-user, real-time digital control processors consisting of modular hardware with plug-in enclosed processors.
 2. Each HVAC Mechanical Controller shall have 72 Megabytes of memory to support its own operating system and databases, including:
 - a. Control processes
 - b. Energy management applications
 - c. Alarm management applications including custom alarm messages for each level alarm for each point in the system.
 - d. Historical/trend data for points specified
 - e. Maintenance support applications
 - f. Custom processes
 - g. Operator I/O
 - h. Remote communications

3. HVAC Mechanical Equipment Controllers shall provide a RS-232C serial data communication port for operation of operator I/O devices such as industry standard printers, operator terminals, modems and portable laptop operator's terminals.
 4. HVAC Mechanical Equipment Controllers shall provide local LED status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.
 5. Each HVAC Mechanical Equipment Controller shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all components. The HVAC Mechanical Equipment Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.
 6. In the event of the loss of normal power, there shall be an orderly shutdown of all HVAC Mechanical Equipment Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
 - a. Upon restoration of normal power, the HVAC Mechanical Equipment Controller shall automatically resume full operation without manual intervention.
 - b. Should HVAC Mechanical Equipment Controller memory be lost for any reason, the user shall have the capability of reloading the HVAC Mechanical Equipment Controller via the local RS-232C port, via telephone line dial-in or from a network workstation PC.
- O. DDC & HVAC Mechanical Equipment Controller Resident Software Features
1. General:
 - a. The software programs specified in this Section shall be provided as an integral part of DDC and HVAC Mechanical Equipment Controllers and shall not be dependent upon any higher level computer for execution.
 - b. All points shall be identified by up to 30 character point name and 16 character point descriptor. The same names shall be used at the PC workstation.
 - c. All digital points shall have user defined two-state status indication (descriptors with minimum of 8 characters allowed per state (i.e. summer/winter)).
 2. Control Software Description:
 - a. The DDC and HVAC Mechanical Equipment Controllers shall have the ability to perform the following pre-tested control algorithms:
 1. Two-position control
 2. Proportional control
 3. Proportional plus integral control
 4. Proportional, integral, plus derivative control
 5. Automatic tuning of control loops
 3. DDC and HVAC Mechanical Equipment Controllers shall provide the following energy management routines for the purpose of optimizing energy consumption while maintaining occupant comfort.
 - a. Start-Stop Time Optimization (SSTO) shall automatically be coordinated with event scheduling. The SSTO program shall start HVAC equipment at the latest possible time that will allow the equipment to achieve the desired zone condition by time of occupancy. The SSTO program shall also shut down HVAC equipment at the earliest possible time before the end of the occupancy period, and still maintain desired comfort conditions.
 1. The SSTO program shall operate in both the heating and cooling seasons.
 - a. It shall be possible to apply the SSTO program to individual fan systems.
 - b. The SSTO program shall operate on both outside weather conditions as well as inside zone conditions and empirical factors.
 2. The SSTO program shall meet the local code requirements for minimum outside air while the building is occupied.

- b. Event Scheduling: Provide a comprehensive menu driven program to automatically start and stop designated points or groups of points according to a stored time.
 - 1. It shall be possible to individually command a point or group of points.
 - 2. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start or stop within that group.
 - 3. The operator shall be able to define the following information:
 - a. Time, day
 - b. Commands such as on, off, auto, and so forth.
 - c. Time delays between successive commands.
 - d. There shall be provisions for manual overriding of each schedule by an appropriate operator.
 - 4. It shall be possible to schedule events up to one year in advance.
 - a. Scheduling shall be calendar based.
 - b. Holidays shall allow for different schedules.
 - c. Enthalpy switchover (economizer). The Energy Management Control Software (EMCS) will control the position of the air handler relief, return, and outside air dampers. If the outside air dry bulb temperature falls below changeover set point the EMCS will modulate the dampers to provide 100 percent outside air. The user will be able to quickly changeover to an economizer system based on dry bulb temperature and will be able to override the economizer cycle and return to minimum outside air operation at any time.
 - d. Temperature-compensated duty cycling.
 - 1. The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.
 - 2. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.
 - e. Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.
 - f. Night setback control: The system shall provide the ability to automatically adjust setpoints for night control.
 - g. The Peak Demand Limiting (PDL) program shall limit the consumption of electricity to prevent electrical peak demand charges.
 - 1. PDL shall continuously track the amount of electricity being consumed, by monitoring one or more electrical kilowatt-hour/demand meters. These meters may measure the electrical consumption (kWh), electrical demand (kW), or both.
 - 2. PDL shall sample the meter data to continuously forecast the demand likely to be used during successive time intervals.
 - 3. If the PDL forecasted demand indicates that electricity usage is likely to exceed a user preset maximum allowable level, then PDL shall automatically shed electrical loads.
 - 4. Once the demand peak has passed, loads that have been shed shall be restored and returned to normal control.
- 4. DDC and HVAC Mechanical Equipment Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
 - a. A single process shall be able to incorporate measured or calculated data from any and all other DDC and HVAC Mechanical Equipment Controllers on the network. In addition, a single process shall be able to issue commands to points in any and all other DDC and HVAC Mechanical Equipment Controllers on the network. Database shall support 30 character, English language point names, structured for searching and logs.

- b. Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.
 - c. DDC and HVAC Mechanical Equipment Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.
 - d. DDC and HVAC Mechanical Equipment Controller shall be capable of comment lines for sequence of operation explanation.
- 5. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC and HVAC Mechanical Equipment Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC and HVAC Mechanical Equipment Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
 - a. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.
 - b. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of six priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC and HVAC Mechanical Equipment Controller shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.
 - c. Alarm reports and messages will be directed to a user-defined list of operator devices or PCs based on time (after hours destinations) or based on priority.
 - d. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.
 - e. In dial-up applications, operator-selected alarms shall initiate a call to a remote operator device.
- 6. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for points as specified in the I/O summary.
 - a. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC and HVAC Mechanical Equipment Controllers point group. Two methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of 1 minute to 7 days shall be provided. Each DDC and HVAC Mechanical Equipment Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a sufficient number of data samples. All trend data shall be available for transfer to a Workstation without manual intervention.
 - b. DDC and HVAC Mechanical Equipment Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for operator-selected PID control loops as identified in the point I/O summary.
 - 1. Loop tuning shall be capable of being initiated either locally at the DDC and HVAC Mechanical Equipment Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

7. DDC and HVAC Mechanical Equipment Controllers shall be capable of automatically accumulating and storing run-time hours for digital input and output points and automatically sample, calculate and store consumption totals for analog and digital pulse input type points, as specified in the point I/O schedule.
 8. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to access any data from or send control commands and alarm reports directly to any other DDC and HVAC Mechanical Equipment Controller or combination of controllers on the network without dependence upon a central or intermediate processing device. DDC and HVAC Mechanical Equipment Controllers shall send alarm reports to multiple workstations without dependence upon a central or intermediate processing device. The peer to peer network shall also allow any DDC and HVAC Mechanical Equipment Controller to access, edit, modify, add, delete, back up, and restore all system point database and all programs.
 9. The peer to peer network shall allow the DDC and HVAC Mechanical Equipment Controllers to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any PC workstation or portable operator terminal) shall enable the operator to monitor, adjust and control the points that the operator is authorized for. All other points shall not be displayed on the PC workstation or portable terminal (e.g. all base building and all tenant points shall be accessible to any base building operators, but only tenant points shall be accessible to tenant building operators). Passwords and priorities for every point shall be fully programmable and adjustable.
- P. Floor Level Network Application Specific Controllers (FEC)
1. Each DDC Controller shall be able to extend its performance and capacity through the use of remote application specific controllers (FECs) through Floor Level LAN Device Networks.
 2. Each FEC shall operate as a stand-alone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each FEC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Each FEC shall be capable of control of the terminal device independent of the manufacturer of the terminal device.
 3. Terminal Equipment Controllers:
 - a. Provide for control of each piece of equipment, including, but not limited to, the following:
 1. VFR Equipment
 2. Heating Coils
 3. ERV
 4. Exhaust Fans
 5. Unit Heaters, Cabinet Unit Heaters
 6. Radiant Floor and Snowmelt
 - b. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. Analog outputs shall be industry standard signals such as 24V floating control, 3-15 psi pneumatic, 0-10v, allowing for interface to a variety of modulating actuators.
 - c. All controller sequences and operation shall provide closed loop control of the intended application. Closing control loops over the FLN, BLN or MLN is not acceptable.

Q. Local User Display

Where specified in the sequence of operation or points list, the controllers on the peer to peer building level network shall have a display and keypad for local interface. A keypad shall be provided for interrogating and commanding points in the controller.

1. The display shall use the same security password and access rights for points in the display as is used in the associated controller.
2. The LCD display shall be a minimum of a 2 line 40 character display.
3. The LCD display shall include the full point name, value (numeric, digital or state text), point priority and alarm status on one screen.
5. The LCD shall dynamically update the value, priority, and alarm status for the point being displayed.
6. The display shall be mounted either on the door of the enclosure or remote from the controller.

R. Personal Computer Operator Laptop Hardware

1. Personal computer operator workstations shall be provided for command entry, information management, system monitor, alarm management and database management functions. All real-time control functions shall be resident in the DDC Controllers to facilitate greater distribution, fault tolerance and reliability of the building automation control.
 - a. Provide laptop of equal capability located at room indicated on drawings.
 - b. Laptop shall consist of a personal computer with minimum 8.0GB RAM, hard drive with minimum 1 TB available space, video card capable of supporting 1024 x 768 resolution with a minimum of 32 Bit color, Windows 10 Professional, DVD-ROM Drive, mouse and 101-key enhanced keyboard. Personal computer shall be a Windows 10 Professional Compatible PC and shall include a minimum i5 Pentium processor.
2. Alarm Display shall list the alarms with highest priority at the top of the display. The alarm display shall provide selector buttons for display of the associated point graphic and message. The alarm display shall provide a mechanism for the operator to sort alarms.
3. Intranet/Internet access
 - a. Web Based Operator Interface
 1. The BAS shall provide a web based graphical interface that allows users to access the BAS data via the Internet, extranet, or Intranet. The interface shall use HTML based ASP pages to send and receive data from the BAS to a web browser.
 2. A web server computer will be supplied. The web server shall use Microsoft's Windows 10, and support browser access via Microsoft Internet Explorer 10 (or higher).
 3. All information exchanged over Internet shall be optionally encrypted and secure via SSL (provided by Owner).
 4. Access to the web interface may be password protected. A users rights and privileges to points and graphics will be the same as those assigned at the BAS workstation. An option will exist to only allow users "read" access via the web browser, while maintaining "command" privileges via the BAS workstation.
 5. Commissioning of the Web interface shall not require modification or creation of HTML or ASP pages. All graphics available at the BAS graphical workstation shall be available to users via a web browser.
 6. The web-based interface shall provide the following functionality to users, based on their access and privilege rights:
 - a. Logon Screen – allows the user to enter their user name, password and Domain name for logging into the web server.

- b. Alarm Display – a display of current BAS alarms to which the user has access will be displayed. Users will be able to acknowledge and erase active alarms, and link to additional alarm information including alarm messages, and informational and memo text. Any alarm acknowledgements initiated through the web interface will be written to the BAS central workstation activity log.
 - c. Graphic Display – Display of system graphics, including animated motion, available in the BAS workstation will be available for viewing over the web browser. Software that requires creation of dedicated “web” graphics in order to display them via the browser interface will not be acceptable. A graphic selector list will allow users to select any graphics to which they have access. Graphic displays will automatically refresh with the latest change of values. Users will have the ability to command and override points from the graphic display as determined by their user accounts rights.
 - d. Point details – users will have access to point detail information including operational status, operational priority, physical address, and alarm limits, for point objects to which they have access rights.
 - e. Point Commanding – users will be able to override and command points they have access to via the web browser interface. Any commands or overrides initiated via the web browser interface will be written to the BAS central workstation activity log.
- 7. The web server licensing options will allow concurrent access by a minimum of 10 browser connections.
 - 8. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the Owner as required to support the web access feature.

S. Operator Interface

1. Basic Interface Description

- a. Operator workstation interface software shall minimize operator training through the use of user-friendly and interactive graphical applications, 30-character English language point identification, on-line help, and industry standard Windows application software. Interface software shall simultaneously communicate with existing system and share data between the dedicated, modem autodial, and Ethernet-connected building level networks. The software shall provide, as a minimum, the following functionality:
 - 1. Real-time graphical viewing and control of the BAS environment
 - 2. Reporting
 - 3. Scheduling and override of building operations
 - 4. Collection and analysis of historical data
 - 5. Point database editing, storage and downloading of controller databases.
 - 6. Utility for combining points into logical Point Groups. The Point Groups shall then be manipulated in Graphics, trend graphs and reports in order to streamline the navigation and usability of the system.
 - 7. Alarm reporting, routing, messaging, and acknowledgment
 - 8. “Collapsible tree,” dynamic system architecture diagram application:
 - a. Showing the real-time status and definition details of all workstations and devices on a management level network
 - b. Showing the real-time status and definition details of all DDC and HVAC Mechanical Controllers at the building level
 - c. Showing the status and definition details of all field-level application controllers

9. Definition and construction of dynamic color graphic displays.
 10. Online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.
 11. On-screen access to User Documentation, via online help or PDF-format electronic file.
 12. Automatic database backup at the workstation for database changes initiated at DDC Controller operator interface terminals.
- b. Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a "drag and drop" approach to inter-application navigation. Selection of applications within the workstation software shall be via a graphical toolbar menu – the application toolbar menu shall have the option to be located in a docked position on any of the four sides of the visible desktop space on the workstation display monitor, and the option to automatically hide itself from the visible monitor workspace when not being actively manipulated by the user.
 - c. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. BAS software shall run on a Windows 10 Professional operating system. System database parameters shall be stored within an object-oriented database, which is compliant with the Open Database Connectivity (ODBC) or Structured Query Language (SQL) standards. Standard Windows applications shall run simultaneously with the BAS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BAS alarms and monitoring information
 - d. Provide functionality such that any of the following may be performed simultaneously on-line, and in any combination, via adjustable user-sized windows. Operator shall be able to drag and drop information between the following applications, reducing the number of steps to perform a desired function (e.g., Click on a point on the alarm screen and drag it to the dynamic trend graph application to initiate a dynamic trend on the desired point):
 1. Dynamic color graphics application
 2. Alarm management application
 3. Scheduling application
 4. Dynamic trend graph data plotter application
 5. Dynamic system architecture diagram application
 6. Control Program and Point database editing applications
 7. Reporting applications
 8. Report and alarm printing shall be accomplished via Windows Print Manager, allowing use of network printers.
 - e. Operator-specific password access protection shall be provided to allow the administrator/manager to limit users' workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password. Operator privileges shall "follow" the operator to any workstation logged onto (up to 999 user accounts shall be supported). The administrator/manager shall be able to grant discrete levels of access and privileges, per user, for each point, graphic, report, schedule, and BAS workstation application. And each BAS workstation user account shall use a Windows 10 user account as a foundation.
 - f. Dynamic Color Graphics application shall include the following:
 1. Must include graphic editing and modifying capabilities
 2. A library of standard control application graphics and symbols must be included

3. Must be able to command points directly off graphics application
4. Graphic display shall include the ability to depict real-time point values dynamically with animation, picture/frame control, symbol association, or dynamic informational text-blocks.
5. Navigation through various graphic screens shall be optionally achieved through a hierarchical "tree" structure
6. Graphics viewing shall include zoom capabilities
7. Graphics shall automatically display the HAND status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.
8. Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls, etc.), internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.
- g. Reports shall be generated on demand or via pre-defined schedule, and directed to CRT displays, printers or file. As a minimum, the system shall allow the user to easily obtain the following types of reports:
 1. A general listing of all or selected points in the network
 2. List of all points currently in alarm
 3. List of all points currently in override status
 4. List of all disabled points
 5. List of all points currently locked out
 6. List of user accounts and access levels
 7. List all weekly schedules and events
 8. List of holiday programming
 9. List of control limits and deadbands
 10. Custom reports from 3rd party software
 11. System diagnostic reports including, list of DDC panels on line and communicating, status of all DDC terminal unit device points
 12. List of programs
 13. List of point definitions
 14. List of logical point groups
 15. List of alarm strategy definitions
 16. List of DDC Control panels
 17. Point totalization report
 18. Point Trend data listings
 19. Initial Values report
 20. User activity report

- h. Scheduling and override
Provide a calendar type format for simplification of time and date scheduling and overrides of building operations. Schedule definitions reside in the PC workstation, DDC Controller, and HVAC Mechanical Equipment Controller to ensure time equipment scheduling when PC is off-line -- PC is not required to execute time scheduling. Provide override access through menu selection, graphical mouse action or function key. Provide the following capabilities as a minimum:
 - 1. Weekly schedules
 - 2. Zone schedules
 - 3. Event schedules – an event consists of logical combinations of equipment and/or zones
 - 4. Report schedules
 - 5. Ability to schedule for a minimum of up to 365 days in advance
 - 6. Additionally, the scheduling application shall:
 - a. Provide filtering capabilities of schedules, based on name, time, frequency, and schedule type (event, zone, report)
 - b. Provide sorting capabilities of schedules, based on name, time and type of schedule (zone, event, report)
 - c. Provide searching capabilities of schedules based on name – with wildcarding options
- i. Collection and Analysis of Historical Data
 - 1. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals (up to four time-based definitions per point) or change of value, both of which shall be user-definable. Trend data shall be collected stored on hard disk for future diagnostics and reporting. Automatic Trend collection may be scheduled at regular intervals through the same scheduling interface as used for scheduling of zones, events, and reports. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
 - 2. Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of selected points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred on-line to Microsoft Excel. DDC contractor shall provide custom designed spreadsheet reports for use by the owner to track energy usage and cost, equipment run times, equipment efficiency, and/or building environmental conditions. DDC contractor shall provide setup of custom reports including creation of data format templates for monthly or weekly reports.
- j. The ATC contractor shall provide an additional 40 hours of ATC/BMS system programming time to assist the owner with customized programming of the ATC/BMS system.
- 2. Dynamic Color Graphic Displays
 - a. Create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems and hot water boiler systems, and room level terminal units, shall be provided by the BAS contractor as indicated in the point I/O schedule of this specification to optimize system performance, analysis and speed alarm recognition.
 - b. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, point alarm association, or text-based commands. Graphics software shall permit the importing of Autocad or scanned pictures for use in the system.

- c. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations within the system schematics or graphic floor plan displays, and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.
 - 1. Provide the user the ability to display real-time point values by animated motion or custom picture control visual representation. Animation shall depict movement of mechanical equipment, or air or fluid flow. Picture Control shall depict various positions in relation to assigned point values or ranges. A library (set) of animation and picture control symbols shall be included within the workstation software's graphics application. Animation shall reflect, ON or OFF conditions, and shall also be optionally configurable for up to five rates of animation speed.
 - 2. Sizable analog bars shall be available for monitor and control of analog values; high and low alarm limit settings shall be displayed on the analog scale. The user shall be able to "click and drag" the pointer to change the setpoint.
 - 3. Provide the user the ability to display blocks of point data by defined point groups; alarm conditions shall be displayed by flashing point blocks.
 - 4. Equipment state or values can be changed by clicking on the associated point block or graphic symbol and selecting the new state (on/off) or setpoint.
 - 5. State text for digital points can be user-defined up to eight characters.
 - d. Colors shall be used to indicate status and change as the status of the equipment changes. The state colors shall be user definable.
 - e. Advanced linking within the Graphics application shall provide the ability to navigate to outside documents (e.g., .doc, .pdf, .xls, etc.), internet web addresses, e-mail, external programs, and other workstation applications, directly from the Graphics application window with a mouse-click on a customizable link symbol.
 - f. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
 - g. Off the shelf graphic software, html web-based graphic software shall be provided to allow the user to add, modify or delete system graphic background displays.
 - h. A clipart library of HVAC application and automation symbols shall be provided including fans, valves, motors, RTU systems, standard ductwork diagrams. The user shall have the ability to add custom symbols to the clipart library. The clipart library shall include a minimum of 400 application symbols. In addition, a library consisting of a minimum of 700 graphic background templates shall be provided.
 - i. The Graphics application shall include a set of standard Terminal Equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected Terminal Equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.
3. System Configuration and Definition
- a. A "Collapsible tree," dynamic system architecture diagram/display application of the site-specific BAS architecture showing status of controllers, PC workstations and networks shall be provided. This application shall include the ability to add and configure workstations, DDC Controllers or HVAC Mechanical Equipment controllers, as well as 3rd-party integrated components. Symbols/icons representing the system architecture components shall be user-configurable and customizable, and a library of customized icons representing 3rd-party integration solutions shall be included. This application shall also include the functionality for real-time display, configuration and diagnostics of dial-up modems to DDC Controllers.

- b. Network wide control strategies shall not be restricted to a single DDC Controller or HVAC Mechanical Equipment controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.
 - c. Provide automatic backup and restore of all DDC controller and HVAC Mechanical Equipment controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate DDC Controller or HVAC Mechanical Equipment Controller. Changes made at the user-interface of DDC Controllers or HVAC Mechanical Equipment Controllers shall be automatically uploaded to the workstation, ensuring system continuity.
 - d. System configuration, programming, editing, graphics generation shall be performed on-line. If programming and system back-up must be done with the PC workstation off-line, the BAS contractor shall provide at least 2 operator workstations.
 - e. Point database configuration shall be available to the user within a dedicated point database editor application included in the workstation software. The editor shall allow the user to create, view existing, modify, copy, and delete points from the database. The point editor shall also allow the user to configure the alarm management strategy for each point. The editor shall provide the option for editing the point database in an online or offline mode with the DDC Controllers.
 - 1. The workstation software shall also provide the capability to perform bulk modification of point definition attributes to a single or multiple user-selected points. This function shall allow the user to choose the properties to copy from a selected point to another point or set of points. The selectable attributes shall include, but are not limited to, Alarm management definitions and Trend definitions.
4. Alarm Management
- a. Alarm Routing shall allow the user to send alarm notification to selected printers or workstation location(s) based on time of day, alarm severity, or point type.
 - b. Alarm Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each alarm point: name, value, alarm time & date, alarm status, priority, acknowledgement information, and alarm count. Each alarm point or priority shall have the ability to sound a discrete audible notification.
 - c. Alarm Display shall have the ability to list & sort the alarms based on alarm status, point name, ascending or descending alarm time.
 - d. Directly from the Alarm Display, the user shall have the ability to acknowledge, silence the alarm sound, print, or erase each alarm. The interface shall also have the option to inhibit the erasing of active acknowledged alarms, until they have returned to normal status. The user shall also have the ability to command, launch an associated graphic or trended graphical plot, or run a report on a selected alarm point directly on the Alarm Display.
 - e. Each alarm point shall have a direct link from the Alarm Display to further user-defined point informational data. The user shall have the ability to also associate real-time electronic annotations or notes to each alarm.
 - f. Alarm messages shall be customizable for each point, or each alarm priority level, to display detailed instructions to the user regarding actions to take in the event of an alarm. Alarm messages shall also have the optional ability to individually enunciate on the workstation display via a separate pop-up window, automatically being generated as the associated alarm condition occurs.
 - g. Alarm Display application shall allow workstation operators to send and receive real-time messages to each other, for purposes of coordinating Alarm and BAS system management.

h. Remote notification of messages

1. Workstation shall be configured to send out messages to numeric pagers, alphanumeric pagers, phones (via text to speech technology), SMS (Simple Messaging Service, text messaging) Devices, and email accounts based on a point's alarm condition.
2. There shall be no limit to the number of points that can be configured for remote notification of alarm conditions and no limit on the number of remote devices which can receive messages from the system.
3. On a per point basis, system shall be configurable to send messages to an individual or group and shall be configurable to send different messages to different remote devices based on alarm message priority level.
4. Remote devices may be scheduled as to when they receive messages from the system to account for operators' work schedules.
5. System must be configurable to send messages to an escalation list so that if the first device does not respond, the message is sent on to the next device after a configurable time has elapsed.
6. Message detail shall be configurable on a per user basis.
7. During a "flood" of alarms, remote notification messages shall have the ability to optimize several alarms into an individual remote notification message.
8. Workstation shall have the ability to send manual messages allowing an operator to type in a message to be sent immediately.
9. Workstation shall have a feature to send a heartbeat message to periodically notify users that they have communication with the system.

T. Field Devices

1. Provide instrumentation as required for monitoring, control or optimization functions.
2. Room Temperature Sensors
 - a. Office areas shall be provided with digital room sensors shall have LCD display, day / night override button, and setpoint slide adjustment override options. The setpoint slide adjustment can be software limited by the automation system to limit the amount of room adjustment. Public areas such as corridors, entry areas, vestibules, restrooms shall have chrome cover plate without adjustment or occupied/unoccupied capability. Temperature sensors located in sally ports and cell block areas shall be provided with open cage guard. All temperature sensors shall be BACnet compatible network type.

Temperature monitoring range	+20/120°F -13° to 49°C)
Output signal	Changing resistance
Accuracy at Calibration point	+0.5°F (+/- 0.3°C)
Set Point and Display Range	55° to 95° F (13° to 35°C)

Liquid immersion temperature:	
Temperature monitoring range	+30/250°F (-1°/121°C)
Output signal	Changing resistance
Accuracy at Calibration point	+0.5°F (+/-0.3°C)

Duct (single point) temperature:	
Temperature monitoring range	+20/120°F (-7°/49°C)
Output signal	Changing resistance
Accuracy at Calibration point	+0.5°F (+/-0.3°C)

Duct Average temperature:	
monitoring range	+20° +120°F(-7°/+49°C)

- | | | |
|----|---|--|
| | Output signal | 4 – 20 mA DC |
| | Accuracy at Calibration point | +0.5°F (+0.3°C) |
| | Sensor Probe Length | 25' L (7.3m) |
| | Outside air temperature: | |
| | Temperature monitoring range | -58°+122° F(-50°C to +50°C) |
| | signal | 4 – 20 mA DC |
| | Accuracy at Calibration point | +0.5°F (+/-0.3°C) |
| 3. | Liquid Differential Pressure Transmitter | |
| | Ranges | 0-5/30 inches H2O
0-25/150 inches H2O
0-125/750 inches H2O |
| | Output | 4 – 20 mA DC |
| | Calibration Adjustments | Zero and span |
| | Accuracy | +/-0.2% of span |
| | Linearity | +/-0.1% of span |
| | Hysteresis | +/-0.05% of span |
| 4. | Differential pressure: | |
| | a. Unit for fluid flow proof shall be Penn P74. | |
| | Range | 8 to 70 psi |
| | Differential | 3 psi |
| | Maximum differential pressure | 200 psi |
| | Maximum pressure | 325 psi |
| | b. Unit for air flow settings. | |
| | Set point ranges: | 0.5" WG to 1.0" WG (124.4 to 248.8 Pa)
1.0" WG to 12.0" WG (248.8 to 497.6 Pa) |
| 5. | Static pressure sensor: | |
| | Range | 0 to .5" WG (0 to 124.4 Pa)
0 to 1" WG (0 to 248.8 Pa)
0 to 2" WG (0 to 497.7 Pa)
0 to 5" WG (0 to 1.2 kPa)
0 to 10" WG (0 to 2.5 kPa) |
| | Output Signal | 4 – 20 mA VDC |
| | Combined static error | 0.5% full range |
| | Operating Temperature | -40° to 175° F (-40C to 79.5°C) |
| 6. | Air Pressure Sensor: | |
| | Range: | 0 to 0.1 in. water (0 to 24.9 Pa)
0 to 0.25 in. water (0 to 63.2 Pa)
0 to 0.5 in. water (0 to 124.5 Pa)
0 to 1.0 in. water (0 to 249 Pa)
0 to 2.0 in water 90 to 498 Pa)
0 to 5.0 in. water (0 to 1.25 kPa)
0 to 10.0 in.water (0 to 2.49 kPa) |
| | Output signal | 4 to 20 mA |
| | Accuracy | +1.0% of full scale |
| 7. | Humidity Sensors: | All room/zone humidity sensors shall be BACnet compatible |
| | network type. | |
| | Range | 0 to 100% RH |
| | Sensing Element | Bulk Polymer |
| | Output Signal | 4 – 20 mA DC |
| | Accuracy | At 77°F(25°C) + 2% RH |

Humidistat:
 Range 0 to 100% RH
 Sensing Element Bulk Polymer
 Output Signal 4 – 20 mA DC
 Accuracy At 77°F(25°C) + 2% RH

8. Insertion Flow Meters (Equal to Onicon Series F-1200)
 Sensing Method Impedance Sensing
 Accuracy + 2% of Actual Reading
 Maximum Operating Pressure 400 PSI
 Output Signal 4 – 20 mA

Bi-directional where required.

9. Pressure to Current Transducer
 Range 3 to 15 psig (21 to 103 kPa) or
 3 to 30 psig (21 to 207 kPa)
 Output signal 4 – 20 mA
 Accuracy + 1% of full scale (+ 0.3 psig)

10. Carbon Dioxide Sensor : All room/zone CO2 sensors shall be BACnet compatible network type and shall have a minimum 5 year calibration period.

Range 0 to 1500 ppm
 Accuracy 20+ ppm
 CO2 sensors located in gymnasiums and locker rooms shall be provided with tamper proof guard.

11. Control Valves (all control valves shall have electric actuators).

Electric Control
 Rangeability 40:1
 Flow Characteristics Modified. Equal percentage
 Control Action Normal open or closed as selected
 Medium Steam, water, glycol
 Body Type Screwed ends 2" and smaller, flanged
 Valves 2½" and larger
 Body Material Bronze
 Body Trim Bronze
 Stem Stainless Steel
 Actuator 0-10 VDC, 4-20 MA or 2 position
 24 VAC/120VAC

- a. All automatic temperature control valves in water lines shall be provided with Characterized throttling plugs and shall be sized for minimum 25% of the system pressure drop or 5 psi, whichever is less.
 1. Positive positioning relays shall be provided on pneumatic control when required to provide sufficient power for sequencing.
 2. Two position valves shall be line size.

12. Damper Actuators

- a. Electric control shall be direct coupled actuators.
 b. Damper actuators shall be Brushless DC Motor Technology with stall protection, bi-directional, fail safe spring return, all metal housing, manual override, independently adjustable dual auxiliary switch.
 1. The actuator assembly shall include the necessary hardware and proper mounting and connection to a standard ½" diameter shaft or damper blade.

- c. Actuators shall be designed for mounting directly to the damper shaft without the need for connecting linkages.
- d. All actuators having more than 100 lb-in torque output shall have a self-centering damper shaft clamp that guarantees concentric alignment of the actuator's output coupling with the damper shaft. The self-centering clamp shall have a pair of opposed "v" shaped toothed cradles; each having two rows of teeth to maximize holding strength. A single clamping bolt shall simultaneously drive both cradles into contact with the damper shaft.
- e. All actuators having more than a 100 lb-in torque output shall accept a 1" diameter shaft directly, without the need for auxiliary adapters.
- f. All actuators shall be designed and manufactured by Johnson Inc. or approved equal using ISO900 registered procedures, and shall be Listed under Standards UL873 and CSA22.2 No. 24-93 I.

U. Miscellaneous Devices

- 1. Thermostats (Stand-alone electric type - only where specified or indicated on drawings)
 - a. Room thermostats shall be of the gradual acting type with adjustable sensitivity.
 - b. They shall have a bi-metal sensing element capable of responding to a temperature change of one-tenth of one degree. (Provide all thermostats with limit stops to limit adjustments as required.)
 - c. Thermostats shall be arranged for either horizontal or vertical mounting.
 - d. In the vertical position thermostat shall fit on a mullion of movable partitions without overlap.
 - e. Mount the thermostat covers with tamper-proof socket head screws.
- 2. Freezestats:
 - a. Install freezestats on each coil that mixes outside and return air (rooftop air handling units, fan coils, unit ventilators, etc.) and provide protection for every square foot of coil surface area with one linear foot of element per square foot of coil.
 - 1. Upon detection of low temperature, the freezestats shall stop the associated supply fans and return the automatic dampers to their normal position close outside air dampers and open coil valve for full flow. Provide manual reset.
- 3. Firestats:
 - a. Provide manual reset, fixed temperature line voltage type with a bi-metal actuated switch.
 - 1. Switch shall have adequate rating for required load.
- 4. Current Sensing Relay:
 - a. Provide solid-state, adjustable, current operated relay. Provide a relay which changes switch contact state in response to an adjustable set point value of current in the monitored A/C circuit.
 - b. Adjust the relay switch point so that the relay responds to motor operation under load as an "on" state and so that the relay responds to an unloaded running motor as an "off" state. A motor with a broken belt is considered an unloaded motor.
 - c. Provide for status device for all fans and pumps.
- 5. Gas Detection System:
 - a. DETECTORS E3Point Model E3SM-E3SCO (Carbon Monoxide) & E3SM-E3NO2 (Nitrogen Dioxide)
 - 1. Transmitter will be powered by the control panel power supply rated at 24 Vac. Fully addressable gas transmitter must be capable of communicating digitally with controller through an RS-485 communication port. Gas transmitters must be installed in a true daisy chain with an end of the line resistor on the last transmitter. The gas transmitter will incorporate an electrochemical cell for toxic gas monitoring and catalytic bead sensor for combustible gases. Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy.

2. When placed in a network configuration the transmitter will be capable of transmitting gas concentrations through the controller. For local activation of fans or louvers (or other equipment) an on-board DPDT relay 5 A, 30 Vdc or 250 Vac (resistive load) will be activated at programmable set points (and programmable time delays) through the control panel. An LCD display will provide gas concentration readings.
3. Transmitter will be capable of operating within relative humidity ranges of 5-95 percent and temperature ranges of -4 deg. F to 104 deg. F (-20 deg. C to 40 deg. C).
4. Unit will be certified to ANSI/UL 61010-1 label and CAN/CSA-C22.2 No. 61010-1. Transmitter must be manufactured in an ISO 9001-2000 production environment.
5. The transmitter should have a plug-in capability for a gas cartridge with a smart sensor capable of self-testing.
6. For local activation of audible alarms, the transmitter shall have an on-board device able to generate an audible output of 85 dBA @ 10 ft (3 m).
7. Detector alarm levels are to be activated and the unit is to be installed in accordance with the following parameters:

TOXIC GASES	1st ALARM SET POINT (TLV-TWA)	2nd ALARM SET POINT (TLV-STEL)	3rd ALARM SET POINT	MOUNTING HEIGHT	COVERAGE RADIUS
Carbon Monoxide (CO)	25 PPM	200 PPM	225 PPM	5 ft (150 cm) above finished floor	50 ft (15 m)
Nitrogen Dioxide (NO2)	0.72 PPM	2.0 PPM	9.0 PPM	1 ft (30 cm) from ceiling	50 ft (15 m)

8. Local Building Codes recommendations take precedence over these parameters. Coverage can differ depending on application
- b. Controller VA301C

1. The control panel must be capable of communicating digitally with the networked transmitters and relay modules through three RS-485 Modbus communication buses. Each communication bus must be capable of accepting a combination of up to 32 addressable transmitters, relay modules, or annunciator panels at a maximum distance of 2,000 feet. The power supply shall be of either 24 Vac or 24 Vdc
2. The controller will manage four internal DPDT relays at fully programmable alarm levels (and within programmable time delays) and be capable of activating multiple relay modules of eight relays each. The relay rating will be no lower than 5 A, 30 Vdc or 250 Vac (resistive load).
3. The controller must include a self-test function that allows for the activation/deactivation of all the programmed outputs by simulating a continuous 5 percent increase/decrease value until the maximum/minimum value is reached.
4. The controller must include a real-time clock that enables operation of the outputs for a specific timeframe.

5. The controller must also include an energy saving feature that allows for output operation on alarms set at the max, min or average value of a specific group of transmitters. This feature must also allow for the activation of outputs upon a certain number of a specific group ($\frac{3}{4}$, $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$) of transmitters reaching their alarm levels. A total of 128 groups can be assigned.
 6. The controller will be capable of communicating with an annunciator panel that can serve as a remote display panel in a secondary control room.
 7. The controller will indicate the exact concentration of gas, the gas detected, and the location of the sensor by sweeping through the network and displaying the detected levels at each point on a graphic LCD display.
 8. BACnet option (For Future Connection):
 - a. The controller must enable BACnet™ communication through its optional BACnet output using BACnet/IP protocol over twisted-pair Ethernet (10BaseT) wires.
- c. Accessories
1. Strobe and Horn type STAS for 24 Vac FHS-240 for 24 Vdc or STACKSTAS for 120 V AC
 - a. Strobe & Horn combo unit will be capable of operating within relative humidity ranges of 0-100 percent and temperature ranges of -30 deg. F to 150 deg. F (-35 deg. C to 66 deg. C). Rating of horn will be no less than 72dB at 10 feet. Intensity of light will be no less than 40W and will flash at a frequency of 1 per second. Unit will be certified by CSA. Honeywell Analytics.
 2. Power Transformer type T100VA, T200VA, T300VA or Class 2 devices type T100VAC2, T200VAC2 or T300VAC2
 - a. Transformer shall have an input voltage of 120 V AC and an output voltage of 24 V AC with a VA range of 50-300. Operating frequency shall be 60 Hz. Unit will provide insulation systems up to 130 deg. C (50-1300 VA). Unit will operate at sound levels of less than 40 db. Transformers shall be of fused type.
 3. Relay Modules VA301R8
 - a. Relay module will be powered by the control panel's power output or by power transformer rated at 24 Volts AC or DC (always respect minimum voltage requirements at device). Module must be capable of communicating digitally with the Vulcain controller through an RS-485/MODBUS communication port. Relay module will have eight relays rated at no lower than 5A, 30 Vdc or 250 Vac (resistive load). Honeywell Analytics model VA301R8
 4. Detector Guards E3PT- GUARD
 - a. The grid is made of a 9-gauge steel wire. The guard must be designed to allow calibration without removing the guards.

PART 3 EXECUTION

3.1 INSTALLATION OF HANGERS AND ATTACHMENTS

- A. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

- B. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors, and other building structural attachments.
- C. Prior to installation of hangers, supports, anchors, and associated work, Installer shall meet at project site with Contractor, installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Architect/Engineer for purposes of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.
- D. Install building attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten insert securely to forms. Where concrete with compressive strength less than 2500 psi is indicated, install reinforcing bars through the openings at the tops of inserts.
- E. Install hangers, supports, clamps, and attachments to support piping properly from building structure; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Install supports with maximum spacing complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
 - 1. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
 - 2. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, or by other recognized industry methods.
 - 3. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
 - 4. Load Distribution: Install hangers and supports so that piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
 - 5. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.
 - 6. Insulated Piping: Comply with the following installation requirements:
 - a. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ANSI B31.
 - b. Shields: For pipe sizes up to and including 4" provide heavy gage shield at each hanger point.
 - c. Saddles: For all pipe sizes over 4" provide saddle at each hanger point. Completely fill void in saddle with loose insulation.
- F. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B31, and to prevent transfer for loading and stresses to connected equipment.
- G. Fabricate and install anchor by welding steel shapes, plates, and bars to piping and to structure. Comply with ANSI B31 and with AWS standards.

- H. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions, to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- I. Anchor Spacings: Where not otherwise indicated, install anchors at ends of principal pipe-runs, at intermediate points in pipe-runs between expansion loops and bends. Make provisions for preset of anchors as required to accommodate both expansion and contraction of piping.
- J. Provide concrete housekeeping bases for all floor-mounted equipment. Size bases to extend minimum of 4" beyond equipment base in any direction; and 4" above finished floor elevation. Construct of reinforced concrete, roughen floor slab beneath base for bond, and provide steel rod anchors between floor and base. Locate anchor bolts using equipment manufacturer's templates. Chamfer top and edge corners.
- K. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.
- L. Adjusting and Cleaning:
 - 1. Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.
 - 2. Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.
 - 3. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.2 INSTALLATION OF MECHANICAL IDENTIFICATION

- A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.
- B. Mechanical Equipment Identification:
 - 1. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device.
 - 2. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2' - 0", 1/2" high for distances up to 6' - 0", and proportionately larger lettering for greater distances. Provide secondary lettering of 2/3 to 3/4 of size of the principal lettering.
- C. Adjusting and Cleaning:
 - 1. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.
 - 2. Cleaning: Clean face of identification devices, and glass frames of valve charts.

3.3 INSTALLATION OF MECHANICAL INSULATION

- A. Installation of Piping Insulation:
 - 1. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

2. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.
3. Clean and dry pipe surfaces prior to insulating. Butt installation joints firmly together to ensure a complete and tight fit over surfaces to be covered.
4. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.
5. Cover valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.
6. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.
7. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3" wide vapor barrier tape or band.

B. Installation of Ductwork Insulation:

1. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its indented purpose.
2. Install insulation materials with smooth and even surfaces.
3. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.
4. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.
5. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.
6. Lined Ductwork: Except as otherwise indicated, omit insulation on ductwork where internal insulation or sound absorbing linings have been installed.

C. Protection and Replacement:

1. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.
2. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

3.4 INSTALLATION OF HYDRONIC PIPING AND ACCESSORIES

- A. Vibration Control and Seismic Restraint: Refer to SECTION 23 05 48 and drawings VS.1 and VS.2 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section s and drawings VS.1 and VS.2.
- B. Piping Installations:
 1. Locations and Arrangements: Drawings indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design consideration. So far as practical, install piping as indicated.

2. Install piping at a uniform grade of 1" in 40' upward in the direction of flow.
3. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.
4. Install branch connections to mains using Tee fittings in main with take-off out the bottom, except for up-freed risers which shall have take-off out the top of the main line.
5. Install unions in pipes 2" and smaller, adjacent to each valve, at final connections of each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
6. Install flanges on valves, apparatus, and equipment having 2-1/2" and larger connections.
7. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, inline pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2" and larger.
8. Anchor piping to ensure proper direction of expansion and contraction. Expansion loops and joints are indicated on the Drawings
9. Install pipe sleeves at all wall and floor penetrations.
10. Install escutcheons at all exposed pipe wall penetrations.
11. Provide Dielectric couplings at all dissimilar piping/valve connections.

C. Pipe Applications:

1. Copper Tubing: Use Type L, drawn copper tubing with wrought copper fittings and solder joints for 2" and smaller, above ground, within building. Use Type K, annealed temper copper tubing for 2" and smaller without joints, below ground or within slabs. Mechanical fittings (crimp or flair) are not permitted.
2. Steel Pipe: Use steel pipe with threaded joints and fittings for 2" and smaller, and with welded joints for 2-1/2" and larger.
3. Steel Pipe: Use mechanical grooved end steel pipe and mechanical couplings and fittings.

D. GROOVED PIPE ENDS AND FITTINGS:

1. Roll Groove pipe ends in accordance with the latest published instructions from manufacturer of grooved couplings.
2. Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. All grooved system components shall be of same manufacturer. Use grooved-end fittings and rigid or flexible, where required, grooved-end-pipe couplings. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
3. Training
 - a. The grooved coupling manufacturer's (the "manufacturer") factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of groove joints products.
 - b. IACET/Training: A factory trained manufacturer's representative (direct employee) shall provide on-site training of contractor's field personnel in the use of grooving tools, application of groove, and product installation in compliance with the following:
 1. Manufacture must be accredited by the International Association for Continuing Education and Training (IACET).

2. IACET Accredited Provider status demonstrates that the manufacture complies with the ANSI/IACET standard, which is recognized internationally as a standard of excellence in instructional practices.
 4. Inspection
 - a. A manufacture's factory trained representative shall periodically visit the job site and review the installation for best practices. The installing Contractor shall correct any identified deficiencies.
 - b. The grooved fittings manufacturer's product that has been examined and has not met the visual inspection criteria for proper installation must be corrected and re-examined by Inspection Services prior to the completion of the project. Any Victaulic product that has not been corrected or was not examined will not be considered as part of the successful completion of Inspection Services.
 5. Application
 - a. Upon completion of the manufacturer's inspection of the installation and any identified corrections, the manufacturer may provide the Owner or purchaser with a limited warranty on manufacturer's products.
- E. Valve Applications:
1. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:
 - a. Shut-Off Duty: Use gate, and ball, valves.
 - b. Throttling Duty: Use globe, ball, and plug valves.
 2. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.
 3. Install pump discharge valves with stem in upward position; allow clearance above stem for check mechanism removal.
 4. Install safety relief valve on hot water generators, and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 01 for installation requirements.
 5. Install pressure reducing valves on hot water generators, and elsewhere as required to regulate system pressure.
- F. Hydronic Specialties Installation:
1. Install automatic air vents at high points in the system, heat transfer coils, and elsewhere as required for system air venting. Install air vents with cocks such that vents can be removed without draining system.
 2. Install combination separator/strainer in pump suction lines. Run piping to compression tank with 1/4" per foot (2%) upward slope towards tank. Install blowdown piping with gate valve; extend to nearest drain.
 3. Install pump suction diffusers on pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.
 4. Install shot-type chemical feeders in each hydronic system; in upright position with top of funnel not more than 48" above floor. Install feeder in bypass line, off main using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.
 5. Install diaphragm-type compression tanks as indicated. Vent and purge air from hydronic system, charge tank with proper air charge to suit system design requirements.
 - a. In the absence of details provide support from the floor or structure above sufficient for the weight of water assuming a full tank of water. Do not overload building components and structural members.

G. Field Quality Control:

1. Preparation for Testing: Prepare hydronic piping in accordance with ASME B 31.9 and as follows:
 - a. Leave joints including welds uninsulated and exposed for examination during the test.
 - b. Provide temporary restraints for expansion joints which cannot sustain the reactions due to test pressure. If temporary restraints are not practical, isolate expansion joints from testing.
 - c. Flush system with clean water. Clean strainers.
 - d. Isolate equipment that is not to be subjected to the test pressure from the piping. If a valve is used to isolate the equipment, its closure shall be capable of sealing against the test pressure without damage to the valve. Flanged joints at which blinds are inserted to isolate equipment need not be tested.
 - e. Install relief valve set at a pressure no more than 1/3 higher than the test pressure, to protect against damage by expansion of liquid or other source of overpressure during the test.
2. Testing: Test hydronic piping as follows:
 - a. Use ambient temperature water as the testing medium, except where there is a risk of damage due to freezing. Another liquid may be used if it is safe for workmen and compatible with the piping system components.
 - b. Use vents installed at high points in the system to release trapped air while filling the system. Use drains installed at point for complete removal of the liquid.
 - c. Examine system to see that equipment and parts that cannot withstand test pressures are properly isolated. Examine test equipment to ensure that it is tight and that low pressure filling lines are disconnected.
 - d. Subject piping system to a hydrostatic test pressure which at every point in the system is not less than 1.5 times the design pressure. The test pressure shall not exceed the maximum pressure for any vessel, pump, valve, or other component in the system under test. Make a check to verify that the stress due to pressure at the bottom of vertical runs does not exceed either 90% of specified minimum yield strength, or 1.7 times the "SE" value in Appendix A of ASME B31.9, Code for Pressure Piping, Building Services Piping.
 - e. After the hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connection for leakage. Eliminate leaks by tightening, repairing, or replacing components as appropriate, and repeat hydrostatic test until there are no leaks.

H. Adjusting and Cleaning:

1. Clean and flush hydronic piping systems. Remove, clean, and replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine mesh strainers in pump suction diffusers.
2. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.5 INSTALLATION OF REFRIGERANT PIPING AND ACCESSORIES

- A. Vibration Control and Seismic Restraint: Refer to SECTION 23 05 48 and drawings VS1.1 and VS.2 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 23 05 48 and drawings VS.1 and VS.2.
- B. Piping Installations:
 - 1. Locations and Arrangements: Drawings indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, and other design consideration. So far as practical, install piping as indicated.
 - 2. Install pipe sleeves at all wall and floor penetrations.
 - 3. Install escutcheons at all exposed pipe wall penetrations.

3.6 INSTALLATION OF DUCTLESS COOLING UNIT SYSTEMS

- A. Vibration Control and Seismic Restraint: Refer to SECTION 23 05 48 and drawings VS.1 and VS.2 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 23 05 48 and drawing VS.1 and VS.2.
- B. General:
 - 1. Verify all dimensions by field measurements. Verify roof structure, mounting supports, wall structure, and membrane installations are completed to the proper point to allow installation of wall mounted and roof mounted units. Examine rough-in for refrigerant piping systems to verify actual locations of piping connections prior to installation. Do not proceed until unsatisfactory conditions have been corrected.
 - 2. Install equipment in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- C. Field Quality Control:
 - 1. Provide the services, to include a written report, of a factory authorized service representative to examine the field assembly of the components, installation, and piping and electrical connections.
 - 2. Charge systems with refrigerant and oil, and test for leaks. Repair leaks and replace lost refrigerant and oil.
- D. Demonstration:
 - 1. Provide the services of a factory authorized service representative to provide start-up service and to demonstrate and train the Owner's maintenance personnel as specified below.
 - 2. Start-up service: Place units into operation and adjust controls and safeties. Replace damaged or malfunctioning components and controls.
- E. Training:
 - 1. Train the Owner's maintenance personnel on start-up and shut-down procedures, troubleshooting procedures, and servicing and preventative maintenance schedules and procedures.
 - 2. Schedule training with Owner through the Architect/Engineer with at least 7 days prior notice.

3.7 INSTALLATION OF HIGH EFFICIENCY CONDENSING BOILERS

- A. Vibration Control and Seismic Restraint: Refer to SECTION 230548 and drawings VS.1 and VS.2 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 230548 and drawings VS.1 and VS.2.
- B. General: Install boilers in accordance with manufacturer's installation instructions, in accordance with State and Local Code requirements. Install units plumb and level, to tolerance of 1/8 in. in ten ft. – zero in. in both directions. Maintain manufacturer's recommended clearances around and over boilers.
- C. Support: Install boilers on four in. thick concrete pad, four in. larger on each side than base of unit.
- D. Electrical Work: Install electrical devices furnished by manufacturer but not specified to be factory mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical work installation is in accordance with manufacturer's submittal and installation requirements of Division 260000 sections. Do not proceed with equipment start-up until electrical work is acceptable to equipment Installer.
- E. Gas Piping: Connect gas piping to boiler, full size of boiler gas train inlet, provide union with sufficient clearance for burner removal and service.
- F. Hot Water Piping: Connect supply and return boiler tapings as indicated, with shutoff valve and union or flange at each connection.
- G. Regulator Vents: Provide 3/4 in. vent from each main and pilot regulator. Each vent shall terminate outdoors per code requirements.
- H. Breeching: Connect breeching to boiler outlet, full size of outlet. Route as indicated.
- I. Flush and clean boilers upon completion of installation, in accordance with manufacturer's start-up instructions.
- J. Hydrostatically test assembled boiler and piping in accordance with applicable sections of ASME Boiler and Pressure Vessel Code.
- K. Arrange with National Board of Boiler and Pressure Vessel Inspectors for inspection of boiler piping, observation of hydrostatic testing, and for certification of completed boiler units.
- L. Start-up boilers, in accordance with manufacturer's start-up instructions, and in presence of boiler manufacturer's start up representative. Test controls, and demonstrate compliance with requirements. Adjust burner for maximum burning efficiency. Replace damaged or malfunctioning controls and equipment.
- M. Owner's Instructions: Provide services of manufacturer's technical representative for four hour day to instruct Owner's personnel in operation and maintenance of boilers and hot water distribution system.
 - 1. Schedule training with Owner, provide at least seven-day notice to Contractor and Engineer of training date.

3.8 INSTALLATION OF HYDRONIC PUMPS AND ACCESSORIES

- A. Vibration Control and Seismic Restraint: Refer to SECTION 23 05 48 and drawings VS.1 and VS.2 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 23 05 48 and drawings VS.1 and VS.2.
- B. General: Install HVAC pumps where indicated, in accordance with manufacturer's published installation instructions, complying with recognized practices to ensure that HVAC pumps comply with requirements and serve intended purposes.
- C. Access: Provide access space around HVAC pumps for service as indicated, but in no case less than that recommended by manufacturer.
- D. Support: Install base-mounted pumps on minimum of 4" high concrete base equal or greater than 3 times total weight of pump and motor. Set and level pump in base and grout with non-shrink grout.
 - 1. Install in-line pumps, supported from piping system.
- E. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 - 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- F. ADJUSTING AND CLEANING
 - 1. Alignment: Check alignment, and where necessary, realign shafts of motors and pumps within recommended tolerances by manufacturer, and in presence of manufacturer's service representative.
 - 2. Start-Up: Lubricate pumps before start-up. Start-up in accordance with manufacturer's instructions.
 - 3. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.9 INSTALLATION OF RADIANT FLOOR AND SNOW MELT SYSTEM

- A. EXAMINATION
 - 1. The installing contractor shall examine the tubing, manifolds, stations, fittings, and controls for any visible defects. There shall be no visible defects on products used in installation. Any products with defects shall be rejected and returned.
- B. PREPARATION
 - 1. Tubing shall be cut with Viega tubing cutters or other cutters that ensure the tubing will be cut square. Tubing shall be cut square to permit proper joining with the fittings and manifolds.
- C. INSTALLATION
 - 1. Tubing and manifolds shall be installed as per engineering's CAD drawings. Manufacturer to provide a heat loss and complete design prior to ordering for review and approval by Engineer.

2. Tubing: Tubing used shall be provided by manufacturer and handled with general care. Tubing shall not be exposed to excessive UV light, harmful substances, excessive heat, sharp objects and any other potentially harmful situations. Tubing shall be laid out taking into account the minimum bending radius. Tubing shall be sleeved at all floor and slab penetrations. Tubing shall be secured by plastic zip ties, or plastic clips approved by manufacturer. At no time should a metallic clip or tie be used to secure tubing.
3. Manifolds/Stations: Manifolds used shall be provided by manufacturer and installed per installation manual. Tubing shall be connected to manifolds using the recommended SVC press fittings or compression fittings with split compression ring. Connections of manifolds to stations shall be done with the recommended fittings or adapters.
4. Controls: Controls should be installed by a licensed electrician. Refer to manufacturer's installation manuals for correct programming and hook-up of controls.
5. Freeze Protection: System should be protected from freezing at all times. If system is installed and pressure tested in an unfinished building during heating season, air or the proper glycol mixtures should be used to prevent any freeze damage. Insulation may be used in exposed areas. Glycol mixtures may also be needed in systems that are not used year-round and may be exposed to freezing temperatures.

D. FIELD QUALITY CONTROL

1. Pressure testing: Air or water may be used for testing the system for leaks. Pressurize system to 60 psi and cap off. Be sure to keep system pressurized while finish flooring is installed over it to ensure tubing is not damaged during this step.

3.10 INSTALLATION OF TERMINAL HEATING UNITS (HYDRONIC)

- A. Vibration Control and Seismic Restraint: Refer to SECTION 23 05 48 and drawings VS.1 and VS.2 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 23 05 48 and drawings VS.1 and VS.2.
- B. Installation of Baseboard Radiation: (HYDRONIC)
 1. General: Install baseboard radiation as indicated, and in accordance with manufacturer's installation instructions.
 2. Locate baseboard radiation as indicated, run cover continuous wall-to-wall unless otherwise indicated.
 3. Install end caps where units butt against walls. Install access panels centered in front of each shutoff valve, balancing cock, or temperature control valve.
- C. Installation of Finned Tube Radiation: (HYDRONIC)
 1. General: Install finned tube radiation as indicated, and in accordance with manufacturer's installation instructions.
 2. Locate finned tube radiation as indicated, run cover wall-to-wall unless otherwise indicated. Provide butt caps, splice joints, "Z" bends etc. for a complete installation.
 3. Install access panels centered in front of each shutoff valve, balancing cock, steam trap, or temperature control valve.
- D. Installation of Convectors: (HYDRONIC)
 1. General: Install convectors as indicated, and in accordance with manufacturer's installation instructions.
 2. Locate convectors as indicated, coordinate with other trades to assure correct recess size for recessed convectors.

E. Installation of Horizontal Unit Heaters: (HYDRONIC)

1. General: Install unit heaters as indicated, and in accordance with manufacturer's installation instructions.
2. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.
3. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible unless otherwise indicated.
4. Support units with rod-type hangers anchored to building substrate.
5. Install piping as indicated.
6. Protect units with protective covers during balance of construction.

F. Installation of Cabinet Unit Heaters: (HYDRONIC)

1. General: Install cabinet heaters as indicated, and in accordance with manufacturer's installation instructions.
2. Coordinate with other trades to assure correct recess size for recessed units.
3. Install piping as indicated.
4. Protect units with protective covers during balance of construction.

3.11 INSTALLATION OF POWER AND GRAVITY VENTILATORS

- A. Vibration Control and Seismic Restraint: Refer to SECTION 23 05 48 and drawings VS.1 and VS.2 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in SECTION 23 05 48 and drawings VS.1 and VS.2.
- B. General: Except as otherwise indicated or specified, install ventilators in accordance with manufacturer's installation instructions and recognized industry practices to insure that products serve the intended function.
- C. Coordinate ventilator work with work of roofing, walls and ceilings, as necessary for proper interfacing.
- D. Ductwork: Connect ducts to ventilators in accordance with manufacturer's installation instruction, and details on drawings.
- E. Roof Curbs: Furnish roof curbs to roofing Installer for installation.
- F. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division-26 sections. Verify proper rotation direction of fan wheels. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- G. Remove shipping bolts and temporary supports within ventilators. Adjust dampers for free operation.
- H. Testing: After installation of ventilators has been completed, test each ventilator to demonstrate proper operation of unit at performance requirements specified. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

- I. Cleaning: Clean factory-finished surface. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- J. General: Furnish to Owner, with receipt, one spare set of belts for each belt driven power ventilator.

3.12 INSTALLATION OF METAL DUCTWORK

A. Installation of Metal Ductwork:

- 1. General: Assemble and install ductwork in accordance with recognized industry practices which will achieve air-tight (5% leakage for systems rated 3" and under; 1% for systems rated over 3") and noiseless (no objectionable noise) systems, capable of performing each indicated service. Install each run with minimum number of joints. Align ductwork accurately with internal surface smooth. Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor.
- 2. Sealing: All ductwork joints and seams shall be sealed with flexible duct sealer to assure an airtight installation.
- 3. Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2". Fasten to duct and substrate.
 - a. Where ducts pass through fire-rated floors, walls, or partitions, provide firestopping between duct and substrate.
- 4. Coordination: Coordinate duct installation with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system.
- 5. Installation: Install metal ductwork in accordance with "SMACNA HVAC Duct Construction Standards".

B. Installation of Duct Liners:

- 1. General Install duct liners in accordance with SMACNA "HVAC Duct Construction Standards".

C. Installation of Flexible Ducts:

- 1. Maximum Length: For any duct run using flexible ductwork, do not exceed 4'-0" extended length.
- 2. Installation: Install in accordance with Section II of SMACNA's, "HVAC Duct Construction Standards, Metal and Flexible".

D. Field Quality Control:

- 1. Leakage Tests: After each duct system, which is constructed for duct classes over 3" is completed, test for duct leakage in accordance with SMACNA "HVAC Air Duct Leakage Test Manual". Repair leaks and repeat tests until total leakage is less than 1% of system design air flow.

E. Equipment Connections:

- 1. General: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery.

F. Adjusting and Cleaning:

1. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.
2. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until final connections are to be completed.
3. Balancing: Refer to Division 23 section "Testing, Adjusting, and Balancing" for air distribution balancing of metal ductwork. Seal any leaks in ductwork that become apparent in balancing process.

3.13 INSTALLATION OF DUCTWORK ACCESSORIES

- A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.
- B. Install turning vanes in square or rectangular 90 degree elbows in supply, return, and exhaust air systems, and elsewhere as indicated.
- C. Install splitter damper with adjusting rod in each supply branch. Install according to detail on drawings.
- D. Install access doors to open against system air pressure, with latches operable from either side, except outside only where duct is too small for person to enter.
- E. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.
- F. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.
- G. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- H. Furnish extra fusible links to owner, one link for every 10 installed of each temperature range; obtain receipt.

3.14 INSTALLATION OF AIR OUTLETS AND INLETS

- A. General: Install air outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended function.
- B. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling module.

3.15 INSTALLATION OF WALL AND CEILING ACCESS DOORS

- A. General: Install access doors in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended function.
- B. All access doors shall be located in a workmanlike manner in closets, storage rooms, and/or other non-public areas, positioned so that the item or part can be easily reached, and the size shall be sufficient for this purpose (minimum size 12" X 16"). Furnish access doors to permit thorough inspection. When access doors are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect.

3.16 INSTALLATION OF ARCHITECTURAL LOUVERS AND VENTS

- A. Examination:
 - 1. Inspect all surfaces and verify that they are in proper condition to receive the work of this Section. Verify that prepared openings and flashings are ready to receive the work of this Section and opening dimensions are as indicated on the shop drawings. Verify that all blocking and nailers are set in place and secure.
 - 2. Beginning of installation means acceptance of existing project conditions.
- B. Installation:
 - 1. Install penthouse in accordance with manufacturer's instructions. Erect penthouse plumb and level, free of warp or twist. Maintain dimensional tolerances, aligning with adjacent work. Install flashings and align penthouse assembly to ensure moisture shed from flashings and diversion of moisture to exterior.
 - a. Secure penthouse in opening framing with concealed fasteners.
 - 2. No permanent exposed to view labels of any kind will be permitted to remain on the louvers or frames.
 - 3. Coordinate installation with Architectural, Electrical, and Fire Suppression systems.
- C. Tolerances:
 - 1. Maximum Variation from Level or Plumb: 0.06 inches every 3 feet non-cumulative or 0.5 inches per 100 feet, whichever is less.
- D. Cleaning and Touch Up:
 - 1. Upon completion of the work of this Section in any given area, remove tools, equipment and all rubbish and debris from the work area; leave area in broom-clean condition.
 - 2. Remove excess sealant by solvent acceptable to sealant manufacturer. All exposed edges of sealant and gaskets shall be left smooth, uniform in line, and with edges neatly struck.
 - 3. Remove protective material from prefinished aluminum surfaces. Wash down exposed surfaces free of dirt, handling marks, packing tapes, and foreign matter, using a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
 - 4. Touch-up all scratches, abrasions, and other defects in the prefinished metal surfaces with shop-coat finish material, supplied with the various items to be furnished hereunder.

3.17 INSTALLATION OF CARBON MONOXIDE/CARBON DIOXIDE EXHAUST SYSTEM

A. General:

1. Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
2. Install winch, hoisting cables, and related field installed accessories per manufacturer's recommendations.

B. Adjusting and Cleaning:

1. Test and adjust systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning equipment.
2. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

C. Closeout Procedures:

1. Owner's Instructions: Provide services of manufacturer's technical representative for one 2-hour day to instruct Owner's personnel in operation and maintenance of systems.

3.18 INSTALLATION OF GAS DETECTION & MONITORING SYSTEM

- A. This system is provided as an Emergency Vehicle exhaust system for noxious vehicle exhaust harmful to occupant's health. This system has not been designed to replace and should not be used as a substitute for the primary Vehicle exhaust system provided by the owner.
- B. Provide sensors in the quantities and locations indicated on contract documents. Sensors shall be mounted in accordance with the manufacturer's recommendations and fully capable of monitoring Carbon Monoxide and Nitrogen Dioxide levels of each garage indicated in the specifications.
- C. In the event the CO/NO2 sensors detect levels indicated in the specifications, the sensors shall activate the associated exhaust fan and run continuously until CO/NO2 levels in the occupied spaces return down to an acceptable safe level for the occupants.
 1. All sensors shall be calibrated and installed in accordance with the manufacturer's recommendations.
- D. Provided start services for Emergency Vehicle exhaust systems.

3.19 INSTALLATION OF HEAT EXCHANGERS

- A. VIBRATION CONTROL AND SEISMIC RESTRAINT: Refer to section 230548 and drawings VS1.1 & VS1.2 for the appropriate support of each piece of HVAC equipment noted as requiring such. The vibration control and seismic restraint manufacturer shall recommend the correct connection and device as outlined in section 230548 and drawings VS1.1 & VS1.2.
- B. Inspection:
 1. Examine areas and conditions under which heat exchangers are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

- C. Testing the plate frame heat exchanger shall be designed to withstand full test pressure in one circuit with zero pressure in the alternate circuit. Hydrostatic testing shall be in accordance with ASME Section VIII, Division, I Paragraph UG-99. A nameplate shall be securely attached to the exchanger in a location that is easily accessible and visible after installation. The name plate must include working pressure, design temperature, closing dimension, surface area, media and plate/gasket material. The plate frame heat exchanger shall be flushed clean at factory, prior to shipment. All connections shall be factory sealed to prevent the entrance of foreign material during transit.
- D. Adjusting and Cleaning:
 - 1. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- E. Spare Parts:
 - 1. General: Furnish to Owner, with receipt, one spare gasket for each flanged connection for each heat exchanger

3.20 INSTALLATION OF AUTOMATIC TEMPERATURE CONTROLS (DDC):

- A. Installation of Control Systems:
 - 1. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
 - 2. Control Wiring: Install control wiring, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with National Electrical Code.
 - a. Install circuits over 25-volt with color-coded No. 12 wire in electric metallic tubing.
 - b. Install circuits under 25-volt with color-code No. 18 wire with 0.031" high temperature 105° F. (41° C) plastic insulation on each conductor and plastic sheath over all.
 - c. Install electronic circuits with color-coded No. 22 wire with 0.023" polyethylene insulation on each conductor with plastic-jacketed copper shield over all.
 - d. Install low voltage circuits, located in concrete slabs and masonry walls, or exposed in occupied areas, in electrical conduit.
 - e. Power sources from lighting circuits and wall outlets shall not be used to power DDC controllers.
 - 3. Controllers and safety devices:
 - a. All safety devices such as freezestats, duct mounted heat detectors, smoke detectors, etc., shall be hard wired to shut down the fans independently. Provide audible alarm with silence switch as well as DDC indication.
 - b. Humidifier controls shall be hard wired through fan proof flow differential switch and starter auxiliary contacts to disable humidifier system on fan shutdown. Provide DDC indication.
 - c. All supply, return and exhaust fans shall be provided with pressure differential switches. Current sensing devices, starter axillary contacts, and relay contacts are unacceptable proof of fan operation.
 - d. Primary and standby pumps shall be selectable through the DDC control system. Provide local pilot light to indicate selected pump as well as alarm and silence switch for failed pump. Provide differential pressure switch to prove flow.

B. Adjusting and Cleaning:

1. Start-Up: Start-up, test, and adjust pneumatic control systems in presence of manufacturer's authorized representative. Demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.
2. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
3. Final Adjustment: After completion of installation, adjust thermostats, control valves, motor and similar equipment provided as work of this section.
 - a. Final adjustment shall be performed by specially trained personnel in direct employ of manufacturer of primary temperature control system.

C. Closeout Procedures:

1. Owner's Instructions: Provide services of manufacturer's technical representative for one 8-hour day to instruct Owner's personnel in operation and maintenance of control systems, and 40 hours of onsite instruction on running and basic troubleshooting of DDC control system.
2. Validation: The automatic temperature control contractor shall completely check out, calibrate and test all connected hardware and software to insure that the system performs in accordance with the approved specifications and sequence of operation submitted.
 - a. Witnessed validation demonstration shall consist of:
 1. Execute digital and analog commands in English and graphic mode.
 2. Demonstrate all specified diagnostics.
 3. Demonstrate scan, update, and alarm responsiveness.
3. Training:
 - a. All training shall be by the automatic temperature control contractor and shall utilize specified manuals and as-build documentation.
 - b. Operator training shall include:
 1. Sequence of Operation review.
 2. Sign on-Sign off.
 3. Modifying warning limits, alarm limits and start-stop times.
 4. System initialization.
 5. Use of Portable Operators Terminal.
 6. Troubleshooting of sensors (determining bad sensors).
 7. Point disable/enable.
 8. Software review of Sequence of Operation programs.
 9. Modification of control programs.
 10. Add/Delete/Modify data points.
 11. Use of diagnostics.
 12. Review of initialization.
 - c. Training shall be for Owner-designated personnel at the subject site, and shall be scheduled by the Owner with two week notice.

D. Installation of Gas Detection & Monitoring System:

1. This system is provided as an Emergency Vehicle exhaust system for noxious vehicle exhaust harmful to occupant's health. This system has not been designed to replace and should not be used as a substitute for the primary Vehicle exhaust system provided by the owner.
2. Provide sensors in the quantities and locations indicated on contract documents. Sensors shall be mounted in accordance with the manufacturer's recommendations and fully capable of monitoring Carbon Monoxide and Nitrogen Dioxide levels of each garage indicated in the specifications.
3. In the event the CO/NO2 sensors detect levels indicated in the specifications, the sensors shall activate the associated exhaust fan and run continuously until CO/NO2 levels in the occupied spaces return down to an acceptable safe level for the occupants.
 - a. All sensors shall be calibrated and installed in accordance with the manufacturer's recommendations.
4. Provided start services for Emergency Vehicle exhaust systems.

3.21 TESTING, ADJUSTING, AND BALANCING

A. Requirements:

1. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet specifications, and recording and reporting the results.
2. Test, adjust and balance the following mechanical systems:
 - a. Supply air systems.
 - b. Return air systems.
 - c. Exhaust air systems.
 - d. Outside air systems.
 - e. Verify temperature control system operation.
3. Do not include:
 - a. Testing boilers and pressure vessels for compliance with safety code.
 - b. Installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing. Contact Mechanical Contractor and the Engineer for direction.

B. Report:

1. Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
 - a. General Information and Summary.
 - b. Air Systems.
 - c. Temperature Control Systems.

2. Contents: Provide the following minimum information, forms and data:
 - a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect, Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the seal and name address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentation used for the procedures along with the proof of calibration.
 - b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC for each respective item and system.
 - c. Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.
- C. Quality Assurance:
 1. An independent testing, adjusting, and balancing agency certified by the AABC or NEBB as a Test and Balance Engineer in those testing and balancing disciplines required for this project.
 2. Codes and Standards:
 - a. AABC: "National Standards For Total System Balance".
 - b. ASHRAE: ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.
 3. Pre-Balancing Conference: Prior to beginning of the testing, adjusting, and balancing procedures, schedule and conduct a conference with the Architect/Engineer and Mechanical Contractor. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.
 4. System Operation: Systems shall be fully operational prior to beginning procedures. All new automatic temperature controls shall be fully operational. Test, adjust and balance the air systems before refrigerant systems. Test, adjust and balance air conditioning systems during summer season, and heating systems during winter season, including at least a period of operation at outside conditions within 5° F. wet bulb temperature of maximum summer design condition, and within 10° F. dry bulb temperature of minimum winter design condition. Take final temperature reading during seasonal operation.
- D. Preliminary Procedures:
 1. Air Systems:
 - a. Obtain drawings and become thoroughly acquainted with the systems.
 - b. Compare drawings to installed equipment and field installations.
 - c. Walk the system from the system air handling equipment to terminal units to determine variations in installation.
 - d. Check filters for cleanliness.
 - e. Check all dampers (volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
 - f. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross check with required fan volumes.

- g. Determine best locations in main and branch ductwork for most accurate duct traverses. Traverses shall be performed in each supply and return duct main and sub-mains for each AHU and return air fan.
 - h. Place outlet dampers in the full open position.
 - i. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.
 - j. Verify lubrication of all motors and bearings.
 - k. Check fan belt tension.
 - l. Check fan rotation.
 - 2. Measurements:
 - a. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerance specified in the referenced standards. Instruments shall be properly maintained and protected against damage.
 - b. Provide instruments meeting the specifications of the referenced standards.
 - c. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.
 - d. Apply instrument as recommended by the manufacturer.
 - e. Use instruments with minimum scale and maximum subdivisions and with scaled ranges proper for the value being measured.
 - f. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5%. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.
 - g. Take all reading with the eye at the level of the indicated value to prevent parallax.
 - h. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.
 - i. Take measurements in the system where best suited to the task.
- E. Performing Testing, Adjusting, and Balancing:
- 1. Test, adjust and balance all noted systems according to SMACNA standards and as follows:
 - a. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.
 - b. Cut insulation and ductwork for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.
 - c. Patch insulation, ductwork, and housings, using materials identical to those removed.
 - d. Seal ducts and test for and repair leaks.
 - e. Seal insulation to re-establish integrity of the vapor barrier.
 - f. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
 - g. Retest, adjust and balance system subsequent to significant system modifications, and resubmit test results.
 - 2. System Deficiencies:
 - a. The Balancing Contractor shall advise the Mechanical Contractor and the Engineer of all system deficiencies in writing. Report all motors not running, missing dampers, inoperative valves and controls, lack of access, etc.

- b. Upon completion of system deficiencies, Balancing Contractor shall balance and record data.
- F. Subject to compliance with the above requirements and certifications, provide the services of air and water testing and balancing of one of the following:
- 1. Thomas Young
 - 2. Airflow Associates
 - 3. American Testing and Balancing
 - 4. Or equal.

END OF SECTION

Section 23 05 48

VIBRATION CONTROL AND SEISMIC RESTRAINT

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 DESCRIPTION	1
1.3 SUBMITTAL DATA REQUIREMENTS	2
1.4 CODE AND STANDARDS REQUIREMENTS	3
1.5 MANUFACTURER'S RESPONSIBILITY	3
1.6 RELATED WORK	3
1.7 DESIGN REQUIREMENTS	4
1.8 QUALITY ASSURANCE	4
PART 2 - PRODUCTS	4
2.1 INTENT	4
2.2 PRODUCT DESCRIPTIONS	5
PART 3 - EXECUTION	11
3.1 GENERAL	11
3.2 VIBRATION ISOLATION AND SEISMIC RESTRAINT OF PIPING, DUCTWORK, AND CONDUIT	13
3.3 SEISMIC RESTRAINT EXCLUSIONS.....	15
3.4 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT	15

END OF INDEX

Section 23 05 48
VIBRATION CONTROL AND SEISMIC RESTRAINT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION

- A. General: The work noted within section 23 05 48 is referenced by divisions 21 00 00, 22 00 00, 23 00 00, and 26 00 00. Provide all necessary labor & material in each division as required herein.
- B. Intent:
 - 1. All mechanical equipment, piping, and ductwork shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
 - 2. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
 - 3. It is the intent of the seismic portion of this specification to keep all mechanical and electrical building system components in place during a seismic event.
 - 4. All such systems must be installed in strict accordance with seismic codes, component manufacturer's, and building construction standards. Whenever a conflict occurs between the manufacturer's or construction standards, the most stringent shall apply.
 - 5. This specification is considered to be minimum requirements for seismic consideration and is not intended as a substitute for legislated, more stringent, national, state or local construction requirements (i.e. California Title 24, California OSHPD, Canadian Building Codes, or other requirements).
 - 6. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.
- C. The work in this section includes, but is not limited to the following:
 - 1. Vibration isolation for piping, ductwork and equipment.
 - 2. Equipment isolation bases.
 - 3. Flexible piping connections.
 - 4. Seismic restraints for isolated equipment.
 - 5. Seismic restraints for non-isolated equipment.
 - 6. Certification of seismic restraint designs and installation supervision.
 - 7. Certification of seismic attachment of housekeeping pads.
 - 8. All mechanical and electrical systems. Equipment buried underground is excluded but entry of services through the foundation wall is included. Equipment referred to below is typical. (Equipment not listed is still included in this specification).

AC Units
Air Cooled Condensing Units
Air Handling Units
Air Separators
Boilers
Cable Trays
Conduit
Ductwork
Electrical Panels
Fans (all types)

Generators
Heat Exchangers
Light Fixtures
Piping
Pumps (all types)
Rooftop Units
Tanks (all types)
Unit Heaters
Var. Freq. Drives
VAV Boxes
Water Heaters

D. Definitions:

1. Life Safety Systems

- a. All systems involved with fire protection including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, fire dampers and smoke exhaust systems.
- b. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers, and all flowpaths to fire protection and/or emergency lighting systems.
- c. All medical and life support systems.
- d. Fresh air & relief systems on emergency control sequence including air handlers, conduit, duct, dampers, etc.

2. Positive Attachment

- a. A positive attachment is defined as a cast-in anchor, a drill-in wedge anchor, a double sided beam clamp loaded perpendicular to a beam, or a welded or bolted connection to structure. Single sided "C" type beam clamps for support rods of overhead piping, ductwork, fire protection, electrical conduit, bus duct, or cable trays, etc. are not acceptable as seismic anchor points.

3. Transverse Bracing

- a. Restraint(s) applied to limit motion perpendicular to the centerline of the pipe, duct or conduit.

4. Longitudinal Bracing

- a. Restraint(s) applied to limit motion parallel to the centerline of the pipe, duct or conduit.

1.3 SUBMITTAL DATA REQUIREMENTS

- A. In addition to requirements of Section 013300, the manufacturer of vibration isolation and seismic restraints shall provide submittals for products as follows:

1. Descriptive Data

- a. Catalog cuts or data sheets on vibration isolators and specific restraints detailing compliance with the specification.
- b. Detailed schedules of flexible and rigidly mounted equipment, showing vibration isolators and seismic restraints by referencing numbered descriptive drawings.

2. Shop Drawings

- a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
- b. Provide all details of suspension and support for ceiling hung equipment.

- c. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
- d. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
- 3. Seismic Certification and Analysis
 - a. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.
 - b. All restraining devices shall have a pre-approval number from California OSHPD or some other recognized government agency showing maximum restraint ratings. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 450 to the weakest mode.
 - c. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All seismic restraint devices shall be designed to accept, without failure, the forces required acting through the equipment center of gravity. Overturning moments may exceed forces at ground level.

1.4 CODE AND STANDARDS REQUIREMENTS

A. Typical Applicable Codes, Standards, and Categories:

- 1. International Building Code 2009 with an effective peak acceleration coefficient of 0.15.
- 2. Massachusetts State Building Code, Eighth Edition.
- 3. Seismic hazard exposure group of I, II, III and seismic performance category of C, D.

1.5 MANUFACTURER'S RESPONSIBILITY

A. Manufacturer of vibration isolation and seismic control equipment shall have the following responsibilities:

- 1. Determine vibration isolation and seismic restraint sizes and locations.
- 2. Provide vibration isolation and seismic restraints.
- 3. Provide calculations and materials if required for restraint of unisolated equipment.
- 4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

1.6 RELATED WORK

A. Housekeeping Pads:

- 1. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.

B. Supplementary Support Steel:

1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment.

C. Attachments:

1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

1.7 DESIGN REQUIREMENTS

- A. Design isolators for equipment installed outdoors to provide adequate restraint to withstand the force of a 100 mph wind applied to any exposed surface of the isolated equipment. Isolators for outdoor equipment shall have bolt holes for attachment to equipment and to supports. The vibration isolation Vendor shall submit verifying shear and over turning calculations, for their product and equipment installation arrangement, stamped by a licensed Professional Engineer. The design and supply of miscellaneous support steel above and below isolators will not be the responsibility of the vibration isolation manufacturer.

1.8 QUALITY ASSURANCE

- A. Coordinate the size, location, and special requirements of vibration isolation equipment and systems with other trades. Coordinate plan dimensions with size of housekeeping pads.
- B. Provide vibration isolators of the appropriate sizes, with the proper loading to meet the specified deflection requirements.
- C. Supply and install any incidental materials such as mounting brackets, attachments and other accessories as may be needed to meet the requirements stated herein, even if not expressly specified or shown on the drawings, without claim for additional payment.
- D. Verify correctness of equipment model numbers and conformance of each component with manufacturer's specifications.
- E. Should any rotating equipment cause excessive noise or vibration when properly installed on the specified isolators, the Contractor shall be responsible for rebalancing, realignment, or other remedial work required to reduce noise and vibration levels. Excessive is defined as exceeding the manufacturer's specifications for the unit in question.

PART 2 - PRODUCTS

2.1 INTENT

- A. All vibration isolators and seismic restraints described in this section shall be the product of a single manufacturer. Mason Industry's products are the basis of these specifications; products of other manufacturers are acceptable provided their systems strictly comply with the specification.
- B. For the purposes of this project, failure is defined as the discontinuance of any attachment point between equipment or structure, vertical permanent deformation greater than 1/8 inch and/or horizontal permanent deformation greater than 1/4 inch.

2.2 PRODUCT DESCRIPTIONS

A. Vibration Isolators and Seismic Restraints.

GENERAL:

1. All metal parts installed out-of-doors shall be corrosion resistant after fabrication. Galvanizing shall meet ASTM Salt Spray Test Standards and Federal Test Standard No. 14.
2. Isolators installed out-of-doors shall have base plates with bolt holes for fastening the isolators to the support members.
3. Isolator types are scheduled to establish minimum standards. At the Contractor's option, labor-saving accessories can be an integral part of isolators supplied to provide initial lift of equipment to operating height, hold piping at fixed elevations during installation and initial system filling operations, and similar installation advantages. Accessories and seismic restraint features must not degrade the isolation performance of the isolators.
4. Static deflection of isolators shall be as provided in the EXECUTION section and as shown on the drawings. All static deflections stated are the minimum acceptable
5. deflection for the mounts under actual load. Isolators selected solely on the basis of rated deflections are not acceptable and will be disapproved.

SPECIFICATION:

1. Two layers of 3/4" thick neoprene pad consisting of 2" square waffle modules separated horizontally by a 16 gauge galvanized shim. Load distribution plates shall be used as required. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc.
2. Bridge-bearing neoprene mountings shall have a minimum static deflection of 0.2" and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge-bearing specifications. Mountings shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be Type BR as manufactured by Mason Industries, Inc.
3. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.
4. A one (1) piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.

5. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height. Mountings shall be Type SLF as manufactured by Mason Industries, Inc.
6. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Pre-approval "R" Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings. Mountings shall be SLR as manufactured by Mason Industries, Inc.
7. Spring mountings as in specification 5 built into ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4 inch travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Pre-approval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Mountings shall be SSLFH as manufactured by Mason Industries, Inc.
8. Air Springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8". Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician. Air Springs shall be Type MT and leveling valves Type LV as manufactured by Mason Industries, Inc.
9. Restrained air spring mountings shall have an MT air spring as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces. Mountings shall be SLR-MT as manufactured by Mason Industries, Inc.
10. Hangers shall consist of rigid steel frames containing minimum 1 1/4" thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30° capability. Hangers shall be type 30° as manufactured by Mason Industries, Inc.

11. Hangers shall be as described in specifications 10, but they shall be pre-compressed and locked at the rated deflection by means of a resilient seismic upstop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
 12. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement. Cables must not be allowed to bend across sharp edges. Cable assemblies shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California verifying the maximum certified load ratings. Cable assemblies shall be Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam all as manufactured by Mason Industries, Inc.
 13. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment. Seismic solid brace assembly shall have anchorage pre-approval "R" number from OSHPD in the state of California verifying the maximum certified load ratings. Solid seismic brace assemblies shall be type SSB as manufactured by Mason Industries, Inc.
- Note: Specifications 12 - 14 apply to trapeze as well as clevis hanger locations. At trapeze anchor locations piping must be shackled to the trapeze. Specifications apply to hanging equipment as well.
14. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.
 15. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose performed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.
 16. All-directional seismic snubbers shall consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene. Bushing shall be replaceable and a minimum of 1/4 inch thick. Rated loading shall not exceed 1,000 psi. A minimum air gap of 1/8 inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces. Snubber end caps shall be removable to allow inspection of internal clearances. Neoprene bushings shall be rotated to insure no short circuits exist before systems are activated. Snubbers shall have an Anchorage Pre-approval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings. Snubber shall be Type Z-1 225 as manufactured by Mason Industries, Inc.

17. All directional seismic snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials compounded to bridge bearing specifications. Elastomeric materials shall be replaceable and a minimum of 3/4" thick. Rated loadings shall not exceed 1,000 psi. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" nor more than 1/4". Snubbers shall be installed with factory set clearances. The capacity of the seismic snubber at 3/8" deflection shall be equal or greater than the load assigned to the mounting grouping controlled by the snubber multiplied by the applicable "G" force. Submittals shall include the load deflection curves up to 1/2" deflection in the x, y and z planes. Snubbers shall have an anchorage pre-approval "R" number from OSHPD in the state of California verifying the maximum certified horizontal and vertical load ratings. Snubbers shall be series Z-101 1 as manufactured by Mason Industries, Inc.
18. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc.
19. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load. Female wedge anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying to its allowable loads. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.
20. Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Centrifugal refrigeration machines and pump bases may be T or L shaped where space is a problem. Pump bases for split case pump shall include supports for suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Base depth need not exceed 14' provided that the deflection and misalignment is kept within acceptable limits as determined by the manufacturer. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1 ". Bases shall be type WF as manufactured by Mason Industries, Inc.
21. Vibration isolation manufacturer shall furnish rectangular steel concrete pouring forms for floating and inertia foundations. Bases for split case pumps shall be large enough to provide for suction and discharge elbows. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6". The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" bars welded in place on 6" centers running both ways in a layer 1 1/2" above the bottom. Forms shall be furnished with steel templates to hold the anchor bolts sleeves and anchors while concrete is being poured. Height saving brackets shall be employed in all mounting locations to maintain a 1 " clearance below the base. Wooden formed bases leaving a concrete rather than a steel finish are not acceptable. Base shall be type BMK or K as manufactured by Mason Industries, Inc.
22. Roof Curb (by HVAC Contractor)
 - a. Curb mounted rooftop equipment shall be mounted on structural spring isolation curbs that bear directly on the roof support structure, and are flashed and waterproofed into the roof's membrane waterproofing system. All spring locations shall have removable waterproof covers to allow for spring adjustment and/or removal. Springs shall be Type A.
 - b. Unit shall be provided with wood nailer and flashing.
 - c. Curbs shall meet all NRCA Standards.

- d. Curbs shall be similar to Novia Associates VibCurb III or equal having a minimum 3" rated static deflection or approved equal.
- e. Vibration control: The spring roof curb shall have the top isolated or floating rail attached in a manner to the fixed lower portion of the curb without short circuiting or bridging between the two. Restraining bolt(s) or threaded rod shall be of sufficient size to withstand the applied wind & or seismic forces at each spring pack location.
- f. An alignment bolt shall be installed before connecting the floating to non-floating parts to guarantee perfect centering of the restraining bolts.
- g. Weather proofing & air seal: The spring curb must keep the weather (air and water) out and any airflow from the RTU in. The weather seal must not have the ability to fail and allow water or air into the building.
- h. The use of exposed exterior neoprene or some other elastomer material to seal the top floating rail from the base of the curb is not acceptable.
- i. Vibration Mountings: Provide a rubber gasket covered by formed galvanized sheet metal top flashing that overhangs the top wood nailer and galvanized bottom flashing. The overlapping shall effectively cover the rubber gasket so it is protected from the elements.
- j. The top flashing / support rail shall be 14 ga. G60-Zc steel formed with 90 bends that extend down to the wood nailer. Provide a counter flashing member with a sponge gasket attached that presses up against the horizontal bend. The seal shall be replaceable, protected from the elements and easy to install.
- k. Curb side material: Provide 12 Ga. G60 galvanized steel for curb side construction. All side and end seam between sheets shall be continuously welded, corner joints to be caulked and bolted.
- l. Structural Capability:
 - 1) Curbs shall be installed on metal decking/concrete slab. Air handling unit load shall be properly distributed. Coordinate curb construction with pitch of roof. Curbs shall be built to match the roof pitch in accordance with all requirements of this project. Positive attachment of the curb to the structure is imperative. Pitch correction shall be fabricated from 12 gauge galvanized material and be continuous on all sides and ends. Field fabricated and installed tube steel stub-ups are not acceptable. HVAC contractor shall provide detailed information to the curb manufacturer regarding pitch correction.
 - 2) Plenum Sections: The side material must be capable of handling the static pressure developed by the fans and not 'oil can'. Provide spanning bar joists as required to support plenum installation (even when the spring pockets are center span).
 - 3) Provide a continuous bottom tube steel member or side material of sufficient strength. Mechanical contractor shall coordinate and verify all dimensions, weights, roof penetrations, etc. with the Structural Engineer prior to installation.
 - 4) Curb Insulation: Provide spring curbs with a space between the floating and non-floating parts for the installation of insulation. Curb manufacturer shall provide factory installed insulation adhered to roof curb. Curbs shall be externally factory insulated with a 1.7" thick R-12 foam insulation, FM Class 1 and UL Class A Ratings, with bonded fiber reinforced facer.
- m. Protection: Curbs shall be completely shrink-wrapped during shipping.
- n. Mechanical contractor shall provide all necessary materials to completely weather proof and sound proof the curb installation.

o. Additional features:

- 1) Sound barrier: Provide a sound barrier package, consisting of G60 galvanized back-to-back angles. Sound barrier package shall be capable of supporting two layers of 1/2" Durock concrete board with a maximum deflection over the width of the curb of L/360. Durock furnished and installed by the HVAC Contractor. Overlap all joints, caulk all seams and edges. Transmission Loss & STC shall be as shown as follows. Sound Transmission Loss at Frequency (Cycles per second) of (125)=20, (250)=27, (500)=30, (1000)=32, (2000)=30, (4000)=38, (STC)=31.
 - 2) Provide with framed Supply & Return air duct openings. Openings shall match duct sizes and have 1" galvanized steel flanges.
 - 3) Plenum sections: Where indicated on the drawings, provide in the interior of the curb, double wall acoustical floor, walls and plenum divider. All insulation shall be 2" thick fiber glass acoustical duct liner with reinforced coating system. Insulation acoustical performance shall be as follows. Liner shall not support microbial growth and shall be EPA registered and pass ASTM C 1071 & ASTM G21 bacterial tests conducted in accordance with ASTM G22. Floors up to 90" curb I.D. width shall be constructed of 22 Ga., 20 Ga. thereafter, solid G60 galvanized bottom panels and 22 Ga. galvanized perforated 22.7% open area top panel. Floor shall be attached to walls and plenum divider to provide an airtight plenum. Walls shall have 22 Ga. galvanized perforated 22.7% open area inside panels. Plenum divider shall be double wall 22 Ga. perforated galvanized 22.7% open area panel on the supply side with a 14 gauge solid panel opposite. Sound Absorption Coefficient at Frequency (Cycles per second) of (125)=.23, (250)=.64, (500)=.99, (1000)=1.05, (2000)=1.00, (4000)=.98, (NRC)=.90,
23. Flexible spherical expansion joints shall employ peroxide cured EPDM in the covers, liners and Dacron tire cord friction ring. Solid steel rings shall be used within the raised face rubber ends to prevent pullout. Flexible cable bead wire is not acceptable. Sizes 2" and larger shall have two spheres reinforced with a ring between spheres to maintain shape and complete with split ductile iron or steel flanges with hooked or similar interlocks. Sizes 16" to 24" may be single sphere. Sizes 3/4" to 1 1/2" may have threaded bolted flange assemblies, one sphere and cable retention. 14" and smaller connectors shall be rated at 250 psi up to 190°F. with a uniform drop in allowable pressure to 190 psi at 250°F. 16" and larger connectors are rated 180 psi at 190°F. and 135 psi at 250°F. Safety factors to burst and flange pullout shall be a minimum of 3/1. All joints must have permanent markings verifying a 5 minute factory test at twice the rated pressure. Concentric reducers to the above specifications may be substituted for equal ended expansion joints.

Expansion joints shall be installed in piping gaps equal to the length of the expansion joints under pressure. Control rods need only be used in unanchored piping locations where the manufacturer determines the installation exceeds the pressure requirement without control rods, as control rods are not desirable in seismic work. If control rods are used, they must have 1/2" thick Neoprene washer bushings large enough in area to take the thrust at 1000 psi maximum on the washer area. Expansion joints shall be installed on the equipment side of the shut off valves.

Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies on this or a similar product by the same manufacturer. All expansion joints shall be installed on the equipment side of the shut off valves. Expansion joints shall be SAFEFLEX SFDEJ, SFEJ, SFDCR or SFU and Control Rods CR as manufactured by Mason Industries, Inc.

24. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

<u>Flanged</u>		<u>Male Nipples</u>	
3 x 14	10 x 26	½ x 9	1-½ x 13
4 x 15	12 x 28	¾ x 10	2 x 14
5 x 19	14 x 30	1 x 11	2-1/2 x 18
6 x 20	16 x 32	1-1/4 x 12	
8 x 22			

Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be type BSS as manufactured by Mason Industries, Inc.

25. All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi and the design shall be balanced for equal resistance in any direction. All-directional anchors shall be type ADA as manufactured by Mason Industries, Inc.
26. Pipe guides shall consist of a telescopic arrangement of two sizes of steel tubing separated by a minimum 1/2" thickness of 60 durometer neoprene. The height of the guides shall be preset with a shear pin to allow vertical motion due to pipe expansion or contraction. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of + 1 5/8" motion, or to meet location requirements. Pipe guides shall be type VSG as manufactured by Mason Industries, Inc.
27. Split Wall Seals consist of two bolted pipe halves with minimum 3/4" thick neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240°F., 10# density fiberglass may be used in lieu of the sponge. Seals shall be Type SWS as manufactured by Mason Industries, Inc.
28. The horizontal thrust restraint shall consist of a spring element in series with a neoprene molded cup as described in specification 5 with the same deflection as specified for the mountings or hangers. The spring element shall be designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop. The assembly shall be furnished with 1 rod and angle brackets for attachment to both the equipment and the duct work or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrical on either side of the unit. Horizontal thrust restraints shall be type WBI/WBD as manufactured by Mason Industries, Inc.

PART 3 - EXECUTION

3.1 GENERAL

- A. All vibration isolators and seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data. At the completion of all construction work the vibration and seismic device supplier shall inspect all installations and provided a written report of installation compliance to the engineer of record. A copy of this written certification shall also be provided in the operations manual provided to the owner.

- B. Installation of vibration isolators and seismic restraints must not cause any change of position of equipment, piping or duct work resulting in stresses or misalignment.
- C. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- D. The contractor shall not install any equipment, piping, duct or conduit which makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
- E. Coordinate work with other trades to avoid rigid contact with the building.
- F. Any conflicts with other trades which will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- G. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.
- H. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense.
- I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
 - 1. Flanges of structural beams.
 - 2. Upper truss cords in bar joist construction.
 - 3. Cast in place inserts or wedge type drill-in concrete anchors.
- J. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.
- K. Specification 12 cable assemblies are installed taut on non-isolated systems. Specification 13 seismic solid braces may be used in place of cables on rigidly attached systems only.
- L. At locations where specification 12 or 13 restraints are located, the support rods must be braced when necessary to accept compressive loads with specification 14 braces.
- M. At all locations where specification 12 or 13 restraints are attached to pipe clevis's, the clevis cross bolt must be reinforced with specification type 15 braces.
- N. Drill-in concrete anchors for ceiling and wall installation shall be specification type 18, and specification type 19 female wedge type for floor mounted equipment.
- O. Vibration isolation manufacturer shall furnish integral structural steel bases as required. Independent steel rails are not permitted on this project.
- P. Hand built elastomeric expansion joints may be used when pipe sizes exceed 24" or specified movements exceed specification 23 capabilities.
- Q. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide specification 27 wall seals.

R. Air handling equipment and centrifugal fans shall be protected against excessive displacement which results from high air thrust in relation to the equipment weight. Horizontal thrust restraint shall be specification type 28.

S. Locate isolation hangers as near to the overhead support structure as possible.

3.2 VIBRATION ISOLATION AND SEISMIC RESTRAINT OF PIPING, DUCTWORK, AND CONDUIT

A. Where piping connects to rotating or vibrating mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.

B. Seismic Restraint of Piping:

1. Seismically restrain all piping listed as a, b or c below. Use specification 12 cables.
 - a. Fuel oil piping, gas piping, medical gas piping, and compressed air piping.
 - b. Piping located in boiler rooms, mechanical equipment rooms, and refrigeration equipment rooms that is 1 1/4" I.D. and larger.
 - c. All other piping 2 1/2" diameter and larger.
2. Transverse piping restraints shall be at 40' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
3. Longitudinal restraints shall be at 80' maximum spacing for all pipe sizes, except where lesser spacing is required to limit anchorage loads.
4. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
5. For fuel oil and all gas piping transverse restraints must be at 20' maximum and longitudinal restraints at 40' maximum spacing.
6. Transverse restraint for one pipe section may also act as a longitudinal restraint for a pipe section of the same size connected perpendicular to it if the restraint is installed within 24" of the elbow or TEE or combined stresses are within allowable limits at longer distances.
7. Hold down clamps must be used to attach pipe to all trapeze members before applying restraints in a manner similar to clevis supports.
8. Branch lines may not be used to restrain main lines.

C. Pipe Isolation

1. All chilled water, condenser water, hot water, steam, refrigerant, drain and engine exhaust piping that is connected to vibration-isolated equipment shall be isolated from the building structure within the following limits:

Within mechanical rooms;

Within 50' total pipe length of connected vibration-isolated equipment (chillers, pumps, air handling units, pressure reducing stations, etc.);

At every support point for piping that is greater than 4 inches in diameter.
2. Piping shall be isolated from the building structure by means of vibration isolators, resilient lateral supports, and resilient penetration sleeve/seals.

3. Isolators for the first three support points adjacent to connected equipment shall achieve one half the specified static deflection of the isolators supporting the connected equipment. When the required static deflection of these isolators is greater than 1/2", Type FSN or HSN isolators shall be used. When the required static deflection is less than or equal to 1/2", Type FN or HN isolators shall be used. All other pipe support isolators within the specified limits shall be either Type FN or HN achieving at least 1/4" static deflection.
4. Where lateral support of pipes is required within the specified limits, this shall be accomplished by use of resilient lateral supports.
5. Pipes within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
6. Provide flexible pipe connections as called for under Major Equipment above and wherever shown on the drawings.

D. Seismic restraint of ductwork:

1. Seismically restrain all duct work with specification 12 or 13 restraints as listed below:
 - a. Restrain rectangular ducts with cross sectional area of 6 sq. ft. or larger.
 - b. Restrain round ducts with diameters of 28" or larger.
 - c. Restrain flat oval ducts the same as rectangular ducts of the same nominal size.
2. Transverse restraints shall occur at 30' intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
3. Longitudinal restraints shall occur at 60' intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4' of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
4. The ductwork must be reinforced at the restraint locations. Reinforcement shall consist of an additional angle on top of the ductwork that is attached to the support hanger rods. Ductwork is to be attached to both upper angle and lower trapeze.
5. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
6. Walls, including gypsum board non-bearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide channel framing around ducts and solid blocking between the duct and frame.

E. Duct Isolation:

1. All sheet metal ducts and air plenums that are within mechanical rooms or within a distance of 50' total duct length of connected vibration-isolated equipment (whichever is longer) shall
2. be isolated from the building structure by Type FN, PCF or HN isolators. All isolators shall achieve 0.1" minimum static deflection.
3. Ducts within the specified limits that penetrate the building construction shall be isolated from the building structure by use of resilient penetration sleeve/seals.
4. Flexible duct connections shall be provided as called for above under Major Equipment and wherever shown on the drawings.

F. Seismic Restraint of Electrical Services:

1. All electrical conduit 2-1/2" in diameter and larger shall be restrained with specification type 12 seismic cable restraints or specification type 13 for seismic solid brace restraints.

2. All electrical bus ducts, cable trays and ladder trays shall be restrained with specification type 12, seismic cable restraints or specification 13 seismic solid brace restraints.
3. Transverse restraints shall occur at 30' intervals or both ends if the electrical run is less than the specified interval. Transverse restraints shall be installed at each electrical services turn and at each end of the electric run.
4. Longitudinal restraints shall occur at 60' intervals with at least one restraint per electric run. Transverse restraints for one electric section may also act as a longitudinal restraint for a duct for an electric section connected perpendicular to it if the restraints are installed within 4' of the intersection of the electric run and if the restraints are sized for the larger electric run.
5. All rigid floor mounted equipment must have a resilient media between the equipment mounting hole and the anchor bolt. Neoprene bushings shall be specification type 4 and anchor bolts shall be specification type 18 or 19.
6. Wall mounted panels shall be mounted with specification type 3 bushings. Floor mounted panels shall be mounted on specification type 4 bushings. Anchor bolts shall be specification type 18 or 19.

G. All fire protection piping shall be braced in accordance with NFPA 13 and 14.

H. All mechanical equipment shall be vibration isolated and seismically restrained.

1. All fire protection equipment is considered life safety equipment and shall be seismically restrained.

3.3 SEISMIC RESTRAINT EXCLUSIONS

A. Piping:

1. All piping less than 2 1/2" except for gas and fire protection piping.
2. All piping in boiler and mechanical equipment rooms less than 1 1/4" I.D.
3. All clevis or trapeze supported piping suspended from hanger rods where the point of attachment is less than the 12" in length from the structure to the structural connection of the clevis or trapeze.
4. All PVC and fiberglass suspended waste or vent pipe 6" in diameter and smaller.

B. Ductwork:

1. Rectangular, square or oval ducts less than 6 sq. ft. in cross sectional area.
2. Round duct less than 28" in diameter.
3. Duct supported by hanger rods where the point of attachment is less than 12" in length from the structure to the structural connection of the duct work.

C. Electrical:

1. All conduit less than 2 1/2" diameter suspended by individual hanger rods.
2. All clevis or trapeze supported conduits suspended by hanger rods where the point of attachment is less than 12" in length from the structure to the structural connection of the clevis or trapeze.

3.4 INSTALLATION OF VIBRATION ISOLATION EQUIPMENT

A. General

1. Locations of all vibration isolation devices shall be selected for ease of inspection and adjustment as well as for proper operation.

2. Installation of vibration isolation equipment shall be in accordance with the manufacturer's instructions.

B. Isolators

1. All vibration isolators shall be aligned squarely above or below mounting points of the
2. supported equipment.
3. Isolators for equipment with bases shall be located on the sides of the bases which are parallel to the equipment shaft unless this is not possible because of physical constraints.
4. Locate isolators to provide stable support for equipment, without excess rocking.
5. Consideration shall be given to the location of the center of gravity of the system and the location and spacing of the isolators. If necessary, a base with suitable footprint shall be provided to maintain stability of supported equipment, whether or not such a base is specifically called for herein.
6. If a housekeeping pad is provided, the isolators shall bear on the housekeeping pad and the isolator base plates shall rest entirely on the pad.
7. Hanger rods for vibration-isolated support shall be connected to major structural
8. members, not the floor slab between major structural members. Provide suitable
9. intermediate support members as necessary.
10. Vibration isolation hanger elements shall be positioned as high as possible in the
11. hanger rod assembly, but not in contact with the building structure, and so that the hanger housing may rotate a full 360° about the rod axis without contacting any object.
12. Parallel running pipes may be hung together on a trapeze that is isolated from the
13. building. Isolator deflections must be the greatest required by the provisions for pipe
14. isolation for any single pipe on the trapeze. Do not mix isolated and unisolated pipes on the same trapeze.
15. Pipes, ducts and equipment shall not be supported from other pipes, ducts and equipment.
16. Resiliently isolated pipes, ducts and equipment shall not come in rigid contact with the building construction or rigidly supported equipment.
17. The installed and operating heights of equipment supported by Type FSNTL isolators or with Type RC-2 isolation bases shall be identical. Limit stops shall be out of contact
18. during normal operation. Adjust isolators to provide 1/4" clearance between the limit
19. stop brackets and the isolator top plate, and between the travel limit nuts and travel limit brackets.
20. Adjust all leveling bolts and hanger rod bolts so that the isolated equipment is level and in proper alignment with connecting ducts or pipes.

C. Bases

1. No equipment unit shall bear directly on vibration isolators unless its own frame is suitably rigid to span between isolators and such direct support is approved by the equipment manufacturer. This provision shall apply whether or not a base frame is called for on the schedule. In the case that a base frame is required for the unit because of the equipment manufacturer's requirements and is not specifically called for on the equipment schedule, a base frame recommended by the equipment manufacturer shall be provided at no additional expense.

2. Unless otherwise indicated, there is to be a minimum operating clearance of 1" between steel rails, steel frame bases or inertia bases and the floor beneath the equipment. The isolator mounting brackets shall be positioned and the isolators adjusted so that the required clearance is maintained. The clearance space shall be checked by the Contractor to ensure that no construction debris has been left to short circuit or restrict the proper operation of the vibration isolation system.
 3. Isolation bases shall be installed in strict accordance with the manufacturer's instructions.
- D. Flexible Duct Connections:
1. Prior to installation of the flexible connection, sheet metal ducts and plenum openings shall be squarely aligned with the fan discharge, fan intake, or adjacent duct section, and the gap between connected parts shall be uniform. Flexible duct connections shall not be installed until this provision is met. There shall be no metal-to-metal contact between connected sections, and the fabric shall not be stretched taut.
- E. Flexible Pipe Connections:
1. Install flexible pipe connections in strict accordance with the manufacturer's instructions.
- F. Thrust Restraints:
1. Thrust restraints shall be attached on each side of the fan parallel to the thrust force. This may require custom brackets or standoffs. The body of the thrust restraint shall not come in contact with the connected elements. Thrust restraints shall be adjusted to constrain equipment movement to the specified limit.
- G. Grommets:
1. Where grommets are required at hold down bolts of isolators, bolt holes shall be properly sized to allow for grommets. The hold down bolt assembly shall include washers to distribute load evenly over the grommets. Bolts and washers shall be galvanized.
- H. Resilient Penetration Sleeve/Seals:
1. Maintain an airtight seal around the penetrating element and prevent rigid contact between the penetrating element and the building structure. Fit the sleeve tightly to the building construction and seal airtight on both sides of the construction penetrated with acoustical sealant.

END OF SECTION

Section 26 00 00

ELECTRICAL
 (FILED SUB-BID REQUIRED)

PART 1 - GENERAL	1
1.1 GENERAL PROVISIONS.....	1
1.2 RELATED DOCUMENTS	1
1.3 DESCRIPTION OF WORK	1
1.4 DEFINITIONS	2
1.5 ITEMS TO BE FURNISHED ONLY	3
1.6 ITEMS TO BE WIRED ONLY.....	3
1.7 RELATED WORK SPECIFIED IN OTHER SECTIONS	3
1.8 CONTRACT COST BREAKDOWN	3
1.9 INSPECTION OF SITE	3
1.10 CONTRACTOR'S REPRESENTATIVE	3
1.11 COOPERATION.....	4
1.12 CODES, ORDINANCES, AND PERMITS.....	4
1.13 ELECTRICAL ROOMS OR SPACES	4
1.14 SUBMITTALS.....	4
1.15 COMMISSIONING REQUIREMENTS	5
1.16 GUARANTEE	5
1.17 ELECTRICAL CHARACTERISTICS.....	5
1.18 TEMPORARY ELECTRICAL SUPPORT FACILITIES	6
1.19 INSPECTIONS AND TESTS.....	6
1.20 ENERGY REBATE PROGRAM.....	6
1.21 INFORMATION TECHNOLOGY SYSTEM PROVISIONS	6
1.22 RECORD DRAWINGS.....	6
1.23 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS	7
1.24 COORDINATION DRAWINGS	7
1.25 RETURN AIR PLENUM	8
1.26 ALTERNATES.....	8
1.27 STAGING AND SCAFFOLDING.....	8
1.28 INTEGRATED SECURITY SYSTEM PROVISIONS	8
1.29 TRADE RESPONSIBILITY FOR INTERCONNECTIONS MATRIX	10
PART 2 PRODUCTS	11
2.1 GENERAL	11
2.2 RACEWAYS AND FITTINGS.....	12
2.3 CONDUCTORS	14
2.4 ACCESS PANELS	15
2.5 SLEEVES, INSERTS, AND OPENINGS	16
2.6 FLOOR OUTLETS (FLUSH TYPE)	16
2.7 WIRING DEVICES.....	23
2.8 LIGHTING FIXTURES	24
2.9 ELECTRICAL POWER EQUIPMENT.....	28
2.10 ELECTRICAL SYSTEM CONTROLS AND INSTRUMENTS	30
2.11 GROUNDING SYSTEM	30
2.12 PANELBOARDS	31
2.13 ELECTRIC SERVICE.....	32
2.14 STANDBY ELECTRICAL SYSTEM.....	32
2.15 MANUAL TRANSFER SWITCH.....	37
2.16 FIRE ALARM AND DETECTION SYSTEM	40

2.17	SURGE PROTECTION DEVICES.....	53
2.18	LADDER TRAY/WIREWAYS.....	57
2.19	SEALS.....	58
2.20	UNDERGROUND DUCTBANKS.....	59
2.21	VARIABLE FREQUENCY DRIVES (VFD'S)	61
2.22	AUTOMATED LIGHTING CONTROL SYSTEM.....	65
2.23	FIRESTOP SYSTEMS.....	82
2.24	EMERGENCY RESPONDER RADIO SIGNAL AMPLIFICATION SYSTEM (BDA SYSTEM).....	82
PART 3 EXECUTION		86
3.1	WORK COORDINATION AND JOB OPERATIONS	86
3.2	PLANS AND SPECIFICATIONS.....	87
3.3	IDENTIFICATION.....	87
3.4	PROTECTION AND CLEANUP.....	88
3.5	PORTABLE OR DETACHABLE PARTS	88
3.6	SAFETY PRECAUTIONS	88
3.7	MOUNTING HEIGHTS	88
3.8	WORKMANSHIP AND INSTALLATION METHODS	89
3.9	FEEDER CIRCUITS	93
3.10	BRANCH CIRCUITS.....	93
3.11	WATERPROOFING.....	94
3.12	CUTTING AND PATCHING.....	94
3.13	MECHANICAL SYSTEM COORDINATION	94
3.14	DISTRIBUTION EQUIPMENT TESTING	95
3.15	FAULT CURRENT, ARC FLASH AND COORDINATION STUDY.....	97
3.16	INSTALLATION OF FIRESTOP SYSTEMS.....	97
3.17	STORAGE AND INSTALLATION OF EQUIPMENT.....	98

END OF INDEX

Section 26 00 00

ELECTRICAL
(FILED SUB-BID REQUIRED)

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. The BIDDING REQUIREMENTS, CONTRACT FORMS, and CONTRACT CONDITIONS as listed in the Table of Contents, and applicable parts of Division 01 – GENERAL REQUIREMENTS, shall be included in and made a part of this Section.
- B. Work of this Section requires Filed Sub-Bids and is governed by the provisions of the Massachusetts General Laws (MGL), Public Bidding Law - Chapter 149, Sections 44A to 44J inclusive, as amended, and applicable Sections of the MGL, Public Contract Law – Chapter 30.
- C. The work to be completed by the Filed Subcontractor for the work of this Section is shown on the following listed Drawings:
 - 1. Electrical & Technology Drawings: E001, E002, E003, E004, E005, E006, E101, E102, E201, E202, E203, E300, E301, E302, E303, E400, E401, E402, E403, E501, E502, T001, T101, T102, T200, T201.
 - 2. Seismic Drawings: TBD
- D. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section. The listing of Contract Drawings above does not limit Filed Subcontractor's responsibility to determine full extent of work of this Section as required by all Drawings listed in the Drawing List on the Drawing Title Sheet, as modified by Addenda.
- E. Sub-Bids for work under this Section shall be for the complete work and shall be filed electronically with the Awarding Authority at a time and place as stipulated in INVITATION TO BID and INSTRUCTIONS TO BIDDERS.
- F. Sub Sub-Bid Requirements:

CLASS OF WORK	SECTION
Technology	27 00 00

If Sub-Bidder intends to perform with persons of his own staff the classes of work listed above, he must nevertheless list his own name therefore, under Paragraph E, of the FORM FOR SUB-BID.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.3 DESCRIPTION OF WORK

- A. Work described herein shall be interpreted as work to be done by the Electrical Contractor. Work to be performed by other trades will be referenced to a particular contractor.

- B. Provide all labor, materials, tools, and equipment, including scaffolding, to complete the installation of the electrical system. Install, equip, adjust, and put into operation the respective portions of the installation specified, and so interconnect various items or sections of work in order to form a complete and operating whole. Systems may be referenced in singular or plural terms, also refer to drawings to confirm quantities. The work shall consist of, but shall not necessarily be limited to the following:
1. Primary, secondary and low tension ductbanks, handholes and manholes.
 2. Secondary distribution equipment, including metering, motor controls, Variable Frequency Drives, distribution panels, and panelboards, including feeders and subfeeders.
 3. Fire alarm system, addressable type.
 4. Emergency power system, including diesel fueled emergency generator, emergency lighting and exit signs.
 5. Lighting systems exterior and interior, including lamps, fixtures, occupancy sensors and controls.
 6. All raceway systems, including boxes, couplings, and fittings.
 7. All branch circuit wiring systems, including wiring devices and plates.
 8. Excavation and backfill within building foundation walls for any underground raceways.
 9. Connections for all building equipment, including mechanical, plumbing, fire protection, and the like.
 10. All testing of equipment installed.
 11. Any other item of work hereinafter specified or indicated on electrical drawings.
 12. Drilling, coring, and cutting of holes (where the largest dimension thereof does not exceed 12 inches) for electrical conduit systems, and equipment.
 13. Systems Identification.
 14. Scaffolding, Rigging, and Staging required for all Electrical Work.
 15. Fire stopping for all Electrical Work.
 16. Provide Seismic Restraints for all Electrical Systems conforming to the requirements of Section 23 05 48 which Section is herein incorporated by reference.
 17. Coordination Drawings.
 18. Technology system provisions, including cable tray, 120 volt power sources, raceways and backboxes for Fireproofing, and Grounding for Voice, Data, Video Systems, and Sound System shown on drawings and specified in Division 270000.
 19. Alternates, Refer to Section 012300.
 20. Automated lighting control system.
 21. Temporary Light and Power, refer to Section 01 50 00 – TEMPORARY FACILITIES.
 22. Lightning Protection System
 23. Integrated Electronic Security System provisions, IESS including 120 volt power sources, cable tray, j-hooks, raceways, and backboxes for security systems as shown on drawings. Coordination with the Owner's Security Vendor responsible for installing and wiring the IESS System.
 24. Box and conduit and 120V provisions for Zetron Station Alerting System.
 25. Bi-directional Antennae System Provisions.

1.4 DEFINITIONS

- A. Most terms used within the documents are industry standard. Certain words or phrases shall be understood to have specific meanings as follows:
1. Provide: Furnish and install completely connected up and in operable condition.
 2. Furnish: Purchase and deliver to a specific location within the building or site.
 3. Install: With respect to equipment furnished by others, install means to receive, unpack, move into position, mount and connect, including removal of packaging materials.

4. Conduit: Raceways of the metallic type which are not flexible. Specific types as specified.
5. Connect: To wire up, including all branch circuitry, control and disconnection devices so item is complete and ready for operation.
6. Subject to Mechanical Damage: Equipment and raceways installed exposed and less than eight ft. above finished floor in mechanical rooms or other areas where heavy equipment may be in use or moved.

1.5 ITEMS TO BE FURNISHED ONLY

- A. Furnish the following items for installation under designated sections.
 1. Duct smoke detectors with sampling tube, SECTION 230000 – HVAC.

1.6 ITEMS TO BE WIRED ONLY

- A. Install the following items furnished under designated sections.
- B. Specialty backboxes including boxes for speakers, Owner's Vendor

1.7 RELATED WORK SPECIFIED IN OTHER SECTIONS

- A. The following related work is to be performed under designated sections.
 1. Temp. Controls – SECTION Division 01 – Section 01 50 00 – TEMPORARY FACILITIES.
 2. Excavation and Backfill: DIVISION 31 - EARTHWORK (except within building foundation).
 3. Concrete Bases and Duct Envelopes: DIVISION 03 - CONCRETE.
 4. Insulation: SECTION 07 21 00- THERMAL/ACOUSTIC INSULATION.
 5. Finish Painting: SECTION 09 91 00 – PAINTING.
 6. Payment for energy for temporary light and power shall be made by General Contractor.
 7. Cutting beyond 1.2, B.12 above and patching of all openings regardless of size will be by respective Sections of the trade responsible for the surface on which the penetration occurs.
 8. Automatic Temperature Control: SECTION 23 00 00 - HEATING, VENTILATING, AND AIR CONDITIONING.
 9. Hardware: SECTION 08 71 00 – DOOR HARDWARE.
 10. Security System equipment and wiring: Owner's Security Vendor.
 11. Technology System equipment and wiring: Section 270000 – TECHNOLOGY.

1.8 CONTRACT COST BREAKDOWN

- A. Submit a breakdown of contract price to aid Architect in determining value of work installed as job progresses.

1.9 INSPECTION OF SITE

- A. Electrical bidders will be permitted to inspect site. Failure to inspect existing conditions or to fully understand work which is required shall not excuse Electrical Subcontractor from his obligations to supply and install work in accordance with specifications and the drawings and under all site conditions as they exist.

1.10 CONTRACTOR'S REPRESENTATIVE

- A. Retain a competent representative on the project.

1.11 COOPERATION

- A. Work shall be carried on under usual construction conditions, in conjunction with other contractors work. Cooperate with other contractors, coordinate work and proceed in a manner as not to delay progress.
- B. Before proceeding, examine all construction drawings and consult other contractors to coordinate installation and avoid interference.
- C. In case of dispute, the Architect will render a decision in accordance with General and Supplementary General Conditions.

1.12 CODES, ORDINANCES, AND PERMITS

A. Codes and Ordinances:

- 1. All material and work provided shall be in accordance with all applicable codes including the following codes and standards as most recently amended.

Commonwealth of Massachusetts Building Code

Massachusetts Electric Code, 2020 Edition

State Department of Public Safety

NFPA 101 Life Safety Code

NFPA Standards

Standards of the Underwriters Laboratories (UL)

Occupational Safety and Health Act (OSHA)

Americans with Disabilities Act (ADA)

Energy Conservation Code

Town of Millbury

- 2. Where contract documents indicate more stringent requirements than codes, the contract documents shall take precedence.

- B. Permits: Be responsible for filing documents, and securing of inspection and approvals. Pay all permit and inspection fees.
- C. Refer to DIVISION 01 – GENERAL REQUIREMENTS. Utility company backcharges related to permanent service will be paid by Owner.

1.13 ELECTRICAL ROOMS OR SPACES

- A. Be responsible for ensuring that the dedicated space and clearances required in the NEC, Sections 110-26 are maintained for all electrical equipment.
- B. Call other contractors' attention to the requirements contained in the above mentioned code sections, prior to the installation of equipment by other contractors, in order to ensure no violations.

1.14 SUBMITTALS

- A. Refer to Supplementary General Conditions for information relative to submission of shop drawings. Six copies are required. No equipment shall be installed prior to approval, except at Contractor's own risk.

- B. Notwithstanding any restrictions upon contractor proposed substitutions, should apparatus or materials be permitted by Architect to be substituted for those specified for good cause, and such substitution necessitates changes in or additional connections, piping, supports, or construction, same shall be provided. Assume cost and entire responsibility thereof.
- C. Submit the following samples:
 - 1. Lighting fixtures as may be requested.
 - 2. Other items as may be requested.

1.15 COMMISSIONING REQUIREMENTS

- A. An independent Commissioning Agent (CxA) has been retained for this project. The commissioning process will be implemented in accordance with industry standard commissioning protocols and procedures.
- B. This contractor shall assist and support the CxA as necessary in accordance with the requirements of specification section 01 81 00 – GENERAL COMMISSIONING REQUIREMENTS.

1.16 GUARANTEE

- A. All parts of the work shall be guaranteed for a period of one (1) year from the date of acceptance of the job by Owner. If during that period of general guaranty, any part of the work fails, becomes unsatisfactory, or does not function properly due to any fault in material or workmanship whether or not manufactured or job built, the Owner shall upon notice from owner promptly proceed to repair or replace such faulty material or workmanship without expense to owner, including cutting, patching, and painting, or other work involved, and including repair or restoration of any damaged sections of the premises resulting from such faults.
- B. In the event that a repetition of any one defect occurs indicating the probability of further failure and which can be traced to faulty design, material, or workmanship, then repair or replacement shall not continue to be made but the fault shall be remedied by a complete replacement of the entire defective unit.
- C. In addition to the general guaranty, obtain and transmit to owner any guaranties or warranties from manufacturers of specialties, but only as supplementary to the general guaranty which will not be invalidated by same.

1.17 ELECTRICAL CHARACTERISTICS

- A. In general, and unless specifically indicated otherwise, all building service, heating, ventilating, air conditioning, and plumbing equipment shall be of the following characteristics:
 - 1. Motors up to and including 1/3 HP shall be suitable for 120 volts, one phase operation.
 - 2. Motors larger than 1/3 HP shall be suitable for 208 volts, three-phase operation.
 - 3. Electric heating equipment 1.5 KW and less shall be suitable for 120 volt single-phase operation. Over 1.5 KW shall be 208 volt three phase.
- B. Power Factor: All equipment provided rated greater than 1,000 watts and lighting equipment greater than 15 watts with an inductive reactance load component shall have a power factor of not less than 90 percent under rated load conditions.

1.18 TEMPORARY ELECTRICAL SUPPORT FACILITIES

- A. Refer to Section Division 01, Section 01 50 00 – TEMPORARY FACILITIES.
- B. Provide own field office and/or storage facilities. Provide all tools, equipment, ladders, and temporary construction required for execution of the work.
- C. All scaffolding, ladders, and other temporary construction shall be rigidly built in accordance with all local and state requirements, and shall be removed upon completion.

1.19 INSPECTIONS AND TESTS

- A. Inspection: If inspection of materials installed shows defects, such defective work, materials, and/or equipment shall be replaced and inspection and tests repeated.
- B. Tests: Make reasonable tests and prove integrity of work and leave electrical installation in correct adjustment and ready to operate. All panels and distribution panels shall have phases balanced as near as practical. A consistent phase orientation shall be adhered to at all terminations.

1.20 ENERGY REBATE PROGRAM

- A. This project has been designed to incorporate equipment approved for energy rebate such as fixtures, drivers, and lamps. Provide accordingly and file all forms required by utility company on behalf of the Owner. Obtain Utility Co. approval for light fixtures and controls prior to submitting shop drawings.

1.21 INFORMATION TECHNOLOGY SYSTEM PROVISIONS

- A. Electrical Contractor shall work closely with the Technology System Contractor to assure a first class installation. Coordinate all back boxes and conduits required prior to installation. In general, the electrical contractor shall provide conduits from (Technology equipment) outlets to accessible ceiling spaces.
- B. Responsibilities of the Electrical Contractor: The Electrical Contractor shall be responsible for furnishing and installing all related system provisions including, but not limited to: power, cable trays, conduits with bushings, conduit stubs with bushings, j-hooks every 5 ft. along cable paths, sleeves with bushings, backboxes, plaster rings, pull strings, bonding, and grounding, Specialty backboxes will be furnished by Technology System Contractor and installed under Section 260000.
- C. Responsibilities of the Technology Systems Contractor: The Technology Systems Contractor will be responsible for furnishing, installing, wiring, programming, troubleshooting, training and warranty service of all Technology System cabling and equipment, for a complete operational system.

1.22 RECORD DRAWINGS

- A. Provide two sets of black or blue line on white drawings to maintain and submit record drawings, one set shall be maintained at site and which shall be accurate, clear, and complete showing actual location of all equipment as installed. Record drawings shall be updated at least monthly. Record drawings shall show outlet from which homeruns are taken, and location of all junction boxes and access panels. These drawings shall be available to Architect/Engineer field representative. Refer to Division 01.
- B. Any addenda sketches and supplementary drawings issued during course of construction shall be attached to drawings.

- C. At completion, submit an accurate checked set of drawings.
- D. After approval of these drawings, photo reproductions of original tracings shall be revised to incorporate changes, including addenda sketches and supplementary drawings. These as-built drawings shall be certified as correct and delivered to the Architect along with one set of black line prints and an AutoCAD CD.

1.23 OPERATING INSTRUCTIONS AND MAINTENANCE MANUALS

- A. Operating Instructions: Furnish operating instructions to Owner's designated representative with respect to operations, functions and maintenance procedures for equipment and systems installed. Cost of such instruction up to a full three days of Electrical Subcontractor's time shall be included in contract. Cost of providing a manufacturer's representative at site for instructional purposes shall also be included.
- B. Maintenance Manuals:
 - 1. At completion of the project, provide four copies of complete manuals containing the following:
 - a. Complete shop drawings of equipment.
 - b. Operation description of systems.
 - c. Names, addresses, and telephone numbers of suppliers of systems.
 - d. Vendors' P.O. numbers for equipment installed.
 - e. Preventive maintenance instructions for systems.
 - f. Spare parts list of system components.
 - 2. All information shall be in one binder.

1.24 COORDINATION DRAWINGS

- A. Before materials are purchased or work is begun, prepare and submit to the Architect, Coordination Drawings showing the size and location of all equipment and piping lines relevant to the complete system. Ensure that these Drawings are compatible and correctly annotated and cross-referenced at their interfaces. Refer to Division 01 – GENERAL REQUIREMENTS for additional requirements.
- B. The General Contractor shall be responsible for the coordination of all mechanical and electrical work. Before materials are fabricated or work begun, he shall submit to the Architect complete Coordination Drawings in the form of reproducible (vellum) transparencies at not less than 1/4 inch scale. Congested areas and sections through shafts shall be prepared at not less than 3/8 inch scale. The General Contractor may request electronic files, from the Architect, to generate the indication of the building shell background for the Coordination Drawings.
- C. Coordination Drawings shall indicate the necessary offsets for all ductwork, piping, conduit, and other items to clear the work of all other trades and to maintain the required ceiling height and partition layout. Each subcontractor shall indicate both top and bottom elevations of their equipment taking into account hangers, flanges, and other accessories.
- D. Prepare Coordination Drawings as follows:
 - 1. The General Contractor shall require the HVAC Subcontractor to prepare original Drawings showing all his/her equipment, ducts, and piping on these transparencies.
 - 2. The General Contractor shall have vellum transparencies made therefrom.
 - 3. The General Contractor shall then require the PLUMBING Subcontractor to indicate all Plumbing piping and heating lines.

4. The General Contractor shall then require the FIRE PROTECTION Subcontractor to indicate all his/her equipment and piping on these transparencies.
 5. The General Contractor shall then require the ELECTRICAL Subcontractor to indicate all his/her equipment and conduit lines on these transparencies.
 6. The General Contractor shall resolve conflicts and then submit these transparencies to the Architect for review.
- E. Coordination Drawings shall bear the signature of all Subcontractors involved indicating that all space conditions have been satisfactorily resolved. In addition, the Drawings shall bear the Contractor's stamp bearing the notation "Drawings Have Been Checked and Coordinated with All Trades". Drawings without these notations will not be accepted by the Architect.
- F. If any space conflicts cannot be resolved by the Contractor, he shall immediately notify the Architect and request disposition of the conflict.
- G. Coordination Drawings are for the Contractor's and Architect's use during construction and shall not be construed as replacing any Shop, As-Built, or Record Drawings required elsewhere in these Contract Documents.
- H. Architect's review of Coordination Drawings shall not relieve the Contractor from his overall responsibility for coordination of all work performed pursuant to the Contract or from any other requirement of the Contract.

1.25 RETURN AIR PLENUM

- A. All wiring for areas above suspended ceilings shall be UL Listed plenum rated cable or wiring shall be installed in conduit.

1.26 ALTERNATES

- A. Refer to Section 012300 for Alternates affecting this section.
- B. Include in your bid a separate price for amounts to be added or deducted from base bid amount for the following areas of Electrical work.

1.27 STAGING AND SCAFFOLDING

- A. Unless otherwise specified, each sub-contractor shall provide all lifts and man-lifts, and furnish, erect and maintain in safe condition, all staging and scaffolding as specified under Section 015000 Temporary Facilities, as needed for proper execution of the work of this Section. Staging and scaffolding shall be of adequate design, erected and removed by experienced stage builders having all accident prevention devices required by Federal, state and local laws.

1.28 INTEGRATED SECURITY SYSTEM PROVISIONS

- A. The work shall be so performed so that the progress of the entire building construction, including all other trades, shall not be delayed and not interfered with. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as directed.

- B. Responsibilities of the Electrical Contractor: The Electrical Contractor shall be responsible for furnishing and installing all related building preparation including, but not limited to: outlet boxes with plaster rings, 120 volt power, surface raceways, conduits with bushings, conduit stubs with bushings, sleeves with bushings (all conduits, stubs, sleeves, etc. shall be brought to an accessible ceiling of the same floor), backboxes, plaster rings, pull strings, bonding, grounding, core drilling, cutting, fireproofing of penetration & openings, environmental seals, smoke and fire stopping seals, seismic supports, etc., for a completely operational system, as shown on electrical drawings and security drawings. Specialty backboxes furnished by the Security System contractor, shall be installed by Electrical Contractor.
1. The Electrical Contractor shall be responsible for furnishing and installing: conduits from each door electric lock, latch, mag lock, door contact, card reader, etc. to an accessible ceiling space. Provide power and fire alarm interface at each door controller requiring same including doors with readers in and out designated as fail safe in the hardware schedule.
- C. Responsibilities of the Owner's Security System Contractor: The Owner's Security Systems Contractor will be responsible for furnishing, installing, wiring, programming, troubleshooting, training and warranty service of all cabling, terminal equipment, headend equipment, etc. for a completely operational system. The Security System Contractor will furnish specialty backboxes including but not limited to card reader/keypads, speakers, etc. to be installed by Electrical Contractor.
- D. Keep fully informed as to the shape, size and position of all openings required for all apparatus and give information in advance to build openings into the work.
- E. All distribution systems which require pitch or slope such as plumbing drains, steam and condensate piping shall have the right of way over those which do not. Confer with other trades as to the location of pipes, ducts, lights and apparatus and install work to avoid interferences.
- F. Coordinate exact locations and roughing in dimensions of all work before installation and make all final connections as required. Any changes required to avoid interference or to provide adequate clearances for Code and maintenance requirements shall be made at no additional costs.
- G. Structural elements of the project shall not be relocated, altered or changed to accommodate the work without written authorization from the Architect.
- H. Work that is installed before coordination with other trades, or that causes interference with the work of other trades shall be changed to correct condition.
- I. Obtain a complete set of Project Drawings and Specifications for coordination and to determine the full scope of work.
- J. Attend project coordination meetings to coordinate work of this Section, work of other trades and project and phasing requirements.

1.29 TRADE RESPONSIBILITY FOR INTERCONNECTIONS MATRIX

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring	Notes
Smoke Detectors (Area type)	26 00 00	26 00 00	26 00 00	230000 (ATC)	26 00 00	
Smoke Detectors (Duct mounted)	26 00 00	23 00 00	26 00 00	230000 (ATC)	26 00 00	
Smoke & Fire/Smoke Dampers	23 00 00	23 00 00	N/A	N/A	N/A	
Smoke & Fire/Smoke Damper Actuators	23 00 00	23 00 00	26 00 00 & 230000 (ATC)	230000 (ATC)	26 00 00	2
Fire Dampers	23 00 00	23 00 00	N/A	N/A	N/A	
VAV Boxes	23 00 00	23 00 00	26 00 00	230000 (ATC)	N/A	2
VAV Box Damper Actuator	230000 (ATC)	Box Mfr	230000 (ATC)	230000 (ATC)	N/A	2
VAV Box DDC Controller	230000 (ATC)	Box Mfr	230000 (ATC)	230000 (ATC)	N/A	2
Hydronic Control Valves	230000 (ATC)	23 00 00	N/A	230000 (ATC)	N/A	1
Hydronic Control Valve Actuator	230000 (ATC)	23 09 23	230000 (ATC)	230000 (ATC)	N/A	1
Sheet Metal Damper	23 00 00	23 00 00	N/A	N/A	N/A	1
Sheet Metal Damper Actuators	230000 (ATC)	23 09 23	230000 (ATC)	230000 (ATC)	N/A	1
Natural Gas Energy Meters	22 00 00	22 00 00	26 00 00 & 230000 (ATC)	230000 (ATC)	N/A	3
Electrical Energy Meters	26 00 00	26 00 00	26 00 00 & 230000 (ATC)	230000 (ATC)	N/A	3
Domestic Water Meters	22 00 00	22 00 00	26 00 00 & 230000 (ATC)	230000 (ATC)	N/A	3
HVAC Hydronic Energy Meters	23 00 00	230000 (ATC)	26 00 00 & 230000 (ATC)	230000 (ATC)	N/A	3
Airflow Measuring Stations	230000 (ATC)	230000 (ATC)	N/A	230000 (ATC)	N/A	
DDC Panels	230000 (ATC)	230000 (ATC)	26 00 00 & 230000 (ATC)	230000 (ATC)	N/A	4

Device	Furnished By	Installed By	Power Wiring	Control Wiring	Fire Alarm Wiring	Notes
VFDs at AHU, EFs	230000 (ATC)	230000 (ATC)	26 00 00	230000 (ATC)	N/A	
Elevator Hoistway Vent Damper	23 00 00	23 00 00	N/A	N/A	N/A	
Elevator Hoistway Vent Damper Actuator	230000 (ATC)	230000 (ATC)	230000 (ATC)	230000 (ATC)	26 00 00	
Boiler/DHW Intake & Exhaust Breeching	22 00 00	22 00 00	N/A	N/A	N/A	
Generator Exhaust Breeching	22 00 00 (if gas fired) 23 00 00 (if diesel fired)	22 00 00 (if gas fired) 23 00 00 (if diesel fired)	26 00 00	26 00 00	26 00 00	
Kitchen Emergency Gas Valve	22 00 00	22 00 00	26 00 00	26 00 00	26 00 00	

Notes:

1. Division 23 00 00 and Division 230000 (ATC) Contractors shall fully coordinate all airflow damper and hydronic valves sizes and quantities.
2. Smoke Damper and VAV Box power wiring shall be provided by Division 26 00 00 to junction box locations shown on electrical drawings; Division 230000 (ATC) Contractor shall provide final power wiring from junction box to end device location.
3. Division 26 00 00 Contractor shall provide all line-voltage power wiring required for meters; Division 23 00 00 (ATC) Contractor shall provide all low-voltage power wiring required for meters.
4. Division 26 00 00 shall provide power at main DDC Panel. Division 230000 (ATC) shall provide power to all other DDC Panels.

PART 2 PRODUCTS

2.1 GENERAL

- A. Product specifications are written in such a manner so as to specify what materials may be used in a particular location or application and therefore do not indicate what is not acceptable or suitable for a particular location or application. As an example: non-metallic sheathed cable is not specified; therefore, it is not acceptable.
- B. For purpose of establishing a standard of quality and not for purpose of limiting competition, the basis of this Specification is upon specified models and types of equipment and materials, as manufactured by specified manufacturers.
- C. In all cases, standard cataloged materials and systems have been selected. Materials such as lighting fixtures specially manufactured for this particular project and not part of a manufacturers' standard product line will not be acceptable. In the case of systems, the system components shall be from a single source regularly engaged in supplying such systems. A proposed system made up of a collection of various manufacturers' products will be unacceptable.
- D. All material shall be new and shall be UL listed.

2.2 RACEWAYS AND FITTINGS

A. Raceways - General:

1. No raceway shall be used smaller than $\frac{3}{4}$ in. diameter and shall have no more than four 90 degree bends in any one run, and where necessary, pull boxes shall be provided. Only rigid metal conduit or intermediate metal conduit is allowed for slab work. Cable systems, if allowed to be used by other sections of this specification, shall not be used exposed or in slabs, whether listed by UL for such use or not.
2. Rigid metal conduit conforming to, and installed in accordance with, Article 344 shall be heavy wall zinc coated steel conforming to American Standard Specification C80-1 and may be used for service work, exterior work, slab work, and below grade level slab, wet locations, and in penthouse for drops down to equipment from elevations below eight ft. and also where raceway may be subject to mechanical damage.
3. Intermediate metal conduit conforming to, and installed in accordance with, Article 342, may be used for all applications where rigid metal conduit is allowed by these specifications.
4. Electrical Metallic Tubing (EMT), conforming to, and installed in accordance with, Article 358 shall be zinc coated steel, conforming to industry standards, may be used in masonry block walls, stud partitions, above furred ceilings, where exposed but not subject to mechanical damage, and may be used for fire alarm work.
5. Surface metal raceways conforming to, and installed in accordance with, Article 386 may be used where raceways cannot be run concealed in public spaces including corridors, offices, toilets.
6. Flexible metal conduit shall be used for final connections to recessed lighting fixtures from above ceiling junction boxes and for final flexible connections to motors and other rotating or vibrating equipment. Liquid tight flexible metal conduit shall be used for the above connections which are located in moist locations. All flexible connections shall include an insulated grounding conductor.
7. Rigid non-metallic conduit shall be used for underground electric and telephone services outside the foundation wall and shall be polyvinyl chloride (PVC) schedule 40, 90 degrees Celsius.
8. PVC Schedule 40 may also be used for below slab feeders and circuits within building confines. Below slab rigid non-metallic conduits do not require concrete encasement. Rigid non-metallic conduits may also be used for exterior feeders and branch circuits. Rigid non-metallic conduits shall not be used in-slabs, for elbows that penetrate slabs or thru-foundation walls. Raceways and fittings shall be produced by same manufacturer.
9. Acceptable manufacturers:
 - Pittsburgh Standard Conduit Company
 - Republic Steel and Tube
 - Youngstown Sheet and Tube Company
 - Carlon
 - Or Equal
10. Fittings:
 - a. Provide insulated bushings on all raceways 1 inch diameter or larger.
 - b. Manufacturer's standard fittings shall be used for raceway supports.
 - c. Expansion Fittings: Expansion fittings shall be used where structural and concrete expansion joints occur and shall include a ground strap.
 - d. Couplings for rigid metal and intermediate metal conduit shall be threaded type.

- e. Threadless fittings for EMT shall be watertight compression type or set-screw type (dry-locations). All fittings shall be concrete tight. No diecast fittings allowed except for raceways larger than 1 inch diameter.
- f. Cable supports in vertical raceways shall be of the split wedge type. Armored cable supports for vertical runs to be of wire mesh basket design.
- g. Wall entrance seals shall be equal to O.Z. Gedney type WSK.
- h. Couplings, elbows and other fittings used with rigid nonmetallic conduit shall be of the solvent cemented type to secure a waterproof installation.
- i. Acceptable manufacturers:
 - O.Z.
 - Crouse Hinds
 - Appleton
 - EFCOR
 - Steel City
 - Or Equal

B. Outlets, Pull and Junction Boxes:

1. Outlets:

- a. Each outlet in wiring or raceway systems shall be provided with an outlet box to suit conditions encountered. Boxes installed in normally wet locations or surface mounted shall be of the cast-metal type having hubs. Concealed boxes shall be cadmium plated or zinc coated sheet metal type. Old work boxes with Madison clamps not allowed in new construction. Thru the wall boxes are not permitted. Surface mounted boxes below 8 ft. above finish floor in finish spaces shall be of the finish type without knockouts.
- b. Each box shall have sufficient volume to accommodate number of conductors in accordance with requirements of Code. Boxes shall not be less than 1-1/2 in. deep unless shallower boxes are required by structural conditions. Ceiling and bracket outlet boxes shall not be less than 4 in. octagonal except that smaller boxes may be used where required by particular fixture to be installed. Flush or recessed fixtures shall be provided with separate junction boxes when required by fixture terminal temperature requirements. Switch and receptacle boxes shall be 4 in. square or of comparable volume.
- c. Far side box supports shall be Caddy J-1A.
- d. Acceptable manufacturers:
 - Appleton
 - Crouse Hinds
 - Steel City
 - RACO
 - Or Equal

2. Pull and Junction Boxes: Where indicated on plans, and where necessary to terminate, tap off, or redirect multiple raceway runs or to facilitate conductor installation, furnish, and install appropriately designed boxes. Boxes shall be fabricated from code gauge steel assembled with corrosion resistant machine screws. Box size shall be per Code.

3. Boxes in moist or wet areas shall be galvanized type. Boxes larger than 4-11/16 inches square shall have hinged covers. Boxes larger than 12 inches in one dimension will be allowed to have screw fastened covers, if a hinged cover would not be capable of being opened a full 90 degrees due to installation location.

- a. Acceptable Manufacturers:

Brasch
Hoffman
Keystone
Lee Products Co.
McKinstry Inc.
Eldon Inc.
Or Equal

2.3 CONDUCTORS

- A. All conductors shall be a minimum size of #12 AWG except for control wiring and fire alarm wiring where #14 AWG may be used. For all exit sign circuits, normal/emergency and/or emergency only circuits, exterior lighting circuits, and also where distance from panelboard to first outlet exceeds 100 ft. at 120 volts, #10 AWG shall be minimum size wire allowed. All feeder and branch circuit conductor shall be color coded as follows:

1. 208Y/120V	Phase A	Black
2. 208Y/120V	Phase B	Red
3. 208Y/120V	Phase C	Blue
4. Grounded Conductor		
	120/208	White
5. Equipment Ground		
	120/208	Green
6. Isolated Ground		
	120/208	Green with Orange Trace

- B. All conductors not installed in accordance with color scheme shall be replaced. All conductors larger than #6 AWG must be identified with colored tape.

- C. Connections throughout the entire job shall be made with solderless type devices.

1. For #10 AWG and smaller: spring type.
2. For #8 AWG and larger: circumferential compression type.
3. Acceptable manufacturers:
 - a. 3M "Scotchlock"
 - b. IDEAL "Wingnut"
 - c. BURNDY
 - d. MAC
 - e. Or equal
4. Any splices made up in ground mounted pull boxes shall be resin cast waterproof type or waterproof pressure type.

- D. Conductors shall be copper, soft drawn, and annealed of 98 percent conductivity. Conductors larger than #10 AWG shall be stranded; #10 AWG and smaller shall be solid. Conductors shall be insulated for 600 volts and be of following types:
 - 1. All conductors shall have heat/moisture resistant thermoplastic insulation type THHN/THWN (75 degrees C) except as follows:
 - a. In sizes #1 AWG and larger: Crosslinked polyethylene insulation type XHHW (75 degrees C – 90 degrees C) may be used.
 - b. Fire alarm system conductors shall be #14 AWG, type THHN, solid. Color coding of fire alarm conductors shall be in accordance with fire codes.
 - c. Fixture whips #16AWG type "SF".
- E. Stranded conductors for all wiring systems except fire alarm will be allowed if installed and terminated as specified under Execution Section.
- F. Mineral-Insulated Metal-Sheathed Fire-Resistive Cables (Type MI) - Cables shall consist of a factory assembly of one or more solid copper conductors insulated with highly-compressed magnesium oxide and enclosed in a seamless, liquid-and-gas-tight continuous copper sheath. Cables shall be rated for 600 volts and less. Cables shall comply with Article 332 of the National Electrical Code. Cables shall be classified by Underwriters Laboratories, Inc. as having a 2-hour fire resistive rating. Cable terminations shall be made with UL listed mineral-insulated cable fittings. Approved Manufacturer - Pyrotenax USA, Inc. or equal.
- G. Type MC Cable may be used for concealed branch circuits in hollow spaces where allowed by code if installed and terminated as specified under Execution Section. Armor to be galvanized steel and shall be UL listed for 2 hour fire wall penetration. Light steel armor is acceptable.
- H. Type MC Cable may be used for fire alarm where concealed and allowed by Code, armor shall be red.
- I. Acceptable manufacturers:
 - 1. AFC Cable Systems
 - 2. American Wire & Cable
 - 3. Cerro
 - 4. Cornish
 - 5. Cresent
 - 6. General Cable
 - 7. Okonite
 - 8. Or equal

2.4 ACCESS PANELS

- A. Provide access panels for access to concealed junction boxes and to other concealed parts of system that require accessibility for operation and maintenance. In general, electrical work shall be laid out so access panels are not required.
- B. Access panels shall be located in a workmanlike manner in closets, storage rooms, and/or other non-public areas, positioned so that junction can be easily reached and size shall be sufficient for purpose (minimum size 12 in. x 12 in.). Access panels shall be prime painted and equipped with screwdriver operated cam locks.

C. Acceptable manufacturers:

Inland Steel Products Company - Milcor
Miami Carey
Walsh-Hannon-Gladwin, Inc. - Way Locator
Or Equal

Specific types:

Acoustical Tile Ceiling	"Milcor Type AT"
Plastered Surfaces	"Milcor Type K"
Masonry Construction	"Milcor Type M"
Drywall Construction	"Milcor Type DW"

D. Furnish access panel shop drawings.

2.5 SLEEVES, INSERTS, AND OPENINGS

A. Sleeves: Provide sleeves of proper sizes for all openings required in concrete floors and walls. Sleeves passing through floors shall be set with top of sleeve 1 in. above finished floor. Core drilling will also be acceptable if in accordance with any structural standards. Any unsleeved openings shall be waterproofed.

B. Inserts: Provide inserts or other anchoring devices in concrete and masonry construction to support raceways and equipment.

C. Openings: Where an opening is required in concrete slabs to allow passage of a multitude of raceways, give adequate notice to General Contractor so he may box out opening in form work.

D. Any openings through fire rated surfaces shall be closed off with fireproofing materials providing the same rating as the surface penetrated.

Acceptable Manufacturers:

Specified Technologies Inc.
Thomas & Betts
International Protective Coatings Corp.
3M Fire Protection Products
Dow Corning
Or Equal

2.6 FLOOR OUTLETS (FLUSH TYPE)

A. Section includes flush floor boxes equal to Wiremold RFB Series. Provide appropriate floor box model that meets the intent of what is shown on the drawings.

B. Quality Assurance

1. Electrical Raceways and Components: Comply with requirements of applicable local codes, NEC, UL, and NEMA Standards pertaining to raceways and components. Listed and labeled in accordance with NFPA 70, Article 100.

C. Floor Boxes

1. RFB4 and RFB4-4DB Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 12-3/4" L x 10" W x 3-7/16" H [324mm x 254mm x 87mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The RFB4 Series Box shall permit tunneling from end power compartment to end power compartment. The RFB4-4DB Series Box shall permit tunneling from adjacent or opposite compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 16.4 cu in [269cu cm], one (1) compartment shall have a minimum capacity of 32.3 cu in [529cu cm], and one (1) compartment shall have a minimum capacity of 50 cu in [820cu cm]. Four (4) compartments shall have a minimum of two (2) inches of space behind the device plates. The box shall include the following number of conduit knockouts: one (1) 1/2-inch [12.7mm], three (3) 1-inch [25mm], six (6) 3/4-inch [19.1mm], and six (6) 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [47.7mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
2. RFB4-CI-1 and RFB4-CI-NA Series Floor Boxes: Manufactured from cast-iron and approved for use on grade and above grade floors. The box shall be 14-1/2" L x 11-7/8" W x 3-7/16" H [368mm x 302mm x 87mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles and/or communication services. The box shall permit tunneling from adjacent or opposite compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 27 cu in [443cu cm], and two (2) compartments shall have a minimum wiring capacity of 36 cu in [590cu cm]. Four (4) compartments shall have a minimum of two (2) inches of space behind the device plates. The box shall include the following number of conduit hubs: four (4) 1-inch [25mm] and four (4) 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [48mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
3. RFB4-SS Series Floor Boxes: Manufactured from stamped-steel and approved for use on above grade floors. The box shall be 13-5/8" L x 10" W x 2-7/16" H [346mm x 254mm x 62mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the four (4) compartments shall have a minimum wiring capacity of 15.7 cu in [257cu cm] and two (2) compartments shall have a minimum wiring capacity of 31.2 cu in [511cu cm]. Four (4) compartments shall have a minimum of two (2) inches of space behind the device plates. The box shall contain the following number of conduit knockouts: two (2) 1/2-inch [12.7mm], six (6) 3/4-inch [19.1mm], and eight (8) 1-inch [25mm]. The box shall be fully adjustable, providing a maximum of 1-7/8-inch [48mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics® workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

4. RFB4E Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 13-1/8" W x 4-1/16" H [333mm x 333mm x 103mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The box shall permit feed through removable barriers from adjacent compartments. Four (4) compartments shall have a minimum wiring capacity of 75 cu in [1230cu cm]. Four (4) compartments shall have a minimum of 3-1/2 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: six 3/4-inch [19.1mm], ten (10) 1-inch [25mm], and eight (8) 1-1/4-inch [32mm]. The box shall have two removable knockout plates that can be replaced with a 2-inch trade size conduit hub (2HUB). The box shall be fully adjustable, providing a maximum of 2-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
5. RFB4E-OG Series Floor Boxes: Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and approved for use on grade and above grade floors. The box shall be 13-1/8" L x 13-1/8" W x 4-1/16" H [333mm x 333mm x 103mm]. Provide the box with four (4) independent wiring compartments that allow capacity for up to four (4) duplex receptacles, communication and/or audio/video services. The box shall permit feed through removable barriers from adjacent compartments. Four (4) compartments shall have a minimum wiring capacity of 75 cu in [1230cu cm]. Four (4) compartments shall have a minimum of 3-1/2 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: six 3/4-inch [19.1mm], ten (10) 1-inch [25mm], and eight (8) 1-1/4-inch [32mm]. The box shall have two removable knockout plates that can be replaced with a 2-inch trade size conduit hub (2HUB). The box shall be fully adjustable, providing a maximum of 2-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
6. RFB6 Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 3-1/4" H [333mm x 317mm x 83mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of space behind the device plates and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

7. RFB6-OG Series Floor Boxes: Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and approved for use on grade and above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 3-1/4" H [333mm x 317mm x 83mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of space behind the device plates and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment.

The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

8. RFB6E Series Floor Boxes: Manufactured from stamped steel and approved for use on above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 4" H [333mm x 317mm x 102mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments through 1-1/4-inch grommet openings. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of space behind the device plates and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.

9. RFB6E-OG Series Floor Boxes: Manufactured from stamped steel and painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and approved for use on grade and above grade floors. The box shall be 13-1/8" L x 12-1/2" W x 4" H [333mm x 317mm x 102mm]. Provide the box with six (6) independent wiring compartments that allow capacity for up to six (6) duplex receptacles, communication and/or audio/video services. The box shall permit feed through tunneling from adjacent compartments. Two (2) of the six (6) compartments shall have a minimum wiring capacity of 23 cu in [376cu cm] and four (4) compartments shall have a minimum wiring capacity of 52cu in [850cu cm]. Four (4) of the six (6) compartments shall have a minimum of 3-1/4 inches of space behind the device plates, and two (2) of the six (6) compartments shall have a minimum of 2-3/8 inches of space behind the device plates. The box shall contain the following number of conduit knockouts: twelve 3/4-inch [19.1mm], four (4) 1-inch [25mm], and twelve 1-1/4-inch [32mm]. The box shall be fully adjustable, providing a maximum of 1-3/8-inch [35mm] pre-pour adjustment, and a maximum of 3/4-inch [19.1mm] after-pour adjustment. The box shall include a series of device mounting plates that will accept both duplex power devices as well as plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, Legrand AVIP audio/video device plates, and other open system devices.
10. Gang Floor Box:
- a. Classification and Use: Floor boxes shall have been examined and tested by Underwriters Laboratories Inc. to meet UL 514A and/or UL 514C and Canadian Standard C22.2, No. 18.1-04 and 18.2-06 and bear the U.S. and Canadian UL Listing Mark. Floor boxes shall also have been tested by Underwriters Laboratories Inc. and classified for fire resistance and bear the U.S. and Canadian UL Classification Mark. Devices shall be classified for use in 2-hour rated, unprotected reinforced concrete floors and 2-hour rated floors employing unprotected steel floor units and concrete toppings (D900 Series Designs) or concrete floors with suspended ceilings (fire resistive designs with suspended ceilings should have provisions for accessibility in the ceiling below the floor boxes). Floor boxes shall also conform to the standards set in Section 300-21 of the National Electrical Code. Floor boxes shall meet UL scrub water requirements, but are not suitable for wet or damp locations, or other areas subject to saturation with water or other liquids such as commercial kitchens. Floor boxes shall also have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, bare concrete, terrazzo, wood, and carpet covered floors. Floor boxes shall be suitable for use in air handling spaces in accordance with Section 300-22 (C) of the National Electrical Code.
 - b. Floor Boxes, General: Evolution Series Floor Boxes for use on above grade concrete floors, raised floors or wood floors. Provide boxes with a component to permit installation in polished concrete or terrazzo floors. Boxes shall be compatible with complete line of Ortronics workstation connectivity outlets and modular inserts.
 1. Floor boxes provide the interface between power, communication and audio/video (A/V) cabling in above-grade floors, on-grade concrete floors, raised floors, wood floors, and fire-classified floors and the workstation or activation location where power and communication and/or A/V device outlets are required. Boxes shall provide recessed device outlets that will not obstruct the floor area. Refer to Drawings for size and types.
 2. Floor boxes shall permit all wiring to be completed at floor level. The FC models shall be used as defined by the UL Fire Resistance Directory at a minimum spacing of 24 inches (610 mm) on center.

- c. **Model EFB10S-OG Floor Boxes:** Manufactured from stamped steel approved for use in above grade and on-grade floor applications. Boxes shall have the ability to accept a component (EFB610-CTR) that will allow the box to be installed in polished concrete or terrazzo floors. Boxes shall be painted with a fusion-bonded epoxy designed for use on metal reinforcement bar and related accessories before encapsulation in concrete, and be approved for use on-grade and above grade floors. Boxes shall be 15-3/16 inches L x 12-5/8 inches W x 6-1/16 inches H (385 mm x 321 mm x 154 mm). Provide boxes with 10 independent wiring compartments that allow for up to 10 duplex receptacles, communication and/or audio/video services. Boxes shall have removable and relocatable dividers to permit custom configuration of compartments as well as permit feed to adjacent compartments. Boxes shall permit feed to compartments on the opposite side of the box through a tunnel. Six of the 10 compartments shall have a minimum wiring capacity of 23-1/2 in3 (597 ml). Four of the 10 compartments shall have a minimum wiring capacity of 27 in3 (686 ml). Each of the 10 compartments shall have a minimum depth of 3-1/2 inches (89 mm) behind the plate. Provide boxes with removable compartments to facilitate installation. The compartments shall be removable from the top of the floor box. Provide boxes with two cable guides to organize and maintain the cables egress out of the box. The box shall contain the following number of knockouts: 14 1 inch trade size, six 1-1/4 inch trade size, and four 2 inch trade size. Boxes shall be fully adjustable, accommodating a maximum 2 inch (51 mm) pre-concrete pour and a maximum 1/2 inches (12.7 mm) post-concrete pour adjustment. Include mounting brackets with the boxes that will accommodate 15 amp, 20 amp straight blade, 20 amp turn loc, 30 amp straight blade and 30 amp turn loc receptacles. Boxes shall have the ability to accommodate a bracket (EFBS-50A) allowing for one 50-amp receptacle. Boxes shall also accommodate Ortronics workstation connectivity and modular adapters, a variety of audio/video devices from most manufacturers, and other open system devices.
- d. **Activation Covers:** Manufactured of die-cast aluminum. Activation covers shall be available in surface mount and flush versions. Provide covers with two gaskets (one for carpet and one for tile) to go under the trim flange to maintain scrub watertightness. Covers shall be 16-15/16 inches x 12-1/2 inches x 3/16 inches (430 mm x 318 mm x 4 mm). Covers shall be available with a carpet recess area or a solid lid. Secure the cover to the flange and enable cover to rotate greater than 180 degrees to reduce trip hazards and provide maximum amount of working space. Provide covers with spring-loaded self-closing slide egress doors to reduce egress opening when cables are exiting and reduce trip hazards. Each of the two egress openings shall have a minimum of 4 in2 (102 mm2), or a minimum of 8 in2 (203 mm2) per cover assembly. Cover finish shall be as follows:

D. Activation Covers

- 1. **FloorPort FPCT, FPBT, and FPFPT Series Covers:** Manufactured of die-cast aluminum or die-cast zinc, and available in brushed aluminum finish and powder-coated paint finishes (black, gray, bronze, nickel and brass). Activation covers shall be available in flanged and flangeless versions. Covers shall be available with options for tile or carpet inserts, or flush covers. The cover's hinge shall allow for the cover to open 180 degrees. The furniture feed covers shall come equipped with one (1) 1-inch trade size screw plug opening and one (1) combination 1-1/4-inch and 2-inch trade size screw plug.
 - a. Flanged covers shall be 7-3/4" L x 6-9/16" W [197mm x 167mm].
 - b. Flangeless covers shall be 6-3/4" L x 5-9/16" W [171mm x 142mm].

2. 6CT, 6CTC, 6CFFTC, 8CTC, and 8CT Series Covers: Manufactured of die-cast aluminum alloy and available in powder-coated gray, black, brass, nickel or bronze finish. The covers shall be available in carpet and tile versions. Provide covers with two (2) gaskets (one (1) for carpet and one (1) for tile) to go under the trim flange to maintain scrub water tightness. The activation cover for the 8CTC and 8CT series shall be 9-1/4-inch [235mm] in diameter. The activation cover for the 6CT and 6CTC series shall be 7-1/4-inch [184mm] in diameter and the activation cover for the 6CFFTC series shall be 7-3/4-inch [197mm] in diameter. The carpet covers shall be surface mounted and the tile covers shall be flush with the finished floor covering. The covers shall have spring loaded slides to allow cables to egress out of the unit and maintain as small an egress opening as possible.
3. The covers shall have been evaluated by UL to meet the applicable U.S. and Canadian safety standards for scrub water exclusion when used on tile, terrazzo, wood, and carpet covered floors.

E. Communication Modules Mounting Accessories

1. The floor box manufacturer shall provide a complete line of faceplates and bezels to facilitate mounting of UTP, STP (150 ohm), fiber optic, coaxial, and communication devices. The box shall provide a series of device mounting plates that will accommodate Ortronics workstation connectivity outlets and modular adapters, and other open system devices.

F. Installation

1. Strictly comply with manufacturer's installation instructions and recommendations and approved shop drawings. Coordinate installation with adjacent work to ensure proper clearances and to prevent electrical hazards.
2. Mechanical Security: Raceway systems shall be mechanically continuous and connected to all electrical outlets, boxes, device mounting brackets, and cabinets, in accordance with manufacturer's installation sheets.
3. Accessories: Provide accessories as required for a complete installation, including insulated bushings and inserts where required by manufacturer.
4. Unused Openings: Close unused box openings using manufacturer's recommended accessories.
5. Provide a minimum concrete pour depth of 3-7/16-inch [87mm] plus 1/16-inch [1.6mm] above the top of the box for the RFB4, RFB4-4DB, RFB2, and the RFB2-OG Series Boxes; 2-7/16-inch [62mm] plus 1/16-inch [1.6mm] for the RFB4-SS and RFB2-SS Series Boxes; and 3-7/16-inch [87mm] plus 13/16-inch [21mm] above the top of the box for the RFB4-CI-1, RFB6, and RFB6-OG Series Boxes; and 4-1/16-inch [103mm] above the top of the RFB4E and RFB4E-OG Series Boxes; and 4-inch [102mm] above the top of the RFB6E and RFB6E-OG Series Boxes. Provide the box with four (4) locations to accommodate leveling for pre-concrete pour adjustment and include four (4) leveling screws for the pre-pour adjustment.

G. Cleaning and Protection

1. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer.
2. Protect boxes and fittings until acceptance.

2.7 WIRING DEVICES

- A. Receptacles: Receptacles shall be flush mounted. All standard 20 ampere devices to be of same manufacturer.
 - 1. Acceptable Manufacturers:
20 ampere duplex grounding type NEMA 5-20R,
Cooper 5362-V,
Hubbell 5362I,
Pass and Seymour 5362I,
Leviton 5362-I
Or Equal
 - 2. 30 ampere, 250 volt NEMA 10-30R complete with plate,
Cooper 1257,
Hubbell 9430-A,
Pass and Seymour 3864
Or Equal
 - 3. 20 ampere, USB receptacle duplex grounding type NEMA 5-20R
Hubbell MX20X2
Or equal
Color to be chosen by Architect.
- B. Switches: 20 ampere,
Cooper CWD-2221,
Hubbell 1221,
Pass and Seymour 20AC-2,
Leviton 1221.
Prewired devices with pigtails acceptable
Or Equal
- C. Composition material of wiring devices to be nylon with ivory finish. Outlets on computer circuits shall be gray.
- D. Cover plates: Brushed US 302 stainless steel
- E. Provide gaskets on all wiring device plates where devices are on walls separating conditioned and non-conditioned spaces.
- F. Dimmer Controls (Refer to Stage Lighting for specific stage lighting controls):
 - 1. All devices shall be UL listed specifically for the required loads (i.e., incandescent, fluorescent, magnetic low voltage, electronic low voltage). Manufacturer shall provide file card upon request. Universal dimmers are not acceptable.
 - 2. All dimmers and switches shall incorporate an air gap switch. The air gap switch shall be capable of meeting all applicable requirements of UL 20 for air gap switches on incandescent dimmers.
 - 3. All dimmers and switches shall provide power- failure memory. Should power be interrupted and subsequently returned, the lights will come back on to the same levels set prior to the power interruption. Restoration to some other default level is not acceptable.
 - 4. Dimmers and switches shall meet ANSI/IEEE Std. C62.41-1980, tested to withstand voltage surges of up to 6000V and current surges of up to 200A without damage.
 - 5. Dimmers and switches shall meet the UL 20 limited short circuit test requirement for snap switches.

6. Dimmer shall provide a smooth and continuous Square Law dimming curve.
 7. Dimmers shall be voltage regulated so that +10 percent variation in line voltage shall cause not more than + 5 percent variation in load voltage when dimmer is operating at 40V (5 percent light output).
 8. Dimmers, where ganged, shall be derated in accordance with manufacturer's instructions. Ratings in watts listed on the drawings are the derated ratings.
 9. Dimmers shall be Lutron, Leviton, lightolier or approved equal.
- G. Exterior Outlets with Lockable Covers and outlets within 6 ft. of water.
1. Provide exterior outlets with lockable covers equal to Hubbell #5753-0 at all exterior outlet locations. Provide GFCI Circuit Breakers on all branch circuits. Provide ground fault interrupter type receptacles within 6ft. of water and as indicated on drawings.

2.8 LIGHTING FIXTURES

A. General

1. Submit the following in accordance with project submittal procedures:
 - a. Catalog Data: Submit catalog data describing luminaires, lamps, and ballasts. Include data substantiating that materials comply with specified requirements. Arrange data for luminaires in the order of fixture designation.
 - b. Performance Curves/Data:
 1. Submit certified photometric data for each type of luminaire.
 2. Submit light level calculations when requested by Engineer in accordance with IESNA standards to support proposed fixtures are of equal performance to the specified products (applies to all fixture types in all spaces).
 - c. Drawings: Submit shop drawings for non-standard luminaires.
 - d. Warranty: Submit warranties for luminaires and for electronic ballasts.
2. All lamps, ballasts, led sources, drivers, and controls shall meet the latest utility company incentive requirements. Refer to the latest program requirements documentation and coordinate with the utility company to ensure compliance.

B. Quality Assurance

1. Comply with the National Electrical Code (NEC) and the Massachusetts Building Code (MBC) for components and installation.
2. Provide luminaires listed and labeled by a nationally recognized testing laboratory (NRTL) for the application, installation condition, and the environments in which installed.
3. Use manufacturers that are experienced in manufacturing luminaires, lamps and ballasts similar to those indicated for this Project and have a record of successful in-service performance.
4. Coordinate luminaires, mounting hardware and trim with the ceiling system.

C. LED Assemblies

1. LED luminaires shall conform to UL 1598 and to UL 8250 – Safety Standard for Light-Emitting Diode (LED) Light Sources for Use in Lighting Products.
2. Products shall be lead and mercury free.
3. Photometric characteristics shall be established using IESNA LM-79-08, IESNA Approved Method for the Electrical and Photometric Measurement of Solid-State Lighting Products.

4. Color characteristics of LED luminaires shall be as follows in accordance with ANSI C78.377 – Specifications for the Chromaticity of Solid State Lighting Products.
5. LED and driver cooling system shall be passive and shall resist the buildup of debris.
6. LED luminaire output after 50,000 hours of operation shall be not less than 70 percent of the initial lumen output when determined in accordance with IESNA LM-80-08 – IESNA approved Method for Measuring Lumen Maintenance of LED Lighting Sources.
7. LED source package electrical characteristics:
 - a. Supply voltage: 120 V, 208 V, 240 V, 277 V, or 480 V as indicated on the Drawings. Provide step-down transformers if required to match driver input voltage rating.
 - b. Total harmonic distortion (current): Not more than 10 percent
 - c. Power factor: Not less than 90 percent
 - d. RF interference: Meet FCC 47 CFR Part 15/18
 - e. Transient protection: IEEE C62.41 Class A.

D. Extra Materials

1. Furnish the following extra materials matching products installed. Package with protective covering for storage and identify with labels describing contents.
 - a. One (two percent of quantity of LED drivers of each type, but not less than one of each type).

E. Interior General:

1. Furnish interior luminaires that comply with requirements specified below, indicated on the Drawings, to meet conditions of installation.
2. Metal parts shall be free from burrs and sharp corners and edges.
3. Metal components shall be formed and supported to prevent sagging and warping.
4. Steel parts shall be finished with manufacturer's standard finish applied over a corrosion-resistant primer. Finish shall be free from runs, streaks, stains, holidays or defects.
5. Doors and frames shall be smooth operating and free from light leakage under operating conditions. Relamping shall be possible without the use of tools. Doors, frames, lenses and diffusers shall be designed to prevent accidental falling during relamping and when secured in the operating position.
6. Luminaires shall have minimum reflecting surface reflectance as follows unless specified otherwise on the Drawings:
 - a. White Surfaces: 85 percent
 - b. Specular Surfaces: 83 percent
 - c. Diffusing Specular Surfaces: 75 percent
7. Lenses, diffusers, covers and globes shall be 100 percent virgin acrylic unless specified otherwise on the Drawings. Lenses shall have 0.125 inches minimum thickness. Lenses for fluorescent troffers shall be injection molded.
8. Luminaires shall conform to UL 1598 - Luminaires. Provide product with damp location listing or wet location listing per installation location.

F. Interior Accessories

1. Provide stud supports, mounting brackets, frames, plaster rings and other accessories required for luminaire installation.

2. Furnish hangers as specified below and by conditions of installation:
 - a. Stem hangers shall be made of 1/2-inch steel tubing with 45 degrees swivel ball hanger fitting and ceiling canopy. Finish the same as the luminaire.
 - b. Rod hangers shall be made of 1/4 inch threaded zinc-plated steel rod.
3. Use NRTL-listed T-bar safety clips for lay-in fluorescent luminaires.
4. Where indicated on the Drawings or where lamp breakage is detrimental, such as above food counters, provide open fluorescent luminaires with:
 - a. Self-locking sockets or lamp retainers, two per lamp, and
 - b. Clear polycarbonate protective lamp sleeves with end caps over each lamp. Sleeve shall have a light transmission of 95 percent and shall be rated for the thermal profile of the lamp and ballast.

G. Interior Installation

1. Install interior lighting system in accordance with the NEC, manufacturer's installation instructions, approved shop drawings, and NECA National Electrical Installation Standards.
2. Have the manufacturer's installation instructions available at the Project site.
3. Mounting heights specified or indicated on the Drawings are to the bottom of the luminaire for ceiling-mounted fixtures and to the center of the luminaire for wall-mounted fixtures.
4. Where the ceiling forms the protective membrane of a fire resistive assembly, install protective coverings over luminaires in accordance with NRTL requirements.
5. Install slack safety wires as described below for luminaires in or on suspended ceilings.
 - a. Wire shall be minimum 12 gage galvanized soft annealed steel wire conforming to ASTM A641.
 - b. Attach wire to the building structure directly above the attachment point on the box or luminaire; make trapezes of framing channel material to span obstacles
 - c. Secure wire(s) at each end with not less than three tight turns in 1-1/2 inches.
6. Support pendant-mounted or cable-supported luminaires directly from the structure above using a 9 gage wire or an approved alternate support without using the ceiling suspension system for direct support.
 - a. Install seismic restraints for pendant-mounted and cable-supported luminaires.
 - b. Pendants, rods, cables, or chains 4 ft or longer shall be braced to prevent swaying using three cables at 120 degrees separation.
7. Connect luminaires in suspended ceilings using 6 ft. lengths of flexible wiring method arranged accommodate not less than 4 inches of differential seismic movement in any direction.

H. Interior Quality Control

1. Make electrical connections, clean interiors and exteriors of luminaires, install lamps, energize and test luminaires, inspect interior lighting system, and deliver spare parts in accordance with manufacturer's instructions and NECA National Electrical Installation Standards:
2. Test electronic dimming ballasts for full range dimming capability.
 - a. Burn-in dimmer controlled fluorescent lamps at full output for not less than 100 hours before dimming.
 - b. Check for visually detectable flicker over the full dimming range.

3. Prior to turnover to Owner, replace lamps that were installed and used during construction if more than 15 percent of their rated lamp life has been used.

I. Exterior - General

1. Furnish exterior luminaires that comply with requirements specified in this Section and in the luminaire schedule on the Drawings.
2. Luminaire photometric characteristics shall be based on IESNA approved methods for photometric measurements performed by a recognized photometric laboratory.
3. Luminaire housing shall be primarily metal.
 - a. Metal parts shall be free from burrs and sharp corners and edges.
 - b. Sheet metal components shall be fabricated from corrosion-resistant aluminum, formed and supported to prevent sagging and warping.
 - c. Exposed fasteners shall be stainless steel.
4. Doors and frames shall be smooth operating and free from light leakage under operating conditions.
 - a. Relamping shall be possible without the use of special tools.
 - b. Doors, frames, lenses and diffusers shall be designed to prevent accidental falling during relamping and when secured in the operating position.
 - c. Door shall be removable for cleaning or replacing lens.
5. Luminaires shall have minimum reflecting surface reflectance as follows unless scheduled otherwise:
 - a. White surfaces: 85 percent
 - b. Specular surfaces: 83 percent
 - c. Diffusing specular surfaces: 75 percent
6. Provide lenses, diffusers, covers and globes as scheduled on the Drawings fabricated from materials that are UV stabilized to be resistant to yellowing and other changes due to aging or exposure to heat and ultraviolet radiation.
7. Doors shall have resilient gaskets that are heat-resistant and aging-resistant to seal and cushion lens and refractor.

J. Exterior Poles and Accessories

1. Furnish poles and accessories that comply with requirements specified in this Section and the luminaire schedule on the Drawings.
2. Pole, base, and anchorage shall carry the luminaires, supports, and appurtenances at the indicated height above grade without deflection or whipping.
3. Mountings, fastenings and other appurtenances shall be fabricated from corrosion-resistant materials that are compatible with poles and luminaires and will not cause galvanic action at contact points. Mountings shall correctly position luminaires to provide scheduled light distribution.
4. A reinforced access handhole shall be located in the wall of each metal pole.
5. A welded ½ inch grounding lug shall be accessible through the handhole of each metal pole. Grounding connection shall be designed to prevent electrolysis when used with copper ground wire.
6. Metal poles shall have anchor type bases and galvanized steel anchor bolts and leveling nuts.
7. Metal poles shall have a metal base cover that covers the entire base plate and anchorage.

8. Protect painted, anodized, or brushed pole finishes during shipment and installation. Minimum protection shall consist of spirally wrapping each pole shaft with protective paper secured with tape, and shipping small parts in boxes.
9. Aluminum poles shall be fabricated from corrosion resistant aluminum Alloy 6063-T6 or Alloy 6005-T5 for wrought alloys or Alloy 356-T4 for cast alloys.
 - a. Poles shall be square or round, tapered or straight as indicated on the Drawings.
 - b. Aluminum poles over 30 ft. tall shall include factory-installed vibration dampers.
 - c. Poles shall be seamless extruded or spun seamless type with minimum 0.188 inch wall thickness.
 - d. Tops of shafts shall be fitted with a round or tapered cover.
 - e. Base shall be anchor bolt mounted, made of cast 356-T6 aluminum alloy in accordance with ASTM B 108/B 108M, Standard Specification for Aluminum-Alloy Permanent Mold Castings and shall be machined to receive the lower end of shaft. Joint between shaft and base shall be welded.
 - f. Hardware, except anchor bolts, shall be either 2024-T4 anodized aluminum alloy or stainless steel.
10. Anchor bolts shall be steel rod having minimum yield strength of 50,000 psi. The top 12 inches of the anchor bolt shall be galvanized in accordance with ASTM A153/A153M.
11. Manufacturers: Subject to compliance with requirements, provide products as scheduled or specified on the Drawings.
12. Fuses and Fuse holders
 - a. Furnish fuse overcurrent protection for each pole-mounted luminaire to isolate faulted ballasts from the lighting circuit.
 - b. Use 600 volt, Class CC, time-delay, current-limiting fuses.
 - c. Select fuses rated between 200 percent and 300 percent of the luminaire ballast or driver maximum current.
 - d. Manufacturer: Bussman LP-CC or approved equal.
13. Furnish in-line fuse holders for installation in pole hand hole or transformer base.
 - a. Use non-breakaway type fuse holders unless breakaway poles are indicated on the Drawings.
 - b. Use breakaway type fuse holders where breakaway poles are indicated on the Drawings.
 - c. Load and line terminal sizes and types shall correspond to line and load conductor sizes and quantities.
 - d. Both breakaway and non-breakaway fuse holders shall have insulating boots.
 - e. Manufacturers: Ferraz Shawmut "FEC" for phase conductor(s), "FEBN" for neutral conductor, or approved equal.

2.9 ELECTRICAL POWER EQUIPMENT

A. Motor Controls - Manual and Magnetic:

1. Individually-mounted magnetic starters shall be NEMA rated across-the-line type with thermal overload on each phase, single-speed, two-speed, or reduced voltage start as indicated.
2. Motor Starters shall be furnished by Electrical Sub-Contractor unless part of package mechanical equipment such as rooftop units.

3. Starters shall be of maintained contact type, of size and type required for particular motor horsepower and voltage. Minimum size starter to be size 1 FVNR, unless noted otherwise.
 - a. Starters shall have OL reset button, green push-to-test type pilot light to indicate "ON", and "HAND-OFF-AUTO" switch in cover.
 - b. Starters to have 120 volt control transformers with fused output being provided for those units operating on 277/480 volt system.
 - c. Provide Class 20 fixed heater overloads with auto/manual reset.
 - d. Provide four sets of auxiliary contacts of convertible type N.O. to N.C. for each starter.
 - e. Motor starters shall have NEMA I enclosures. Those in wet locations shall be NEMA 3R.
 - f. Acceptable Manufacturers:
Westinghouse
Square D/Groupe Schneider
Siemens
Allen Bradley
General Electric
Or Equal
 4. Manual motor starters shall have pilot lights and shall be furnished with thermal overloads on each phase.
- B. Motors: Each motor shall have disconnect switch and starter provided under this section.
1. Provide motor terminal boxes for each motor not furnished with same.
- C. Disconnect Switches:
1. Disconnect (safety) switches shall conform to industrial standards of NEMA, be UL listed and shall be heavy duty type, quick-make, quick-break type with interlocking cover mechanism and provisions for padlocking switch handle in "OFF" position. Three pole toggle switches are not acceptable as substitute for disconnect switches.
 2. Disconnect switches shall be of fused or unfused type as indicated with number of disconnecting poles indicated. The grounded conductor shall not be switched. Switches for use with current limiting fuses shall be rejection type and those used in conjunction with motors shall be horsepower rated. Provide oversize termination lugs if required by conductor size.
 3. Enclosures shall be of proper NEMA type for intended location and shall be phosphate coated or equivalent code gauge galvanized sheet steel with ANSI #24 dark gray baked enamel finish.
 4. Acceptable Manufacturers:
Westinghouse
Square D/Groupe Schneider
Siemens
Allen Bradley
Or Equal
- D. Fuses:
1. Provide a complete set of fuses for each item of fusible type equipment.

2. Turn over to authorized representative of Owner upon completion a spare set of fuses of each different type and ampere rating installed. These spares shall be bound with twine and tagged.
3. Secondary system fuses, rated at 600 volts or less, shall be UL listed and constructed in conformance with the applicable standards set forth by NEMA and ANSI. All fuses of a particular class shall be of same manufacturer.
4. All fuses in distribution panelboards and switchboards shall be class L above 600 amperes and class RK1 for 600 amperes and below.
5. Main, Feeder, and Branch Circuits:
 - a. Circuits 601 amperes and above shall be protected by (Bussmann type KRP-C LOW-PEAK) current limiting time delay fuses.
 - b. Circuits 0-600 amperes shall be protected by (Bussmann LOW-PEAK dual element), time delay current limiting fuses, LPN-RK (250 volts), LPS-RK (600 volts), UL class RK-1.
6. Acceptable Manufacturers:
Bussmann, Division of McGraw
Gould/Shawmut
GEC-ALSTHOM
Or Equal

2.10 ELECTRICAL SYSTEM CONTROLS AND INSTRUMENTS

- A. Provide a complete power system consisting of branch circuits, motor disconnect switches, pushbutton stations, motor starters, and other devices to connect up and leave in operating condition each piece of electrically operated equipment provided either under this section or other Divisions.
- B. All control wiring, not indicated in the electrical specifications or not shown on electrical drawings, will be provided by Temperature Control Subcontractor.

2.11 GROUNDING SYSTEM

- A. All equipment and systems shall be grounded. Refer especially to NEC Section 250 Requiring Connections to Building Steel, Foundation, Water Service, and Interior Piping. Provide transformer pad grounding in accordance with utility company standards.
- B. The grounded conductor shall be supplemented by an equipment grounding system.
- C. The equipment grounding system shall be installed so all conductive items in close proximity to electrical circuits operate continuously at ground potential and provide a low impedance path for ground fault currents.
- D. Grounding conductors shall be so installed as to permit shortest and most direct path to ground.
- E. Maximum measured resistance to ground of 5.0 ohms shall not be exceeded. Ground separately derived systems (dry type transformers) in accordance with Article 250-26 by grounding neutral to transformer ground lug and providing insulated grounding electrode conductor to nearest effectively grounded building steel or, if unavailable, to nearest available effectively grounded metal water pipe.
- F. Equipment grounding conductors and straps shall be sized in compliance with Code Table 250.

- G. Grounding conductors shall be insulated with green color. Grounding conductors for use on isolated ground receptacles shall be green with trace color to differentiate between normal ground conductors.
- H. Branch circuits shall consist of phase and grounded conductor installed in common metallic raceway. All circuits shall have a separate insulated grounding conductor installed. Any flexible cable system or non-metallic raceway system shall have an insulated grounding conductor. Any cable system for use on isolated ground circuits shall have both an isolated ground conductor as well as an equipment ground conductor, both of which shall be insulated.
- I. Each electrical expansion fitting shall be furnished with a bonding jumper. Provide grounding bushings and ground connections for all raceways terminating below equipment where there is no metal-to-metal continuity.
- J. Continuity between all metallic and non-metallic raceway systems and equipment shall be maintained.
- K. Outdoor lighting fixtures shall be grounded and bonded in common with building system via a separate grounding conductor.

2.12 PANELBOARDS

- A. Panelboards shall be dead front, door in door safety type equipped with single or multi pole circuit breakers suitable for 120/208 volt, 3 phase, 4 wire operation.
- B. Buses shall be copper. Panelboards shall have a circuit directory card mounted in a frame with plastic cover on inside of door. Panelboards to have a copper ground bus with terminals for each circuit. Panelboards serving isolated ground receptacles shall have a separate ground bus for terminations of the isolated grounds. The isolated ground bus shall be mounted to the panel tub via non conducting means with a separate grounding conductor run to the normal panel ground bus. Provide oversize lugs for any termination requiring same due to oversize conductors. Provide 200 percent neutral buses on 120/208 volt panelboards as indicated on plans.
- C. Cabinets shall be minimum of 20 inches wide and be made of code gauge steel. Surface type shall be ordered without knockouts.
- D. Trims shall be made of code gauge steel, surface or flush as indicated. Panelboards shall be keyed alike. Trims shall be provided with full length piano hinge on one side, and secured to tub with sufficient quantity of latches opposite the hinge side to allow trim to fit flush with tub and when released, allow full access to wiring gutters. Inner door shall allow access to circuit breakers only.
- E. Panelboards shall be of the following types with minimum circuit breaker frame sizes listed below. Refer to schedules for larger circuit breaker frame sizes due to fault current availability.
 - 1. 120/208 volt, three phase, four wire. Symmetrical interrupting capacity 42,000 AIC.

Style	
Eaton-Cutler Hammer type PRL-1	BAB Breakers (bolt-on)
Square D type NQOD	QOB Breakers (bolt-on)
Siemens type CDP 7	BQ Breakers (bolt on)

ABB/General Electric Type AQ

HHQB Breakers
(bolt-on)

2. Distribution Panels:

- a. Where scheduled as circuit breaker type, symmetrical interrupting capacity 42,000 AIC.

Eaton-Cutler Hammer type PRL 3

FD Breakers

Square D I Line type

FA Breakers

Siemens SPP

FXD6 Breakers

ABB/General Electrical Spectra

THED Breakers

- F. Panelboards and distribution panels shall be of same manufacturer. Refer to drawings where higher interrupting are required.

2.13 ELECTRIC SERVICE

- A. Coordinate and cooperate with NGRID, hereinafter called the utility company, with respect to providing service and metering.
- B. Provide all primary system raceways, elbows, pull wires and all pad grounding. Utility company will provide pad mounted transformer and primary conductors including making up of all terminations and connections.
- C. Provide secondary service complete including all conductors, raceways, and connectors at transformer. Provide oversized lugs if required due to conductor sizing. Coordinate attachment of secondary conductors to the transformer terminals with utility company.
- D. General contractor will do all excavation and back filling in accordance with utility company standards.
- E. All work to be done in accordance with utility company standards.
- F. Metering: All usage will be on one secondary meter. Meter will be located on exterior pedestal or building mounted. Provide meter socket and 1 ½ in. conduit between current transformers and meter socket.

2.14 STANDBY ELECTRICAL SYSTEM

- A. Provide one 200KW, 250 kVA at .8 PF standby power rated diesel-fueled generator set, mounted in perfect alignment on an all welded, fabricated steel sub-base which shall allow for attachment of all necessary engine and generator accessories.
- B. Manufacturers:
1. Kohler
 2. Caterpillar
 3. Onan/Cummings
 4. Or equal
- C. Engine
1. Water cooled with unit-mounted radiator. Provide starter and all field wiring required by manufacturer
 2. Dry-type replaceable element air cleaners.

3. Full flow lube oil filters and bypass oil filter.
 4. Twelve (12) volt starting motor, 12 volt, 3 ampere battery charging alternator.
 5. Engine instrument panel to include ammeter, lube oil pressure gauge, lube oil temperature gauge, water temperature gauge, and hour meter.
 6. Engine-mounted safety control to provide alarm signals for engine shutdown in event of low oil pressure, high coolant temperature, overspeed, over crank, and pre-alarm signals for high water temperature and low oil pressure.
 7. Jacket water heater, 2000 watt, 120 or 208 volt, single phase or as recommended by generator manufacturer.
- D. Generator: 200KW, 250 kVA, 120/208 volt, 3 phase, 4 wire, 60 Hz, 1800 RPM revolving field type main generator with brushless exciter and permanent magnet.
1. Voltage regulation + 1 percent from no load to full load.
- E. Cooling System: Unit mounted radiator with flange attached.
- F. Starting System: 12 volt heavy duty lead acid storage battery, connected for 12 volt DC output.
1. Battery rack, cables, and connectors shall be provided.
 2. Provide 10 amp battery charger fed from a 120 volt, single phase, 60 Hz service. Battery charger to include high and low battery voltage alarm relays for derangement panel. Battery charger shall meet NFPA 110 Standards.
 3. Exhaust System: Furnish one Maxim M-51 3 in. critical silencer, 3 in. side inlet, and one 3 in. end outlet complete with two (2) 3 in. companion flanges. Furnish one 3 in. x 18 in. flexible stainless steel exhaust connector, flanged on one end, threaded nipple on opposite end. Generator shall meet all applicable emissions regulations.
- G. Vibration Isolators: Set of four (4) Korfund rubber type vibration isolators for installation between steel base and concrete foundation.
- H. Generator Control Panel:
1. To completely control operation of engine generator set. Panel to have automatic start control, AC volt meter, AC ammeter, pointer type frequency meter, volt meter, ammeter and selector switch. Alarm signals to indicate pre-low oil pressure, pre-high coolant temperature, and alarm signals to shut down engine in event of a low oil pressure, high coolant temperature, engine overspeed, or overcrank. Lights on face of panel to indicate failure. Provide dry contacts for remote disarrangement signal & louvers. Locate remote annunciator in administration area.
 2. Terminal strip shall be included with alarms and prewarning devices prewired for remote annunciator specified herein. Provide wiring between generator and remote annunciator panel. Generator control switch shall be mounted on control panel face. A flashing light for selector switch "OFF" shall be included.
 3. Provide molded case line circuit breakers mounted on generator in distribution panel located within the generator enclosure.

4. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:
 - a. Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 - b. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10 seconds.
 - c. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.
 - d. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
 - e. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.

I. Load Bank

1. Automatically controlled multiple stage resistor load bank in NEMA I enclosure intended for indoor mounting adjacent to the generator in series with the engine radiator.
2. Characteristics: Unit shall be made up of (4) continuously rated 25% Steps, 3 phase resistance stages with voltage rating to match generator output, designed and connected so as to provide a load of up to 50% of generator rating.
3. Construction: The load bank shall be completely self-contained, incorporating all of the following, integrally mounted in a single enclosure, except as otherwise noted:
 - a. Four (4) independent resistance stages made up of chromium alloy wire, each so connected as to provide a 50 % at rated voltage. Resistors shall operate at a temperature not to exceed 1,100 deg F (600 deg C).
 - b. A 3-pole magnetic contactor and 3 current limiting fuses for each stage.
 - c. Fused control transformer with 120 volt output.
 - d. Integral manual override control to permit staged manual on-off control as desired.
 - e. Load bank shall be located in-line with, and downstream of the generator radiator.
 - f. Complete set of factory installed power and control wiring. Power wiring shall be rated for 150 deg C operation.
4. Construction: The load bank shall be completely self-contained, incorporating all of the following, integrally mounted in a single enclosure except as otherwise noted:
 - a. Load steps: Not less than four (4) independent resistance stages, made up of
 - b. chrome alloy wire, connected so as to provide load steps up to the total rating of the load bank. No stage shall exceed 50 KW.
 - c. Each resistance stage shall be independently protected by means of factory installed current limiting fuses and shall be provided with a magnetic contactor. Fuses and magnetic contactor shall be factory wired so as to provide a self-protected, individually controllable unit for each stage.
 - d. Main terminals arranged to accommodate a single power connection, sized for the full load rating of the load bank, complete with power circuit extensions to the protective devices for each branch circuit (i.e., stage).

- e. Automatic protection against regenerative power from elevators. Include reverse
 - f. Both control panels include step-by-step manual control as well as status lights.
- 5. Malfunction detection system shall incorporate sensors, alarms and wiring for intake and exhaust air overtemperature and loss of cooling airflow; so arranged as to shut down load bank to avoid overheating.
 - 6. Complete set of factory installed power and control wiring. Cooling fan and control power shall be derived from a protected tap on the load side of the nearest transfer switch.

J. Automatic Transfer Switches:

- 1. Provide automatic transfer switches as shown on drawings for operation on 120/208 volts, 3 phase, 4 wire operation. Units to be housed in a NEMA 1 enclosure and shall be 3 pole as indicated on drawings.
- 2. The transfer switches shall be rated for 42,000 ARMS when rated over 400 amperes. Transfer switches shall be rated 42,000 ARMS when rated 400 amperes or less and fed from a current limiting breaker.
- 3. Entire switch shall be listed under UL 1008.
- 4. Manufacturers:
 - a. Russ Electric
 - b. ASCO
 - c. Kohler
 - d. Onan/Cummins
 - e. Or equal
- 5. Unit shall be provided with standard accessories as follows.
 - a. Voltage and Frequency Sensing:
 - 1. Close differential voltage sensing on all phases of normal pickup adjustable 85-100 percent. Dropout 75-98 percent
 - 2. Voltage sensing of emergency source. Adjustable pickup 85-100 percent.
 - 3. Frequency sensing of emergency source. Adjustable pickup 90-100 percent.
 - b. Time Delays:
 - 1. Time delay to override momentary normal source outages. Adjustable 0.5 to 6 seconds.
 - 2. Retransfer to normal with 5 minute cooldown timer.
 - c. Engine Control:
 - 1. Contact to close when normal source fails.
 - 2. Contact to open when normal source fails.
 - 3. Test switch to simulate normal source failure.
 - d. Indicators: Pilot lights to indicate switch in normal position or emergency position.
 - e. Auxiliary Contacts: Two (2) to close on normal. Two (2) to close on emergency.
- 6. Required Accessories:
 - a. Plant exerciser.
 - b. Option 27 – In-phase monitor (Motor Load Transfer). (ATS-OS)
 - c. Option 6A – Manual transfer to normal source.

K. Remote Annunciator Panel: A flush mounted panel shall include a visual signal that battery charger is functioning properly and both audible and visual signals. Annunciator shall meet NFPA 110 Standards.

1. Audible signal shall have a silencing switch. A lamp test button shall be provided.

L. Factory Testing: A certified factory test to be conducted at 1.0 power factor. Test for four (4) hours, one hour each at 25 percent, 50 percent, 75 percent and 100 percent load. Take standard readings and submit test reports for approval prior to shipment. Also, perform field test with load bank at same ratings for 2 hours, in addition to the 2 hour building load test specified below.

M. Miscellaneous: Necessary lube oil and anti-freeze.

N. Equipment Testing and Instruction Manual and Drawings:

1. Operating instructions and maintenance manuals shall contain the following information:

- a. Operating Instructions
- b. Replacement Parts
- c. Wiring Diagram
- d. Maintenance

2. The entire emergency system shall be field test operated for two (2) hours. A normal power failure shall be simulated. The engine generator unit shall automatically start, come up to speed, and assume full emergency load. Entire building shall be in operation during test.

3. Custodians of the equipment shall be present during test. At that time they shall be instructed in operation and maintenance.

4. Upon completion of tests, written reports containing results shall be submitted. Test reports shall contain readings taken at 30 minute intervals along with all other pertinent test information.

- a. Ambient Temperature
- b. Oil Pressure
- c. Battery Charge Rate
- d. AC Volts
- e. AC Amperes All Phases
- f. Frequency
- g. Kilowatts
- h. Power Factor

O. Coordination of Trades:

1. The following equipment shall be furnished by Electrical Contractor but shall be installed under other sections.

- a. Anchor bolts to be installed by General Trades Contractor based on approved shop drawings.

P. Generator Outdoor Housing

1. The engine generating set shall be factory installed in a weatherproof outdoor housing. The housing shall provide year round generating set protection against adverse weather and environmental conditions. The enclosure shall be sound attenuated and meet Federal Specifications.
2. The weatherproof shelter shall be constructed or welded and bolted of reinforced aluminum, 14 gauge walls and 14 gauge floor plate. All metal parts shall be prime coated and finished painted.
3. The shelter assembly shall have shuttered air openings on front and sides with mesh screens covering side shutters. The air shutters shall be opened by four 22 volt AC motors when the generating set operates. Motors shall be spring loaded to close shutters when set stops.
4. Hinged double doors on each side and one door in rear of the shelter shall allow easy access to engine generator and controls. All door handles shall be key lock design.
5. Vibration isolators of the open coil spring type, selected for 3 inch (76mm) static deflection, shall be furnished and installed. The number of isolators shall be as recommended by the generator set manufacturer, and complete details shall be included in the Submittals. Anchor bolts, nuts and sleeves shall be supplied with recommended Foundation Plan.
6. Provide an integral base mounted tank, double wall containment with alarms and capacity to run generator for 48 hours at 100% load. Include conduit entry provisions for tank. Tank shall be supplied in accordance with the state Fuel Storage Codes for above ground diesel fuel tanks. Provide tank level gauge at remote annunciator. Electrical Contractor shall fill tank after testing and provide fuel for testing.
7. The weatherproof housing shall allow installation of the silencer outside or inside the enclosure. Provide critical type silencer.
8. Provide sound deadening materials, baffles, hoods, etc. to reduce noise levels to 75DBA at 7 meters in any direction.
9. Provide a main breaker distribution panel within the enclosure with branch breakers as indicated on plans.

2.15 MANUAL TRANSFER SWITCH

A. Scope:

1. Electrical SubContractor shall furnish, deliver, install and test the manual transfer switches as specified herein and in accordance with the drawings.

B. Quality Assurance:

1. Manual transfer switch shall be UL listed and labeled under the UL 1008 standard.
2. Manual transfer switch manufacturer shall provide a complete factory assembled, wired and tested manual transfer switch.
3. Manual transfer switch shall be factory Hi-pot tested for a period of not less than 60 seconds.
4. Manual transfer switch installation shall meet all applicable NEC standards.

C. Submittals:

1. Electrical SubContractor shall submit manufacturer's drawings and data of manual transfer switches for Engineer's approval prior to start of fabrication. Drawings and data shall include, as a minimum, dimensioned general arrangement drawings and wiring diagrams, UL listing information including UL control or file number, component data, mounting provisions, conduit entry locations and installation instructions.
2. Upon installation of manual transfer switches Electrical SubContractor shall submit manufacturer's Operating & Maintenance Manual which shall include as a minimum:
 - a. Certified as-built General Arrangement drawings and Wiring Diagram.
 - b. Materials / Component List including part numbers.
 - c. Maintenance and service requirements.
 - d. Certificate of Compliance and hi-pot test data.

D. Warranty:

1. Manual transfer switches shall be covered by manufacturer's warranty for a minimum period of one year after shipment from manufacturer.

E. General:

1. All equipment shall be new.
2. Manual transfer switch manufacturer must have produced and sold manual transfer switches as a standard product for a minimum of three years.
3. Manual transfer switches shall be molded case circuit breaker type; knife switch or fused switches are not acceptable.
4. Electrical SubContractor shall be responsible for the equipment until it has been installed and is finally inspected, tested and accepted in accordance with the requirements of this Specification.
5. Manual transfer switches shall be StormSwitch, Model "SSDX-400A-H-400A-H-480-3-1-1-D-C" as manufactured by ESL Power Systems, Inc. or equal as approved by the Engineer.

F. Manual Transfer Switches:

1. Manual transfer switch shall consist of two mechanically-interlocked molded case circuit breakers, cam-style male connectors, power distribution block and grounding terminals, all housed within a padlockable enclosure.
2. Manual transfer switch enclosure shall be Type 3R, constructed of continuous seam-welded, powder coated galvanized steel. The main access shall be through an interlocked, hinged door that extends the full height of the enclosure. Access for portable generator cables with female cam-style plugs shall be via cable entry openings in the bottom of enclosure. A hinged flap door shall be provided to cover the cable openings when cables are not connected; the hinged flap door shall allow cable entry only after the main access door has been opened. Enclosure shall be powder coated after fabrication; color shall be light gray RAL 7038.

3. Cam-style male connectors (inlets) shall be UL Listed single-pole separable type and rated 400 amps at 600VAC. Cam-style male connectors shall be color coded. Cam-style male connectors shall be provided for each phase and for ground, and shall also be provided for neutral if required. Each of the phase cam-style male connectors within the enclosure shall be factory-wired to a molded case circuit breaker. The ground cam-style male connectors shall be bonded to the enclosure, and a ground lug shall be provided for connection of the facility ground conductor. The neutral cam-style male connectors, if required, shall be factory wired to a power distribution block. None of the cam-style male connectors shall be accessible unless both molded case circuit breakers are in the "OFF" position and the main access door is open.
4. A power distribution block shall be provided for load-side field wiring. The power distribution block shall be factory wired to the molded case circuit breakers.
5. Molded case circuit breakers shall be UL Listed and the short circuit interrupt rating shall be a minimum of 35kAIC at 480VAC. Trip rating of the molded case circuit breakers shall be as shown on the drawings. One molded case circuit breaker shall be fed from utility power; the other molded case circuit breaker shall be fed from the cam-style male connectors to supply power from a portable generator. Both molded case circuit breakers shall include UL Listed door-mounted operating mechanisms, preventing the opening of the main access door unless both breakers are in the "OFF" position. Both molded case circuit breakers shall be mounted behind a deadfront panel. The load-side of the molded case circuit breakers shall not be energizable unless the main access door is closed and one of the molded case circuit breakers is in the "ON" position. The (2) molded case circuit breakers shall be safety interlocked by mechanical means to ensure that only one breaker can be closed at any given time.
6. Manual transfer switch shall be suitable for use as service equipment in the USA.

G. Installation:

1. Prior to installation of manual transfer switches, Electrical SubContractor shall examine the areas and conditions under which the manual transfer switch is to be installed and notify the Engineer in writing if unsatisfactory conditions exist.
2. Manual transfer switch shall be installed as shown on the drawings and per the manufacturer's written instructions. In addition, the installation shall meet the requirements of local codes, the National Electrical Code and National Electrical Contractors Association's "Standard of Installation".
3. Conduit entry into the manual transfer switch shall be by Electrical SubContractor; Electrical SubContractor shall furnish and install listed watertight conduit hubs, as manufactured by MYERS or T&B, for each conduit entry on the manual transfer switch. The incoming hub size shall match the conduit size for feeders and ground as shown on the drawings. The outgoing hub size shall match the conduit size for loads and ground as shown on the drawings. Hubs shall be properly installed and tightened to maintain Type 3R integrity of the manual transfer switch enclosure.
4. Electrical SubContractor shall terminate feeder conductors, load conductors and ground per the manufacturer's instructions. Use copper wire only for all conductors and grounds. All field wiring terminations shall be torqued as required per the instructions on the manual transfer switch's power distribution block, circuit breaker & ground lug.

H. Field Testing:

1. Prior to energizing manual transfer switch, the Electrical SubContractor shall perform the following checks and tests as a minimum:
 - a. Verify mounting and connections are complete and secure.
 - b. Verify internal components and wiring are secure.
 - c. Perform continuity check of all circuits.
 - d. Perform 1,000 VDC megger test on feeder, load and ground cables.
 - e. Verify deadfront is secure.
 - f. With the manual transfer switch deadfront in place and the main access door closed and properly latched, actuate both Operator Mechanisms; verify only (1) breaker at a time can be turned to the "ON" position.
 - g. Confirm operation of the manual transfer switch ground receptacle by attaching a plug to the manual transfer switch ground receptacle and then verify that the plug is grounded to the facility ground.
 - i. Once utility power has been applied, confirm operation of manual transfer switch by following directions on main access door.

2.16 FIRE ALARM AND DETECTION SYSTEM

A. Description:

1. This section of the specification includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm network equipment rearm initiating devices, alarm notification appliances, Network Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.
2. The fire alarm system shall comply with requirements of latest NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
3. The fire alarm manufacturer shall be of the highest caliber and insist on the highest quality. The system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.
4. The FACP and peripheral devices shall be manufactured 100 percent by a single U.S. manufacturer (or division thereof).
5. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing.
6. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final check-out and to ensure the systems integrity.

B. Scope:

1. A new network intelligent reporting, microprocessor controlled fire detection and alarm system shall be installed in accordance with the specifications and drawings.
2. Basic Performance:
 - a. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded onto NFPA Style 7 (Class A) Signaling Line Circuits (SLC).
 - b. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D).
 - c. Notification Appliance Circuits (NAC) shall be wired Class A (NFPA Style Z).
 - d. Digitized electronic signals shall employ check digits or multiple polling.

- e. Power for initiating devices and notification appliances must be from the main fire alarm control panel.
- f. A single ground or open on any system signaling line circuit, initiating device circuit, or notification appliance circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
- g. Alarm signals arriving at the main FACP shall not be lost following a power failure (or outage) until the alarm signal is processed and recorded.

3. System Functional Operation:

When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

- a. The FACP alarm LED on the FACP shall flash.
- b. A local piezo-electric signal in the FACP control panel shall sound.
- c. The 80-character LCD display on the local FACP node and on the intelligent network display shall indicate all information associated with the fire alarm condition, including the type of alarm point, and its location within the protected premises. This information shall also be displayed on the network reporting terminal.
- d. Printing and history storage equipment shall log the information associated with the fire alarm control panel condition, along with the time and date of occurrence.
- e. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated on either local outputs or points located on other network nodes.

4. Software Modifications:

- a. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
- b. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm network on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

5. Certifications:

- a. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer and trained on network applications. Include names and addresses in the certification.
- b. Power supplies, relays, water flow switches and all accessories of the fire alarm system.
- c. Each circuit in the fire alarm network shall be tested semiannually.
- d. Each smoke detector shall be tested in accordance with the requirements of NFPA 72, Chapter 7.

C. Applicable Publications:

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

1. National Fire Protection Association (NFPA) - USA:

No. 72	National Fire Alarm Code
No. 70	National Electric Code
No. 101	Life Safety Code

2. Underwriters Laboratories Inc. (UL) - USA:

No. 50	Cabinets and Boxes
No. 268	Smoke Detectors for Fire Protective Signaling Systems
No. 864	Control Units for Fire Protective Signaling Systems
No. 268A	Smoke Detectors for Duct Applications
No. 521	Heat Detectors for Fire Protective Signaling Systems
No. 228	Door Closers-Holders for Fire Protective Signaling Systems
No. 464	Audible Signaling Appliances
No. 38	Manually Actuated Signaling Boxes
No. 346	Waterflow Indicators for Fire Protective Signaling Systems
No. 1481	Power supplies for Fire Protective Signaling Systems
No. 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
No. 1971	Visual Notification Appliances

3. Local and State Building Codes.

4. All requirements of the Authority Having Jurisdiction (AHJ).

D. Approvals:

1. The system must have proper listing and/or approval from the following nationally recognized agencies:

UL	Underwriters Laboratories Inc.
FM	Factory Mutual
MEA	Material Equipment Acceptance (NYC)
CSFM	California State Fire Marshal

2. The fire alarm control panel shall meet the modular labeling requirements of Underwriters Laboratories, Inc. Each subassembly, including all printed circuits, shall include the appropriate UL modular label. Systems which do not include modular labels which may require return to the manufacturer for system upgrades, and are not acceptable.

E. Equipment and Material, General:

1. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system.

2. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.
3. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place. (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

F. Conduit and Wire:

1. Conduit:

- a. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
- b. All wiring exposed shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
- c. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
- d. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
- e. Conduit shall not enter any FACP, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
- f. Conduit shall be 3/4 inch (19.1 mm) minimum.

2. Wire:

- a. All fire alarm system wiring must be new, unless specified herein.
- b. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 16 AWG (1.02 mm) for initiating device circuits and signaling line circuits, and 14 AWG (1.32 mm) for notification appliance circuits.
- c. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
- d. Wiring used for the SLC multiplex communication loop shall be twisted and shielded unless specifically excepted by the fire alarm equipment manufacturer.
- e. All field wiring shall be completely supervised.

3. Terminal Boxes, Junction Boxes and Cabinets:

All boxes and cabinets shall be UL listed for the intended purpose.

4. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
5. The FACP shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution Panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The FACP cabinet shall be grounded securely to either a cold water pipe or grounding rod. Provide lock-on device on breaker

G. Fire Alarm Control Panel:

1. Fire alarm control panel shall be Notifier, Edwards, FCI, Autocall, or equal and shall contain a microprocessor based central processing unit (CPU). The FACP shall communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, local and remote operator terminals, annunciators, and other system controlled devices.
2. Node Capacity and General Operation:
 - a. Each node shall provide, or be capable of, expansion to 198 intelligent addressable devices and 198 monitor/control modules for a total of 396 intelligent devices per system. FACP shall have two intelligent loops.
 - b. Each FACP node shall include a full featured operator interface control and annunciation panel which shall include a backlit Liquid Crystal Display (LCD), individual, color coded system status LEDs, and an alpha-numeric keypad for field programming and control of the node.
 - c. All programming or editing of the existing programming the system shall be achieved without special equipment or interrupting the alarm monitoring functions of the fire alarm control panel.
 - d. Each FACP node shall provide the following features:

Block Acknowledge	Printer Interface
Control-by-Time	Non-Alarm Module Reporting
Day/Night Sensitivity	Periodic Detector Test
Device Blink Control	Remote Page
Drift Compensation	Trouble Reminder
NFPA 72, Sensitivity	Upload/Download to PC
Test	computer
System Status Reports	Verification Counters
Security Monitor Points	Walk Test
Alarm Verification	Maintenance Alert
3. Loop Interface Board (LIB):
 - a. Loop interface boards shall be provided to monitor and control each of the Signaling Line Circuit (SLC) loops in the network node. The loop interface board shall contain its own microprocessor and shall be capable of operating in local mode in the case of a failure in the main CPU of the control panel. In local mode, the loop interface board shall detect alarms and activate output devices on its own SLC loop.
 - b. The LIB shall not require any jumper cuts or address switch settings to initialize SLC Loop operations.
 - c. The loop interface board shall provide power to, and communicate with, all of the intelligent detectors and addressable modules connected to its SLC Loop over a single pair of wires. This SLC Loop shall be capable of operation as NFPA Style 4, Style 6, or Style 7.
 - d. The LIB shall be able to drive two Style 4 SLC loops, each up to 10,000 ft. in length, for an effective loop span of 20,000 ft.
 - e. The loop interface board shall receive analog information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular detector. The loop interface board software shall include software to automatically adjust and compensate for dust accumulation to maintain detector performance as it is affected by environmental factors. The analog information may also be used for automatic detector testing and for the automatic determination of detector maintenance requirements.

- f. The LIB shall communicate with each intelligent addressable detector and addressable module on its SLC loop and verify proper device function and status. Communication with up to 198 intelligent devices shall be performed every 6 seconds or less.
4. Enclosures:
- a. Control panels shall be housed in UL listed cabinets suitable for surface or semi-flush mounting. Cabinets shall be corrosion protected, given a rust-resistant prime coat, and the manufacturer's standard finish.
 - b. The back box and door shall be constructed of .060 steel with provisions for electrical conduit connections into the sides and top.
 - c. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side.
 - d. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.
5. FACP nodes shall be designed so that it permits continued local operation of remote transponders under both normal and abnormal network communication loop conditions. This shall be obtained by having transponders operate as local control panels upon loss of network communication.
6. FACP nodes shall be modular in construction to allow ease of servicing. Each CPU and transponder shall be capable of being programmed on site without requiring the use of any external programming equipment. Systems which require use of external programmers or change of EPROM's are not acceptable.
7. The CPU and associated equipment are to be protected so that they will not be affected by voltage surges or line transients including RFI and EMI.
8. Each peripheral device connected to the FACP node CPU shall be continuously scanned for proper operation. Data transmissions between network nodes, FACP CPUs, transponders, and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques. Failure of any transponder or peripheral device to respond to an interrogation shall be annunciated as a trouble condition.
9. FACP Power Supplies:
- a. Main power supplies shall operate on 120 VAC, 60Hz, and shall provide all necessary power for the FACP.
 - b. Each main supply shall provide 3.0 amps of usable notification appliance power, using a switching 24 VDC regulator.
 - c. The main power supply shall be expandable for additional notification appliance power in 3.0 ampere steps. Provide dedicated power supplies for signal circuit.
 - d. Each main power supply shall provide a battery charger for 60 hours of standby using dual-rate charging techniques for fast battery recharge. It shall charge 55 Amp hour batteries with-in a 48 hour period.
 - e. The supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults on sensitive addressable modules.
 - f. It shall provide meters to indicate battery voltage and charging current.
 - g. The main power supply shall be power-limited per 1995 UL864 requirements.

10. System Circuit Supervision:

- a. Each FACP node shall supervise all circuits to intelligent devices, transponders, annunciators and peripheral equipment and annunciate loss of communications with these devices. The FACP CPU shall continuously scan the above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information on the printer.
- b. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off-normal position.

11. Field Wiring Terminal Blocks:

- a. For ease of service, all wiring terminal blocks shall be the plug-in type and have sufficient capacity for 18 to 12 AWG wire. Fixed terminal blocks are not acceptable.

12. Field Programming:

- a. The system shall be programmable, configurable and expandable in the field without the need for special tools or electronic equipment and shall not require field replacement of electronic integrated circuits.
- b. All local FACP node programming shall be accomplished through the FACP keyboard.
- c. All field-defined programs shall be stored in non-volatile memory.
- d. The programming function shall be enabled with a password that may be defined specifically for the system when it is installed. Two levels of password protection shall be provided in addition to a key-lock cabinet. One level is used for status level changes such as zone disable or manual on/off commands. A second (higher-level) is used for actual change of program information.

13. Specific System Operations:

- a. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent detectors in the FACP node from each system keypad or from the keyboard of the video terminal. Sensitivity range shall be within allowed UL limits.
- b. Alarm Verification: Each of the intelligent addressable detectors in the system may be independently selected and enabled for alarm verification. Each FACP shall keep a count of the number of times each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.
- c. System Point Operations:
 1. All devices in the FACP node may be enabled or disabled through the local keypad or video terminal.
 2. Any FACP node output point may be turned on or off from the local system keypad or the video terminal.
- d. Point Read: The FACP node shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point will be annunciated for the parameters listed:
 1. Device Status
 2. Device Type
 3. Custom Device Label
 4. Software Zone Label

5. Device Zone Assignments
 6. Detector Analog Value
 7. All Program Parameters
-
- e. System Status Reports: Upon command from a password-authorized operator of the system, a status report will generated, and printed, listing all local FACP system status.
 - f. System History Recording and Reporting: Each FACP node shall contain a history buffer that shall be capable of storing a minimum of 400 system events. Each local activation will be stored and time and date stamped with the actual time of the activation, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed, one event at a time, and the actual number of activations may also be displayed and or printed.
 1. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.
 - g. Automatic Detector Maintenance Alert: Each FACP node shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.
 1. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular intelligent detector will be annunciated on the system display, network display and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

H. Addressable Devices – General:

1. Addressable devices shall use simple to install and maintain decade (numbered 1 to 10) type address switches.
2. Addressable devices which use a binary address setting method, such as a Dip switch, are difficult to install and subject to installation error. This type of device is not an allowable substitute.
3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the FACP signaling line circuit.
4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
5. Smoke detector sensitivity shall be set in the fire alarm control panel and shall be adjustable in the field through the field programming of the system. Sensitivity may be automatically adjusted by the panel on a time-of-day basis.
6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Class A applications.

8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
 9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
 10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
 11. A magnetic test switch shall be provided to test each detector for 100 percent obscuration, reported to the FACP.
 12. Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
 13. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100 percent of the alarm threshold.
- I. Addressable Pull Box (manual station):
1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
 2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
 3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger.
 4. Stations shall be suitable for surface mounting or semiflush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.
 5. Manual pull stations shall be of the double action type.
- J. Intelligent Photoelectric Smoke Detector:
1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
- K. Intelligent Thermal Detectors:
1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit. Up to 99 intelligent heat detectors may connect to one SLC loop.

L. Intelligent Duct Smoke Detector:

1. The duct smoke detector housing shall accommodate intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

M. Duct mounted carbon monoxide detector:

1. Manufactured by Air Products and Controls Model SL-701 or Equal
2. Product Specifications

Voltages available: APPROVALS	230VAC, 115VAC, 24VAC, 24VDC Electrochemical Carbon Monoxide Sensor is a UL Recognized component in accordance with the requirements of UL2034. Also meets EN50291 requirements. SL-2000 Series Duct Smoke Detector Fire Alarm Certifications referenced side one: UL & CUL Listed (UL268A, UROX, UROX7) File # S2829 CSFM Listed (3240-1004:105); MEA Accepted (73-92-E, VOL. 27)
----------------------------------	---

SAMPLING TUBES Provide required length for duct coordinate with HVAC drawings ACCESSORIES	Sectional sampling tube Metal sampling tube for 6" to 2.5' duct width Metal sampling tube for 2.5' to 5.0' duct width Metal sampling tube for 5.0' to 10.0' duct width MSR-50/CO remote accessory TG-701 aerosol test gas T-PB power supplies WP-2000 weatherproof enclosure (All available from Air Products and Controls Inc.)															
POWER REQUIREMENTS	<table border="0"> <tr> <td>Input Power</td> <td>Standby Current</td> <td>Alarm Current</td> </tr> <tr> <td>24VAC</td> <td>55mA</td> <td>190mA</td> </tr> <tr> <td>24VDC</td> <td>14mA</td> <td>68mA</td> </tr> <tr> <td>115VAC</td> <td>22mA</td> <td>32mA</td> </tr> <tr> <td>230VAC</td> <td>12mA</td> <td>18mA</td> </tr> </table>	Input Power	Standby Current	Alarm Current	24VAC	55mA	190mA	24VDC	14mA	68mA	115VAC	22mA	32mA	230VAC	12mA	18mA
Input Power	Standby Current	Alarm Current														
24VAC	55mA	190mA														
24VDC	14mA	68mA														
115VAC	22mA	32mA														
230VAC	12mA	18mA														

RELAY CONTACT RATING:

Alarm Contacts Trouble Contacts	Resistive load: 2 sets form "C" rated at 10 Amps @ 115VAC Resistive load: 1 set form "A" rated at 2 Amps Resistive load: 1 set form "C" rated at 10 Amps @ 115VAC
--	---

AIR VELOCITY AMBIENT TEMPERATURE HUMIDITY WIRING	100 to 4,000 ft. /min. 32°F to 158°F (0°C to 70°C) 10% to 85% RH Non-Condensing / Non-Freezing Solid or stranded: #12 to #22 AWG terminals
---	---

MATERIAL	Grey plastic back box, clear plastic cover (Makrolon 94V-0) Do not expose to corrosive atmospheres.
DIMENSIONS	13 ½" L x 4 ½" W x 2 ¼" D
MAX. NET WT.:	2 ½ lbs.
HARDWARE	7" exhaust tube, FAST Tube starter sampling tube, sampling tube end cap, mounting template, and mounting hardware included.

N. Addressable Dry Contact Monitor Module:

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLC loops.
2. The monitor module shall mount in a four in. square, 2-1/8 in. deep electrical box.
3. The IDC zone may be wired for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 in. x 1-1/4 in. x 1/2 in. This version need not include Style D or an LED.

O. Two-Wire Detector Monitor Module:

1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional two wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
2. The two-wire monitor module shall mount in a four in. square, 2-1/8 in. deep electrical box or with an optional surface backbox.
3. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

P. Addressable Control Module:

1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.
2. The control module shall mount in a standard four in. square, 2-1/8 in. deep electrical box, or to a surface mounted backbox.
3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or two amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100 percent of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
4. Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply.
5. The control module shall be suitable for pilot duty applications and rated for a minimum of .6 amps at 30 VDC.

Q. Isolator Module:

1. Isolator modules shall be provided to automatically isolate wire-to-wire short circuits on an SLC loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. At least one isolator module shall be provided for each floor or protected zone of the building.
2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.
3. The isolator module shall not require any address setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.
4. The isolator module shall mount in a standard 4-inch deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

R. LCD Alphanumeric Display Annunciator:

1. The alphanumeric display annunciator shall be a supervised, backlit LCD display containing a minimum of eighty characters for alarm annunciation in clear English text.
2. The LCD annunciator shall display all alarm and trouble conditions from either the network node or complete network, via the INA.
3. Up to 32 LCD annunciators may be connected to a specific (terminal mode) EIA 485 interface. LCD annunciators shall not reduce the annunciation capacity of the system. Each LCD shall include vital system wide functions such as, system acknowledge, silence and reset.
4. LCD display annunciators shall mimic the local control panel 80 character display or network annunciator and shall not require special programming.

S. Batteries and External Charger:

1. Battery:
 - a. Batteries shall be 12 volt, Gell-Cell type.
 - b. The battery shall have sufficient capacity to power the fire alarm system for not less than 60 hours plus 10 minutes of alarm upon a normal AC power failure.
 - c. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills and leakage shall not be required.

T. Audio/Visual Unit (Xenon Strobe):

1. Combination horn strobe units - Provide Truealert Non-Addressable 75 Cd, Red Sync. Two Wire. Comprised of a 24 VDC Xenon Flash Tube entirely solid state. The unit shall require a sync. Control module. Provide True 75 Cd from all axis.
2. Combination horn strobe units - Provide Truealert Non-Addressable 110 Cd, Red Sync. Two-Wire. Comprised of a 24 VDC Xenon Flash Tube entirely solid state. The unit shall require a sync. Control module. Provide True 110 Cd from all axis.
3. Visual only – Provide Truealert Non-Addressable 15 Cd, Red Sync. Two-Wire comprised of a 24 VDC Xenon flash tube entirely solid state.

U. Magnetic Door Holders:

1. Provide Semi-Flush Wall Mounted, 24 V.D.C. with catch plate.

- V. Provide clear plastic covers with local audible alarm for pull stations in apparatus area, and where indicated on drawings, or required by fire department.
- W. Provide UL listed digital dialer to be connected to a remote central station to report by device, Contract ID via Owner provided cellular transmitter.
- X. Testing:
 - 1. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.
 - 2. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:
 - a. Factory trained and certified.
 - b. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
 - c. International Municipal Signal Association (IMSA) fire alarm certified.
 - d. Certified by a state or local authority.
 - e. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.
 - 3. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.
 - 4. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.
 - 5. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.
 - 6. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.
 - 7. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.
 - 8. Final Test, Certificate of Completion, and Certificate of Occupancy:
 - a. Test the entire system 100 percent including devices in the presence of the Authority Having Jurisdiction in order to obtain a certificate of occupancy.
 - 9. Fire Alarm Testing and Maintenance Agreement
 - a. Provide a one-year inspection and testing agreement in accordance with local Fire Department requirements and NFPA 72 recommendations. The holder of the testing and maintenance contract shall be a properly licensed and NRTL certified provider of Fire Alarm services and acceptable to the Fire Department.
 - b. Fire alarm testing agreement shall provide for a minimum of four inspections per year. Upon completion of each test, list actual devices checked. Provide a report to the Owner.
- Y. Training:
 - 1. Provide eight hours Owner training with Owner's Representative.

2.17 SURGE PROTECTION DEVICES

A. SCOPE

1. This section describes the materials and installation requirements for surge protective devices (SPD) for the protection of all main service and panelboards.

B. SUBMITTALS

1. Submit shop drawings and product information for approval and final documentation in the quantities listed according to the Conditions of the Contract. All transmittals shall be identified by customer name, customer location, and customer order number.
2. Submittals shall include UL 1449 3rd Edition Listing documentation verifiable by visiting www.UL.com, clicking "Certifications" link, searching using UL Category Code: VZCA and VZCA2:
 - a. Short Circuit Current Rating (SCCR)
 - b. Voltage Protection Ratings (VPRs) for all modes
 - c. Maximum Continuous Operating Voltage rating (MCOV)
 - d. I-nominal rating (I-n)
 - e. SPD shall be UL listed and labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications
3. Upon request, an unencapsulated but complete SPD formally known as TVSS shall be presented for visual inspection.
4. Minimum of a ten year warranty

C. RELATED STANDARDS

1. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits,
2. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits,
3. IEEE C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
4. National Electrical Code: Article 285
5. UL 1283 - Electromagnetic Interference Filters
6. UL 1449, Third Edition, effective September 29, 2009 – Surge Protective Devices

D. QUALITY ASSURANCE

1. Manufacturer Qualifications: Engage a firm with at least five years experience in manufacturing transient voltage surge suppressors.
2. Manufacturer shall be ISO 9001 or 9002 certified.
3. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of ten years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.
4. The SPD shall be compliant with the Restriction of Hazardous Substances (RoHS) Directive 2002/95/EC.

E. DELIVERY, STORAGE AND HANDLING

1. Handle and store equipment in accordance with manufacturer's Installation and Maintenance Manuals. One copy of this document to be provided with the equipment at time of shipment.

F. MANUFACTURERS

1. Provide an internally mounted Surge Protective Devices (SPD) formerly called Transient Voltage Suppressor (TVSS) by:
 - a. Siemens Industry.
 - b. Current Technology
 - c. LEA
 - d. Liebert
 - e. APT
 - f. Or Equal

G. ELECTRICAL DISTRIBUTION EQUIPMENT

1. Service Entrance
 - a. SPD shall be UL 1449 labeled as Type 1 or Type 4 intended for Type 1 or Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.
 - b. SPD shall be factory installed integral to electrical distribution equipment.
 - c. SPD shall be UL labeled with 20kA I-nominal (I-n)
 - d. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).
 - e. Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
 - f. True 10 Mode Protection paths: SPD shall provide "directly connected protection elements" between all possible modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
 - g. SPD shall be connected external of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.
 - h. SPD shall meet or exceed the following criteria:
 1. Maximum 7-Mode surge current capability shall be [300kA] [400kA] [500kA] per phase.
 2. Maximum 10-Mode surge current capability shall be [300kA] [450kA] per phase.
 3. UL 1449 - Third Edition Revision; effective September 29, 2009 Voltage Protection Ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L	MCOV
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

2. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (percent)	MCOV
208Y/120	25 percent	150V
480Y/277	15 percent	320V

- a. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.
- b. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
- c. SPD shall include a serviceable, replaceable module.
- d. SPD shall be equipped with the following diagnostics:
 1. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
 2. Audible alarm with on/off silence function and diagnostic test function (excluding branch).
 3. Form C dry contacts
 4. Optional – Surge Counter
- e. No other test equipment shall be required for SPD monitoring or testing before or after installation.
- f. SPD shall have a response time no greater than 1/2 nanosecond.
- g. SPD shall have a ten year warranty.

3. Distribution Panel

- a. SPD shall be UL 1449 labeled as Type 4 intended for Type 1 or Type 2 applications, verifiable at UL.com, without need for external or supplemental overcurrent controls. Every suppression component of every mode, including N-G, shall be protected by internal overcurrent and thermal overtemperature controls. SPDs relying upon external or supplementary installed safety disconnectors do not meet the intent of this specification.
- b. SPD shall be factory installed integral to electrical distribution equipment.
- c. SPD shall be UL labeled with 20kA I-nominal (I-n)
- d. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR).
- e. Standard 7 Mode Protection paths: SPD shall provide surge current paths for all modes of protection: L-N, L-G, L-L, and N-G for Wye systems; L-L, L-G in Delta and impedance grounded Wye systems.
- f. SPD shall be connected to the buss of the distribution equipment with an appropriately sized 200kA SCCR rated disconnect.
- g. SPD shall meet or exceed the following criteria:
 1. Maximum 7-Mode surge current capability shall be 100kA per phase.
 2. Maximum 10-Mode surge current capability shall be 150kA per phase.
 3. UL 1449 - Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L	MCOV
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

- h. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (percent)	MCOV
208Y/120	25 percent	150V
480Y/277	15 percent	320V

- i. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.
- j. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.
- k. SPD shall include a serviceable, replaceable module.
- l. SPD shall be equipped with the following diagnostics:
1. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
 2. Audible alarm with on/off silence function and diagnostic test function (excluding branch).
 3. Form C dry contacts
 4. Optional – Surge Counter
- No other test equipment shall be required for SPD monitoring or testing before or after installation.
- m. SPD shall have a response time no greater than 1/2 nanosecond.
- n. SPD shall have a ten year warranty.

4. Branch Panels

- a. The panelboard shall be UL 67 Listed and the SPD shall be UL 1449 labeled as Type 1 or as Type 4 intended for Type 1 or Type 2 applications.
- b. The unit shall be top or bottom feed according to requirements. A circuit directory shall be located inside the door.
- c. SPD shall meet or exceed the following criteria:
1. Maximum 7-Mode surge current capability shall be 100kA per phase.
 2. Maximum 10-Mode surge current capability shall be 150kA per phase.
 3. UL 1449 - Third Edition Revision; effective September 29, 2009, Voltage Protection Ratings shall not exceed the following:

VOLTAGE	L-N	L-G	N-G	L-L	MCOV
208Y/120	800V	800V	800V	1200V	150V
480Y/277	1200V	1200V	1200V	2000V	320V

4. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV) (verifiable at UL.com):

System Voltage	Allowable System Voltage Fluctuation (percent)	MCOV
208Y/120	25 percent	150V
480Y/347	15 percent	320V

- d. SPD shall incorporate a UL 1283 listed EMI/RFI filter with minimum attenuation of - 50dB at 100 kHz.
- e. Suppression components shall be heavy duty 'large block' MOVs, each exceeding 30mm diameter.

- f. SPD shall include a serviceable, replaceable module.
- g. SPD shall be equipped with the following diagnostics:
 - 1. Visual LED diagnostics including a minimum of one green LED indicator per phase, and one red service LED.
 - 2. Audible alarm with on/off silence function and diagnostic test function (excluding branch).
 - 3. Form C dry contacts
 - 4. Optional – Surge CounterNo other test equipment shall be required for SPD monitoring or testing before or after installation.
- h. SPD shall have a response time no greater than 1/2 nanosecond.
- i. SPD shall have a 10 year warranty.
- j. The unit shall have removable interior.
- k. The main bus shall be [copper] [aluminum] and rated for the load current required.
- l. The unit shall include a 200 percent rated neutral assembly with copper neutral bus.
- m. The unit shall be provided with a safety ground bus.
- n. The field connections to the panelboard shall be main lug or main breaker.
- o. The unit shall be constructed with flush or surface mounted trim and shall be in a NEMA Type 1 enclosure.

H. INSTALLATION

- 1. Install per manufacturer's recommendations and contract documents.

I. ADJUSTMENTS AND CLEANING

- 1. Remove debris from installation site and wipe dust and dirt from all components.
- 2. Repaint marred and scratched surfaces with touch up paint to match original finish.

J. TESTING

- 1. Check tightness of all accessible mechanical and electrical connections to assure they are torqued to the minimum acceptable manufacture's recommendations.
- 2. Check all installed panels for proper grounding, fastening and alignment.

K. WARRANTY

- 1. Equipment manufacturer warrants that all goods supplied are free of non-conformities in workmanship and materials for one year from date of initial operation, but not more than eighteen months from date of shipment.

2.18 LADDER TRAY/WIREWAYS

- A. Provide 12 in. wide aluminum ladder tray with 9 in. rung spacing with 6 in. side rail. Ladder tray shall be as manufactured by b-line ladder type. Provide all hangers required.
- B. Wireway:
 - 1. This specification covers NEMA type 1 wireway used to house and protect communication cable. The wireway system shall consist of wireway and appropriate fittings to complete the installation per the electrical drawings.

2. Metal wireway (NEMA type 1) is to be utilized in dry interior locations only as covered in Article 362 Part A of the national electrical code, as adopted by the national fire protection association and as approved by the American National Standards Institute. The wiremold c or sp series is listed by underwriters' laboratories under file no. E137690 guide zoyx.
3. The wireway system specified herein shall be the c or sp system as manufactured by the wiremold company. Systems of other manufacturers may be considered equal if, in the opinion, and the written approval of the engineer, they meet all the performance standards specified herein.
4. The wireway and all system components must be UL Listed in full compliance with their standard ul870, electrical wireways, auxiliary gutters and associated fittings. It shall be manufactured from 16-gauge cold rolled steel, finished in ASA 61 gray powder coat paint. All sizes larger than 6 in. x 6 in. shall be manufactured from 14-gauge cold rolled steel, finished in ASA 61 gray powder coat paint. A factory installed divider shall be available to separate power and low voltage wiring housed in the same wireway sections.
5. A full complement of fittings for the raceway shall be available including, but not limited to, 45 degrees and 90 degrees flat, vertical inside and outside elbows, tee and cross fittings, couplings for joining sections of wireway, reducers, hangers, end blanks, a field installed divider and all other components necessary to make the system workable. The fittings shall have an ASA 61 gray powder coat paint finish to match the wireway.
6. Prior to and during installation, refer to system layout drawing containing all elements of the system. Installer shall comply with detailed manufacturer's instruction sheets which accompany system components as well as complete system instruction sheets, whichever is applicable.
7. All wireway systems shall be mechanically continuous and connected to all electrical boxes and cabinets, in accordance with manufacturer's installation sheets.
8. All connections shall be checked to make sure they are correctly tightened and to insure that all wireway shall be electrically continuous and bonded in accordance with the national electric code for proper grounding.
9. All wireway systems shall be installed complete. Work shall include fastening all wireway and appropriate fittings to install a complete wireway system as indicated on the electrical and/or communication drawings and in the applicable specifications

2.19 SEALS

A. Water Tight Seals

1. Conduits entering from the exterior or below grade shall have water tight fittings on the outside and on the inside of the conduit.
 - a. Fittings on the outside of the conduit shall be O-Z Gedney type FSK or approved equal. Provide type WSK if penetration is within two ft. of the high water table. Provide grounding attachment.
 - b. Fittings on the inside of the conduit shall be O-Z Gedney type CSBI or approved equal. Provide type CSBG if penetration is within two ft. of the high water table. Provide a blank fitting to seal spare or empty conduits.
 - c. O-Z Gedney type CSM fitting may be used when sealing within a sleeve or cored hole.
2. Submit on seals to be used.

B. Environmental Seals

1. Provide seals on raceways exposed to widely different temperatures, as in refrigerating or cold storage areas. Install seal to prevent circulation of air from warmer to colder sections through the raceway.

C. Hazardous Area Seals

1. Provide explosion proof seals per Code.

D. Smoke and Fire Stopping Seals

1. Provide a seal around raceways or cables penetrating full height walls (slab to slab), floors or ventilation or air handling ducts so that the spread of fire or products of combustion shall not be substantially increased.
2. Penetrations through fire-resistant-rated walls, partitions, floors or ceilings shall be firestopped using approved methods and NRTL listed products to maintain the fire resistance rating.
3. Fire stopping in sleeves or in areas that may require the addition or modification of installed cables or raceways shall be a soft, pliable, non-hardening fire stop putty. Putty shall be water resistant and intumescent. Provide for all sleeves and raceways.
4. Firestopping in locations not likely to require frequent modification shall be NRTL listed putty, caulk or mortar to meet the required fire resistant rating.
5. Box penetrations into a fire rated wall or shaft shall have a fire stopping pad installed on the back of the box.
6. Firestopping of cable trays or busways through walls shall be within a non-hardening putty or with seal bags.
7. Firestopping materials shall be NRTL listed to UL 1479 (ASTM E814). Installation methods shall conform to a UL firestopping system. Submit specifications and installation drawings for the type of material to be used. Firestopping materials shall be as manufactured by 3M, International Protective Coatings Corp., RayChem or approved equal.

2.20 UNDERGROUND DUCTBANKS

- A. General: Furnish and install the ductbanks as herein specified and as shown on drawings.

B. Division of Work:

1. The General Contractor shall be responsible for the work and material required for the following:
 - a. Excavation
 - b. Backfill
 - c. Installation of handholes/manholes
 - d. Brick or concrete collars to bring handhole frames and covers up to grade. Installation of frames and collars which are to be furnished by the Electrical Contractor.
 - e. Concrete Encasement.
2. All other material, equipment, and labor required for the complete ductbank shall be furnished and installed by the Electrical Contractor under this Section, including the following:
 - a. Service raceways.

- b. Grounding material.
- c. Ductbank warning tape.
- d. Furnish pre-cast handholes/manholes.
- e. Conduit spacers.

C. Materials:

- 1. Conduit: UL listed, schedule 40 PVC in accordance with NEMA standard TC-2.
- 2. See BASIC MATERIALS SECTION.
- 3. Conduit Supports (duct system): Shall be molded plastic with interlocking lugs and skeletonized structure, minimum separation 3 in.
- 4. Tags: Non-ferrous metal or fibre, 1/4 in. high letters.
- 5. Warning tape shall be yellow polyethylene 4 mil thick, 6 in. wide terratape, similar to REEF Industries, Houston, Texas and shall be installed above all ductbanks both high and low tension.

D. Duct System:

- 1. The duct system shall consist of Schedule 40 PVC conduit except where otherwise specified. The size and number of conduits shall be as indicated on the drawings. Provide a pull wire in each conduit.
- 2. The entire length between handholes and end of ductbank shall be excavated and graded before any conduit is laid.
- 3. The ductbank shall be set on undisturbed earth.
- 4. The conduit shall be installed so that top is a minimum of 36 in. below finished grade unless otherwise indicated, and shall be laid to a minimum grade of 4 in. for each 100 ft. of length. Duct system shall drain to manholes/handholes.
- 5. Changes in direction shall be made by long sweep bends, minimum radius 25 ft. except that at the end of a run, within 10 ft. of termination. Manufactured ends may be used having a minimum radius of 36 inches.
- 6. Conduit base and intermediate spacers shall be installed a maximum of 5 ft. on centers. Spacers shall not be placed one above the other, but shall be staggered a minimum of 6 in.
- 7. All conduit joints shall be made watertight by means of a sealing compound before the coupling is installed. Joints in conduit shall be staggered; minimum space between joints in adjacent conduit shall be 6 in.
- 8. When the required number of conduits has been installed, securely tie the assembly together at distances not exceeding 7 ft. Tie shall consist of three turns of No. 18 iron wire. Separate ties required for low tension and high tension conduit runs.
- 9. Duct envelope shall be vibrated to eliminate voids.
- 10. Ductbanks shall not be covered until the conduit installation has been observed by the utility company and Architect.
- 11. Warning tape shall be installed during backfilling and shall be placed approximately 12 in. above the conduits.
- 12. After the installation is completed, each conduit shall be cleaned and identified. A standard flexible mandrel and a stiff bristle brush shall be pulled through each conduit. The mandrel shall not be less than 12 in. long and the diameter approximately 1/4 in. less than the conduit.

2.21 VARIABLE FREQUENCY DRIVES (VFD'S)

- A. The variable frequency drives (VFD's) shall be solid state, with a Pulse Width Modulated (PWM) output waveform (VVI, six-step, and current source drives are not acceptable). The VFD package as specified herein shall be enclosed in a NEMA 1 enclosure, completely assembled and tested by the manufacturer. The VFD shall employ a full wave rectifier (to prevent input line notching), DC Line Reactor, capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the output switching device (SCR's, GTO's and Darlington transistors are not acceptable). The drive efficiency shall be 97 percent or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.
- B. Specifications at 208 volts:
 - 1. Input VAC +/-10 percent, 3 phase, 48-63Hz. Output 0 - Input Voltage, 3 phase, 0 to 500 Hz for drives up to 75 HP; 0 to 120 Hz for drives over 75 HP. Operation above 60 Hz. shall require programming changes to prevent inadvertent high speed operation. Environmental operating conditions: 0 to 40 C @ 3 kHz switching frequency, 0 to 3300 ft. above sea level, less than 95 percent humidity, non-condensing. Units shall be UL, CUL and CA approved.
- C. All VFD's shall have the following standard features:
 - 1. All VFD's shall have the same customer interface, including digital display, keypad and customer connections; regardless of horsepower rating. The keypad is to be used for local control, for stepping through the displays and menus.
 - 2. The VFD shall give the user the option of either (1) displaying a fault, (2) running at a programmable preset speed, (3) hold the VFD speed based on the last reference revised, or (4) cause a Warning to be issued, if the input reference (4-20mA or 2-10V) is lost; as selected by the user. The VFD shall provide a programmable relay output for customer use to indicate the loss of reference condition.
 - 3. The VFD's shall utilize plain English digital display (code numbers and letters are not acceptable). The digital display shall be a 40-character (2 line X 20 characters/line) LCD display. The LCD shall be backlit to provide easy viewing in any angle. All set-up parameters, indications, faults, warnings and other information must be displayed in words to allow the user to understand what is being displayed without the use of a manual or cross-reference table.
 - 4. The VFD's shall utilize pre-programmed application macro's specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application to reduce programming time.
 - 5. The VFD shall have the ability to automatically restart after an overcurrent, overvoltage, or loss of input signal protective trip. The number of restart attempts, trial time, and time between reset attempts shall be programmable. If the time between reset attempts is greater than zero, the time remaining until reset occurs shall count down on the display to warn an operator that a restart will occur.
 - 6. The VFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
 - 7. The VFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and not inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.
 - 8. The customer terminal strip shall be isolated from the line ground.

9. Prewired three-position Hand-Off-Auto switch and speed potentiometer. When in "Hand", the VFD will be started, and the speed will be controlled from the speed potentiometer. When in "Off", the VFD will be stopped. When in "Auto", the VFD will start via an external contact closure, and its speed will be controlled via an external speed reference.
 10. The drive shall employ three current limit circuits to provide trip free operation:
 11. The Slow Current Regulation limit circuit shall be adjustable to 125 percent (minimum) of the VFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load. The Rapid Current Regulation limit shall be adjustable to 170 percent (minimum) of the VFD's variable torque current rating. The Current Switch-off limit shall be fixed at 255 percent (minimum, instantaneous) of the VFD's variable torque current rating. The overload rating of the drive shall be 110 percent of its variable torque current rating for one minute every ten minutes, and 140 percent of its variable torque current rating for two seconds every 15 seconds, input line fuses standard in the drive enclosure. VFD shall have a DC Line Reactor to reduce the harmonics to the power line and to increase the fundamental power factor.
 12. The VFD shall be optimized for a three kHz carrier frequency to reduce motor noise and provide high system efficiency. The carrier frequency shall be adjustable by the start-up engineer in ACH 501 units. The VFD shall have a manual speed potentiometer in addition to using the keypad as a means of controlling speed manually.
- D. All VFD's to have the following adjustments:
1. Five programmable critical frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.
 2. PI Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the VFD, using the microprocessor in the VFD for the closed loop control.
 3. Two programmable analog inputs shall accept a current or voltage signal for speed reference or for reference and actual (feedback) signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0-20 MA and 0-10 Volts. Additionally, the reference must be able to be scaled so that maximum reference can represent a frequency less than 60 Hz, without lowering the drive maximum frequency below 60 Hz.
 4. Six programmable digital inputs for maximum flexibility in interfacing with external devices. One digital input is to be utilized as a customer safety connection point for fire, freeze, and smoke interlocks (Enable). Upon remote, customer reset (reclosure of interlock) drive is to resume normal operation.
- E. The following operating information displays shall be standard on the VFD digital display. The display shall be in complete English words (alpha-numeric codes are not acceptable):
- Output Frequency
 - Motor Speed (RPM, Percent, or Engineering units)
 - Motor Current
 - Calculated Motor Torque
 - Calculated Motor Power
 - DC Bus Voltage
 - Output Voltage
 - Heatsink Temperature
 - Analog Input Values
 - Keypad Reference Values

Elapsed Time Meter
kWh meter

F. Speed Command Input shall be via:

1. Keypad.
2. Two Analog inputs, each capable of accepting a 0-20mA, 4-20mA, 0-10V, 2-10V signal. Input shall be isolated from ground, and programmable via the keypad for different uses.
3. Floating point input shall accept a three-wire input from a Dwyer photohelic (or equivalent type) instrument.

G. Accessories to be furnished and mounted by the drive manufacturer.

1. Customer Interlock Terminal Strip-provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external interlocks and start/stop contacts shall remain fully functional whether the drive is in hand, Auto or Bypass.
2. All wires to be individually numbered at both ends for ease of troubleshooting.
3. Door interlocked thermal magnetic circuit breaker which will disconnect all input power from the drive and all internally mounted options. The disconnect handle shall be thru-the-door type, and be padlockable in the "Off" position.
4. Manual transfer to line power via contactors. Include motor thermal overload and fuse or circuit breaker protection while in bypass operation. A three position selector switch to control the bypass contactor and the drive output contactor is to be mounted on the enclosure door. When in the "Normal" mode, the bypass contactor is open and the drive output contactor is closed. In the "Test" position both contactors are open, and in the "Bypass" position, the drive output contactor is open, and the bypass contactor is closed. The drive output contactor shall also open when a stop command is given, isolating the motor from the drive. Start/stop signals and safety interlocks will work in drive and bypass modes.
5. Pilot lights shall be provided for indication of "Normal" operation, "Bypass" operation, and "External Fault". All pilot lights shall be push-to-test type.
6. Service contactor (drive input contactor) which provides the ability to service the drive (electrically isolate the drive while in bypass operation without having to remove power from the motor). The service contactor shall open when the drive is switched to bypass, and also be controlled by a switch which is mounted inside the drive enclosure so that its access is limited to service personnel only.
7. A class 20 bimetallic thermal motor overload relay shall be provided to protect the motor in bypass.

H. Compliance to IEEE - 519

1. The VFD manufacturer shall provide calculations specified to this installation showing that the Total harmonic Distortion for the VFD's, reflected into the electrical distribution system is limited to the level defined by IEEE - 519 (latest edition) for general systems. Harmonic analysis shall be included with VFD submittal for approval by the engineer.
2. The VFD manufacturer shall conduct on site harmonic measurements before and after start up of the VFD's. Results of the measurements, showing harmonic contribution of the VFD's, shall be provided to the engineer one month after start up.
3. Three phase A. C. input line reactors shall be provided as a minimum, with all VFD's. The line reactors are to provide attenuation of line side voltage transients, thus preventing overload trips or other unnecessary V.F.D. shutdown, and provide a reduction in harmonic distortion.

4. Line reactors shall have the following requirements:
 - a. Three (3) percent line impedance (line side of drive).
 - b. 150 percent continuous current rating for one minute.
 - c. Saturation rating no less than 2.5 times the continuous current rating.
 - d. U.L. recognized.
- I. General: Install variable frequency drives where indicated, in accordance with manufacturer's published installation instructions, complying with recognized practices to ensure that variable frequency drives comply with requirements and serve intended purposes.
- J. Access: Provide access space around control panels for service as indicated, but in no case less than that recommended by manufacturer.
- K. Support: Install drive control panels on walls where indicated on drawings. Provide necessary Unistrut and structural steel to provide adequate support.
- L. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Installer.
 1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until wiring installation is acceptable to equipment installer.
- M. Start-Up
 1. Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the owner, and a copy kept on file at the manufacturer.
- N. Adjusting and Cleaning:
 1. Alignment: Check compatibility of control panel to motor and where necessary, adjust frequency and provide necessary filters to assure noise free operation of motors. Verify response from control panel to motor to assure turn down ratio specified and that static pressure signals are being received and that drives are controlling as specified and within recommended tolerances by manufacturer. Provide start-up report prepared by manufacturer's representative to assure operation is as specified.
 2. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.
- O. Acceptable Manufacturers:

Square D
Allen – Bradley
ABB
Siemens
Or Equal

2.22 AUTOMATED LIGHTING CONTROL SYSTEM

A. General: Summary

1. Section Includes:
 - a. Addressable Networked Light Management System.

B. References

1. National Fire Protection Association (NFPA)
2. cULus Listing/Certification
 - a. Certified as Energy Management Equipment (UL 916)
 - b. Certified as Emergency Lighting Equipment (UL 924)
 - c. Meet Heat and Smoke Release for Air-Handling Spaces (UL 2043)
3. Federal Communications Commission (FCC) / Industry Canada (IC)
4. California Energy Commission (CEC)
5. Local Building Codes

C. System Description

1. Lighting Control System includes computer-based software that provides control, configuration, monitoring and reports. System includes the following components:
 - a. Central Control Unit
 - b. System Server
 - c. 0-10V Dimming, Fixed Output Ballasts or 0-10V LED Drivers
 - d. System Field Devices (Input and Output Modules)
 - e. Lighting Control System Software
 - f. Lighting Controllers
 - g. Communication Wire
 - h. Occupancy sensors
 - i. Photo sensors
 - j. Power packs
 - k. Lighting control panels
 - l. Interface to audio visual equipment
 - m. Interface to BACnet
 - n. Interface to Tridium Niagara
 - o. Incandescent low-voltage dimming modules

D. Submittals

1. General: Provide submittals per 1.4 (B – J) below:
2. Bill of Materials: Complete list of all parts needed to fully install selected system components.
3. Product Data: For each type of product indicated.
4. Shop and Wiring Drawings: Submit shop drawings detailing control system, as supplied, including one-line diagrams, wire counts, coverage patterns, interconnection diagrams showing field-installed wiring and physical dimensions of each item.
5. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.
 - a. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.

- b. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
 6. Software Operational Documentation:
 - a. Software operating and upgrade manuals.
 - b. Program Software Backup: On compact disc or DVD, complete with data files.
 - c. Printout of software application and graphic screens, or upon request, a live demonstration of Control, Configure and Analyze functionality or a video demonstrating above stated system capabilities.
 7. Installation Instructions: Manufacturer's installation instructions.
 8. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.
 9. Warranty: Copy of applicable warranty.
- E. Quality Assurance
1. Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.
 2. Manufacturer Requirements: The manufacturer shall have a minimum of 10 years experience manufacturing networked lighting control systems and shall provide 24/7 telephone support by qualified technicians.
 3. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the system provider to ensure proper system operation and maintainability.
 4. Performance Requirements: provide all system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.
 5. Performance Testing Requirements
 - a. Manufacturer shall 100 percent test all equipment prior to shipment. Sample testing is not acceptable.
 6. Code Requirements
 - a. System Control Unit and System Field Devices shall be cULus listed and certified.
 - b. All system components shall be FCC /IC compliant.
 - c. All system components shall be installed in compliance with National Electrical Codes and Canadian Electrical Code.
 - d. Building Codes: All units shall be installed in compliance with applicable, local building codes.
 7. ISO Certification: System components shall be manufactured at ISO-9000 certified plants.

F. COORDINATION

1. Coordinate lighting control components to form an integrated interconnection of compatible components.
 - a. Match components and interconnections for optimum performance of lighting control functions.
 - b. Display graphics showing building areas controlled; include the status of lighting controls in each area.

G. Delivery, Storage & Handling

1. Ordering: Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
2. Delivery: Deliver materials in manufacturer's original, unopened, undamaged packaging with intact identification labels.
3. Storage and Protection: Store materials away from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

H. Warranty

1. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements shall be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
2. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.
3. Manufacturer's Warranty: All equipment shall be warranted free of defects in materials and workmanship.
 - a. Warranty Period: All system hardware components shall have full warranty (non-prorated) for at least four years and all software components shall carry a warranty of 90 days from date of installation.
 - b. Owner Rights: Manufacturer's warranty is in addition to, not a limitation of, other rights the Owner may have under contract documents, or warranties of third party component manufacturers.

I. Basis of Design Products

1. Controls: ENCELIUM Energy Management System by OSRAM SYLVANIA
2. Sensors: ENCELIUM Sensors by OSRAM SYLVANIA & Hubbell Building Automation, Inc.

J. Acceptable Alternate Manufacturers

1. Controls: Lutron, Sensor Switch, Crestron, Philips, Cooper, or equal.
2. Sensors: Lutron, Sensor Switch, Watt Stopper, Leviton, Cooper or equal.

K. System Performance Requirements

1. This specification is intended to fully describe all of the design, engineering, programming, hardware, software, ancillary devices and associated technical services required to provide a building-wide networked lighting control system. This system is specified to perform scheduled and automated lighting control sequences.

2. The lighting control "system" shall include a fully distributed WAN/LAN network of global controller/routers, individually addressable System Field Devices, sensors, switches, relays and other ancillary devices required for a complete and operable system. The system WAN/LAN shall be commissioned by ENCELIUM personnel or other ENCELIUM certified commissioning contractors.
3. The basis of system design shall utilize non-proprietary industry standard 0-10V dimming or fixed output ballasts and/or 0-10V LED drivers, occupancy sensors, and daylight sensors.
4. On-going system expansion, service and support shall be available from multiple factory certified vendors. Recommended service agreements may be submitted at the time of bid complete with manufacturers suggested inventory and pricing for system parts and technical support labor.
5. Lighting Control Software: The system shall offer two separate levels of lighting control: one personal lighting control for the average building occupant to control and adjust basic lighting functions in their workspace, and two central lighting control for the facility lighting administrator to perform energy management, configuration maintenance, monitoring operations, and providing support to building occupants.
 - a. Native central control software shall be utilized for energy reporting status and complete programming without the need for any third party hardware or software. Systems that require any third party linked software or graphics shall be unacceptable.
 - b. Software shall provide information on general system settings via mouse click on a floor plan. Left clicking over a device on the graphical software interface shall show a description of the selected device/function attribute.
6. Central Lighting Control:
 - a. Shall provide an Interactive, Web-based graphical user interface (GUI) showing floor plans and lighting layouts that are native to the lighting control software. The only means required to program and operate the lighting control system shall be programmed and operated from a user interface that is based on a plan view graphical screen on the user's computer or the lighting control system's main computer. Shall include the navigational features listed below to allow for user's orientation within the controlled space, geographic heading and/or landmarks:
 1. Interactive
 2. Vector based
 3. Zoom
 4. Rotate
 5. Pan
 6. Tilt
 - b. Shall allow building operator to navigate through an entire facility both in two-dimensional and three-dimensional multi-floor view, allowing for fast and easy navigation.
 - c. Three-dimensional view shall exclude walls and other structural features to avoid shadowing and cluttering of the plan view.
 - d. All programming, assignments of lighting loads to control strategies, lighting status and lighting energy reporting shall be native to the software and executed from this GUI. Editing shall be available from this GUI in a drag and drop format or from drop down menus without the need for any third party software. Systems that utilize or require third party linked graphics are unacceptable. The GUI shall continuously indicate the status of each connected device on the system and a warning indicator on the software if a device goes offline. Systems requiring spreadsheet editing for programming and that don't offer real time feedback are not acceptable.

- e. Software settings and properties shall be selectable per individual device, room based, floor based or global building based.
 - 1. Lighting Control Software interface shall provide current status and enable configuration of all system zones including selected individual fixture availability, current light level, maximum light level, on/off status, occupancy status, and emergency mode (response to an emergency signal) status.
- f. Shall have the ability to display various lighting system parameters such as Lighting status (ON/OFF); Lighting levels, Load shedding status, or Lighting energy consumption, Occupancy status in a colorized gradient ("weather" map) type of graphical representation.
- g. Energy Analysis data shall be exportable in a CSV or similar format.
- h. Shall allow import of native AutoCAD files.
- 7. Reports: Reporting feature shall be native to the lighting control software and capable of reporting the following parameters for each device and zone individually without requiring any third party hardware and software:
 - a. Energy consumption broken down by energy management strategy.
 - b. Energy demand broken down by energy management strategy.
 - c. Occupancy data by zone.
 - d. Building wide occupancy status
 - e. Lighting energy consumption in a color gradient ("weather map" type) view
 - f. Energy performance reports shall be printable in a printer friendly format and downloadable for use in spreadsheet applications.
- 8. Personal Lighting Controls: The Personal Control Software interface shall provide current status and enable each user with the ability to dim and brighten lights, and turn them on and off by individual fixture or zone. The Software shall offer user configurable light scenes, which may be programmed and then selected via the Software. Personal lighting control shall be available in open/private office environments.
- 9. Daylight Harvesting (Light Regulation Averaging): In a photo sensor-equipped system, the Central Controller Unit shall rationalize changes to light levels when ambient (natural) light is available and shall maintain a steady light level when subjected to fluctuating ambient conditions where dimming ballasts and/or drivers exist. Areas equipped with fixed output ballasts and/or drivers shall energize when natural light falls below foot-candle levels specified. System shall utilize light level inputs from common and/or remote sensor locations to minimize the number of photo sensors required. The System shall operate with multiple users in harmony and not react adversely to manual override inputs.
- 10. Time Clock Scheduling: The system shall be programmable for scheduling lights on or off via the Lighting Control Software interface.
 - a. Support for BACnet Time Schedule Object: This allows the export of Lighting Control time schedules to BACnet devices and vice versa in the event of Lighting Control System's integration with BACnet.
 - b. Override: Manual adjustments via lighting controllers or personal control software shall temporarily override off status imposed by time clock schedule.
 - c. Response to Power Failure: In the event of a power failure, the time clock shall execute schedules that would still be in progress had they begun during the power outage.
 - d. Flick Warning: Prior to a scheduled lights-off event or expiry of a temporary override, the system shall provide two short light level drops as a warning to the affected occupants. Flick warning time shall have the ability to be programmed via software between one and five minutes.

11. Load Shed Mode: An automatic load shedding mode shall be available where, when activated through the system, the control unit will reduce its output to a programmable maximum electrical demand load. The system shall not shed more load than required and load shedding priority shall be centrally configurable by control zone or by common uses (i.e., all hallways can be treated as one load shed group), with subsequent load shed priority groupings being utilized until the required defined load has been shed, for either a defined period, or until the demand response input has been removed. Systems that simply select a "load shed scene" whereby there is no guarantee that the defined required load will actually be shed are not acceptable.
12. Emergency Mode: There shall be a mode, when activated through the system, that will immediately adjust lights to full light output and retain that level until the mode is deactivated in the event of an emergency. This setting shall override all other inputs. The system shall interface with the building of life safety transfer switch, fire alarm control panel, and security system control panel.
13. Addressing: All ballasts and/or drivers shall be centrally addressable, on a per fixture or multiple fixtures/zone basis, through the Central Control Software. The basis of design shall utilize industry standard 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers connected to an Output Module. To simplify ongoing maintenance, the system shall not require manual recording of addresses for the purpose of commissioning or reconfiguration.
14. Programmable Task Tuning: Maximum light level programmability shall be available by individual fixture.
15. Unoccupied State: The system shall provide two states when occupancy status is vacant as per an occupancy sensor: lights turn off or lights adjust to configurable (dimmed) light level.
16. Occupied State: The system shall be capable of creating "comfort" or "support" zones to ensure that occupants are not isolated by turning off lights in adjacent areas for occupant comfort and safety, such as a hallway path to exit the premises.
17. The Automated Lighting Control System (ALCS) BACnet Interface shall share the following information with the BACnet enabled Building Automation System and other systems listed below:

<u>Property</u>	<u>BACnet Type</u>	<u>Description</u>
Lighting Load	Analog Value*	Reports the total lighting load of the ALS, defined in Watts
Light Zone State	Binary Value*	State of the defined lighting zone - ON or OFF
Light Zone Dimming	Analog Value*	Light output level of the defined lighting zone, from 100 percent (maximum light output) to 0 percent (minimum light output)
Emergency System State	Binary Input	State of the emergency alarm system: alarm activated or alarm not activated

Fire Alarm State	Binary Input	State of the fire alarm system: alarm activated or alarm not activated
Security System State	Binary Input	State of security alarm system: alarm activated or alarm not activated
Occupancy State	Binary Output	State of the defined occupancy sensor – occupancy detected or not detected
Sheddable Load	Analog Output	Reports the total lighting load available for load reduction according to ALS, defined in Watts
Shed Status	Analog Output	Reports the total current load reduction achieved according to ALS defined prioritization, defined in Watts
Shed Request	Analog Input	Requested total amount of load reduction, defined in Watts or as a percentage of sheddable load
Sheddable Load (Group)	Analog Output	(As above, unprioritized for the selected group)
Shed Status (Group)	Analog Output	(As above, unprioritized for the selected group)
Shed Request (Group)	Analog Input	(As above, unprioritized for the selected group)

18. LAN Operations: System shall be capable of operating independent of building's existing network infrastructure if desired and shall not rely on tenant supplied PCs for operation. Network infrastructure shall only be utilized for Personal Control Software.
19. Firewall Security: Firewall technology shall be utilized to separate tenants from the lighting control network.
20. Lamp Burn In: The system software shall not permit dimming of new lamps prior to completion of lamp manufacturer 100 hour recommended accumulated operation at full brightness.
21. Re-configurability: The assignment of individual fixtures to zones shall be centrally configurable by Central Control Software such that physical rewiring will not be necessary when workspace reconfiguration or re-zoning is performed. Removal of covers, faceplates, and ceiling tiles. shall not be required.
22. Automatic Control Parameters: Occupancy sensor time delays shall be configurable through software. Light level sensor parameters shall be configurable through software.
23. Automatic Time Adjustment: System shall automatically adjust for leap year and daylight savings time and shall provide weekly routine and annual holiday scheduling.

24. Contact closure input: System shall be capable of receiving a momentary and sustained contact closure input from third party sources to control lighting zones.
25. The light management system shall interface digitally with the building automation system via BACnet/IP and Tridium Niagara AX interface. The lighting control system shall communicate the status of output devices (lighting loads) as well as input devices (dry contacts, switches, occupancy sensors, vacancy sensors, and photocells) over this connection allowing the building automation system to utilize lighting control system input devices such as occupancy sensors to determine if mechanical control zones are occupied for climate adjustments.
26. The system software shall provide a web based energy dashboard to show real time energy savings data and carbon footprint reductions.
27. Migration Plan to Control LED Fixtures
 - a. System shall be capable of migrating from the control of 0-10V Ballasts to 0-10V LED Drivers utilizing the same Output Modules without the need to change control hardware.

L. Lighting Controllers

1. Description: The system shall include separate lighting controllers for each of the listed functionalities and at minimum meet listed electromagnetic, mechanical, electrical and data specifications:
 - a. Software configurable lighting controller that provides on/off switching and dimming control for up to three lighting zones/scenes per controller or more with allowable multi-gang configurations. Status is indicated by an LED display to indicate function, scene or zone. Allows manual override of the time schedule.
 - b. Manual dimming and/or switching lighting controller that provides local on/off and dimming control over at least three lighting zones. Allows manual dimming of light levels and override of the time schedule.
 - c. Scenes in the central control software shall be synchronized with the buttons on the lighting controller.
 - d. Lighting controllers shall fit in a standard Decorator style wall plate and may be ganged together.
2. General
 - a. Addressing: All controllers shall be individually addressable & reconfigurable via Central Control Software.
 - b. Shall provide local on/off or dimming control over lighting zones
 - c. Shall utilizing a standard single-gang or multi-gang form factor
 - d. Shall have a terminal block that connects to lighting system with 18 AWG, polarity independent, CMP rated and low voltage wire
 - e. Shall be manufactured with push-in wire receptacles
 - f. LED's: All controllers shall feature LED's to indicate light on and light off status.
 - g. Color: All controllers shall meet NEMA WD1 color specifications.
 - h. Style: All controllers shall feature Decorator styling wall plates.
 - i. Lighting scenes reconfigure automatically based on scene changes from personal control software.
 - j. Industrial lighting controllers shall also be available for damp location applications.
 - k. Shall comply or exceed the following electromagnetic requirements:
 1. EN 61000-4-2
 2. EN 61000-4-4
 3. EN 61000-4-5
 4. FCC Part 15/ICES-003

3. Mechanical Specifications:

- a. Dimensions: Shall meet NEMA WD-6 spec.
- b. Maximum Operating Ambient Temperature: 60 deg C.
- c. Mounts in standard size wall box suitable for multi gang installation or alternative of Low Voltage mounting bracket.
- d. Suitable for use with Decorator style wall plates.

4. Electrical Specifications:

- a. Class 2 Low Voltage device.
- b. Power through interconnected 18 AWG cable with 2-pin header

5. Data Specifications:

- a. Class 2 communication bus that uses prefabricated 18 AWG cable.

M. System Field Devices (Input and Output Modules)

1. General: Input Modules provide a common interface to low voltage occupancy sensors and photo sensors while Output Modules provide a common interface to 0-10V Dimming, Fixed Output Ballasts and/or 0-10V LED Drivers and analog dimming devices such as incandescent low-voltage dimming modules. These modules automatically self-address and detect the type of devices they are connected to (i.e., photo sensor, occupancy sensor, 0-10V ballast, 0-10V LED drivers or incandescent dimming module) and establish two-way communication between the system Control Unit (CU) and themselves. These individually addressable modules enable each lighting component to be independently controlled and configured to best meet the needs of the facility.

- a. Addressing: System Field Devices shall be individually addressable via Central Control Software.
- b. System shall automatically address individual nodes during system commissioning thus eliminating the need to pre-address devices or record serial numbers during installation.
- c. Modules shall at minimum meet the listed general, mechanical and environmental specifications set at below.

2. Air Gap Off

- a. Definition: Air Gap Off shall refer to the physical disconnection of AC power to the ballast or driver when "OFF" is selected either automatically or manually, thus ensuring maximum energy savings by eliminating off-state phantom power losses as well as ensuring that no potentially lethal high-voltage is present at the ballast or driver when the lights appear to be off (for life-safety reasons).
- b. Provisions: Provide an air-gap off relay for each control zone in the system. Where each fixture is to be controlled (dimmed and/or switched) independently, provide one relay per fixture. Where multiple fixtures are to be controlled (dimmed and/or switched), provide one relay per control zone, sized to handle both the inrush current as well as the maximum connected load, at the specified voltage.

3. General Specifications:

- a. Shall supply 12VDC (up to 24VDC) to sensors.
- b. Shall have 2 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting Class 2 communication bus that supplies 24 VDC.

- c. Two models, one rated for regular indoor use and other for use in damp locations such as basements, cold storage areas. shall be available.
- d. Memory: Retains all system settings in non-volatile memory.

4. Mechanical Specifications:

- a. Wiring: The System Field Device shall not require wiring connections to the System apart from pre-terminated, quick connecting 18 AWG, polarity independent quick connecting Class 2 communication bus.

5. Environmental Specifications:

- a. Operating Temperature Range: -40 deg C to +55 deg C.
- b. Humidity: 0 percent to 100 percent RH condensing rated for damp locations.
0 percent to 95 percent RH non-condensing rated for indoor locations.

N. Energy Control Unit

- 1. General: The Energy Control Unit (ECU) is a rack or wall mounted lighting control device that collects, processes and distributes lighting control information to System Field Devices and lighting controllers over a Class 2 communication bus. Each ECU has multiple Class 2 communication channels and can control a large quantity of nodes (sensors, lighting controllers, 0-10V Dimming, Fixed Output Ballasts and 0-10V LED Drivers.) per channel, per the manufacturers recommended maximum. The ECU is the central intelligence point for the area that it controls, collecting signal information from sensors, lighting controllers and personal control software and determining appropriate brightness levels or on/off status for each fixture or zone. Each ECU has an Ethernet connection for communication with a facility's or tenant's Local Area Network (LAN) to enable desktop personal control.

- a. Shall interconnect with other ECUs and System Server Unit (SSU) using standard Ethernet connection that employs TCP/IP protocol.
- b. Control units shall at minimum meet the mechanical, electrical, data, electromagnetic and environmental specifications listed below.

2. Mechanical Specifications:

- a. Shall mount in a standard 1 inch rack (1U width), or alternatively where no rack is shown, via an individual wall mount.

3. Electrical Specifications:

- a. Power Supply: 120V/60Hz/200W. Provide dedicated 120V receptacle fed from a dedicated normal power circuit; do not connect to a UPS or normal/emergency power source.

4. Data Specifications:

- a. Shall have 8 ports that accept 18 AWG, pre-fabricated, polarity independent quick connecting Class 2 communication bus that supplies 24 VDC
- b. Each ECU channel shall support up to 100 nodes or 800 nodes in total.
- c. Each ECU shall have two Ethernet 10/100Base - Tx Cat 5 RJ45 ports that employs TCP/IP protocol:
 - 1. Lighting Control Network
 - 2. Tenant LAN Access Point

- d. Shall have a status LED on front of unit.
 - e. Shall have configuration stored in non-volatile flash memory.
 - 5. Shall comply or exceed the following electromagnetic requirements:
 - a. EN 61000-4-2
 - b. EN 61000-4-4
 - c. EN 61000-4-5
 - d. FCC Part 15/ICES-003
 - 6. Environmental Specifications:
 - a. Operating Temperature Range: -20 deg C to +40 deg C.
 - b. Humidity: 0 percent to 95 percent RH non-condensing.
- O. System Server Unit
- 1. General: System Server Unit (SSU) shall host the lighting control system database for all the lighting control devices. Server shall have the ability to:
 - a. Remotely access a system in order to change system settings or configuration;
 - b. Analyze system performance or energy data or generate system report;
 - c. Record energy consumption with average sampling every 5 minutes for unlimited duration;
 - d. Host the web interface required for the web enabled Personal Control Software or web based Central Control Software;
 - e. Optionally can reside on a client server (virtual server) thus eliminating the need for dedicated physical hardware if desired;
 - f. Interconnect with ECUs over standard Ethernet connection that employs TCP/IP protocol;
 - 2. Hardware based servers shall at minimum meet the specifications listed below:
 - 3. Specifications:
 - a. Mechanical Specifications:
 - 1. Shall mount in a standard 19 inch rack (1U width), or alternatively where no rack is shown, via an individual wall mount.
 - b. Electrical Specifications:
 - 1. Power Supply: 120V/60Hz/200W. Provide dedicated 120V receptacle fed from a dedicated normal power circuit.
 - c. Regulatory:
 - 1. FCC (US only) Class A.
 - 2. DOC (Canada) Class A.
 - 3. UL 60950.
 - 4. CAN/CSA-C22.2 No. 60950.

P. Communication Wire

- 1. Wiring: 18 AWG, pre-fabricated, polarity independent quick connecting wiring. The system shall have the capability to use both Class 1 and Class 2 wiring. The maximum connected length of wiring shall be 2500 ft. per channel.
- 2. Field Bus: Integrates peripheral devices such as 0-10V ballasts and/or 0-10V LED drivers, occupancy sensors, photo sensors, relay-based controls, power packs and low voltage wall controls into a complete, networked programmable lighting control system. Provides power to photo sensors, PIR occupancy sensors and dual-technology occupancy sensors. Devices may be connected randomly on the network and special termination of each network channel is not required.

3. Field bus shall at minimum meet the specifications listed below:

- a. Specifications:
 - 1. Class 2 communication bus.
 - 2. Prefabricated one ft., five ft., ten ft., 15 ft., 20 ft., 25 ft. and 50 ft. lengths.
 - 3. Daisy chain topology
 - 4. Prefabricated with 2-wire connectors.
 - 5. Flame rated jacket for plenum use NFPA 262 (UL: FT6, CSA: CMP).
 - 6. Power Supply: 12 VDC (up to 24 VDC) to sensors.

Q. Conductors and Cables

- 1. Class 2 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 18 AWG.

R. Lighting Control Panels

- 1. General
 - a. Addressing: All lighting control panels shall be individually addressable via Central Control Software.
 - b. Communication: All lighting control panels shall communicate via the same prefabricated, quick connecting low voltage wiring as all other devices.
 - c. Wiring: Relay control panels shall be interconnected on the same field bus as all other system components.

S. Lighting Control System Software

- 1. Personal Control Software: Enables individuals in a building to control lighting levels in their workspace from their own desktop PC. User can control the light level of each fixture in their workspace or can control all of the fixtures together as a group. Preset lighting scenes may be stored, recalled and modified. This software shall have the capability of acting as a "virtual occupancy sensor" for the system by detecting keyboard or mouse activity on each PC for incremental occupancy status data.
 - a. Technical Information:
 - 1. TCP/IP network traffic < 2kb/s.
- 2. Web based Personal Control Software: This feature allows individuals to control lighting levels in their workspace without the requirement for installation of software on client PCs. Individuals can access the interface through the web browser and perform individual fixture dimming control, on/off switching, modify and save preset lighting scenes.
- 3. Technical Information: Adobe Flash ® based user interface.
 - a. System Requirements:
 - 1. Internet web browser with Flash® Player 8 or later.
 - 2. Internet/Intranet connection.
 - 3. SSU enabled and configured to host dynamic website.
 - 4. Network connection with access to a network-enabled CU.

4. Web based Central Control Software: Central control software application is used to commission, configure and manage the system. Every system parameter in a building (or campus of buildings) is configured for each individual user or space and baseline settings are established for each of the following (depending on the basis of design) system features:
 - a. Daylight harvesting.
 - b. Occupancy control.
 - c. Smart time scheduling.
 - d. Task tuning.
 - e. Personal control.
 - f. Load shedding.
 1. Software utilizes a web based interface that permits a user to easily navigate between zones, floors or different buildings and allows a user to zoom in or zoom out of specific areas of a building. Both 3-dimensional and 2-dimensional multi-floor views shall be available. System features such as creation of zone hierarchies, overlapping and support zone definitions, user access rights, timeout settings for occupancy sensors, calibration of light levels for daylight harvesting and the configuration of multiple time schedule profiles shall be available. A web based Graphical User Interface (GUI) application integral to the system will be used to develop a dynamic, real-time, point-and-click graphic of each floor plan with representation of all light fixtures, lighting controllers, sensors, and switches. A central system server will be provided to support system data base and enterprise control management.
5. System Requirements:
 - a. Software must be able to run on a Windows Operating systems (Windows XP or newer) and also on Apple Mac Intel PCs (Mac OS 10.4 or newer).
 - b. Must support all common browsers, i.e.,
 1. Internet Explorer 6.0 or later
 2. Mozilla Firefox 3.0 or later
 3. Safari
 4. Google Chrome
 - c. Network connection with access to network-enabled CUs.
 - d. Color gradient ("weather map" type) data view (see below for an example) shall be available to display the following criteria:
 1. Current energy consumption
 2. Current energy savings
 3. Current fixture brightness
 4. Current fixture status
 5. Current occupancy data
 6. Current load shedding status
 7. Other custom modes that may be specified elsewhere

T. Photo Sensor:

Photo sensors shall at minimum meet the specifications listed below:

1. General Specifications:
 - a. Shall be Class 2, low voltage.
 - b. Ambient light sensor designed to interface directly with the analog input of the Lighting Control System.
 - c. Sensor shall supply an analog signal to the ALCS proportional to the light measured.

- d. Sensor output shall provide for zero or offset based signal.
- e. Sensor shall be capable of a fully adjustable response in the range between 0 and 10,000 foot candles with a +/- 1 percent accuracy at 70 deg F.
- f. Input: 10VDC.
- g. Minimum Output: 0 VDC.
- h. Maximum Output: 10 VDC.
- i. Sensor housing shall be flame retardant and meet UL 94 HB standards.
- j. Operating Temp: -10 deg C to 60 deg C.
- k. The sensitivity adjustments shall be at sensor body, and outside of the sensor's viewing angle.
- l. The sensor housing shall be flame retardant and meet UL 94HB standards

2. Interior:

- a. Indoor sensors shall have a Fresnel lens, with a 60 degree cone of response. The indoor sensor range shall be between 0 and 750 FC.

3. Exterior:

- a. Outdoor models shall have a hood over the aperture to shield the sensor from direct sunlight. The outdoor sensor circuitry shall be completely encased in an optically clear epoxy resin. Outdoor sensors shall mount to a standard threaded 1/2 in. conduit or fit a 1/2 in. knockout. The Outdoor sensor range shall be between 0 and 750 FC.

4. Atrium:

- a. The Atrium sensors shall have a translucent dome with a 180 degree field of view. Atrium sensor shall mount to a standard treaded 1/2 in. conduit or fit a 1/2 in. knockout. Atrium sensor range shall be from 2 to 2,500 FC.

5. Skylight:

- a. The Skylight sensors shall have a translucent dome with a 180 degree field of view. Skylight sensor shall mount to a standard treaded 1/2 in. conduit or fit a 1/2 in. Skylight sensor range shall e between 10 and 7,500 FC.

U. Occupancy Sensors

1. Environmental:

Operating Temperature Range: 0°C to 40°C

- a. Relative Humidity: 0 percent to 95 percent non-condensing
- b. Ceiling Mount Occupancy/Vacancy Sensors
 - 1. Sensing mechanism:
 - 2. Dual technology (ultrasonic / passive infrared):
 - 3. Utilize multiple segmented lens, with internal grooves to eliminate dust and residue build-up.
 - 4. Utilize an operating frequency of 32kHz or 40kHz that shall be crystal controlled to operate within plus or minus 0.005 percent tolerance.
 - 5. Electrical: Rating: 12 VDC input voltage, up to 40 mA current draw.
 - 6. Sensors shall turn off or reduce lighting automatically after reasonable time delay when a room or area is vacated by the last person to occupy the space
 - 7. Sensor shall accommodate all conditions of space utilization and all irregular work hours and habits.

8. Sensors shall be UL listed.
9. Sensors shall be fully adaptive and adjust their sensitivity and timing to ensure optimal lighting control for any use of the space
10. Sensors shall have field adjustable controls for time delay and sensitivity to override any adaptive features. Sensor timeouts shall be configurable by System software.
11. Power failure memory:
12. Controls incorporate non-volatile memory. Should power be interrupted and subsequently restored, settings and learned parameters saved in protected memory shall not be lost.
13. Provide all necessary mounting hardware and instructions.
14. Sensors shall be Class 2 devices.
15. Indicate viewing directions on mounting bracket for all Ceiling mount sensors.
16. Provide customizable mask to block off unwanted viewing areas for all ceiling mounted sensors using infrared technology. Field prepare proper maskings for each space to eliminate unnecessary sensing beyond the space in which the sensor is located.
17. Provide an internal additional isolated relay with Normally Open, Normally Closed and Common outputs for use with HVAC control, Data Logging and other control options.

V. Power Packs

1. General:

- a. Power pack shall be a self-contained transformer and relay module.
- b. The internal relay shall control up to 20A for 120, 230, 277VAC or 347VAC ballast loads and 120VAC incandescent loads.
- c. Power packs shall provide a 24 VDC, 150 mA output.
- d. Power packs shall be capable of parallel wiring without regard to AC phases on primary.
- e. Power pack can be used as a standalone, low voltage switch, or can be wired to sensor for auto control.
- f. Construction shall be high impact, UL rated plastic case
- g. Power pack shall be UL/CUL Listed, FCC Certified, UL 2043 plenum rated and meets ASHRAE 90.1 requirements
- h. To ensure quality and reliability, power and auxiliary relay packs shall be manufactured by an ISO 9002 certified manufacturing facility and shall have a defect rate of less than 1/3 of 1 percent.
- i. Shall at minimum meet the following environmental specifications:
 1. Operating Temperature Range: 0 deg. C to 40 deg. C
 2. Relative Humidity: 0 percent to 95 percent non-condensing

W. Examination

1. Site Verification: Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instructions.
2. Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

X. Installation

1. The Electrical Sub-contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Sub-contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown on the plans (including but not limited to System Field Devices, 0-10V dimming ballasts, fixed output ballasts, 0-10V LED drivers and communication wire). The Electrical Sub-contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.
2. Power: The contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.
3. Related Product Installation: Refer to other sections listed in Related Sections for related products' installation.

Y. Sensor Installation

1. Adjust sensitivity to cover area installed
2. Set time delay on occupancy sensors that are connected to the lighting control system to the minimum. Time delays shall be controlled via Central Control Software.
3. Sensor shall be powered through Input Module. No external power packs shall be used for powering sensors.
4. Install occupancy sensors on vibration free stable surface.
5. Install atrium and skylight light sensor facing toward window or skylight.
6. Install interior light sensor in ceiling facing the floor.

Z. Wiring Installation

1. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 3/4 inch.
2. Wiring within Enclosures: Comply with NEC & CEC. Separate power-limited and non power-limited conductors according to conductor manufacturer's written instructions.
3. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
4. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

AA. Software Installation

1. Install and program software with initial settings of adjustable values. Make backup copies of software and user-supplied values. Provide current site licenses for software.

BB. Field Quality Control

1. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
2. Perform the following field tests and inspections with the assistance of a factory-authorized service representative:
 - a. Operational Test: After installing lighting controllers and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.

- b. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Lighting control devices will be considered defective if they do not pass tests and inspections.
4. Prepare test and inspection reports.

CC.Commissioning Requirements

1. Commissioning: The manufacturer shall supply factory trained representatives for a minimum of 24 hours to commission the lighting control system. Manufacturer shall start up all lighting control equipment and verify that it meets the requirements of this specification.
2. Training: As part of the standard commissioning process, the manufacturer shall train the owner's representatives in the operation of the system to a maximum of 4 hours per building. Manufacturer shall also provide owner's representatives with system operating manuals together with a system training video.
3. Technical Support: The manufacturer shall supply 24/7 technical telephone support to the client. If the manufacturer does not provide 24/7 support, they must provide a list of contacts (names and cell phone numbers) in the event of a system failure during non-business hours.
4. Replacement components: The manufacturer shall be able to ship replacement parts within 24 hours for any component that fails during the warranty period.
5. Extended Service Coverage: Maintenance agreements shall be available from the manufacturer to provide service for the system both during and after the warranty period.
6. Requests for commissioning shall be at least two weeks prior to date desired for commissioning.
7. Electrical Sub-contractor shall perform functional testing under the guidance of commissioning agent and in accordance with factory specified guidelines.
8. Factory appointed personnel shall provide commissioning services for the lighting control system.
 - a. Verify proper communication over control wires.
 - b. Map addresses of occupancy sensors (via Input Modules), light level sensors (via Input Modules), lighting controllers to control units and system server.
 - c. Map all system data to appropriate BACnet points and assist BMS sub-sub-contractor in programming all points into the BMS system and verifying their proper functionality.
 - d. Verify communication to control units and system server.
 - e. Configure occupancy sensors, light level sensors, lighting controllers and other contacts to suit design specifications.
 - f. Configure and program lighting control sequences as described on contract documents.
 - g. Demonstrate to Owner and Engineer proper operation of all areas the system is installed.

DD.Testing

1. Upon completion of all line, load and interconnection wiring, and after all fixtures are installed and lamped, a qualified factory representative shall completely configure and test the system.
2. At the time of checkout and testing, the owner's representative shall be thoroughly instructed in the proper operation of the system.

EE. Demonstration

1. Engage a factory-authorized service representative to train Owner's maintenance personnel and building supervisors to adjust, operate, utilize, troubleshoot, conduct software installation, and maintain lighting controls and software training for PC-based control systems. Provide up to eight hours of on-site training with audio and video recorded. Provide a hard copy of manuals, instructional videos, and recorded training session(s) on CD or DVD.

2.23 FIRESTOP SYSTEMS

- A. General: Provide firestopping at all fire-rated construction where penetrated by the Work of this Section.
- B. Refer to Section 07 84 00 – Fire Stopping, for all product requirements for maintaining integrity of fire-rated construction at penetrations.

2.24 EMERGENCY RESPONDER RADIO SIGNAL AMPLIFICATION SYSTEM (BDA SYSTEM)

A. General

1. Provide an in-building radio signal amplification system to provide complete coverage in the building for the public safety agencies as required by the local fire department and other agencies and authorities having jurisdiction. System users shall receive and transmit radio broadcasts from their portable radio units within the building. This shall be accomplished utilizing the following components:
 - a. Bi-Directional Amplifiers (Signal Boosters)
 - b. Plenum rated Coaxial Cable
 - c. Antennas
 - d. Cable taps
 - e. Connectors
 - f. Power dividers
 - g. Other components and interconnecting circuitry as required
2. The system shall comply with the requirements of the Massachusetts State Building Code (780 CMR), 8th Edition as amended on April 11, 2014 and NFPA-72, 2010 edition, as referenced.
3. The entire system shall meet with approval of the Fire Department, the Building Department and all other agencies and authorities having jurisdiction (AHJ).
4. The work in this section shall include the responsibility for all fillings with the AHJ, as required. This responsibility shall include furnishing of floor plans, descriptive notes and/or specifications, wiring diagrams, certifications, shop drawings and amendment forms.
5. Early completion of the in-building radio communication enhancement system will be required as to permit a Certificate of Occupancy to be obtained in a timely manner
6. Any permits necessary for the installation of the work shall be obtained prior to the commencement of the work. All permit costs and inspection fees shall be included as the part of the required work.

B. Design requirements

1. In-building radio signal amplification systems for emergency responders are an integral component of the life safety equipment of a building or structure. The primary function is to provide reliable emergency responder communications at the required signal strength within the specified areas.
2. Critical Areas such as emergency command center, fire pump room, exit stairs, exit passageways, elevator lobbies, standpipe cabinets, sprinkler sectional valve locations and similar critical areas shall be provided with 100% floor area radio coverage.
3. General building areas shall be provided with 95% radio coverage, or as specified by AHJ.
4. The In-building radio signal amplification systems must provide the following signal strengths:
 - a. Downlink - Minimum signal strength of -95 dBm throughout the coverage area.
 - b. Uplink - Minimum signal strength of -95 dBm received at the AHJ Radio System.
5. The system shall be complete with all components and wiring required for compliance with all applicable codes and regulations, and for its operations described hereinafter.
6. EC shall sub-contract an approved manufacturer or a qualified and approved radio systems vendor to supply, test and determine locations of components which are required for proper operation as well as to supply, deploy, test and certify the performance of the complete system. Vendor qualifications and must also be acceptable to the AHJ.
7. All installation and testing personnel shall be certified and authorized by the signal booster manufacturer in the installation and operation of their equipment. Personnel qualifications must also be acceptable to the AHJ.
8. The system design is based on the RSI branded line of Public Safety NFPA-72 and FCC compliant Signal Boosters as manufactured by Radio Solutions, Inc. to establish standards of quality for materials and performance. The naming of a specific manufacturer or a catalog number does not waiver any requirement or performance of individual components described in the specifications.
9. Assembly and installation of all components of the Emergency Responder Radio Communication Enhancement System shall comply with all applicable sections of the National Electrical Code.
10. Survivability from attack by fire shall meet NFPA 72, National Fire Alarm and Signaling Code, 2010 edition
11. The system must comply with all applicable sections of the FCC rules. Signal booster shall have FCC certification prior to installation.
12. Antenna isolation shall be maintained between the donor antenna and all inside antennas to a minimum of 20dB under all operating and environmental conditions.

C. Technical Specifications and Performance Requirements

1. The system specified is based upon RSI branded line of Public Safety NFPA-72 compliant signal boosters, manufactured and integrated by Radio Solutions, Inc. Provide RSI or equal.
2. The signal booster shall be either a Class B or a Class A Public Safety type as designated by the FCC and as required by the AHJ.
3. The secondary power supplies, battery chargers and system monitoring shall be fully compliant with NFPA-72, 2010 edition. The signal booster shall have both the primary and the secondary power supplies fully enclosed in a sealed, non-vented NEMA-4 enclosure.
4. All signal boosters and other active system components must have FCC certification prior to installation. The equipment FCC ID must be shown on the product brochures and technical submittals. The ID must also be displayed on the product as required by the FCC.
5. Equipment installation must be done in accordance with the OEM (original equipment manufacturer) specifications. External filters, attachments or other non-approved aftermarket modifications of the original equipment shall not be accepted.
6. The signal booster shall be set and tuned by the equipment manufacturer to pass all frequencies specified by the local fire department.
7. To reduce the possibility of unwanted interference affecting the operation of the system, signal boosters shall be of a band-selective or channel-selective type with a maximum 200KHz ($F_c \pm 100\text{KHz}$) 3dB channel bandwidth. Wide-band, non-selective signal boosters shall not be accepted unless it is required to cover multiple consecutive channels within the same band, or if specified by the AHJ.
8. Signal Boosters shall have oscillation prevention circuitry to protect the public safety radio system in case of signal booster malfunction.
9. Signal Boosters shall have a minimum of 80dB gain. The gain shall be adjustable in a minimum of 25dB range. System gain shall be set and documented at the time of the final system test.
10. Maximum Propagation delay of the signal booster system shall be 14 μs (microseconds) or as specified by AHJ.
11. The signal booster shall include built-in automatic alarming of malfunctions of the signal booster and battery system as per NFPA 72, 2010 Edition, Sections 24.5.2.6.1, and 24.5.2.6.2. Aftermarket equipment add-ons and modifications to comply with this specification will not be accepted.
12. A dedicated monitoring panel shall be provided within the emergency command center or other location as designated by AHJ to annunciate the status of all signal booster locations. The monitoring panel shall provide visual and labeled indication of the following for each signal booster:
 - a. Normal AC power
 - b. Signal booster trouble
 - c. Loss of normal AC power

- d. Failure of battery charger
- e. Low battery capacity

13. The system installation vendor shall verify the system monitoring requirements with the AHJ prior to system installation. System monitoring shall be fully compliant with the AHJ requirements.
14. All signal booster components shall be contained in a NEMA4 rated waterproof cabinet. Signal booster and battery backup enclosures shall be painted red with signage in bright yellow or as required by AHJ.

D. Installation Requirements

1. Assembly and installation of all components of the Emergency Responder Communication Enhancement System shall comply with all applicable sections of the National Electrical Code, NFPA-70 and the National Fire Alarm and Signaling Code, NFPA-72, current enforceable editions.
2. At least 2 independent and reliable power supplies shall be provided as specified in sections 3 and 4 below.
3. The primary power source shall be supplied from a dedicated twenty (20) ampere branch circuit and comply with NFPA-70 National Electrical Code, and NFPA 72, National Fire Alarm and Signaling Code, 2010 edition
4. The emergency responder radio coverage enhancement system shall be equipped with a secondary source of power. The secondary source of power shall be a battery system with a dedicated battery charger powered by a separate, dedicated twenty (20) ampere branch circuit. The secondary power supply shall supply power automatically when the primary power source is lost. The secondary source of power shall be capable of powering the emergency responder radio coverage enhancement system for a minimum period of 24 hours. The battery system shall automatically charge in the presence of external power input. Battery charger and all other electronic components must be fully enclosed in a non-vented NEMA-4 rated enclosure. Batteries shall be enclosed in a separate, vented NEMA rated enclosure.
5. The signal booster shall be designed to allow continued operation in adverse environmental conditions, such as high temperatures in the event heat from a nearby fire, water spray, voltage fluctuations or other abnormal conditions that may occur during an emergency. Circuits that intentionally disable the signal booster in such situations (i.e. under/over voltage, over/under current, over/under temperature, etc.) are not acceptable, unless required for FCC regulatory or safety compliance. It is the purpose of this specification to assure the maximum possible level of communications to public safety personnel depending upon the signal booster, even to the extent of damaging the signal booster, as long as some communications benefit can be provided during the emergency.
6. External UPS (Uninterruptable Power Supplies) are not acceptable
7. The power supply system design shall be such that neither the failure of the normal power source, the transfer to an emergency source, nor the re-transfer to the normal source shall cause an interruption or change in system status.
8. The amplifier shall be housed in a 2-hour fire rated room or other suitable space as approved by the Engineer or Architect, or where specifically shown on the drawing.

9. Radiating cable, if used, shall be run without conduit. All other cable can be run in conduit if required for mechanical protection of the cable, or where specified by the electrical engineer.
10. RF Coaxial Cable shall be a fire-resistant, low-smoke type, U.L. classified as plenum. The classification shall be clearly marked on the outer surface of the cable regular intervals.

E. Acceptance and Test Procedures

1. Acceptance testing for an in-building radio system is required upon completion of installation.
2. The coverage testing shall be done in accordance with NFPA 72, National Fire Alarm and Signaling Code, 2010 edition, and as required by the local AHJ.
All tests shall be conducted, documented, and signed by a person in possession of a current FCC General Radio Operator License.
3. All test records along with system diagrams, equipment specifications, user manuals, RF link budget calculations, battery backup calculation and other design data shall be submitted upon completion of the project.

PART 3 EXECUTION

3.1 WORK COORDINATION AND JOB OPERATIONS

- A. Equipment shall not be installed in congested and possible problem areas without first coordinating installation of same with other trades. Relocate electrical equipment installed in congested or problem areas should it interfere with the proper installation of equipment to be installed by other trades.
- B. Particular attention shall be directed to coordination of lighting fixtures and other electrically operated equipment requiring access which is to be installed in ceiling areas. Coordinate with other trades, the elevations of equipment in hung ceiling areas to insure adequate space for installation of recessed fixtures before said equipment is installed. Conflicts in mounting heights and clearances above hung ceilings for installation of recessed lighting fixtures or other electrically operated equipment requiring access shall be brought to the attention of Architect for a decision prior to equipment installation.
- C. Furnish to General Contractor and other subcontractors information relative to portions of electrical installation that will affect other trades sufficiently in advance so that they may plan their work and installation.
- D. Obtain from other trades information relative to electrical work which he, the Electrical Subcontractor, is to execute in conjunction with installation of other trades' equipment.
- E. Lighting fixtures in mechanical spaces or utility/storage rooms shall only be installed after all mechanical equipment is in place.

3.2 PLANS AND SPECIFICATIONS

A. Plans:

1. Drawings showing layout of electrical systems indicate approximate location of raceways, outlets, and apparatus. Runs of feeders and branch circuits are schematic and are not intended to show exact routing. Final determination as to routing shall be governed by structural conditions and as indicated on the approved coordination drawings.

B. Specifications:

1. Specifications supplement drawings and provide specifics pertaining to methods and material to be used.

3.3 IDENTIFICATION

A. Equipment shall be marked for ease of identification as follows.

1. Provide screw-on nameplates on panelboards, F.A. terminal cabinets, starters, and disconnect switches. Nameplates to be of black phenolic with white engraving. For starters and disconnect switches lettering shall be minimum of 1/4 in. high. Nameplates on panelboards shall have the following information.
 - a. Line 1 - Panel designation in 1/2 in. high letters.
 - b. Line 2 - Utilization voltage in 3/8 in. high letters.
 - c. Line 3 - Distribution source "Fed from " in 1/4 in. high letters.
2. Neatly typed directory cards listing circuit designations shall be fastened inside the cover of panelboards. Spare circuits shall be penciled.
3. Color coding schedules. If there is more than a single system voltage, different voltages shall have separate color codes, as previously specified. A copy of the color code schedule shall be affixed to each secondary switchboard and distribution panel and shall be of the phenolic nameplate type as previously specified. A typewritten color code schedule shall also be affixed, under plastic, inside each panelboard door.
4. Outlet boxes both concealed and exposed shall be identified as to panel origination and circuit number by means of fibre pen on the inside of coverplate.
5. Special system outlet boxes concealed above hung ceilings shall be identified as to system by spray painting during roughing. The following systems shall be identified.
 - a. Fire Alarm - red.
 - b. Normal/Emergency - yellow.
 - c. Security - blue.
 - d. Sound - green.
6. Wiring device plates on devices connected to normal-emergency circuits shall be red in color.
7. All conductors in boxes larger than standard outlet boxes, in all wireways, trench headers shall be grouped logically and be identified.
8. Grounding conductors and neutrals shall be labeled in panels, wireways as to circuits associated with.

3.4 PROTECTION AND CLEANUP

A. Protection:

1. Materials and equipment shall be suitably stored and protected from weather.
2. During progress of work, pipe and equipment openings shall be temporarily closed so as to prevent obstruction and damage.
3. Be responsible for maintenance and protection of material and equipment until final acceptance.

B. Cleanup:

1. Keep job site free from accumulation of waste material and rubbish. Remove all rubbish, construction equipment, and surplus materials from site and leave premises in a clean condition.
2. At completion, equipment with factory finished surfaces shall be cleaned and damaged spots touched up with the same type paint applied at factory.
3. Particular attention is called to Section 110-12(c) of the NEC, which requires that internal parts of electrical equipment not be contaminated by construction operations.

3.5 PORTABLE OR DETACHABLE PARTS

- #### A.
- Retain possession of and be responsible for spare parts, portable and detachable parts, and other removable portions of installation including fuses, keys, locks, blocking clips, inserts, lamps, instructions, drawings, and other devices or materials that are relative to and necessary for proper operation and maintenance of the system until final acceptance, at which time such parts shall be installed or turned over to the Owner, as the case may be.

3.6 SAFETY PRECAUTIONS

- #### A.
- Provide proper guards, signage, and other necessary construction required for prevention of accidents and to insure safety of life and property. Remove any temporary safety precautions at completion.

3.7 MOUNTING HEIGHTS

- #### A.
- All electrical equipment shall be mounted at the following heights unless noted or detailed otherwise on drawings. Notes on architectural drawings shall supersede those noted below or detailed on the electrical drawings. If mounting height of an electrical component is questionable, obtain clarification from Architect before installation.
1. Duplex convenience outlets, microphone outlets, and telephone outlets - 18 inches.
 2. Light switches, pushbutton stations, HOA switches, and all other toggle or control switches for the operation of heating, ventilating, and air conditioning, plumbing, and general service - 48 inches.
 3. Clock outlets - 84 inches.
 4. Fire alarm pull stations - 48 inches.
 5. Fire alarm audio visual signals - 80 inches or 6 inches below ceiling, whichever is lower.
 6. Panelboards for lighting, power, telephone, and other auxiliary systems - 78 in. to top.
 7. Equipment located in lobbies shall be located as detailed on architectural drawings or as directed by Architect.
 8. All receptacles, light switches, fire alarm signals, and clocks sharing a common location shall be symmetrically arranged.
 9. Exterior and interior wall brackets shall be as detailed on architectural drawings.

- B. Mounting heights given are from finished floor to centerline. In the case of a raised floor, surface of raised floor is the finished floor.

3.8 WORKMANSHIP AND INSTALLATION METHODS

- A. Work shall be installed in first-class manner consistent with best current trade practices. Equipment shall be securely installed plumb and/or level. Flush-mounted outlet boxes shall have front edge flush with finished wall surface. No electrical equipment shall be supported by work of other trades. Cable systems shall be supported and not draped over ducts and piping or laid on ceiling suspension members. Lighting fixtures shall be installed to agree with Architects reflected ceiling plans.
- B. Supports:
1. Support work in accordance with best industry practice and by use of standard fittings.
 2. In general, walls and partitions will not be suitable for supporting weight of panelboards, dry type transformers and the like. Provide supporting frames or racks extending from floor slab to structure above.
 3. Provide supporting frames or racks for equipment, intended for vertical surface mounting in free standing position where no walls exist.
 4. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of equipment.
 5. Provide 3/4 in. thick painted plywood mounting surfaces in all electric and telephone areas and for all equipment on free standing racks. All plywood shall be fire retardant and painted both sides and edges with two coats of white paint.
 6. No work for exposed installations in damp locations shall be mounted directly on any building surface. In such locations, flat bar members or spacers shall be used to create a minimum of 1/4 in. air space between building surfaces and work.
 7. Nothing (including outlet, pull and junction boxes and fittings) shall depend on electric raceways or cables for support. All outlet, pull, and junction boxes shall be independently supported.
 8. Nothing shall rest on, or depend for support on, suspended ceiling or its mounting members.
 9. Support surface or pendant mounted lighting fixtures:
 - a. From outlet box by means of an interposed metal strap, where weight is less than five pounds.
 - b. From outlet box by means of a hickey or other direct threaded connection, where weight is from five to fifty pounds.
 - c. Directly from structural slab, deck or framing member, where weight exceeds fifty pounds.
 - d. Pendant lighting fixtures shall be supported by threaded rods in non-public areas and by manufacturer's standard tube hangers with swivel aligner and canopy in public areas. Provide non-standard pendant lengths where required to mount fixtures at elevations either called for on drawings or as shown in architectural elevations.
 10. Support recessed lighting fixtures directly from structural slabs, decks or framing members, by means of jack chain or air craft cable, one at each end of fixture at opposite corners.
 11. Where support members must of necessity penetrate air ducts, provide airtight sealing provisions which allow for a relative movement between the support members and the duct walls.
 12. Provide channel sills or skids for leveling and support of all floor mounted electrical equipment.

13. Where permitted loading is exceeded by direct application of electrical equipment to a slab or deck, provide proper dunnage to distribute the weight in a safe manner.
14. Support metallic raceways by either running within steel frame or hung from the building frame. Anything hung from building frame shall be attached with metallic fasteners.

C. Fastenings:

1. Fasten electric work to building structure in accordance with the best industry practice.
2. Where weight applied to attachment points is 100 pounds or less, fasten to building elements of:
 - a. Wood -- with wood screws.
 - b. Concrete and solid masonry -- with bolts and expansion shields.
 - c. Hollow construction -- with toggle bolts.
 - d. Solid metal -- with machine screws in tapped holes or with welded studs.
3. Where weight applied to attachment points exceeds 100 pounds, fasten as follows:
 - a. At field poured concrete slabs, provide inserts with 18 in. minimum length slip-through steel rods, set transverse to reinforcing steel.
 - b. Where building is steel framed, utilize suitable auxiliary channel or angle iron bridging between structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
4. Floor mounted equipment shall not be held in place solely by its own dead weight. Provide floor anchor fastenings. Floor mounted equipment over 72 inches in height shall also be braced to nearest wall or overhead structural elements.
5. For items which are shown as being mounted at locations where fastenings to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging to building structural elements.
6. Fastenings for metallic raceways using the fastening as support shall be of the metallic type. Fastenings to hold raceways or cables in place may be via tywraps.

D. General Raceway Installation:

1. Install the various types of raceways in permitted locations as previously specified. All raceways shall be run concealed. Consult Architect for instruction for raceways which must be exposed in public spaces.
2. Raceways for normal-emergency or emergency only wiring cannot contain other conductors.
3. Raceways shall be properly aligned, grouped, and supported in accordance with code. Exposed raceways shall be installed at right angles to or parallel with structural members. Concealed raceways may take most direct route between outlets.
4. Raceways run on trapeze hangers shall be secured to the trapeze.
5. Raceways shall be continuous and shall enter and be secured to all boxes in such a manner that each system shall be electrically continuous from service to all outlets. Provide grounding bushings and bonding jumpers where raceways attach to painted enclosures or terminate below equipment.
6. Where raceways enter boxes, cabinets, tap boxes, other than those having threaded hubs, a standard locknut shall be used on the outside and locknut and bushing on the inside.
7. Where raceways terminate below equipment and there is no direct metal to metal continuity, provide grounding bushings on raceways and interconnect with equipment grounding conductor.

8. All empty raceways shall be provided with a pull wire.
9. All raceway sleeves, stub-ups, or stub-outs, where not connected to a box or cabinet, shall be terminated with a bushing.
10. All raceway joints shall be made up tight and no running threads will be permitted.
11. Where raceways are cut, the inside edge shall be reamed smooth to prevent injury to conductors.
12. All vertical raceways passing through floor slabs shall be supported.
13. Raceways shall not be installed in concrete slabs above grade or below waterproofed slabs.
14. Electric raceways and/or sleeves passing through floors or walls shall be of such size and in such location as not to impair strength of construction. Where raceways alter structural strength or the installation is questionable, the structural engineer shall be contacted for approval.
15. Raceways shall not run directly above or below heat producing apparatus such as boilers, nor shall raceways run parallel within 6 inches of heated pipes. Raceways crossing heated pipes shall maintain at least a 1 inch space from them.
16. Raceways shall be installed in such a manner as to prevent collection of trapped condensates, and all runs shall be arranged to drain.
17. Raceways passing between refrigerated and non-refrigerated spaces and those penetrating enclosures with air movement shall be provided with seals.
18. Raceways feeding fire and jockey pumps shall be rigid metal conduit either run below slab or inside two hour rated enclosure. Final connections to motors shall be liquidtight flexible conduit.
19. Where two alternate wiring methods interconnect such as EMT to flexible metal conduit, an outlet box shall be provided.
20. All empty raceways entering building and all sleeves or core drilled openings through floors shall be sealed.
21. Each exterior raceway or assembly in a ductbank shall be provided with continuous warning tape installed 12 inches above raceway or ductbank.
22. Underground rigid non-metallic raceways where allowed and run as a ductbank encased in concrete shall be installed with plastic spacers to ensure a separation of 3 inches between raceways. Top of ductbanks shall be 30 inches below grade, unless otherwise detailed.
23. Elbows and extensions of rigid non-metallic raceway systems which penetrate slabs shall be rigid or intermediate metal conduit.
24. Raceways used for transformer connections shall be flexible type and shall contain a grounding conductor.
25. Raceways entering building through foundation wall into a basement area shall be provided with wall entrance seals or with other acceptable waterproofing method.

E. General Outlet Box Installation:

1. Boxes shall be set flush with finish surface and provided with proper type extension rings or plaster covers. Thru the wall boxes are not permitted. Check device or fixture to be mounted to box to ensure box orientation is proper.
2. In addition to boxes shown, install additional boxes where needed to prevent damage to cables and wires during pulling-in operation.
3. Remove knockouts as needed and plug unused openings.
4. Where required for horizontal and vertical alignment of boxes in stud partitions, bar hangers spanning two studs shall be used. Device boxes for insertion type receptacles shall be provided with far side box supports where there are less than two entering nonflexible raceways and where bar hangers are not provided.
5. Boxes flush mounted in fire rated partitions and on opposite sides of the partition shall be separated by a distance of 24 inches in accordance with UL listing for the box.
6. Locations of outlets indicated on drawings are approximate. For items exposed to view, refer to architectural drawings and coordinate locations with masonry joints, panel joints, ceiling grids, structural members.

7. In case of conflict with standard mounting heights and device alignment, consult Architect prior to roughing.
8. Check all door swings on architectural drawings to ensure lighting switches are installed on strike side of door.
9. The right to make any reasonable change in location of outlets prior to roughing is reserved by Architect. Reasonable change shall be interpreted as movement within 10 ft. of location shown.
10. Obtain dimensioned plan from Architect for floor outlets.
11. Outlet boxes for use where surface metal raceways are allowed shall be of a type specifically designed to be used with such surface metal raceway systems.

F. Conductor Installation:

1. No conductors shall be pulled into individual raceways until such raceway system is complete and free of debris. No harmful lubricants shall be used to ease pulling.
2. All conductors shall be wired so that grounded conductor is unbroken; switches in all cases being connected in ungrounded conductor.
3. Connections throughout the entire job shall be made with solderless type devices of approved design satisfactory to Inspector of Wires.
4. All taps and splices shall be insulated equal to that of conductor insulation.
5. All conductors of each feeder in pull boxes shall be grouped, tied together, supported, and identified.
6. All conductors in panelboards and other wiring enclosures shall be neatly formed and grouped.
7. All conductors of emergency only and/or normal/emergency shall be run in separate raceway systems to final outlet box.
8. Provide support for conductors in vertical raceways in accordance with Article 300-19.
9. Strip insulation from conductors with approved tools and only of sufficient length for proper termination. Cutting of conductor stranding is unacceptable.
10. Taps from paralleled conductors shall be of a type which tap each conductor, such as ILSCO PTA series.
11. Grounding conductors are to be identified as to associated power circuits.

G. Type MC Cable Installation:

1. Where cable is permitted under the products section, the installation of same shall be done in accordance with code and the following:
 - a. Cable shall be supported in accordance with code. Tie wire is not an acceptable means of support. Horizontally run cable supports such as Caddy WMX-6, and clamps on vertical runs such as Caddy CJ6 shall be used. Where cables are supported by the structure and only need securing in place, then ty-raps will also be acceptable. Ty-raps are not acceptable as a means of support. All fittings, hangers, and clamps for support and termination of cables shall be of types specifically designed for use with cable, i.e., romex connectors not acceptable.
 - b. Armor of cable shall be removed with rotary cutter device equal to roto-split by Seatek Co., not with hacksaw.
 - c. Use split insuliner sleeves at terminations.
 - d. Any cable system used in conjunction with isolated ground circuits shall have both an isolated ground conductor and an equipment ground conductor.

H. Stranded Conductor Installation:

1. If Contractor selects stranded conductors for # 10 AWG and smaller, terminate such conductors as follows:
 - a. No stranded conductor may be terminated under a screwhead. Provide insulated terminal lugs for all screw connections equal to Thomas & Betts STA-KON type RC with forked tongue and turned up toes. Installation of lugs shall be done with compression tool such as T&B WT-145C which prevents opening of tool until full compression action is completed.
 - b. Backwired wiring devices shall be of clamp type; screw tightened. Force fit connections not allowed.
2. Stranded conductors will not be allowed for fire alarm work.

I. Accessibility:

1. Electrical equipment requiring service or manual operation shall be accessible.
2. Work switches for equipment within accessible hung ceiling spaces, such as fan powered terminal boxes, shall be located at terminal box, and so located so as to be accessible.

J. Vibration Elimination:

1. All equipment connections to rotating equipment or equipment capable of vibration shall be made up by flexible raceways.

K. Wiring Device Gaskets:

1. Provide wiring device gaskets at coverplates where device is mounted in wall separating conditioned and non-conditioned spaces.

3.9 FEEDER CIRCUITS

- A. Provide feeders as called for on the drawings.
- B. Feeders shall be defined as any circuit originating from the main building switchboard and/or distribution panels.
- C. All feeder conductors shall be continuous from origin to panel or equipment termination without splicing.
- D. All feeders shall be conductors pulled into raceways. Cable systems are not allowed for feeders unless specifically indicated.

3.10 BRANCH CIRCUITS

- A. Provide all branch circuit wiring and outlets for a complete and operating system. The system shall consist of insulated conductors connected to the panelboards and run in raceways or as cable systems if permitted under products section, to the final outlet and shall include outlet boxes, supports, fittings, receptacles, plates, fuses.

- B. Physical arrangement of branch circuit wiring shall correspond to circuit numbering on drawings. Combining of circuits and raceways will be allowed up to a 3 phase, 4 wire circuit in a single raceway, unless shared neutrals are not allowed by other sections of this Division, or are indicated as separate neutrals on the drawings. Any combination of homeruns such as this, however, shall be indicated on record drawings. When a common grounded conductor is used for more than one circuit, the arrangement shall be such that a receptacle, fixture, or other device may be removed or disconnected without disconnecting the grounded conductor for other circuits. Ground fault circuit breakers and isolated ground outlets shall be wired with separate neutrals and separate grounding conductors per circuit. A consistent phase orientation shall be adhered to throughout project at terminations.
- C. Circuits feeding three phase equipment shall not be combined into common raceways, unless specifically indicated.
- D. All wiring in panelboards and cabinets shall be neatly formed and grouped.

3.11 WATERPROOFING

- A. Waterproof all openings in slabs and walls.

3.12 CUTTING AND PATCHING

- A. All cutting of surfaces, including core drilling of walls and slabs up to 12 in., shall be done by Electrical contractor. Openings through new wall surfaces will be provided by General Conditions if Electrical contractor gives suitable notice as erection of surface proceeds. If suitable notice is not given, Electrical contractor shall then be responsible for cost of corrective work required.
- B. Patching will be provided by the trade responsible for the surface to be patched.

3.13 MECHANICAL SYSTEM COORDINATION

- A. The Mechanical System contractor will be providing various items of mechanical services equipment and control apparatus. In general, Electrical contractor shall connect up power wiring to this equipment.
- B. The Mechanical and Electrical contractor shall closely coordinate their respective portions of work.
- C. If, due to local regulations, electric heating equipment furnished by the mechanical systems subcontractor is required to be installed by licensed electricians in order to allow connection by Electrical contractor's licensed electricians, it will then be Mechanical contractor's responsibility to engage and pay for services of such licensed electricians.
- D. Power wiring to be provided by Electrical contractor is the line voltage power supply wiring. Control wiring is responsibility of Mechanical System contractor unless specifically indicated on electrical drawings, or in this Division of the specifications. Temperature Control contractor shall refer to electrical drawings for location of all magnetic starters.
- E. 120 volt control wiring source to temperature control panel is the responsibility of Electrical contractor.

3.14 DISTRIBUTION EQUIPMENT TESTING

- A. All individual motor starters, main distribution panels, motor controls, VFD's, feeder conductors, and emergency systems shall be tested in accordance with the following. In general, all tests shall be done in accordance with the 1995 Acceptance Testing Specifications of the International Electrical Testing Association.
- B. The Testing Subcontractor may be an independent contractor or a manufacturer of the equipment, which is to be tested.
- C. Test report forms, delineating tests to be made, and method of recording same shall be submitted prior to commencing work. Test reports when submitted shall include interpretation of results and recommendation for any corrective work required.
- D. Main Distribution Panels:
 - 1. Visual Inspection:
 - a. Check for foreign material within bus enclosure.
 - b. Check for missing hardware.
 - c. Inspect entire assemblies for transit damage or factory defects.
 - d. Check for all bus dimensions and bracing per specifications.
 - e. Check ratings of current transformers and potential transformers.
 - f. Check ratings of all protective relays per drawings.
 - g. Physical Inspection:
 - h. Torque all bus hardware to proper tension.
 - i. Circuit breaker interlocks all work properly.
 - j. All doors and hinged panels open and close properly.
 - k. Relay blocking removed from all control and protective relays.
 - l. All circuit breakers operate, close and trip mechanically.
 - m. Torque all feeder conductors to terminal manufacturers' recommendations.
 - 2. Electrical Testing:
 - a. Breakers operated electrically trip and close from local and remote positions.
 - b. All circuit breakers calibrated to manufacturer's respective time current curves as specified.
 - 1. Long time pick-up amps.
 - 2. Long time delay tripping at 300 percent of current setting.
 - 3. Resets okay at 80 percent of pick-up value.
 - 4. Short time pick-up current.
 - 5. Short time delay trip time at 105 percent of setting.
 - 6. Instantaneous minimum pick-up current.
 - c. All protective relays calibrated to manufacturer's characteristic time curves for pick-up, drop-out, instantaneous and time delay.
 - d. All instruments calibrated for accuracy.
 - e. Protective relay schemes to be electrically tested by primary injection of current through current transformers and the tripping of associated circuit breakers.
 - f. Insulation resistance tests made on all circuit breakers, line to load breaker open, line to ground breaker closed, 3 poses tested individually. Switchgear bus to be tested phase to phase and phase to ground with Megohmmeter type instrument. Relays also to be insulation resistance tested.
- E. Magnetic Starters:
 - 1. Visual inspection to determine:
 - a. Shipping damage.

- b. Proper bussing and contactor sizes.
- c. Correct overload relay heater ratings. Any incorrectly sized overloads shall be replaced by the contractor who originally provided same.

2. Electrical Testing:

- a. Electrical operation of control relays, timing relay, and contactor coils.
- b. Insulation resistance test on all current carrying bus to ground and between phases.
- c. Calibration check of overload heater to ascertain tripping point and time delay at 300 percent of heater rating.

F. Conductors:

- 1. All secondary service conductors and all feeder conductors from switchboards and distribution panels shall be tested.
 - a. Visual and mechanical inspection
 - 1. Conductors to be inspected for physical damage and proper connection and sizing in accordance with single line diagram.
 - 2. Conductor connections shall be torque tested to manufacturer's recommended values.
 - b. Electrical Tests:
 - 1. Perform insulation resistance test on each conductor with respect to ground and adjacent conductor.
 - 2. Perform continuity test to insure proper conductor connection.

G. Emergency Systems:

- 1. Engine Generator - Prior to the emergency generator test specified under the emergency generator specification, the testing contractor shall perform the following:
 - a. Visual and Mechanical Inspection:
 - 1. Inspect for physical damage.
 - 2. Compare nameplate rating and connection with specifications and single line diagram.
 - 3. Inspect for proper anchorage and grounding. Verify engine cooling and fuel system integrity.
 - b. Electrical and Mechanical Tests:
 - 1. Perform a dielectric absorption test on generator winding with respect to ground. Determine polarization index.
 - 2. Perform phase rotation test to determine compatibility with load requirements.
 - 3. Test protective relay devices in accordance with applicable sections of these specifications.
 - 4. Perform dc over potential test between winding and ground.
- 2. Automatic Transfer Switches:
 - a. Visual and Mechanical Inspection:
 - 1. Inspect for physical damage.
 - 2. Verify that the short circuit withstand rating exceeds the available short circuit duty.
 - 3. Compare equipment nameplate information and connections with single line diagram and report any discrepancies.

4. Check switch to ensure positive interlock between normal and alternate sources. (Mechanical and Electrical).
 5. Check tightness of all control and power connections.
 6. Perform manual transfer operation.
 7. Ensure manual transfer warnings are attached and visible to operator.
- b. Electrical Tests:
1. Perform insulation resistance tests phase-to-phase and phase-to-ground with switch in both source positions.
 2. Measure contact resistance in normal and alternate source position.
 3. Set and calibrate in accordance with the project electrical engineer's specifications.
 - a. Voltage and frequency sensing relays.
 - b. All time delay relays.
 - c. Engine start and shutdown relay.
 4. Perform automatic transfer by tests.
 - a. Simulating loss of normal power.
 - b. Return to normal power.
 - c. Simulating loss of emergency power on return to normal.
 - d. Simulate all forms of single phase conditions.
 5. Monitor and verify correct operation and timing.
 - a. Normal voltage sensing relays.
 - b. Engine start sequence.
 - c. Time delay upon transfer.
 - d. Alternate voltage sensing relays.
 - e. Automatic transfer operation.
 - f. Interlocks and limit switch function.
 - g. Timing delay and retransfer upon normal power restoration.
 - h. Engine cool down and shutdown feature.

H. Grounding Grids or Electrodes: Measurement of resistance from ground grids or electrodes to earth to determine adequacy of grounding system in building and compliance with specifications and/or electrical code.

I. Settings of Adjustable Devices: Using the result of the fault current and coordination study specified hereinafter, the Testing Contractor shall set all adjustable devices.

3.15 FAULT CURRENT, ARC FLASH AND COORDINATION STUDY

- A. Employ the manufacturer of the secondary distribution equipment or an independent organization to perform a fault current, arc flash and coordination study to ensure a selectively coordinated system from the incoming mains to the branch circuit panelboards.
- B. The report shall be submitted in a standard format and shall include the fault current availability at various points in the distribution system, breaker coordination curves and recommended settings of all adjustable devices in the system.
- C. The study shall be submitted prior or concurrent with switchgear submittal.

3.16 INSTALLATION OF FIRESTOP SYSTEMS

- A. General: Install firestop systems at all fire-rated construction where penetrated by the Work of this Section.
- B. Refer to Section 07 84 00 – Fire Stopping, for all installation requirements for maintaining integrity of fire-rated construction at penetrations.

3.17 STORAGE AND INSTALLATION OF EQUIPMENT

- A. The electrical subcontractor shall store and install electrical equipment and wiring listed for dry locations only after the building is watertight.

END OF SECTION

SECTION 31 10 00

SITE PREPARATION

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT and GENERAL CONDITIONS and all Sections within DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. Provide all labor, materials, equipment, services and accessories necessary to furnish and install the work of this Section, complete and functional, as indicated in the Contract Documents and as specified herein.
- B. The principal work of this Section includes, but may not be limited to, the following:
 - 1. Clearing, grubbing, and disposing of vegetation, including bushes, trees, stumps, roots and debris within work limit lines.
 - 2. Stripping and storage of topsoil within the stockpile areas to be designated by the Architect or shown on the drawings.
 - 3. Protection of trees and other vegetation, stone walls, retaining walls and objects indicated on the drawings or designated by the Architect.
 - 4. Removal of existing pavements, curbs, sidewalks, steps, signage and posts, fencing and all other site improvements that interfere with construction as indicated on the drawings. Pavement shall be properly disposed of at an off-site landfill.
 - 5. Sawcutting of existing pavements, as required for the work and where indicated on the drawings
 - 6. Installation and relocation of construction fencing during construction phasing.
 - 7. Coordination of the disconnection and capping of utilities and/or removal or relocation of utilities and utility poles as required.
 - 8. Coordination of roadway and sidewalk closures and detours as well as furnishing of all police details, barriers, cones, etc. to safely complete work in roadway.

1.3 RELATED WORK

- A. Carefully examine all of the Contract Document for requirements which affect the work of this Section. Other specifications which directly relate to the work of this Section include, but are not limited to, the following:
 - 1. Section 312000 – EARTH MOVING
 - 2. Section 321216 – ASPHALT PAVING
 - 3. Section 321313 – CONCRETE PAVING
 - 4. Section 321600 - CURBS
 - 5. Section 329000 - LANDSCAPING
 - 6. Section 330000 - SITE UTILITIES

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.1 PERFORMANCE

- A. The Contractor shall accept the site as he finds it and shall remove all stumps, rocks, paving, improvements, and rubbish in the contract area. When the Contractor is ready to proceed with the clearing of trees from the site, he shall notify the Architect who will clearly identify in the field all trees to be saved. All other trees and brush shall be cleared from the area as directed. All rocks, strips, obstructions to work and undesirable material shall be removed from the site a properly and legally disposed of at an approved land fill site.
- B. All trees and shrubs to remain shall be protected during the entire progress of the work. This includes protection of the root system. All trees shall be fenced with snow fencing as detailed on the drawings and maintained during course of construction.
- C. Prior to excavating and after tree, stump, brush, etc., removal, strip the topsoil from the area of the buildings and the excavation and grading boundaries and stockpile on the site where directed by the Architect.
- D. All topsoil must be stripped from areas to be occupied by either site improvements or building construction prior to the on-site storage of any materials or the installation of any temporary construction facilities.
- E. Construct around stockpiles, a silt barrier consisting of compost wattles, snow fence, and environmental fabric as detailed on the drawings. This installation shall be coordinated as to timing and placement with the Engineer, the Conservation Commission. Pay particular attention to the Order of Conditions.
- F. Any existing abandoned/unused foundation members, cesspools, septic tanks, or similar subsurface facilities encountered within the project area are to be destroyed and removed in their entirety.

END OF SECTION

SECTION 31 23 19

DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Each and every Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this Division shall also be bound by the Documents identified in Section 01010, Paragraph 1.1A, entitled Related Documents.

1.2 SUMMARY

- A. This Section includes Construction Dewatering.
- B. The following related work is specified under the designated Sections:
 - 1. Section 220000 – PLUMBING
 - 2. Section 260000 – ELECTRICAL
 - 3. Section 310000 – EARTHWORK
 - 4. Section 312500 – EROSION AND SEDIMENTATION
 - 5. Section 321216 – ASPHALT PAVING
 - 6. Section 330000 – SITE UTILITIES

1.3 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, provide, test, operate, monitor, and maintain a dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Work includes removing dewatering system when no longer needed.
 - 2. Maintain dewatering operations to ensure erosion is controlled, stability of excavations and constructed slopes is maintained, and flooding of excavation and damage to structures is prevented.
 - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 4. Completely protect adjacent properties from siltation caused by outfall operations.

1.4 SUBMITTALS

- A. Shop Drawings: For dewatering system, show arrangement, locations, and details of wells and well points; locations of headers and discharge lines; and means of discharge and disposal of water.
 - 1. Include a written report outlining control procedures to be adopted if dewatering problems arise.
 - 2. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- C. Photographs or videotape, sufficiently detailed, of existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.

- D. Field Test Reports: Before starting excavation, submit test results and computations demonstrating that dewatering system is capable of meeting performance requirements.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer to assume engineering responsibility and perform dewatering who has specialized in installing dewatering systems similar to those required for this Project and with a record of successful in-service performance.
- B. Regulatory Requirements: Comply with water disposal requirements of the Town of Millbury and the Commonwealth of Massachusetts agencies. Conform to the Conservation Commission.

1.6 PROJECT CONDITIONS

- A. Project Site Information: A geotechnical report has been prepared for this Project and is available for information only. The report is not part of the Contract Documents. The opinions expressed in this report are those of the geotechnical engineer and represent interpretations of the subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data by Contractor.
 - 1. Make additional test borings and conduct other exploratory operations as necessary.
- B. Survey adjacent structures and improvements, employing a qualified professional engineer or surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
 - 1. During dewatering, resurvey benchmarks weekly, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 – PRODUCTS (Not Applicable)

PART 3 – EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by governing regulations.

3.2 DEWATERING

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls. Maintain site drainage at all times.
- B. Before excavation below ground-water level, place system into operation to lower water to specified levels and then operate it continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.
- C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
 - 1. Maintain piezometric water level a minimum of 24 inches (600 MM) below surface of excavation.
- E. Dispose of water removed from excavations in a manner to avoid endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner to avoid inconvenience to others. Provide sumps, sedimentation tanks, temporary sedimentation basins, and other flow-control devices as required by authorities having jurisdiction. Prevent erosion or siltation of adjacent areas and watercourses. Refer to Section 02370.
- F. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on a continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense.
 - 1. Remove dewatering system from Project site on completion of Dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches (900 mm) below overlying construction.
- G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

3.3 OBSERVATION WELLS

- A. Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated and additional observation wells as may be required by authorities having jurisdiction.
- B. Observe and record daily elevation of ground water and piezometric water levels in observation wells.

- C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. Suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
 - 1. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

END OF SECTION

SECTION 31 25 00

EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Attention is directed to the Contract and General conditions and all Sections within Division 1 – GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Examine all other Sections of the Specifications for requirements that affect work of this Section whether or not such work is specifically mentioned in this Section.
- C. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including, but not limited to, the following:
 - 1. The work to be performed is shown on the Drawings listed on the contract from. The work shall be performed in accordance with Town of Millbury Specification, Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, Latest Edition. Said documents are by reference made a part of the contract.
 - 2. The work is to be phased. Construct the project in phases as directed by the Architect to suit the project progress schedule, as well as the completion dates of the various phases and the overall project. For additional information related to phasing, review the General Conditions and Supplementary Conditions and the Architect's drawings.
 - 3. Furnish and Install all slope protection, sedimentation and erosion control measures as necessary to retain all erosion and sediments within the construction area, as shown on the Drawings and/or as specified herein, including, but not limited to:
 - a. Provide and maintain hay bales or erosion control silt fence for control of soil runoff on exposed slopes, drainage structures and temporary stockpiles.
 - b. Seeding annual ryegrass, installing erosion control blankets, or temporary mulch as a temporary cover on all exposed slopes and stockpiled topsoil.
 - c. Providing stone construction entrance pads to site and cleaning adjacent roadway surfaces of all accumulated sediment and debris as required or a minimum of once per week.
 - d. Temporary settling basins.
 - e. Erosion Control Blankets (ECB) on all key identified slopes.
 - f. Temporary seeding and lawn stabilization of disturbed areas.
 - g. Dust control.
 - h. Provide and maintain drain inlet Sediment Control Bags at all existing or new catch basins to which runoff from the construction site contributes to.
- B. The following Related Work is specified under the designated Sections:
 - 1. Section 024100 – DEMOLITION
 - 2. Section 311000 – SITE PREPARATION

3. Section 310000 – EARTHWORK
4. Section 321216 – ASPHALT PAVING
5. Section 321313 – CONCRETE PAVING
6. Section 321600 – CURBS
7. Section 321723 – PAVEMENT MARKING
8. Section 323000 – SITE IMPROVEMENTS
9. Section 329000 – LANDSCAPING
10. Section 330000 – SITE UTILITIES

1.3 QUALITY ASSURANCE

- A. Material Standards and Standards of Workmanship: Equal to the Commonwealth of Massachusetts Guidelines for Soil Erosion and Sediment Control and Local Town Requirements.
- B. Requirements specified and noted on drawings are minimum. Provide additional measures as required by the local, State or Federal authorities as a result of Contractor's specific scheduling and Work sequencing, or weather conditions at no additional cost to the Owner.
- C. Qualifications: Engaged firm shall be able to demonstrate experience in the installation of the erosion and sedimentation controls described in the Contract Documents.

1.4 SUBMITTALS

- A. Product data for the following:
 1. Silt Fence
 2. Erosion control blankets.
 3. Soil stabilizers.
 4. Sediment Control Bags.
 5. Fertilizers, seed.
 6. Limestone.
 7. Chemical preservatives and controls – also confirm that each of the materials proposed to be applied are permitted within the Commonwealth of Massachusetts and the Town of Millbury.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Seed, Fertilizer and Lime: Deliver in original sealed, labeled, and undamaged containers, showing weighs, analysis, and name of manufacturer.
- B. Protect materials from deterioration during delivery and while stored at site.

1.6 COORDINATION AND SCHEDULING

- A. General: Sow lawn seed and install all stabilization measures as soon as possible in accordance with the Contractor's schedule.
- B. Weather Limitations: Proceed with lawn development only when existing and forecast weather conditions are suitable for work.

1.7 MAINTENANCE

- A. Begin maintenance of stabilized areas immediately after each area is stabilized and continue until project is accepted.

- B. Maintain and establish all disturbed areas by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
 - 1. Replant bare areas.
 - 2. Add new mulch and tackifier in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose. Anchor as required to prevent displacement.

1.8 JOB CONDITIONS

- A. Existing Conditions: The contractor shall examine all work that the work of this Section is contingent upon, and report any deficiencies to the Architect. Commencement of the work will be construed to mean complete acceptance by the Contractor of the preparatory work of others. No adjustment will be made for discrepancies brought to the Architect's attention after work has begun.
- B. Protection of Adjacent Lands:
 - 1. The Contractor shall be totally responsible for protection of any lands or properties as may be subject to any effect or by-product of his demolition/construction effort. Special care shall be taken to avoid erosion of fill or cut slopes onto adjacent properties or downstream siltation of diversion of existing surface drainage. Any damage is to be corrected immediately.
 - 2. Erosion control measures in the locations shown and as detailed and described in the Contract Documents shall be considered minimum requirements and the Contractor shall take whatever other erosion and sedimentation controls steps necessary to accommodate his particular construction procedures.
- C. Schedule Procedure:
 - 1. Erosion control construction shall be done prior to the commencement of demolition, site preparation or earthwork operations. The initial method outlined herein is intended to route all practicable surface water from the excavation area into erosion control facilities. The Contractor shall install any additional protective measures as may be required to control siltation from the site.
 - 2. The following sequence of construction shall be followed: Revisions shall be only with the approval of the Architect and the responsible municipal governing agency.
 - a. Place sedimentation control measures along slopes, at catch basins and across swales and outfalls as shown on the Drawings, and where directed by the Architect.
 - b. Proceed with construction of the remaining items of work in accordance with the approved project sequence and schedule. The contractor shall be responsible for maintaining the integrity of all sediment and erosion control measures for the duration of the Contract.
 - c. Clean and maintain all sedimentation control components to achieve the intended purpose of both temporary and permanent erosion and sediment control facilities.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with the Association of Official Seed Analysts' "Rules for Testing Seeds" for purity and germination tolerance.

1. Seed Mixture: 50% Annual Ryegrass; clean with a minimum of 0.50% noxious weed seed; minimum 97% pure with a germination rate minimum of 80%.
 2. If seeding occurs after September 15, substitute winter rye for annual rye grass.
- B. Straw Mulch: Provide air-dry, clean, mildew-and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- C. Fiber Mulch: Biodegradable dye-wood cellulose-fiber mulch, nontoxic, free of plant growth or germination-inhibitors, with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- D. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application, nontoxic and free of plant growth-or germination-inhibitors.

2.2 EROSION-CONTROL MATERIALS

- A. Compost Wattles
1. Compost wattles shall consist of compost consisting of 25%-100% organic matter with a pH of 5.0-8.5, a moisture content less than 60% and 99% passing a 2" sieve and 30% to 50% passing a 3/8" sieve inside of a biodegradable sock/netting. Compost wattles shall measure at least twelve (12) inches in diameter.
 2. Stakes for wattles shall be one of the following materials. Lengths shall be approximately two feet (2').
 - a. Wood stakes of sound hardwood, one inch by one inch (1" x 1") in size.
 - b. Steel reinforcing bars of at least No. 4 size.
- B. Erosion Control Blanket: C125BN coconut fiber erosion control blanket (100% biodegradable) as manufactured by North American Green or approved Equal. Include biodegradable stakes.
- C. Temporary Mulch: Straw hydromulch or other approved product.
- D. Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, 0.92 lb. Per sq. yd. (0.5 kg per sq. m) minimum, with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (150mm) long.

2.3 SILTATION FENCE

- A. Silt fence shall consist of the following elements:
1. Fabric for siltation fence shall be a minimum width of 3 feet and conforming to the following criteria:

MINIMUM ACCEPTABLE

<u>Fabric Properties</u>	<u>Value</u>	<u>Test Method</u>
Grab Tensile Strength (lbs)	124	ASTM D 4632
Grab Tensile Elongation (%)	15	ASTM D 4632
Mullen Burst Strength (psi)	300	ASTM D 3786
Puncture Strength (lbs)	65	ASTM D 4833
Flow Rate (gal/min/sf)	10	ASTM D 4491
Apparent Opening Size (sieve)	30	ASTM D 4751
Ultraviolet Stability (% strength retained)	70	ASTM D 4355

2. Acceptable fabric materials include "Mirafi Envirofence" by TenCate Mirafi, "Style 2130" by Amoco Fabrics Co., and "LS125-Super Grade" by ACF Environmental, or as approved by the Engineer.
3. Silt fence posts shall be wood or metal. Wood posts shall be a minimum of 1¼ inch by 1¼ inch by 5 feet long hardwood stakes commonly used to support siltation fabric. Metal posts shall be a minimum of 1 inch diameter and 5 feet long. Posts shall be spaced at a maximum distance of 8 feet on center.
4. Furnish and install suitable nylon cord to secure abutting silt fence posts.

2.4 CRUSHED STONE: CONFORM TO MHD, SECTION M2.01.1, GRADATION 2".

PART 3 - EXECUTION

3.1 PRECONSTRUCTION MEETING

- A. Prior to the start of any construction activities on the site, a preconstruction conference shall be held to establish supervisory and inspection procedures for sediment and erosion control measures. This meeting shall be attended by the Contractor, the Architect, the Local Sediment and Erosion Control Officer, the Local Conservation Commission Agent and the Owner.
- B. Submit detailed sequenced construction schedule for the Architect's review and approval. Do not proceed until this schedule is approved.

3.2 CONSTRUCTION ENTRANCE

- A. Install construction entrances to each project work area and staging area. Location and number of entrances to be modified based on Contractor's specific sequencing of work and as approved by the Architect. Maintain each entrance by regrading and providing additional stone as required to maintain a clean and open surface.
 1. Dimensions: 50' length minimum (typical), 6" depth of crushed stone. Refer to Contract Drawings.
 2. Adjacent pavements are to be kept clean of construction generated sediment and debris. Sweeping shall occur once per week at a minimum or more frequently if so required.

3.3 TEMPORARY SETTLING BASINS

- A. Construction temporary settling basins and install erosion control devices washer indicated and around existing and proposed drainage structures in accordance with manufacturer's installation and recommendations. Make any adjustment to location as required by field condition, the Architect, or local Town officials. Install erosion control at limits of grading and topsoil stripping elevations. Do not allow any sediment to enter existing drainage piping systems or wetlands.

3.4 MAINTENANCE

- A. Maintain basins and Erosion control devices by restaking and replacing as required. Remove buildup of silt as necessary or as directed by the Architect. Maintain operations until all lawn/planted areas are stabilized and all paving is completed.

3.5 TEMPORARY SEEDING

- A. Seed all exposed slopes and stockpiled topsoil with winter or annual ryegrass at a rate of two (2) pounds/1,000 sq. feet of area. Seeding shall be done immediately after rough grading operations are complete and maintained until finish grading and seeding have begun.

3.6 HYDROMULCHING/HYDROSEEDING

- A. Hydroseeding: Mix specified seed, fertilizer, and maximum 10% of fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application.
 - 1. Mix slurry with nonasphaltic tackifier.
 - 2. Apply slurry uniformly to all area to be seeded in a 2-step process. Apply first slurry application at the minimum rate of 500 lb. Per are (5.5 kg per 100 sq. m) dry weight but not less than the rate required to obtain specified seed-sowing rate. Apply slurry cover coat of fiber mulch at a rate of 1200 lb. Per acre (11 kg per 100 sq. m).

3.7 TEMPORARY EROSION CONTROL FABRIC OR MULCH

- A. Temporary Erosion Control Fabric or Mulch: Immediately upon formation of rough grades, install on all key identified slopes as per manufacturer's recommendations or slopes steeper than one foot vertical to three feet horizontal or any areas and drainage swales which receive concentrated run-off water and areas that are susceptible to erosion as required by the Architect. Overlap joint of erosion control blankets one foot and secure as recommended by the manufacturer. Maintain until permanent vegetative cover is established.

3.8 CLEAN UP

- A. Upon stabilization of all disturbed areas and the completing of construction activity, remove all erosion control devices including stone construction entrances and restore surrounding areas to acceptable conditions.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.1 GENERAL

- A. General Conditions, Supplementary Conditions and applicable parts of Division 1 form a part of this Specification and the Contractor shall consult them in detail for instructions.
- B. Refer to SECTION 012300, ALTERNATES, for alternates which may affect the work of this SECTION.

1.2 DESCRIPTION OF WORK

- A. The work to be performed is shown on the Drawings listed on the contract form. The work shall be performed in accordance with the local D.P.W. Specifications, Latest Edition and the Commonwealth of Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, Latest Edition. Said documents are by reference made a part of the contract.
- B. The Work to be performed under this Section shall include furnishing all labor, materials and equipment required to do all the Bituminous Concrete Paving and related work as shown on the Drawings or herein specified. The Work shall further include all appurtenant items not specifically shown or itemized but which are implied or required to complete the Work in accordance with the reasonable intent of the Contract Documents.
- C. The principal work of this Section includes, but may not be limited to the following:
 - 1. New Bituminous Concrete Paving for Walks, Parking Areas, and other areas as shown.
 - 2. Paving to consist of a two (2) course hot placed and compacted pavement of mineral aggregate, mineral filler, and bituminous material, to the various depths and cross sections shown on the documents.
 - 3. Fine grading of the gravel base course.

1.3 RELATED WORK

- A. Carefully examine all of the Contract Documents for requirements that affect the work of this Section. Other specifications that directly relate to the work of this section include, but are not limited to, the following:
 - 1. Section 310000 - EARTHWORK
 - 2. Section 321316 - CONCRETE PAVING
 - 3. Section 321600 - CURBS
 - 4. Section 329000 - LANDSCAPING
 - 5. Section 330000 - SITE UTILITIES

1.4 QUALITY ASSURANCE

- A. The following Specifications and all related items and methods shall meet Commonwealth of Massachusetts Department of Public Works Construction Standards and Materials Specifications, latest Edition. Method of payment part of each Section is deleted and shall not be included.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Asphalt Paving and Materials

1. All materials shall meet the requirements of the Commonwealth of Massachusetts Highway Department for Highways and Bridges, Latest Edition, Standard Specifications for Type I-1 Bituminous Concrete Paving, and the materials selected shall be of the highest quality. Prior to starting work, submit job mix formula for review and approval.
2. Bituminous prime coat shall be medium curing Type MC-D or MC-1 conforming to the Commonwealth of Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, Latest Edition. Asphalt cement shall be of a typical penetration grade for the local area. All bituminous material shall meet the minimum requirements of AASHTO specifications.
3. Bituminous concrete aggregates and fine aggregates shall conform to MHD Section M3.11 as amended.
4. Bituminous concrete shall meet the following requirements when tested by the Marshall method. The requirements are based on the bituminous concrete being compacted with 50 blows and tested at 140 degrees F.

Physical Test	Surface Course	Binder Course	Asphalt Base
Stability	1000 PSI	1000 PSI	800 PSI
Flow 1/100"	6 - 18	6 - 18	6 - 20
Total Voids	2 - 5	3 - 6	3 - 8

5. Asphalt cement content to be determined by three point Marshall curve. The amount of asphalt cement shall be selected from the maximum density obtained and within the above minimum requirements.

PART 3 - EXECUTION

3.1 PAVEMENT FOUNDATION CONDITIONS

- A. Subgrade materials and preparation are specified in Section 310000. Gravel base material, thickness, and compaction is detailed on the Drawings. Fine grading is specified herein.

3.2 ESTABLISHMENT OF GRADES

- A. Establish grade stakes from the Contract Drawings Site Grading Plan. The grade stakes shall be set to desired section and elevation and due allowances shall be made for existing improvements, proper drainage and adjoining property rights.

3.3 PROTECTION OF WORK BY OTHERS

- A. Protect all work previously installed such as manholes, catch basins, sewer cleanouts, lighting posts, bases, curbs, sidewalks, etc. Repair any damage to this work caused by work of this Section.

3.4 PAVEMENT TRIMMING

- A. Only sawcutting (without overcuts) shall be allowed as a means of creating the final (permanent) edge between existing and new hot-mix asphalt. All overcuts shall be filled with bituminous joint sealer. The standard cutback for all permanent pavement patches shall be 24" beyond the original pavement cuts made to perform the Contractor's work.

3.5 PAVEMENT APPLICATION

- A. The gravel base course shall be fine graded in accordance with the Drawings and the maximum allowable deviation shall be 1/2 inch in ten (10) feet. Spread additional screening into any area showing segregation and roll into the surface until all voids in the base course have been completely filled. Rolling of the entire base shall be performed in the presence of the Soils Laboratory.
- B. The bituminous prime coat shall be applied to the base course at the rate of 0.05 gallons per square yard. The base course shall be relatively dry at the time the primer is applied. The prime coat shall be allowed to cure for a minimum of twenty-four (24) hours.
- C. Bituminous concrete shall be installed to the minimum thickness as specified. The compacted thickness shall be equal to or greater than the thickness specified. No skin patching will be accepted. Compaction of the bituminous concrete shall be equal to 97% of that obtained in the Laboratory. Bituminous concrete shall be rolled with a ten-ton roller as soon after placing as is practical.
- D. Provide a slope for drainage as indicated on the Drawings. Slope to catch basins as provided.
- E. The surface of the finished pavement shall be free of roller depressions. When tested with water, the surface shall not contain any irregularities which will impede water flow.
- F. Bituminous concrete paving shall abut concrete curbs and walls making a smooth, even, clean joint as indicated on the Drawings.

3.6 FIELD QUALITY CONTROL

- A. As directed by the Architect, the Owner will furnish the services of a testing laboratory to perform compaction and thickness testing. All testing is to be performed in accordance with ASTM or AASHTO recommended procedures.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 32 13 13

CONCRETE PAVING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections within DIVISION 01 - GENERAL REQUIREMENTS which are hereby made a part of this Section of the Specifications.

1.2 DESCRIPTION OF WORK

- A. The Work to be performed under this Section shall include furnishing all labor, materials and equipment required to do all the Portland Cement Concrete Site Work and related work as shown on the Drawings or herein specified. The Work shall further include all appurtenant items not specifically shown or itemized but which are implied or required to complete the Work in accordance with the reasonable intent of the Contract Documents.
- B. The principal work of this Section includes, but may not be limited to, the following:
 - 1. Reinforced Concrete Pads
 - 2. Concrete Walkways and Stoops
 - 3. Joint Treatments
 - 4. Reinforcement
 - 5. Surface Finish
 - 6. Curing

1.3 RELATED WORK

- A. Carefully examine all of the Contract Documents for requirements which affect the work of this Section. Other Specifications which directly relate to the work of this Section include, but are not limited to, the following:
 - 1. Section 033000 – CAST-IN-PLACE CONCRETE
 - 2. Section 310000 – EARTHWORK
 - 3. Section 321216 – ASPHALT PAVING
 - 4. Section 329219 – LAWNS AND GRASSES

1.4 SUBMITTALS

- A. Submit product data under provisions of the General Conditions.
- B. Submit manufacturer's instructions under provisions of the General Conditions
- C. Product Data: Submit product data for the following materials and items.
 - 1. Reinforcement
 - 2. Forming Accessories
 - 3. Admixtures
 - 4. Patching compounds
 - 5. Sealants (including colors)
 - 6. Joint fillers

7. Shop Drawing Reinforcement: Submit detailed shop drawings for fabrication, bending and placement of concrete reinforcement. Elevations of walls shall include form tie placement.
8. Shop Drawing Jointing: Submit detailed layout drawing for joint locations and layout.
9. Show bar schedules, stirrup spacing, diagrams of bent bars and arrangement of reinforcement including bar overlap.
10. Include special reinforcement required for opening through concrete structures.
11. Plastic slip dowel system
12. Laboratory Test Reports: Submit concrete materials test reports and mix design reports certifying that each material or item complies with or exceeds the specified requirements.

1.5 SAMPLES

- A. Mock-up Panels: Prepare one mock-up panel for each paving type at the project site to demonstrate proficiency of the workmen, and define the degree of aggregate exposure. Mock-up panels shall be a minimum of 4'-0" x 4'-0". Contractor shall use the methods and materials proposed for use on the final installation including but not limited to integral color, jointing, edging and finish texture. Uniformity in appearance of each panel shall be the responsibility of the Contractor. The approved mock-up shall serve as a standard appearance for final work. Approved mock-up may not be part of the completed work.
- B. Plastic Slip Dowel System

1.6 QUALITY ASSURANCE

- A. The following Specifications and all related items and methods shall meet The Commonwealth of Massachusetts Department of Public Works Construction Standards and Materials Specifications, Latest Edition (MDPW). Method of payment part of each Section is deleted and shall not be included.
- B. Installer Qualifications
 1. An experienced installer who has completed pavement work similar in material, design and extent to that indicated for this project and whose work has resulted in construction with record of successful in-service performance.
- C. Manufacturer Qualifications
 1. Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
 - a. Manufacturer must be certified according to the National Ready Mix Concrete Association's Plant Certification Program.
- D. Testing Agency Qualifications
 1. An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- E. Source Limitations
 1. Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

F. ACI Publications

1. Comply with ACI 301, "Specification for Structural Concrete," unless modified by the requirements of the Contract Documents.

G. Concrete Testing Services

1. Engage a qualified independent testing agency to perform material evaluation test and to design concrete mixes.

H. Walks constructed for use by persons with accessibility challenges shall conform to the applicable portions of the Americans with Disability Act Accessibility Guidelines (ADA), Massachusetts Architectural Access Board (MAAB) and the Massachusetts State Building Code.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials

1. Plywood, metal, metal-framed plywood or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surface.
2. Use flexible or curved forms for curves of a radius 100 feet or less.

B. Form-Release Agent

1. Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces. Conform to all State and local requirements for levels of toxicity.

2.2 STEEL REINFORCEMENT

A. Epoxy-Coated Welded Wire Fabric

1. ASTM A 884/A 884M, Class A, plain steel. Flat sheets required. No rolls.

B. Reinforced Bars

1. ASTM A 615/A 615M, Grade 60, deformed.

C. Steel Bar Mats

1. ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

D. Joint Dowel Bars

1. Galvanized smooth steel dowels, ASTM A 615/A 615M, Grade 60. Cut dowels true to length with ends square and free of burrs. Provide polypropylene plastic slip dowel sleeves system. System shall be similar to "Speed Dowel" by Aztec Concrete Accessories, or approved equal.

E. Tie Bars

1. ASTM A 615/A, Grade 60, deformed.

F. Hook Bolts

1. ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

G. Bar Supports

1. Bolters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practices" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and as follows.
 - a. Equip wire bar supports with sand plates or horizontal runners where base materials will not support chair legs.
 - b. For epoxy-coated reinforcement, use epoxy or other dielectric-polymer coated wire bar supports.

H. Epoxy Repair Coating

1. Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

2.3 CONCRETE MATERIAL

- A. Use the same brand and type of cementitious material from the same manufacturer throughout the project. Bath mixing at the site is not acceptable.
- B. Compressive Strength: Minimum 4,000 psi at 28 days.
- C. Portland Cement: ASTM C 150, Type I or II.
- D. Aggregate: ASTM C 33, uniformly graded, from a single source, with coarse aggregate as per MPDW M2.02.02, $\frac{3}{4}$ inch aggregate.
 1. Do not use fine or coarse aggregates containing substances that cause spalling.
- E. Water: ASTM C 94

2.4 ADMIXTURES

- A. Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.
- B. Air-Entraining Admixture: ASTM C 260, 5-6 percent.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water Reducing and Accelerating Admixture: ASTM C 494, Type E.

- F. Water Reducing and Retarding Admixture: ASTM C 494, Type D.

2.5 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 ounces per square yard dry.
- B. Moisture-Retaining Cover: White polyethylene film or white burlap polyethylene sheet, ASTM C171; or resin-based, clear emulsion liquid dissipating cure which will not discolor the concrete, conforming to ASTM C309 Type I or ID, Class A & B and AASHTO M-148.

2.6 RELATED MATERIALS

- A. Expansion and Isolation Joint Filler Strips: ASTM D 1751, asphalt saturated, cellular fibers, as manufactured by Sealtight, W.R. Meadows, or approved equal.
 - 1. Thickness: ½ inch.
 - 2. Depth: To match full section of concrete pavement.
- B. Removable Vinyl Joint Cap Strips: Compatible with filler strips width, as manufactured by Vinylex Corp. or approved equal. Provide in length equal to lengths of filler strips.
- C. Joint Sealer: Compatible with filler strips, two component polyurethane elastomeric type complying with FS-TT-S-00227, self leveling designed for pedestrian and vehicular traffic, as manufactured by Sika, Percora, or approved equal. Include primer and backing rods as required.
 - 1. Type: Class II, non-load bearing, for bonding freshly mixed to hardened concrete.
 - 2. Type: Class I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
 - 3. Type: Class IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXES

- A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal weight concrete determined by either laboratory trial mixes or field experience.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.
 - 1. Do not use Owner's field quality-control testing agency as the independent testing agency.
- C. Proportion mixes to provide concrete with the following properties:
 - 1. Compressive Strength (28 Days): 4,000 pounds per square inch.
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 - 3. Slump Limit: 3 inches.
 - 4. Sacks of Cement (minimum): 7 sacks per cubic yard.
- D. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.

2.8 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94, and MDPW, Section M4.

2.9 SEALING MATERIALS

- A. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
 - 1. Available Products:
 - a. L&M Construction Chemicals, Inc.; Lumiseal Plus.
 - b. Meadows, W.R. Inc.; CS-309/30.
 - c. Metalcrete Industries; Seal N Kure 30.
- B. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A, specifically manufactured for use with colored concrete.
- C. Clear Acrylic Sealer: Manufacturer's standard waterborne, membrane-forming, medium-gloss, acrylic copolymer emulsion solution, specifically manufactured for colored concrete, containing not less than 15 percent solids by volume, non-yellowing, and UV resistant.
- D. Slip-Resistant Additive: Manufacturer's standard finely graded aggregate or polymer additive, designed to be added to clear acrylic sealer, to result in a slip-resistant surface.
- E. Polyethylene Film: ASTM D 4397, 1 mil thick, clear.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Proof-roll prepared surface to check for unstable areas and verify need for additional compaction. Proceed with pavement only after nonconforming conditions have been corrected and sub grade is ready to receive pavement. Do not install concrete over saturated, muddy or frozen base.
- B. Remove loose material from compacted base surface immediately before placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement and curbs to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement. At points where change of grades is more than 2% introduce approved vertical curve. No abrupt changes in grade will be accepted.
- B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.
- C. Curb forms to be true to horizontal and vertical alignment. Forms to be true to radiuses specified.

3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.
 - 1. Apply epoxy repair coating to uncoated or damaged surfaces of epoxy-coated reinforcement.

- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lap splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap to adjacent mats.

3.4 JOINTS

- A. General: Construct construction, expansion, score joints, and tool edging true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
 - 1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
- B. Expansion Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlet, structures, walks, other fixed objects, and where indicated. Approval required prior to pour.
 - 1. Locate expansion joints at intervals of 30 feet maximum, unless otherwise indicated
 - 2. Extend joint fillers full width and depth of joint.
 - 3. Install removable vinyl cap strips and set top of cap strip flush with finished concrete surface.
 - 4. Furnish joint fillers in on-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
 - 5. Protect top edge of joint filler during concrete placement with metal cap after concrete has been placed on both sides of joint.
 - 6. Install dowel bars and support assemblies at joints where and as indicated.
- C. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than on-half hour, unless pavement terminates at isolation joints.
 - 1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
 - 2. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
 - 3. Provide tie bars at sides of pavement strips where indicated.
 - 4. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
 - 5. Use epoxy bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

- D. Score Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness as follows:
1. Grooved Joints: Form contraction joint after initial floating by grooving and finishing each edge of joint with groover tool to the following radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks (tool wings) on concrete surfaces. Maximum spacing of 3'-0" in any direction. Areas of concrete sidewalk replacement shall be patterned to match existing pavement. Joints shall be straight or true to radius shown – poor workmanship is just cause for rejection of pavement.
 - a. Radius: ¼ inch.
 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
- E. Edging: Tool edges of pavement, gutters, curbs and joints in concrete after initial floating with an edging tool to following radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surface.
1. Radius: ¼ inch.
- F. Rub all exposed vertical faces of curbs to eliminate blemishes, pockmarks, honeycombing, and all other defects. Plastering is not permitted.

3.5 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work. Protect adjacent work from damage, splatter, and all other concrete operations.
- B. Remove snow, ice, or frost from sub base surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten sub base to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.
- D. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery, at Project site, or during placement, unless approved by Engineer.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.
1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

- H. Place concrete in two operations; strike off initial pour for entire width of placement and to the required depth below finish surface. Lay welded wire fabric or fabricated bar mats immediately in final position. Place top layer of concrete, strike off, and screed.
 - 1. Remove and replace portions of bottom layer of concrete that have been placed more than 15 minutes without being covered by top layer, or use bonding agent if approved by Architect.
 - I. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form an open textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.
 - J. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
 - 2. Do not use frozen materials or materials containing ice or snow.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
 - K. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows when hot-weather conditions exist:
 - 1. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 deg F. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 - 2. Cover reinforcement steel with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 - 3. Fog-spray forms, reinforcement steel, and sub grade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.
- 3.6 CONCRETE FINISHING
- A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.
 - B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and the concrete surface has stiffened sufficiently to permit operations. Float surface with power driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture (standard). Provide cleanly finished fine textured broom finish on all colored concrete pavements including varying directions of the brooming.
 - 2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic (handicap access ramps).
 - C. Detectable Warning Surface Tile: Complete installation of concrete ramp and surface finish in accordance with these specifications.
 - 1. The factory-installed plastic sheeting must remain in place during the entire installation process, to prevent the splashing of concrete onto the finished surface of the tile.

2. When preparing to set the tile, it is important that NO concrete be removed in the area to accept the tile. It is imperative that the installation technique eliminates any air voids under the tile. Holes around the tile perimeter allow air to escape during the installation process. Concrete will flow through the large holes in each vane on the underside of the tile. This will lock the tile solidly into the cured concrete.
3. The concrete shall be poured and finished true and smooth to the required dimensions and slope prior to the tile placement. Immediately after finishing concrete, an electronic level should be used to check that the required slope is achieved. The tile shall be placed true and square to the curb edge in accordance with the contract drawings. Hold the tile a minimum of 1" from the back of any curb or away from any edge of the pour. The Cast-In-Place Tiles shall be tamped (or vibrated) into the fresh concrete to ensure that the field level of the tile is flush to the adjacent concrete surface. The contract drawings indicate that the tile field level (base of truncated dome) is flush to adjacent surfaces to permit proper water drainage and eliminate tripping hazards between adjacent finishes.
4. Immediately after tile placement, the tile elevation is to be checked to adjacent concrete. The tile elevation and slope should be set consistent with contract drawings to permit water drainage to curb as the design dictates.
5. While concrete is workable, a 3/8" radius edging tool shall be used to create a finished edge of concrete, then a steel trowel shall be used to float the concrete around the tile's perimeter, flush to the field level of tile.
6. During and after the tile installation and the concrete curing stage, it is imperative that there is no walking, leaning or external forces placed on the tile to rock the tile, causing a void between the underside of tile and concrete.
7. Following tile placement, review installation tolerances to contract drawings and adjust tile before the concrete sets. Two suitable weights of 25 lb each shall be placed on each tile as necessary to ensure solid contact of the underside of tile to concrete.
8. Following the curing of the concrete, protective plastic wrap is to be removed from the tile face by cutting the plastic with a sharp knife, tight to the concrete/tile interface. If concrete bled under the plastic, a soft wire brush will clean the residue without damage to the tile surface.

3.7 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with SSHB, Section 476, and ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturers written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Begin curing after finishing concrete, but not before free water has disappeared from concrete surface.
- D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, or a combination of these as follows:
 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof.

3.8 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 1. Elevation: $\frac{1}{4}$ inch.
 2. Thickness: Plus $\frac{3}{8}$ inch, minus $\frac{1}{4}$ inch.
 3. Surface: Gap below 10-foot long, unlevelled straightedge not to exceed $\frac{1}{4}$ inch.
 4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
 5. Vertical Alignment of Tie Bars and Dowels: $\frac{1}{4}$ inch.
 6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel $\frac{1}{4}$ inch per 12 inches.
 7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel $\frac{1}{4}$ inch per 12 inches.
 8. Joint Spacing: 3 inches.
 9. Contraction Joint Depth: Plus $\frac{1}{4}$ inch, no minus.
 10. Joint Width: Plus $\frac{1}{8}$ inch, no minus.
- B. Typical cross slope of pavement is 1.5% unless otherwise indicated. In no case will water be allowed to stand or puddle on any finished pavement.

3.9 SEALANTS INSTALLATION

- A. Install joint sealants in all expansion joints in accordance with the manufacturer's installation instructions. Clean and prime joints. Remove dirt and loose coatings.
- B. Apply sealant in continuous beads, without open joints, voids, or air pockets. Hand tool and finish all joints.
- C. Confine materials to joint areas with masking tape or other precautions. Insure joint sealing is cleanly executed with no override onto adjacent pavement.
- D. Remove excess compound promptly as work progresses and clean adjoining surfaces. Protect until full cured.
- E. In rough surfaces of joints of uneven widths, hold joint sealant well back into joints.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Sampling and testing for quality control may include those specified in this Article.
- B. Testing Services: Testing shall be performed according to the following requirements:
 1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C172, except modified for slump to comply with ASTM C 94.
 2. Slump: ASTM C 143; one test at point of placement for each compressive-strength test, but not less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.
 3. Air Content: ASTM C 231, pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of concrete. Additional tests will be required when concrete consistency changes.

4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each set of compressive strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
5. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test, unless otherwise indicated. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
6. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. Yd., but less than 25 cu. Yd., plus one set for each additional 50 cu. yd. One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required
7. When frequency of testing will provide fewer than five compressive-strength tests for a given class of concrete, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
8. When total quantity of a given class of concrete is less than 50 cu. yd., Architect may waive compressive-strength testing if adequate evidence of satisfactory strength is provided.
9. When strength of field-cured cylinders is less than 85 percent of companion laboratory cured cylinders, current operations shall be evaluated and corrective procedures shall be provided for protecting and curing in-place concrete.
10. Strength level of concrete will be considered satisfactory if average of sets of three consecutive compressive-strength test results equal or exceed specified compressive strength and no individual compressive-strength test result falls below specified compressive strength by more than 500 psi.

C. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28 day tests.

D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as the sole basis for approval or rejection.

E. Additional Tests: Testing agency shall make additional tests for the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Architect. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.11 REPAIR AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements in this Section.

B. Drill test cores where directed by Architect when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

- D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 32 16 00

CURBS

PART 1 - GENERAL

1.1 GENERAL

- A. General Conditions, Supplementary Conditions and applicable parts of Division 1 form a part of this Specification and the Contractor shall consult them in detail for instructions.
- B. The Drawings on which this Contract is based are listed in Section 00860. Consult all Drawings, note all conditions that may affect the Work and care for same in executing the Contract.
- C. Refer to Section 012300, Alternates, for alternates which may affect the work of this Section.

1.2 DESCRIPTION OF WORK

- A. The Work to be performed under this Section shall include furnishing all labor, materials and equipment required to do all the Curbs and related work as shown on the Drawings or herein specified. The Work shall further include all appurtenant items not specifically shown or itemized but which are implied or required to complete the Work in accordance with the reasonable intent of the Contract Documents.
- B. The principal work of this Section includes, but may not be limited to, the following:
 - 1. Vertical Granite Curbing

1.3 RELATED WORK

- A. Carefully examine all of the Contract Documents for requirements which affect the work of this Section. Other Specifications which directly relate to the Work of this Section include, but are not limited to, the following:
 - 1. Section 310000 - EARTHWORK
 - 2. Section 321313 - CONCRETE PAVING
 - 3. Section 330000 - SITE UTILITIES
 - 4. Section 329000 - LANDSCAPING

1.4 CODES, ORDINANCES AND PERMITS

- A. Give all requisite notices and file all requisite plans relating to this work with the proper authorities, secure all permits for this work, and pay all fees for same.
- B. Perform all work in accordance with all applicable local, state, and federal codes, statutes, or regulations.

1.5 SHOP DRAWINGS AND MATERIALS SCHEDULES

- A. Submit shop drawings for the following materials and equipment:
 - 1. Sloped Granite Curbing
 - 2. Vertical Granite Curbing
 - 3. Independently developed, dimensioned layout drawings of all curb sections & transition pieces. Drawings shall contain a table with linear footage of curb, quantity of radii and transition pieces.

PART 2 - PRODUCTS

2.1 VERTICAL GRANITE CURB

- A. Type VA4 to be used wherever Vertical Granite Curbing is called for on plans. Types are according to the Massachusetts Highway Department Standard Specifications for Highways and Bridges, Latest Edition.
- B. All granite curb and edging shall be basically light gray in color, free from seams and other structural imperfections or flaws which would impair its structural integrity, and of a smooth splitting appearance. Natural color variation characteristics of the deposit from which the curbing is obtained will be permitted.
- C. Whenever curbing is sawed, all surfaces that are to be exposed shall be thoroughly cleaned and any iron rust or iron particles shall be removed by sand blasting or other approved methods satisfactory to the Architect. Any saw mark in excess of 1/8 inch shall be removed.
- D. Dimensions of curbing to be:

Minimum Length:	6 feet
Width of Top:	6 inches
Depth:	17" - 19"
Minimum width at bottom:	4 inches (for 2/3 length)

The end of all curved stones shall be cut on radial lines. Refer to MHD Section M 9.04.1.

- E. Granite Curb Inlets if required shall conform to MHD Section M 9.04.5 and to the dimensions shown on the plans.

PART 3 - EXECUTION

3.1 LAYOUT AND EXECUTION

- A. All curbs shall be true to line and grade and shall be laid out in the field with suitable offset stakes and top elevation clearly marked on appropriately spaced stakes.
- B. Hold the curb elevations shown on the Grading Plan. Set all top of curb in the field to be 6" above the finish paving grade immediately in front of the curb. Top of curb to be 6" above the overlay in areas indicating on overlay over existing paving.
- C. Curbs are to be set parallel to all buildings and structures. Finish face of all Vertical Granite Curb is to be vertical and plumb.
- D. After excavation to the grade specified above prepare the trench bottom as follows:
 - 1. Place 6" of compacted crushed stone in the bottom of the trench for setting and leveling of all Vertical Granite Curb.
 - 2. Pour 6" of Class "C" cement on the pavement side for backing on all Vertical Granite Curb.
 - 3. Pour 8" (H) x 8" (W) of Class "C" Cement in the bottom of the trench for setting, leveling and backing on all Sloped Granite Curb.
 - 4. The curb shall be set at the line and grade required as shown on the plans unless otherwise directed. Curb shall be fitted together as closely as possible.

5. The joints between curbs (both front and back) shall be carefully filled with cement mortar and neatly pointed on the top and front exposed portions. After pointing, the curbstones shall be satisfactorily cleaned of all excess mortar that may have been forced out of the joints.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 32 17 23

PAVEMENT MARKING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Include GENERAL CONDITIONS and SUPPLEMENTARY CONDITIONS as part of this Section.
- B. Examine all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- C. Coordinate work with trades affecting, or affected by, work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 WORK INCLUDED

- A. Provide all additional equipment and materials not otherwise specified, and do all work necessary for pavement marking, as indicated on the Drawings including but not limited to parking space striping, painted parking islands, fire lane markings, handicap parking symbols, loading areas, stop lines, painted crosswalks, and painted lettering.

1.3 RELATED WORK UNDER OTHER SECTIONS

- A. Carefully examine all of the Contract Documents for requirements which affect the work of this Section. Other Specifications which directly relate to the work of this Section include, but are not limited to, the following:
 - 1. Section 015200 – TRAFFIC MANAGEMENT PLAN
 - 2. Section 321216 – BITUMINOUS CONCRETE PAVING

1.4 REFERENCES

- A. Work shall conform to codes and standards of the following:
 - 1. Massachusetts Highway Department Standard Specifications for Highways and Bridges (MHD Specifications), Latest Edition.

1.5 LAYOUT OF WORK

- A. The Contractor shall furnish to the Architect for approval a schedule of pavement marking operations in accordance with MHD Specifications Section 860.61.

1.6 TRAFFIC CONTROL

- A. Suitable warning signs shall be placed near the beginning of the work site and well ahead of the work site for alerting approaching traffic from both directions.
- B. Place traffic cones along newly painted lines to control traffic and prevent damage to newly painted surfaces. Remove when paint has dried fully.
- C. Painting equipment shall be marked with large warning signs indicating slow moving painting equipment in operation.

PART 2 - PRODUCTS

2.1 PAVEMENT STRIPING

- A. Materials for pavement markings shall conform to MHD Specifications M7.01.03 (for White Thermoplastic Reflectorized Pavement Markings) and M7.1.04 (for Yellow Thermoplastic Reflectorized Pavement Markings)
- B. Paint shall be in sealed containers that plainly show the designated name, formula or specification number, batch number, color, date of manufacture, manufacturer's name, formulation number and directions, all of which shall be plainly legible at time of use.
- C. Paint shall be homogeneous, easily mixed to smooth consistency, and shall show no hard settlement or other objectionable characteristics during a storage period of six months.
- D. Paint color for handicap parking symbol, parking stall stripes, stop lines and other traffic related items shall be white traffic paint.

2.2 MARKING EQUIPMENT

- A. Machines, tools and equipment used in the application of pavement markings shall conform to MHD Specifications Section 860.60 and shall be approved and maintained in satisfactory operating condition.
- B. Push-type machines of a type commonly used for application of paint to pavement surfaces shall be acceptable for marking roadway and parking areas. Applicator machine shall have the necessary paint tanks and spraying nozzles, and shall be capable of applying paint uniformly at coverage specified. Hand-operated spray guns shall be provided for use in areas where push-type machines cannot be used.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. New pavement surfaces shall be allowed to cure for a period of not less than 48 hours before application of marking materials.
- B. Dust, dirt, and other granular surface deposits shall be removed by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods, as required. Rubber deposits, surface laitance, existing paint markings, and other coatings adhering to the pavement shall be completely removed using scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion, as directed.

3.2 PAVEMENT MARKING

- A. Marking materials shall be applied to clean, dry surfaces in accordance with the requirements of MHD Specifications Section 860.62.
- B. Paint shall be applied pneumatically with approved equipment.
- C. Pavement marking materials shall be applied evenly to the pavement surface to be coated at a rate specified in MHD Specifications Section 860.62.
- D. Guidelines and templates shall be employed as necessary to control paint application. Special precautions shall be taken in marking numbers, letters, and symbols.

- E. Edges of markings shall be sharply outlined.
- F. Maximum drying time requirements of the paint manufacturer shall be enforced to prevent undue softening of bitumen, and pickup, displacement or discoloration by vehicle tires.
- G. If markings require more drying time than stated by the paint manufacturer, painting operations shall be discontinued until cause of the slow drying is determined and corrected.

3.3 PROTECTION OF MARKINGS

- A. Markings shall remain protected in accordance with MHD Specifications Section 860.63.

END OF SECTION

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 32 30 00

SITE IMPROVEMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Instructions to Bidders, AIA Document A201, "The General Conditions of the Contract for Construction," 1997 Edition, the Supplementary General Conditions and Division 1, General Requirements, are a part of this Section and shall be binding on the Contractor and/or Subcontractor who performs this work. Note also all Addenda.

1.2 DESCRIPTION OF WORK

- A. Work Included: Providing and installing all site improvements shown on the Drawings and as specified herein, including:
 - 1. Project Signage and Posts
 - 2. Steel Bollards
 - 3. Flagpoles
 - 4. Chain Link Fences & Gates
 - 5. Board-on-board fencing and related hardware
 - 6. Site Benches

1.3 RELATED WORK DESCRIBED ELSEWHERE

- A. Carefully examine all of the Contract Document for requirements which affect the work of this Section. Other specifications which directly relate to the work of this Section include, but are not limited to, the following:
 - 1. Section 099000 – PAINTING
 - 2. Section 033000 – CAST-IN-PLACE CONCRETE
 - 3. Section 310000 – EARTHWORK
 - 4. Section 321216 – BITUMINOUS CONCRETE PAVING
 - 5. Section 321313 – CONCRETE PAVING
 - 6. Section 321600 – CURBS
 - 7. Section 329000 – LANDSCAPING

1.4 SUBMITTALS

- A. Shop Drawings: Contractor shall provide fully dimensioned shop drawings, manufacturer's technical literature, and material certificates for all improvements and confirm fabrication, reinforcing, and anchoring systems for approval.

PART 2 - PRODUCTS

2.1 PROJECT SIGNAGE

- A. 3/32" thick sign face - sheet aluminum signs in conformance with MHD Standard Specifications Section 828.42 Type A.
- B. Graphic image, text, and sign to conform to State Statute and project requirements (see drawings for schedule of graphics).
- C. Posts: Schedule 40, 2 1/2" tubular steel pipe, galvanized, and painted including fabricated dome cap.

- 2.2 METAL BOLLARDS: Schedule 40 galvanized seamless pipe including concrete core and schedule 40 galvanized steel dome welded to pipe and ground smooth. Install as per detail.
- A. Reflective tape, 3M, Reflexite, or approved equal.
 - B. Prime and paint. Colors to be approved. See Division 9.
- 2.3 CONCRETE: Sections 033000 and 321313.
- 2.4 FLAGPOLES shall be 25' (exposed height) Commercial ground set aluminum flagpoles, Model PT255C, as manufactured by POLE TECH, Inc., E. Setauket, NY, or approved equal.
- A. Aluminum 6063-T6 alloy seamless tubing with 30,000 psi (ASTM B241).
 - B. Finish: Dark bronze anodized.
 - C. Internal halyard winch system.
 - D. Ball: 14 gauge aluminum gold anodized - 6" diameter.
 - E. Collar: Standard spun aluminum, finish to match pole.
- 2.5 CHAIN LINK FENCE FABRIC
- A. Selvage: Knuckled on both selvages for all fabrics.
 - B. Steel Chain Link Fence Fabric: Fabricated in one piece widths for fencing 12 feet and less in height to comply with Chain Link Fence Manufacturers Institute (CLMI) "Product Manual" and with requirements indicated below.
 - 1. Thermally fused PVC coating, type 2B, 0.006 inches' minimum thickness.
 - 2. Fabric: 2-inch mesh, 9 gage galvanized steel core wire size, ASTM F668.
 - 3. Framework and Accessories/Components: finish per ASTM F1043, color to match fabric. Framework member's gages and sizes to comply with Paragraph 2.6.
- 2.6 CHAIN LINK FENCE FRAMING
- A. Round member sizes are given in actual outside diameter (OD) to the nearest thousandth of inches. Round fence posts and rails are often referred to in ASTM standard specifications by nominal pipe sizes (NPS) or the equivalent trade sizes in inches. The following indicates these equivalents all measured in inches:

<u>Actual OD</u>	<u>NPS Sizes</u>	<u>Trade Size</u>
1.315	1	1-3/8
1.660	1-1/4	1-5/8
1.900	1-1/2	2
2.375	2	2-1/2
2.875	2-1/2	3
4.000	3-1/2	4
6.625	6	6-5/8
8.625	8	8-5/8
 - B. All posts shall be of sufficient length to allow specified setting into concrete footings.

- C. Type II Round Posts: cold-formed, electric-welded steel pipe conforming to heavy industrial requirements of ASTM F 1043, Group IC, with minimum yield strength of 50,000 psi, either protective coating system below according to ASTM F 1043, and weights per foot as follows:

1. Coatings: Thermally fused PVC coating per ASTM F 1043. Color to match fabric. Interior of pipe to contain a minimum of 0.9 oz of zinc per sq. ft. or a minimum 0.3 mil thick, 87 percent zinc pigmented nominal coating, capable of providing galvanic protection.

Actual OD	Weight (lb/ft)	NPS Size
1.315	1.35	1
1.660	1.84	1-1/4
1.900	2.28	1-1/2
2.375	3.12	2
2.875	4.64	2-1/2
4.000	6.56	3-1/2

- D. Top Rail: Manufacturer's longest lengths (17 to 21 feet) with swaged-end or expansion-type coupling, approximately 6 inches long for joining. Provide rail ends or other means for attaching top rail securely to each gate corner, pull, and end post. Minimum length of any top rail section – 10' – 0".

1. Round Steel: 1.660 inch OD Type II steel pipe.

- E. Steel posts for fabric heights up to 6 feet:

1. Round Line or Intermediate Posts: 2.375 inch OD Type II steel pipe.
2. Round End, Corner, and Pull Posts: 3.00 inch OD Type II steel pipe.

- F. Steel posts for fabric heights over 6 feet:

1. Round Line or Intermediate Posts: 2.875 Type II steel pipe.
2. Round End, Corner, and Pull Posts: 4.00 inch OD Type II steel pipe.

- G. Swing Gate Posts: Furnish posts to support single gate leaf, or one leaf of a double-gate installation, according to ASTM F 900, sized as follows for steel and aluminum pipe posts:

1. Steel posts for fabric height over 6 feet and gate leaf width:
 - a. Up to and including 6 Feet wide: 4.0 inch OD pipe weighting at least 4.64 lb per ft.
 - b. Over 6 to 12 Feet: 4.000 inch OD pipe weighing at least 8.65 lb per ft.
 - c. Over 12 to 24 Feet: 6.625 inch OD pipe weighing at least 10.02 lb per ft.
 - d. Over 18 to 24 Feet: 8.625 OD pipe weighing at least 27.12 lb per ft.
 - e. Provide extra support as needed at corners.

2.7 CHAIN LINK FENCE FITTINGS AND ACCESSORIES

- A. Material: Vinyl coated per ASTM F 1043.

1. Preformed Units: Sizes to fit applications indicated, selected from manufacturer's standard thicknesses, widths, and lengths.
2. Aluminum: Die cast conforming to ASTM B 26, aluminum alloy 360 or sand cast conforming to ASTM B 85, aluminum alloy 365, ZG61A, or Tenzalloy.

- B. Post and Line Caps: Provide weathertight closure cap for each post. Provide line post caps with loop to receive tension wire or top rail. Base of Post Cap to override post a minimum of 2".

- C. Post Brace Assembly: Manufacturer's standard adjustable brace. Use material specified below for brace, and truss to line posts with 3/8-inch diameter rod and prefabricated adjustable tightener. Field bent applications are not accepted. Provide manufacturer's standard galvanized-steel, cast iron or cast aluminum cap for each end.
 - 1. Round Steel: 1-5/8 inch OD Type I or II steel pipe.
- D. Bottom, Auxiliary and Center Rail: Same material as top rail. Provide manufacturer's standard galvanized steel, cast iron or cast aluminum cap for each end. Bottom rails required on all fence systems 8' – 0" or more in height. Bottom and center rails required on all fences 10' – 0" or more in height.
- E. Tension or Stretcher Bars: Hot-dip galvanized steel with a minimum length 2 inches less than the full height of fabric, a minimum cross section of 3/16 inch by 3/4 inch, and a minimum of 1.2 oz. of zinc coating per sq. ft. Provide one bar for each gate and end post, and two for each corner and pull post, except where fabric is integrally woven into the post.
- F. Tension and Brace Bands: 3/4 inch wide minimum hot dip galvanized steel with a minimum of 1.2 oz. of zinc coating per sq. ft.
 - 1. Tension Bands: 0.074-inch-thick (14 gage) minimum.
 - 2. Brace Bands: 0.105-inch-thick (12 gage) minimum.
- G. Tension Wire: 0.177-inch diameter metallic coated steel marcelled tension wire conforming to ASTM A 824 with finish to match fabric. Bottom tension wire is required on all fences less than 8 feet in height.
- H. Tie Wires: 0.106-inch diameter (12 gage) galvanized steel with a minimum of 0.80 oz. per sq. ft. of zinc coating according to ASTM A641, Class 3 or 0.148-inch diameter (9 gage) aluminum wire alloy 1350-H19 or equal, to match fabric wire. Finish to match fabric.
- I. Drive Anchors: As manufactured by Anchor Fencing or approved equal.

2.8 CHAIN LINK FENCE GATE

- A. Fabricate perimeter frames of gates from same material and finish as fence framework. Assemble gate frames by mitering corners and welding, prior to galvanizing or finishing. Provide horizontal and vertical members to ensure proper gate operation and attachment of fabric, hardware, and accessories. Space frame members' maximum of 8 feet apart unless otherwise indicated.
 - 1. Fabric: Same as for fence unless otherwise indicated. Secure fabric at vertical edges with tension bars and bands and to top and bottom of frame with tie wires.
 - 2. Bracing: Install diagonal cross-bracing consisting of 1.660 o.d. pipe on all gates to ensure frame rigidity without sag or twist.

PART 3 - EXECUTION

3.1 JOB CONDITIONS

- A. Confirm completion of pavements and other improvements are properly sequenced prior to installation of specified improvements.

3.2 PROJECT SIGNAGE

- A. Install signs and posts at each designated location.
- B. Install signage plates and fabricated steel post/bollard assembly where and as detailed at handicap parking areas.
- C. Signs to be installed level and plumb, at a constant vertical alignment.

3.3 SITE FURNITURE:

- A. Install site furnishings (bike racks, ornamental benches, and player benches) where and as per manufacturer's recommendations.

3.4 CHAIN LINK FENCING

- A. Examine final grades and installation conditions. Do not start fence construction until satisfactory conditions are corrected.
- B. General: Install fence to comply with the project details and ASTM F 567. Do not begin installation and erection before final grading is completed, unless otherwise permitted.
 - 1. Apply fabric to outside of framework. Install fencing on boundary lines inside of property line established by survey as required by Division 1.

3.5 FLAGPOLES:

- A. Assemble and install flagpoles where indicated on drawings in accordance with manufacturers recommendations. Install concrete foundation with a minimum 5'-0" below finish grade. Conform to manufacturer recommendations.
- B. Hold top of flagpole foundation minimum 3" below bottom of concrete pavement.
- C. Install collar per manufacturer's recommendations.

3.6 BOLLARDS:

- A. Fabricate and finish bollards as detailed. Install bollards where and as detailed. Hold bollards at a constant alignment.
- B. Install collapsible bollards in concrete footings in accordance with manufacturer recommendations. Minimum depth 42" below finish grade. Hold top of footing 3" below bottom of adjacent bituminous concrete.

3.7 BENCHES WITH BACKS

- A. Install as shown in Drawings and per Manufacturer's instructions.
- B. Anchor bolts shall be set in concrete with non-shrink waterproof grout; if bolts are attached to base plates before grouting, care shall be taken to protect all furnishings' surfaces from grout.
- C. Contractor to touch up any scratches and all mars to surfaces or finishes.

3.8 FINISH

- A. Finish all wood construction with one coat of stain preservative as per manufacturer's recommendation

1. Acceptable products: Cabots or equal. Color to be approved by the Architect.

END OF SECTION

SECTION 33 00 00

SITE UTILITIES

PART 1 - GENERAL

1.1 GENERAL

- A. General Conditions, Supplementary Conditions and applicable parts of Division 1 form a part of this Specification and the Contractor shall consult them in detail for instructions.
- B. The Drawings on which this Contract is based are listed in Division 1. Consult all Drawings, note all conditions that may affect the Work and care for same in executing the Contract.
- C. Refer to Section 012300, Alternates for alternates, which may affect the work of this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. All labor, materials, and operations in connection with the installation of the Site Utilities Work.
 - 2. The principal work of this Section includes, but is not necessarily limited to the following:
 - a. Sanitary Sewers Off Site and On Site
 - b. Storm Drainage Systems including Detention/Retention Beds
 - c. Domestic Water Service Piping & Valves
 - d. Catch Basins and Manholes including Frames and Covers, Drainage control structures.
 - e. Concrete Encasement for Electrical Duct Bank
 - f. Transformer Pad constructed to conform to Utility Company Standards
 - g. Concrete Light Pole Bases to conform to detail on Electrical Drawings
 - h. Installation of Manholes and Handholes provided by the Electrical Contractor
 - i. Precast Concrete Oil/Water Separator as detailed on Plumbing Drawings.
 - j. Coordination of roadway closures and detours as well as furnishing of all police details, barriers, cones, etc. to safely complete work in roadway.
- B. The following related work is specified under the designated Sections:
 - 1. Section 210000 – FIRE PROTECTION
 - 2. Section 220000 – PLUMBING
 - 3. Section 260000 – ELECTRICAL
 - 4. Section 310000 – EARTHWORK
 - 5. Section 312319 – DEWATERING
 - 6. Section 312500 – EROSION AND SEDIMENTATION
 - 7. Section 321216 – ASPHALT PAVING
 - 8. Section 321313 – CONCRETE PAVING

1.3 REFERENCE STANDARDS, SPECIFICATIONS, AND CODES

- A. The following are hereby made a part of this SECTION by reference thereto:
1. All work installed under this SECTION shall comply with all Local, State, County and Federal Codes, Laws, Statutes, and Authorities having jurisdiction. Include any and all permit, connection, and/or inspection fees in the bid. Where the Contract Documents indicate more stringent requirements than the above Codes and Ordinances, the Contract Documents shall take precedence.
 2. Give all requisite notices and file all requisite plans relating to this work with the proper Authorities, secure all permits for this work, and pay all fees for same.
 3. All Site Utilities related materials and methods shall conform to the Commonwealth of Massachusetts Highway Department (MHD) Standard Specifications for Highways and Bridges, Latest Edition.

1.4 SUBMITTALS

- A. Submit for approval Shop Drawings for the following:
1. Precast Concrete Structures
 2. Piping of all description including Valves and Hydrants
 3. Frames and Covers

1.5 RECORD DRAWINGS

- A. Maintain on the site at all times one (1) set of black or blue line on white Drawings which shall at all times be accurate, clear and complete, showing the actual location of all piping and structures as installed in colored pencil.
- B. The Contractor shall, as part of the application for substantial completion, provide the Owner a set of "As-Built" drawings for the scope of work provided under this section. "As-Built" drawings shall be prepared and endorsed by a Massachusetts Registered Professional Engineer or Land Surveyor and shall bear the seal of such professional. Drawings shall depict, in relationship to the design plan, the "As-Built" condition of all the utility systems including but not limited to: Drainage, Sewer, Subsurface Sewage Disposal System, Electric, CATV, Telephone, Alarm, Data, Water and Underground Tanks. "As-Built" shall identify the location, elevations, pipe size, pipe material of all site utilities related to grade components.
- C. At project close out provide the services of an outside firm who shall run an underground video camera, locating all sanitary and storm drainage system lines including depth, preparing a video, and identifying and correcting any problem areas. Turn over 4 copies of the video and written report to the Owner. Videos are required for the underground sanitary and storm drainage systems including subsurface infiltration trenches.

1.6 CONTRACT DOCUMENTS

- A. It is the intent of these Specifications and Drawings to call for finished work, tested, and ready for operation. Any apparatus, appliance, materials, or work not shown on the Drawings but mentioned in the Specifications, or vice-versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be furnished, and installed.

- B. The Drawings are generally diagrammatic and are intended to convey the scope of work and indicate general arrangements of equipment, conduits, and piping. The locations of all items shown on the Drawings or called for in the Specifications that are not definitely fixed by dimensions or invert elevations are approximate only. If directed by the Architect, make reasonable modifications in the layout as needed to prevent conflict with other work or for proper execution of work.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Material and equipment for installation under this Section of the Specifications shall be new, unused, free of defects, and the best quality of a manufacturer of established reputation. Any defective or damaged material shall be immediately removed from the Site.
- B. Each piece of pipe, fitting, valve, etc., delivered under this Section of the Specifications shall have indelibly cast or marked thereon the manufacturer's name, trademark, pressure rating, and the date of manufacture.
- C. Specifications for materials included herein are intended for the purpose of establishing minimum quality requirements, and all materials are subject to approval by the Architect.

2.2 PIPING

- A. All piping installed for this job shall be marked with manufacturer's data indicating type, size, etc. Refer to Drawings for various pipe materials to be used on this project.

2.3 DETECTABLE UNDERGROUND WARNING TAPE

- A. Detectable warning tape shall be installed 12" directly above all buried utilities. Detectable warning tape shall consist of a nominal 4.5 mil (0.0045") overall thickness and 6" wide, with a solid aluminum foil core. The imprinted warning message is "Buried, or Encased" to prevent rub-off, and is impervious to acids, alkalis and other destructive elements found in soil. The imprint is as such that it allows for total reflectivity. A tape must be visibly seen before it can be read. The tape shall meet the testing requirements of ASTM D-882, Method A.
- B. Legend/Color & Imprint:

- 1. Tape shall read "CAUTION BURIED _____ LINE BELOW" with respective utility type indicated.
- 2. Tape color coding:
 - a. Electric – Red
 - b. Gas – Yellow
 - c. Water – Blue
 - d. Sewer – Green
 - e. Fiber Optic/Telephone – Orange
 - f. Storm Drain - Green

2.4 MANHOLE AND PRECAST CONCRETE STRUCTURE

- A. Manholes and precast concrete structures shall be constructed as shown on Drawings. Conform accurately to indicated dimensions.
 - 1. Precast concrete manhole barrel, base, and cone sections shall conform to ASTM C-478 and shall be furnished complete with integral cast aluminum polymer coated steel steps. Sections shall be assembled with Kentseal #2 gaskets, or equal.

2. Brick for constructing channels and adjustments to grade shall be waterstruck sewer brick, Grade 'A' concrete brick conforming to ASTM C-55, or precast concrete grade rings mortared in place.
3. Cement mortar for parging and for joining brick shall be made of one (1) part portland cement and two (2) parts sand mixed to the proper consistency. Add approximately twenty (20) pounds of hydrated lime for each sack of cement.
4. Precast concrete structures for pump chamber, acid neutralizer vault, grease trap, leaching pits, etc. shall be as manufactured by A. Rotondo & Sons, Inc. or equal by Scituate Concrete pipe or Shea precast. Structures shall conform to the form and dimensions shown, be reinforced with ASTM A-615-79 Grade 60 reinforcing steel having a minimum 1" cover, and constructed of 5,000 PSI concrete. All field joints shall be sealed with rubber gasket and shall be grouted with hydraulic cement for watertightness. Design loading for all structures shall meet H-20 wheel loading design criteria.

2.5 CONCRETE

- A. Conform to the Concrete Section of the specification for 4,000 PSI 6% air entrained concrete for all concrete structures for the work of this section. Including reinforcing steel where detailed.

2.6 FRAMES, COVERS, AND STEPS

- A. Cast iron manholes, frames, and covers, shall be of the form, dimensions, and manufacture shown on the Contract Drawings. Manhole extensions shall be neatly and accurately brought to dimensions of the base of the frame. Casting shall be of tough gray iron, free from cracks, holes, and cold shuts. All castings shall be made accurately to dimensions and shall be machined to provide even bearing surfaces. Covers must fit the frames in any position and, if found to rattle under traffic, shall be replaced. Filling to obtain tight covers will not be permitted. No plugging, burning-in, or filling will be allowed. All castings shall be carefully coated inside and out with coal tar pitch varnish of approved quality.
- B. Castings shall be as detailed on drawings or castings that appear on the Massachusetts Highway Department approval list for manhole frame & cover castings. Castings shall be by LeBaron Foundry, Neenah Foundry, or Campbell Foundry.

2.7 SAND BORROW

- A. Sand borrow meeting the gradation requirements of MassDOT M1.04.0 Type b shall be used as backfill around all water and natural gas piping.

2.8 CONTROLLED DENSITY FILL

- A. Controlled Density Fill shall be installed in lieu of gravel in utility trench backfills with the public right-of-way as required by the Town of Millbury.
- B. Controlled Density Fill (CDF) material is a flowable, self-consolidating, rigid setting, low density material that can substitute for compacted gravel in backfills, fills and structural fills.
- C. All ingredients shall comply with the following:
 1. Portland Cement: AASHTO M 85
 2. Fly Ash: AASHTO M 295 Class F
 3. Sand: M4.02.02
 4. Air Entraining Admixtures: M4.02.05
- D. Controlled Density Fill shall meet the material requirements of MassDOT M4.08.0 Type 2E

(Flowable (Excavatable)) with the following requirements:

1. Compressive Strength at 28 Days: 30-80 pounds per square inch (psi)
2. Compressive Strength at 90 Days: 100 pounds per square inch (psi) maximum
3. Slump: 10-12 inches

PART 3 - EXECUTION

3.1 GENERAL

- A. Furnish the services of a Registered Land Surveyor for layout of Site Utility Systems.
 1. Leaching trenches and manholes shall be established with offsets and grade. Establish line and grade for all piping. Provide additional control along the pipe runs by use of lasers. Grade stakes and batter boards are not acceptable except as may be used in conjunction with lasers.
- B. Verify inverts and locations of all existing utilities prior to installation of any work. Transmit above information to the Architect who shall make any alterations to the Contract Drawings as required by the existing conditions. Proceed with construction only after written permission from the Architect. If any work is installed without prior written notice of the Architect, and said work requires alteration due to existing conditions, said alterations shall be made by the Contractor at his expense.
- C. Protect all pipe lines, sewers, drains, poles, wiring and the like that interfere in any way with the work whether or not they are specifically shown on the Drawings. Notify the proper Authorities that items are protected, supported and/or relocated as necessary to adjust them to the new work.

3.2 PROTECTION, SHORING AND PUMPING

- A. Protect open excavations with fencing, warning lights and/or other suitable safeguards and as may be additionally required by the Authorities having jurisdiction.
- B. Protect bottom of excavation from frost. Do not place new work on frozen ground. Shore and brace excavation and provide sheet piling, if necessary, to prevent cave-ins and to conform to Local, State, and Federal Safety Regulations. Remove shoring and piling before backfilling is completed, but not until permanent supports are in place.
- C. Provide all necessary pumps, well points and pumping facilities, including attendants, to keep all excavation free from water from whatever source at all times when work is in progress and when necessary for protection and integrity of the work in place. Trenches shall be kept water-free during jointing and for sufficient time thereafter to allow the jointing material to become fully set and completely resistant to water penetration. Pump discharge to be in such a manner that it does not flood, interfere or damage any other area of work and meets with approval of Conservation Commission.

3.3 INSTALLATION OF PIPE

- A. Trenches shall be opened only to such extent as approved by the Architect and the total lengths of open trench shall be as short as practical at all times. Immediately upon opening of trench, pipe bedding shall be placed, compacted, and dressed as specified.
- B. Carefully examine each pipe length before laying, and do not lay defective or damaged pipe. Lay pipe lines to grades and alignment indicated. Provide proper facilities for lowering sections of pipe into trenches. Under no circumstances shall pipe be laid in water, and no pipe shall be laid when trench conditions or weather are unsuitable.

- C. Pipe laying shall proceed upgrade with spigot ends of bell-and-spigot pipe, and tongue ends of tongue-and-groove pipe pointing in direction of flow.
- D. Execute installation of flexible joints by placing gaskets and jointing materials in accordance with recommendation of particular manufacturer in regard to use of lubricants, cements, adhesives and other special installation requirements. Surfaces to receive lubricants, cements or adhesives shall be clean and dry. Affix gaskets and jointing materials to pipe not more than twenty-four (24) hours prior to installation of pipe and protect from sun, blowing dust, and other deleterious agents at all times. Gaskets and jointing materials so damaged shall be removed and replaced. Pipe shall be aligned with previously installed pipe and joint pulled together. If, while making joint, gasket or jointing material becomes loose and can be seen through exterior joint recess when joint is pulled up to within 1 inch of closure, pipe shall be removed and joint remade.

3.4 SLOPE TOLERANCE – SEWER PIPING

- A. Grade tolerance of the flow line of sewer pipe shall not exceed ± 0.05 feet. In addition, in any twenty-five-foot (25') length, the total variation (plus or minus) from flow line grade shall not exceed the following:
 - 1. One-quarter of an inch (0.25") in four inch (4") or smaller pipe.
 - 2. Three-quarters of an inch (0.75") in six- through twelve-inch (6"-12") pipe.
 - 3. One inch (1") in fifteen- through thirty-six-inch (15"-36") pipe.

3.5 SLOPE TOLERANCE – STORM DRAIN

- A. The elevation of the pipe invert for storm drain pipe shall not deviate from the design elevation by more than plus or minus two percent ($\pm 2.0\%$) of the pipe size concern, or one inch (1"), whichever is greater. The rate of deviation from grade or returning to grade shall be limited to one-sixteenth of an inch (1/16") per foot (1') of pipe.

3.6 FLANGED JOINTS

- A. Flanged joints shall be made with full faced one-piece gaskets of best quality cloth inserted sheet rubber at least 1/16 inch thick and all flanges shall be made up evenly and perfectly tight. Bolts and nuts shall be of best quality wrought iron or mild steel with hexagonal heads and nuts and of proper size and length.

3.7 ANCHORAGE AND THRUST BLOCKING

- A. All plugs, caps, tees, and bends on water and fire services deflecting 11-1/2 degrees or more and at other locations where there will be an unbalanced thrust in the line shall be provided with a concrete thrust block or anchorages to prevent movement. Concrete thrust blocks shall be in accordance with the details on the plans. The excavation shall be carried out by hand at such locations to provide a good bearing against undisturbed soil within a short distance from the fitting. The use of joint harnesses in place of anchorage and thrust blocks shall be subject to the approval of the Architect both as to location and to details of the harness. Harnesses shall utilize galvanized rods, nuts and bolts.
- B. Where bends turn down and the resulting thrust will be upward, provision to restrain the thrust shall be made either with concrete anchorages, joint harnesses, or a combination of both.
- C. Insofar as possible, thrust blocking and anchorages shall be so placed that the pipe and fitting joints will be accessible for repair. Concrete from thrust blocks shall conform to the requirements of CONCRETE Section of the Specification for 4,000 PSI, 6% air entrained concrete.

3.8 VALVES

- A. Valves and valve boxes shall be set plumb with valve boxes directly over the valves.

3.9 CATCH BASINS, MANHOLES, AND OVERFLOW STRUCTURES

- A. Catch basins and manholes shall be built accurately to dimensions. Brickwork shall be laid by skilled workmen. Inverts shall have a cross section of the sewers which are connected, and changes in size, grade or lines shall be made gradually and evenly.
- B. The top of the brickwork shall be brought to the dimensions of the flange of the manhole frame. Adequate precautions shall be taken in freezing weather to protect the masonry from damage by frost. Particular care shall be taken that no water rises on the masonry until the mortar is thoroughly set and any brick masonry damaged in this manner shall be removed upon the order of the Contractor.
- C. All pipes or casting to be embedded in brickwork shall be accurately set, and if so required, headers shall be laid around the casting so embedded.
- D. Cement plaster for plastering exterior of brick or block walls shall be 1:2 cement and sand mortar.
- E. The outside of brickwork on all manholes shall be plastered with 3/4" thick coat of Portland cement mortar mixed in the proportions of one (1) part cement to two (2) parts of sand. Plaster shall be troweled to a smooth hard finish, and no backfill shall be placed until mortar has thoroughly hardened.
- F. After the plaster has hardened, exterior walls of sanitary manholes shall be painted with two (2) coats of Bitumastic 300M, as manufactured by the Carboline Company, or approved equal. All work shall be in accordance with the manufacturer's instructions.
- G. Upon completion, all debris shall be removed from manholes.
- H. The entire work of constructing manholes shall be carried on in a manner to insure watertight work, and any leaks in manholes shall be caulked and repaired, or the entire work shall be removed and rebuilt. Attention is particularly called to the necessity of keeping the water below all parts of the brick or concrete foundation and walls until the cement has obtained adequate set.

3.10 TESTS

- A. Provide all labor, materials, and equipment for performing all test as herein specified or required by Local Authorities.
- B. Sanitary and storm sewers shall be tested as follows:
 - 1. If any inspection of the completed sewer or any part thereof shown any manholes, pipes or joints which allow the infiltration of water in a noticeable stream or jet, the defective work shall be replaced or repaired as directed.
 - 2. After the sewers have been laid and otherwise completed, infiltration or exfiltration test shall be made to demonstrate that the line will satisfactorily meet the conditions prevailing in place with leakage not in excess of 375 gallons/day per inch of diameter per mile of pipe.
 - 3. Rate of infiltration shall be determined by means of V-notch weirs or pipe spigot in an approved manner and at such times and locations as may be directed by the Architect during the progress of the work. Provide and install weir plates or other materials

- required and at such time and locations as may be directed by the Architect.
4. Perform an air test as per manufacturer's recommendation and report result to Architect and Town of Millbury.
 5. All joints shall be inspected and inspection of line and grade shall be made with mirrors and lights. Alignment for both line and grade shall be true with full circles visible at manholes.

C. Test Water Piping as follows:

1. When a section of pipe is ready for testing, the line shall be completely filled with water thoroughly checked for elimination of all air, and a leakage test made.
2. All pipe lines shall be tested under a hydrostatic pressure of 200 pounds per square inch on the highest part of the section under test.

D. Sewer Manhole Exfiltration Test:

1. Plug pipes in manhole; remove water in manhole; observe plugs over period of not less than 2 hours to ensure there is no leakage into manhole.
2. Fill manhole with water to within 4 inches of top of cover frame. Prior to test, allow manhole to soak from minimum of 4 hours to maximum of 72 hours; after soak period, adjust water level inside manhole to within 4 inches of top of cover frame.
3. Measure water level from top of manhole frame; at end of 4 hour test period, again measure water level from top of manhole frame; compute drop in water level during test period.
4. Manhole exfiltration test is considered satisfactory when drop in water level is less than values listed in table below:

Manhole Depth (feet)	Allowable Leakage (Inches for Manhole Diameter)		
	4 feet	5 feet	6 feet
4	0.11	0.14	0.17
6	0.17	0.21	0.26
8	0.23	0.29	0.35
10	0.28	0.35	0.42
12 <	0.34	0.43	0.51

5. When unsatisfactory test results are achieved, repair manhole and retest until result meets criteria; repair visible leaks regardless of quantity of leakage.

3.11 CHLORINATION OF PIPE LINES

- A. During the installation of the water main, install flushing, insertion, and test ports in the water main so that the entire main from the point of connection to the street main, up to the water meter and or the sprinkler shutoff, shall thoroughly be chlorinated, flushed, and tested in accordance with the requirements of AWWA B300, B301, B302, B303, and AWWA C.651 Standards for disinfecting water mains and the Local Water Department Standards.
- B. Prior to chlorinating, notify the Architect in writing that the water service main has been properly installed and pressure tested. Using the services of a qualified Testing Lab, extract and analyze the existing water supply to establish a water quality baseline of the existing Municipal Supply. After the disinfection procedures, submit test results of the mains installed hereunder which tests shall be performed by the same Lab.
- C. Sterilization - All water lines shall be thoroughly flushed and chlorinated before being put into service.
- D. Methods - Chlorine may be applied by the following methods subject to approval; liquid chlorine gas-water mixture, direct chlorine gas feed or calcium hypochlorite and water

mixture.

- E. Point of Application - The chlorinating agent shall be applied at the beginning of the reach, adjacent to the source of supply for filling. The chlorine shall be applied through a corporation cock or other approved connection to the newly laid pipe.
- F. Rate of Application - The water from the source of supply shall be controlled to flow very slowly in the newly laid pipe during the application of the chlorine which shall be applied in amounts such as will produce a dosage of at least 40 to 50 parts per million. In the event that the pipe line is already filled, the dose shall be increased to such concentration and shall be applied for a sufficient period to produce a residual of not less than 25 parts per million at all of the outlets within the reach being chlorinated, including the terminus of the reach.
- G. Retention Period - Treated water shall be retained in the pipe long enough to destroy all non-spore containing bacteria. The period shall be at least twenty-four (24) hours and preferably longer, as may be directed. After the chlorine-treated water has been retained for the time required, the chlorine residual at pipe extremities and other intermediate points shall be at least twenty-four parts per million.
- H. Back Pressure to be Prevented - Back pressure causing a reversal of flow from the section being chlorinated to the supply shall be prevented.
- I. Chlorination Valves and Accessories - In the process of chlorinating newly laid pipe, all valves and other pipe line accessories shall be operated while the pipe is filled with chlorinating agent.
- J. Final Flushing and Dose - Following chlorination, and after the entire length of line is ready for operation, all treated water shall be flushed thoroughly from the newly laid pipe line, at its extremities, until the replacement water throughout its length will upon test, both chemical and bacteriological, be proved equal to the quality introduced at the permanent source of supply.
- K. Repetition of Procedures - Should the initial treatment prove ineffective, the chlorination procedure shall be repeated as directed until conformed tests show that water from the newly laid pipe conforms to the requirements of the preceding Section.
- L. Liquid Chlorination - Chlorine gas-water mixture shall be applied by the means of a solution-feed chlorinating device. Chlorine shall be fed directly from a chlorine cylinder equipped with suitable device for regulating the rate of flow and the effective diffusion of gas within the pipe. Calcium hypochlorite shall be comparable to commercial products known as "H.T.H.", "Perchlolen" and "Maxochlor". A solution consisting of 5% of powder to 95% of water by weight should be prepared. The calcium hypochlorite and water mixture, first made into a paste and then thinned to a slurry shall be injected or pumped unto the newly laid line under the conditions specified hereinbefore.

3.12 FLUSHING

- A. The contractor shall flush the fire service from the connection at the street main to the sprinkler shutoff valve within the building at 10 feet per second (ft/sec), meeting the requirements of NFPA 24, latest edition.

END OF SECTION

SECTION 31 13 00

TREE PRUNING, REMOVALS, AND TRANSPLANTING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.
- B. Under this Section, the Contractor shall furnish all labor, materials, equipment and transportation required to complete all aspects of the work in accordance with all local, state and federal regulations in force at the time of this Contract and in accordance with the various Items specified herein.
- C. The work of this Section consists of all tree pruning and removal work and related Items as specified herein and includes, but is not limited to:
 - 1. Crown Cleaning;
 - 2. Crown Raising (only as needed for required clearances);
 - 3. Crown Reduction (only if needed for health or safety);
 - 4. Crown Thinning (only if needed for health or safety);
 - 5. Crown Training (only if appropriate on new plantings);
 - 6. Tree Removal;
 - 7. Tree Transplanting (where indicated).
- D. All work in this section shall be performed by a Massachusetts Certified Arborist. (See 1.02, Qualification of Arborist, below.)
- E. All trees to be pruned or removed are located on the site. All trees indicated shall be inspected by the Arborist and Landscape Architect before work is to be done. In addition to trees indicated for removal on the Drawings, trees should be removed for the following reasons: dead trees, hazardous trees, or trees in serious decline, as determined by a certified Arborist. If the Arborist discovers tree(s) which have not been marked for removal and are intended for pruning, but whose condition is such that removal is warranted, whether due to death, disease, decay, damage, or structural weakness, such tree(s) shall not be pruned and the Arborist shall immediately report these findings in writing to the Owner and await the Owner's direction before proceeding with work on the particular tree(s) in question.
- F. The intent of this portion of the Contract is to identify trees that should be removed while pruning all remaining indicated trees on the site to provide safety, protection of property,

clearance of roadways, walks, buildings, play equipment, and luminaries, and to improve the overall structure of the trees.

- G. The Contractor is required to review and inspect the site regarding trees to be removed (as indicated on the Drawings) prior to bid proposal in order to form his/her own assumptions as to the ultimate cost of the work.

1.2 QUALIFICATION OF ARBORIST

- A. Work on this section of the Contract shall be limited to individuals, partnerships and corporations who are actively engaged in the field of Arboriculture, and who demonstrate competence, experience and financial capability to carry out the terms of this project. Subcontractors must derive a majority of their income from arboricultural work. The Owner may require proof of these qualifications.
- B. Unless otherwise approved by the Owner, all work shall be conducted by qualified and trained personnel under the direct supervision of a Massachusetts Certified Arborist, in good standing. A Massachusetts Certified Arborist must be on site at all times during any pruning operations. The Contractor shall be required to provide proof of certification.
- C. Any subcontractor hired by the General Contractor to perform any portion of the work shall meet all qualifications herein and be acceptable to the Owner.

1.3 SPECIAL REQUIREMENTS

- A. Dutch elm disease wood (if any) shall be disposed of in accordance with provisions of General Laws, Chapter 87, Section 5, and Chapter 132, Section 8 and 11 as amended; and in accordance with any additional local regulations. Wood suspected of infestation with Asian Longhorn Beetle or Emerald Ash Borer (if any) shall be brought to the attention of the Town Arborist. All wood shall be removed from the site and be properly disposed of in accordance with state and local regulations.
- B. No burning is permitted on the project site.
- C. Prior to commencing work, the Contractor shall submit a plan for legal disposal of removed materials, acceptable to the Owner.

1.4 STANDARDS AND DEFINITIONS

- A. Pruning and Removals shall conform to the following:
1. American National Standards Institute (ANSI): Standard A300-2001 Standard Practices for Tree Care Operations – Tree, Shrub and Other Woody Plant Maintenance.

2. American National Standards Institute (ANSI): Standard Z-133.1.-2001 Safety Requirements for Tree Care Operations – Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and Cutting Brush
 3. All other applicable Occupational Safety and Health Administration (OSHA) standards, and state and local regulations.
- B. American National Standards Institute- (ANSI) is the private, non-profit organization that administers the safety and maintenance regulations for the Tree Care Industry.
 - C. Crown Cleaning- The removal of dead, diseased, obstructing, split, and/or broken branches that are 2 inches in diameter or greater. Limbs that are susceptible to failure from dense or heavy foliar masses should be thinned.
 - D. Crown Raising- The removal of lower tree branches to allow safe movement of vehicles and pedestrians under the canopy of the tree. Limbs above sidewalks shall be no lower than 10 feet from the ground. Limbs over the road shall be no lower than 16 feet from the ground. Limbs near or above play equipment shall be no closer than 84" to the nearest portion of the play equipment.
 - E. Crown Reduction- The technique used to reduce the overall mass of the tree by thinning out the top and sides or just removing individual limbs of the tree. Reduction pruning is commonly associated with pruning away from buildings, structures, signs, lights and other overhead obstructions.
 - F. Crown Thinning- The selective removal of branches to increase light penetration and air movement. No more than 25% of the tree's living branches shall be removed.
 - G. Crown Training- A pruning process that utilizes all the major pruning types to promote a strong central leader and strong scaffold branches on recently planted trees.
 - H. D.B.H.- Diameter at breast height. The location on a tree 4.5 feet above ground where the diameter of the tree is measured.
 - I. Massachusetts Certified Arborist- (MCA) An individual who is listed by the Massachusetts Arborist Association as a MCA who has passed a comprehensive exam and maintained their certification through the accumulation of continuing education credits.
 - J. Occupational Safety & Health Administration- (OSHA) is the Federal agency responsible for insuring worker safety.
 - K. Owner- the individual or designated representative responsible insuring the requirements of this Contract are adhered to.

1.5 EXAMINATION OF SITE AND DOCUMENTS

- A. The Contractor shall be responsible for having a clear understanding of the existing conditions of the site before submitting a bid for this Contract and shall be responsible

for fully carrying out the work of the Contract, regardless of actual site conditions encountered.

1.6 ORDER OF WORK

- A. Before any work is started, the Contractor shall attend a conference with the Owner and the Landscape Architect. All trees to remain shall be pruned to provide safety, protection of property, clearance of roadways, walk, buildings and luminaries, and to improve the overall structure of the tree. The type of pruning to be performed includes but is not limited to crown cleaning, crown raising, crown reduction, crown thinning, and crown training. At this conference the Owner will also establish the order of precedence for carrying out the work.
- B. Based on the conference, the Contractor shall submit a schedule of work for the Owner's review and approval prior to beginning work. Any changes to this schedule must be approved by the Owner. Unless otherwise authorized by the Owner, failure of the Contractor to comply with the approved pruning and removal schedule shall be sufficient cause to give notice that the Contractor is in default of the Contract and will result in its termination. Unless otherwise authorized by the Owner, the Contractor must complete ALL pruning work within 40 business days from the notice to proceed.

1.7 CHANGES IN THE WORK

- A. The Owner reserves the rights to change, add, or delete areas or quantities to be pruned or removed as deemed to be in the Town's best interest.
- B. No claim for extra compensation or extension of time will be allowed on account of actual conditions inconsistent with those assumed by the Contractor.
- C. Any alterations or modifications of the work performed under this contract shall be made only by written agreement between the Contractor and the Owner. No claims for extra work or materials shall be allowed unless covered by written agreement.

1.8 PROTECTION OF VEGETATION TO BE PRESERVED

- A. The Contractor shall protect all existing trees, shrubs and lawns designated to remain for the length of the construction period. The placement of protection devices, such as snow fence enclosures, shall, however, be at the Contractor's discretion except those required by the Owner per the Drawings and 01 57 00.
- B. Damage no plant to remain by burning, by pumping of water, by cutting of live roots or branches, or by any other means. No plants to be saved shall be used for crane stays, guys or their fastenings. Vehicles shall not be parked within the dripline of trees to remain, or wherever damage may result to trees to be saved. Construction material shall not be stored beneath trees to be saved.

- C. The Contractor shall be liable for any damage to any tree, shrub or lawn to remain, and shall immediately report to the Owner for appraisal of any damage and for determination of corrective treatment of compensation to the Owner.
- D. The Contractor shall compensate the Owner for damages by installing replacement tree(s) of the size and species approved by the Town, and of sufficient quantity such as the sum of the DBH inches for replacement trees equals the total DBH inches of the damaged tree(s). Damaged shrubs shall be replaced with shrub(s) of the same size, species, and quantity, unless determined otherwise by the Owner.
- E. Damaged shrubs or lawns shall be restored or replaced to match existing to remain to the satisfaction of the Owner, at no cost to the Owner.
- F. See also 01 56 39, Temporary Tree and Plant Protection, for further instruction on Tree Protection measures required.

PART 2 - MATERIALS

2.1 EQUIPMENT AND MATERIALS

- A. Equipment necessary for this Contract shall be properly maintained and in good operating condition to the Town's satisfaction. The Contractor shall promptly remove and replace any equipment which the Owner deems to be in unsatisfactory repair or condition or otherwise unsuitable.
- B. At the discretion of the Owner, if the equipment failures, breakdowns or other related problems occur that are jeopardizing the meeting of deadlines established in the written schedule provided by the Contractor, the Contract will be terminated.
- C. Vehicles shall display prominently the Contractor's name, address, and telephone number on both doors.
- D. Aerial lift equipment shall be required for pruning and removal work unless otherwise approved by the Owner. Such equipment shall have a minimal working height of fifty-five (55) feet, and shall include an articulated upper boom, insulated lower boom, a ten to fifteen (10-15) cubic yard enclosed hydraulic dump body, pintlehook and attachments for a towed chipper, or approved equal.
- E. A chipper, meeting all OSHA requirements, shall be used which will process material up to twelve (12) inches in diameter.
- F. A crane or log loader shall be used on site to remove logs too large to be chipped.

2.2 PERSONNEL

- A. The Contractor shall submit each employee's name and title prior to the commencement of work. The Contractor shall provide a list of all Massachusetts Certified Arborists who will be working on this contract. This list shall include the names of those individuals and

their certification number. The Contractor shall advise the Owner of any changes in the roster assigned to this contract.

- B. A crew shall consist of a minimum, one (1) tree trimmer/ climber, and one (1) ground person (one of which shall be a crew foreman and a Massachusetts Certified Arborist in good standing). The crew foreman shall have a minimum of five (5) years climbing and pruning experience.
- C. Each worker shall be experienced and highly qualified with necessary tree work skills to successfully complete this contract, including the ability and training to perform aerial rescue. Said skill shall also include worker safety and ability to be in compliance with current OSHA and ANSI Z-133.1 Standards.

PART 3 - EXECUTION

3.1 DESCRIPTION OF WORK

- A. Each tree to be pruned shall be serviced according to the following types of pruning, as needed: Crown Cleaning, Crown Raising, Crown Reduction, Crown Thinning and Crown Training.
- B. The Contractor shall adhere to the specifications and provide suitable facilities for inspecting the work. Failure of the Owner to immediately reject unsatisfactory work or to notify the Contractor of deviations from the Specifications shall not relieve the Contractor of responsibility to correct or remedy unsatisfactory work.
- C. The Contractor shall only work on trees designated by the Owner. No compensation will be made for work performed on any other trees.
- D. If the Contractor discovers tree(s) which have been marked for pruning, but whose condition is such that removal is warranted, whether due to death, disease, decay, or structural weakness, such tree(s) shall not be pruned and the Contractor shall report these findings to the Owner, in writing, within 24 hours, and await the Owner's direction before proceeding with work on the particular tree(s) in question.
- E. Tree removal is generally described as the removal of individual trees that have been found to be dead, hazardous, and/ or otherwise marked for removal by the Owner.

3.2 USE AND CARE OF THE SITE

- A. The Contractor shall leave the work site at the end of each working period in a condition satisfactory to the Owner.
- B. Pavements shall be swept and lawns or other surfaces raked or otherwise cleaned of all material related to the work operation. Degree of clean up required will be described by the Owner at the Pre-construction Conference and will be based upon the character of the work area.

- C. All trimmings or any other form of debris shall be collected, chipped, hauled and disposed of properly in accordance with all applicable laws at the Contractor's expense.
- D. No overnight parking of equipment will be allowed without express permission.

3.3 PRUNING PROCEDURES AND QUALITY CONTROL

- A. All pruning shall be performed in manner which maintains the natural aesthetic characteristics of the species and variety of trees. No topping or dehorning of trees or stubbing back of branches shall be permitted. All cuts shall be made to a lateral branch a minimum of one third (1/3) the size of the branch being removed, unless otherwise instructed by the Owner.
- B. The use of climbing spurs or spiked shoes shall not be permitted for pruning trees and their use will result in immediate cancellation of the Contract. They are only permitted during tree removal operations and emergency aerial rescue operations.
- C. All cuts shall be made sufficiently close to the parent stem so that wound closure can be readily started under normal conditions. Cuts shall never be made through the branch collar. Slab cuts, rip cuts and all other cuts that do not meet the most current edition of the ANSI A300 pruning standard will result in cancellation of the Contract.
- D. Luminaries and proper elevation over street and sidewalk surfaces to at least the following minimum specifications:
 - 1. Sidewalk/Paths – All branches shall be pruned to allow a minimum ten (10) foot clearance over sidewalks and paths, including proposed new paths.
 - 2. Luminaries – Any and all branches extending directly below a street light, limiting the light reaching the street or path shall be removed and all branches shall be cut back to afford a minimum four (4) foot clearance.
 - 3. House/Building – All branches shall be pruned to allow a minimum of five (5) foot clearance away from homes and buildings, or if possible ten (10) foot clearance where trees will not be severely disfigured due to crown reduction, this shall be determined by the Town Arborist.
 - 4. Street/Roads – All branches shall be pruned to allow a minimum sixteen (16) foot clearance over street surface.
- E. All limbs over two inches in diameter to be removed shall be precut to prevent splitting. Any branches that would injure the tree or other objects by falling shall be lowered to the ground by proper rigging and rope procedures.
- F. Remove one of two crossed or rubbing branches where practical so the removal will not leave large holes in the general outline of the tree.
- G. On trees known to be diseased, tools are to be disinfected with alcohol after each cut between trees and where there is known to be a danger of transmitting the disease on tools.

- H. Lateral branches as well as occasional water sprouts may be retained. Complete removal of secondary laterals and water sprouts resulting in the stripping of major limbs, will not be permitted.

3.4 REMOVAL PROCEDURES AND QUALITY CONTROL

- A. Trees designated to be removed shall be taken down and all leaves, branches and trunks of trees properly disposed of by chipping or removal from the premises.
- B. Trees are to be felled in such a manner that does not injure trees to be saved or endangers or harms the public and adjacent property.
- C. Removal of all parts of each tree, excluding the stump, shall be completed on the same day that the removal process is started, including the trunk (or butt) of the tree.
- D. Stump removal shall consist of grinding the stump and any roots to a depth of six inches below grade and the disposal of the wood waste. The area or tree pit is to be left at the finish grade using the specified planting mix that meets the requirements laid out in section 32 90 00. Unless otherwise approved by the Owner, the stump must be removed within ten (10) business days from the date the above ground portion of the tree is removed.

3.5 TRANSPLANTING PROCEDURES AND QUALITY CONTROL

- A. All trees to be transplanted shall be pruned per section 3.3, either before or after transplanting at the Arborist's discretion. If pruning is performed before transplanting, additional pruning may be required after transplanting is completed in order to correct any damage incurred during the transplanting operation.
- B. Tree transplanting shall occur only when the ground is not frozen or otherwise in an unsatisfactory condition for working, after leaf fall and before bud break on deciduous trees. This shall be between October 15th to December 1st, or from March 1st to April 15th, unless otherwise directed by the Landscape Architect.
- C. Trees less than 10" in DBH may be hand dug or machine dug using a suitably sized hydraulic tree spade. Trees 10" DBH or greater may not be moved by a mechanical tree spade, and require root pruning and special digging considerations.
- D. Root Ball Size
 - 1. In all cases, the diameter of the ball of native soil to be preserved intact shall be at least 10 times the DBH unless otherwise approved by the Landscape Architect in writing.
 - 2. The depth of the root ball shall be sufficient to preserve the majority of large roots characteristic of the given tree growing in that particular soil type as determined by the Arborist in consultation with the Landscape Architect.

3. Unless otherwise specified, the depth shall be approximately 60% of the ball diameter for root balls up to 80 inches in diameter, and a minimum of 48" for root balls greater than 80" in diameter.

E. Transplant Location:

1. The new locations to receive transplants shall be marked for approval by the Landscape Architect prior to digging the trees.
2. In all cases, these pits shall be dug and prepared prior to completion of final digging of transplant trees. Excavated topsoil and subsoil shall be set aside in separate piles for backfilling use, if deemed suitable by the Landscape Architect.
3. Pits shall be thoroughly watered on the day of transplanting, prior to receiving plants.

F. Transplant Pit Diameter And Depth:

1. Where a Tree Spade is used, the excavated hole may be made with the same spade as will be used to excavate and remove the tree, and shall be the same diameter and depth as the intended root ball of the transplanted tree.
2. Where a tree spade is not used, the diameter shall be a minimum of 40" larger than the intended diameter of the root ball.

G. Transplanting Procedure

1. All precautions customary in good trade practice shall be taken in preparing plants for transplanting. Workmanship that fails to meet the highest standards will be rejected, and the Contractor shall be responsible for the replacement of any trees which failed and which were not provided with proper workmanship.
2. For trees of 10" or greater DBH, Root Pruning shall be executed at least one calendar year (except as specifically waived by the Landscape Architect, and in all cases at least one season) prior to the proposed transplanting.
3. Prior to transplanting, the Contractor shall tie a flag of cloth or plastic ribbon to a branch to mark the north side of the plant as a guide for positioning the plant in the new location. The orientation of the tree shall be preserved after transplanting.
4. If necessary to facilitate positioning of equipment and help avoid injury to the tree, tying up the branches of low-branched plants using heavy twine or burlap strips is allowable, provided that it is approved in advance by the Landscape Architect. Each point of contact of twine on tree trunks or branches shall be protected with burlap.
5. The tree shall be excavated, moved, and transplanted, taking care to avoid damage to the branches and trunk. The tree shall be protected as necessary with burlap or protective padding.
 - a. If a tree spade is used, the root ball shall be excavated, moved, and planted in one operation, without opening and reclosing of the spade, so as to keep the root ball contained.

- b. If a tree spade is not used: The ground shall be cleanly cut along the approved line of the root ball to a minimum depth of 12". The ground outside this line shall be trenched to a minimum width of 20", and as deep as necessary to shape a root ball of the approved size. All remaining woody roots outside the line shall be cleanly cut with a saw, sharp spade, or other approved means. The root ball shall be securely contained by wrapping in burlap secured tightly with "drum-laced" twine; a wooden "soil crate"; or other approved means which will ensure a solid, secure root ball. The tree shall then be moved by crane, winch, or other approved means to the new location, handled so that the ball will not be loosened or broken.
- 6. In a ring extending 20" from the edge of the root ball, the top 8" of soil shall be loosened, and mycorrhizal fungi mixture shall be spread evenly in this zone at a rate of one 85g packet per 8 square feet and thoroughly incorporated.
- 7. The new location shall be backfilled as needed, loamed, mulched, staked, and antidessicant applied, as described in Section 32 90 00, Planting.
- 8. Exposed roots SHALL NEVER be allowed to dry out. If for any reason the plant will sit with roots or root ball exposed, the roots shall be protected by packing them in moist straw, sphagnum, peat moss, bark, or other suitable material, and then wrapping with moist burlap. No plant shall sit above ground for longer than a normal work day. Heeling in of plants in other than their final locations shall not be permitted unless specifically approved by the Landscape Architect and the Owner.

3.6 SAFETY

- A. All equipment to be used and all work to be performed must be in full compliance with all standards as promulgated by OSHA at the time of bidding, including, but not limited to those regulations concerning noise levels, protective devices and operator safety.
- B. The Contractor shall be solely responsible for pedestrian and vehicular safety and control within the work site and shall protect the public and its property from injury or damage that could be caused by the progress of the work. To this end the Contractor shall post all work areas. The Contractor must also provide police details and / or erect and maintain protective devices acceptable to the Town Arborist or Tree Warden, including but not limited to barricades, lights and warning signs.
- C. Any practice employed by the Contractor that is obviously hazardous, as determined by the Town Arborist or Tree Warden, shall be immediately discontinued.

3.7 FINAL ACCEPTANCE

- A. Upon completion of the work the Contractor shall notify the Owner in writing and request that a final inspection for acceptance be made.

END OF SECTION

SECTION 32 14 00

UNIT PAVING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The conditions and general requirements of the Contract, Division 0 and Division 1, apply to the work under this Section.
- B. All references to products by manufacturer, trade name or performance Specifications bearing the connotation "or Approved Equal" shall be as determined by the Owner's Representative and the City, per MGL c. 30 s. 39M, part b, criteria 1.

1.2 WORK INCLUDED

- A. Provide all labor, equipment, implements and materials required to furnish, install, construct and perform all paving operations complete as shown on drawings and specified herein.
- B. Work includes, but is not limited to the following:
 - 1. Precast Concrete Unit Pavers

1.3 REFERENCES

- A. Examine all other sections of the Specifications and all Drawings for the relationship of the work under this Section and the work of other trades. Cooperate with all trades and all departments of the Town of Bedford and coordinate all work under this Section.
- B. The following related items are included under the Sections list below:
 - 1. Section 02 41 00 – Site Preparation and Demolition
 - 2. Section 31 00 00 – Earthwork
 - 3. Section 32 32 53 – Stone Retaining Walls

1.4 DEFINITIONS

- A. The following related items are included herein and shall mean:
 - 1. S.S.H.B. – Standard Specifications for Highways and Bridges, the Commonwealth of Massachusetts, Department of Public Works, latest edition.
 - 2. A.S.T.M. – American Society for Testing and Materials.

- a. D2047 Standard Test Method for Static Coefficient of Friction of Polish-Coated Floor Surfaces as Measured by the James Machine.
 - b. E303 Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester.
 - c. D3389 Abrasion Testing.
 - d. DIN 1835 Part 6-Permeability to Water.
 - e. U. S. Environmental Protection Agency Method 3052:1996.
 - f. D-256 Impact Strength
 - g. D-638 Tensile Strength
 - h. D-790 Flexural Modules
3. A.A.S.H.T.O. – American Association of State Highway and Transportation Officials.
4. FEDERAL STANDARD 191 A METHOD 5804 – Textile Test Methods for Ultraviolet and Weathering.

1.5 JOB CONDITIONS

- A. Start of work under this Section shall constitute acceptance of the foundation conditions to which this work is to be applied. Any defects in work resulting from such conditions shall be corrected under this Section, at no extra cost to the Owner.
- B. Maintain sub-base in satisfactory condition and properly drained until surface improvement is placed.

1.6 SUBMITTALS

- A. Do not order materials or begin installation of work of this Section until Owner approval of submittals of all products has been obtained.

PART 2 - PRODUCTS

2.1 PRECAST CONCRETE PAVERS

- A. Precast Concrete Pavers to be Boston Colonial Pavers by Ideal Concrete Block; Hollandstone 4x8 by Unilock; or Approved Equal.
 - 1. Pavers to meet ASTM C 936 and CSA Standard for freeze thaw performance.
 - 2. Pavers to have a minimum compressive strength of 8500 psi.
 - 3. Pavers sizes to be 4" x 8" x 2 3/4"

4. Paver color to be selected by the Landscape Architect from the products full color range.

B. Sand for Setting Bed

1. Setting bed sand shall be a sharp, washed concrete sand, conforming to ASTM C-33. It shall be free of deleterious soluble salts or foreign matter, symmetrically shaped, natural or manufactured from crushed rock.

C. Sweep joints with Polymeric Sand:

1. Polymeric sand shall be composed of:
 - a. Silica crystalline, quartz: 60-100%
 - b. Non-hazardous polymer: <5%
 - c. Portland cement mixture <5%
2. Sand for sweeping paver joints to be manufactured for high traffic areas that may be exposed to excessive moisture. Polymeric sand shall harden when misted and shall be waterproof within 90 minutes of misting.
3. Landscape Architect to select sand color from available color options.

PART 3 - EXECUTION

3.1 PRECAST CONCRETE PAVERS

- A. Prepare processed graded gravel base. Compact subbase in 6" lifts, uniformly to at least 95+ percent of Standard Proctor Density per ASTM D 698 for pedestrian areas.
- B. Place masonry sand and screed it un-compacted to the grade and profile required, with a uniform depth of 1-1/2". Place only as much sand as can be paved the same day; if any of it should become disturbed or compacted, such as by traffic or rainfall then rake and re-screed as above.
- C. Install pavers by the pattern indicated in the Drawings. Pavers shall be fitted together as closely as possible, with maximum joint spacing no larger than 1/8".
- D. Cut pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit as joining work neatly. Hammer cutting is not acceptable.
- E. Tamp pavers with a high-frequency, low-amplitude plate vibrator until the sand is compacted, the cobblestone are uniformly true to grade and free of movement, and all lipping has been eliminated. Protect top of pavers from scuffing during compaction by utilizing an urethane pad. Remove any cracked or structurally damaged pavers and replace with new pavers prior to installing Joint Sand material.
- F. Install Polymeric Joint Sand per manufacturer's recommended instructions.

G. Remove excess dirt, debris, stains, grit, ect. From exposed paver surfaces; wash and scrub clean.

H. Perform cleaning during installation and upon completion of paving work. Remove from site all excess materials, debris, and equipment. Repair damage resulting from playground paving painting.

3.2 CLEANING

A. Waste disposal: Comply with all regulations regarding handling, storage, and disposal of all hazardous materials and waste. Consult local agencies or disposal companies for individual instructions and requirements. Improper disposal of paint and their related materials is illegal and may result in large fines. Please comply with all regulations and minimize waste whenever possible.

B. Perform cleaning during installation and upon completion of paving work. Remove from site all excess materials, debris, and equipment. Repair damage resulting from playground paving painting.

3.3 GRADE STAKES

A. Install and maintain grade stakes, as directed. All subgrades must be approved before base course construction.

3.4 FINISH GRADES

A. The words "finish grades" as used herein mean the required final grade elevations.

END OF SECTION

SECTION 32 32 53

STONE RETAINING WALLS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.
- B. All references to products by manufacturer, trade name or performance Specifications bearing the connotation "or Approved Equal" shall be as determined by the Landscape Architect and the Owner, per MGL c. 30 s. 39M, part b, criteria 1.

1.2 WORK INCLUDED

- A. Provide all labor, equipment, implements and materials required to furnish, install, construct and perform all site improvements complete as shown on the Drawings and specified herein.
- B. To be included, but not limited to the following:
 - 1. Fieldstone Walls

1.3 REFERENCES

- A. Examine all other Sections of the Specifications and all Drawings for the relationship of the work under this Section and the work of the other trades. Cooperate with all trades and all departments of Watertown Housing Authority and DHCD, and coordinate all work under this Section.
- B. The following related items are included under the Sections listed below:
 - 1. Section 02 41 00 – Site Preparation and Demolition
 - 2. Section 31 00 00 – Earthwork
 - 3. Section 32 14 00 – Unit Paving

1.4 SUBMITTALS

- A. Shop Drawings and Samples
 - 1. Provide complete Shop Drawings and/or samples and catalog cuts for all items called for on the Drawings and as specified and in accordance with applicable requirements under Division 1.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original unopened and undamaged packages with labels legible and intact.
- B. Store materials in unopened packages in a manner to prevent damage from the environment and construction operations.
- C. Handle in accordance with manufacturer's instructions.
- D. The Contractor shall be solely responsible for all materials stored on the site once delivered. Any materials left unsecured at the job site shall be solely at the contractor's own risk.

PART 2 - PRODUCT

2.1 FIELDSTONE WALL

- A. Fieldstone walls to be vernacular-style rubble stone walls ("farm walls") as shown on drawings and similar in character to other stone walls in the neighborhood. Contractor to provide samples of all items called for on the Drawings and as specified for approval before beginning work.
- B. Materials:
 - 1. Fieldstone: uncoursed rubble with rounded corners. Provide sample for approval by Landscape Architect.
 - 2. Mortar to be Type N, Landscape Architect to select mortar color.
- C. Weep hole to be 1.5" schedule 40 PVC pipe. Color to be black or grey. Set weeps back in joints to minimize appearance.
- D. Filter Fabric to be Mirafi 140N or approved equal.
- E. Mockup: Contractor shall build 6 ft. sample section of the wall in place for approval by Landscape Architect before continuing work.

PART 3 - EXECUTION

3.1 FIELDSTONE WALLS

- A. Install as shown in Drawings.
- B. Maintain uniform tight joints.
- C. Mortar to be deep raked.
- D. Upper layer of wall to be made of full width stones.

- E. Weep holes should be recessed and located between stone joints to minimize their visibility. Space approximately every 4' depending on wall joint locations.

3.2 GRADE STAKES

- A. Install and maintain grade stakes, as directed. All subgrades must be approved before base course construction.

3.3 FINISH GRADES

- A. The words "finish grades" as used herein mean the required final grade elevations.

3.4 CLEANING

- A. Waste disposal: Comply with all regulations regarding handling, storage, and disposal of all hazardous materials and waste. Consult local agencies or disposal companies for individual instructions and requirements. Improper disposal of paint and their related materials is illegal and may result in large fines. Please comply with all regulations and minimize waste whenever possible.
- B. Perform cleaning during installation and upon completion of paving work. Remove from site all excess materials, debris, and equipment.

3.5 STANDARDS AND COMPLETION

- A. Upon completion, the contractor(s) shall remove and properly dispose of all construction debris, surplus materials, and empty containers, and leave the site in a condition acceptable to the Owner.

END OF SECTION

THIS PAGE INTENTIONALLY
LEFT BLANK

SECTION 32 33 00

SITE FURNISHINGS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.
- B. All references to products by manufacturer, trade name or performance Specifications bearing the connotation "or Approved Equal" shall be as determined by the Landscape Architect and the Town, per MGL c. 30 s. 39M, part b, criteria 1.

1.2 WORK INCLUDED

- A. Provide all labor, equipment, implements and materials required to furnish, install, construct and perform all site improvements complete as shown on the Drawings and specified herein.
- B. To be included, but not limited to the following:
 - 1. Flagpole & Lighting
 - 2. Peastone Drip Edge

1.3 REFERENCES

- A. Examine all other Sections of the Specifications and all Drawings for the relationship of the work under this Section and the work of other trades. Cooperate with all trades and all departments of the Town and coordinate all work under this Section therewith.
- B. The following related items are included under the Sections listed below:
 - 1. Section 03 30 00 - Cast In Place Concrete
 - 2. Section 32 14 00 – Unit Paving

1.4 SUBMITTALS AND SHOP DRAWINGS

- A. Electronically submit shop drawings, product literature, catalog cuts and / or samples for all items indicating material characteristics, fabrications, details of construction, connections and relationship with adjacent construction, called for on the Drawings and as specified and in accordance with applicable requirements under Division 1. If not submitting above materials electronically, submit (5) complete copies.

- B. Do not order materials or begin installation of Work of this Section until Owner's / Landscape Architect's approval of submittals has been obtained. Delivered materials shall closely match approved samples.

1.5 SAMPLES

- A. Initial Selection Samples: Submit samples showing complete range of colors, textures and finishes available for each material used.

1.6 PRODUCT LITERATURE

- A. For each product or material used, submit manufacturer's product data, including installation instructions, use, limitations and recommendations.

1.7 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original unopened and undamaged packages and containers with labels legible and intact.
- B. Store and handle materials in accordance with manufacturer's instructions. Prevent damage and deterioration of products from the environment and construction operations.
- C. Handle in accordance with manufacturer's instructions.

1.8 JOB CONDITIONS

- A. Examine all surfaces to receive site improvements to see that they are in proper condition to receive the Work specified. Report to the Engineer in writing all unacceptable areas. All defects resulting from use of accepted surfaces shall be corrected by the appropriate Contractor at no additional expense to the Owner.
- B. Start of Work under this Section 12 93 00 shall constitute acceptance of the site conditions to which this Work is to be applied. Site preparation shall be of proper approved quality. Any defects in Work resulting from such conditions shall be corrected under this Section, at no extra cost to the Owner.
- C. Environmental Requirements: Contractor shall not Work on or with soils when they are dry, wet, or frozen. Field Test: Form soil in palm of hand; if soil retains shape and crumbles upon touching, then it may be worked (if it will not retain its shape, it is too dry; if it does not crumble, it is too wet). Landscape Architect shall be final authority on condition of soil.

1.9 DEFINITIONS AND STANDARDS

- A. The following items are included herein and shall mean:

1. A.S.T.M. - American Society for Testing and Materials. The following standard specifications are applicable to the associated items as listed.
 - a. A 36: Specifications for Structural Steel.
 - b. A 48-83: Specifications for Gray Iron Castings.
 - c. A 153...Zinc Coating (hot-dip) on hardware
 - d. A 307: Specifications for Unfinished Bolts and Nuts.
 - e. A 446, GRADE A: Specifications for Steel Sheet.
 - f. A 500-501: Specifications for Structural Tubing.
2. CPSC - Consumer Product Safety Council.
3. AWS: American Welding Society
4. SSPS: Steel Structures Painting Council

1.10 WARRANTIES

- A. Attention is directed to provisions of the CONDITIONS OF THE CONTRACT and applicable parts of Division 1 regarding guaranties and warranties.
- B. Manufacturers shall provide their standard guaranties for Work specified in the Section. However, such guaranties shall be in addition to and not in lieu of all other liabilities which manufacturers and Contractor may have by law or by other provisions of the Contract Documents.

1.11 QUALITY ASSURANCE

- A. Comply with applicable codes, ordinances and regulations. Provide products of acceptable manufacturer's which have been in satisfactory in similar service for three years. Use experienced installers.

PART 2 - PRODUCT

2.1 FLAGPOLE

- A. Flagpole shall be a winch-type concealed halyard flagpole made from one piece of all new seamless 6063-T6 aluminum tubing with uniform conical taper.
 1. Aluminum to have soft sheen, maintenance-free finish.

B. Flagpole components shall be:

1. Foundation Sleeve: fabricated from #16 gauge galvanized steel, with a square base plate equal to the internal dimension of the sleeve plus 3 inches, a 6" square set plate below the base plate, and a ground spike no shorter than 18".
2. Collar: Spun aluminum type FC11 ornamental flash collar finished to match shaft.
3. Winch: Gearless stainless steel direct drive winch internally mounted on a rotator plate system. Winch shall be accessible via a locked door fitted to a flush-mounted, reinforced cast aluminum frame, operable with a removable handle inserted through the access door.
4. Halyard: Stainless steel concealed halyard assembly with internal swivel, connected to sized stainless steel cable flag arrangement, two chrome swivel snaps, coated counterweight, coated steel cable retainer ring, and stainless steel links.
5. Truck: Cast aluminum revolving concealed halyard truck with stainless steel ball bearings and a stainless steel sheave.

2.2 PEASTONE DRIP EDGE

- A. Stone to be semi round and smooth to touch (not angular or sharp).
- B. Stone should be washed and be free of plant debris, organic matter, soil and other deleterious materials.
- C. Sieve Analysis

AGGREGATE GRADATION

US Sieve No.	Percent Passing by Weight
1/2"	100
3/8"	85-100
#4	10-30
#8	0-10
#16	0-5

- D. Color to be Brown / Tan. Submit sample(s) to Landscape Architect for approval.
- E. Steel edging to be 1/4" x 5" secured with 15" long stakes by Ryerson (or approved equal). Color to be black or unpainted metal as selected by Landscape Architect.
- F. Filter Fabric to be Mirafi 140N or approved equal.

PART 3 - EXECUTION

3.1 FLAGPOLE

- A. Flagpole installation detail shall be reviewed and stamped by a Structural Engineer retained by the Contractor before installation.
- B. Install Flagpole according to the manufacturer's directions and per the Drawings.

3.2 PEASTONE DRIP EDGE

- A. Peastone to be set on a 4" base of compacted dense graded gravel (95% compaction).
- B. Peastone to be installed flush with surrounding surfaces (walkways, mow strips, etc.) at a depth of 4" and should be tamped evenly into place.
- C. Steel edge to be installed per manufacturer's instructions.
- D. Steel edge to be used where ever peastone surface is adjacent to lawn, plant bed, or similar softscape.

END OF SECTION

THIS PAGE INTENTIONALLY

LEFT BLANK

SECTION 32 90 00

PLANTING

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. The conditions and general requirements of the Contract, Division 0 and applicable parts of Division 1, apply to the work under this Section.
- B. All references to products by manufacturer, trade name or performance Specifications bearing the connotation "or Approved Equal" shall be as determined by the Landscape Architect and the Town.
- C. Contractor shall comply with all laws, regulations, and quarantines for agricultural and horticultural products.

1.2 WORK INCLUDED

- A. The work of this Section consists of the provision of all materials, labor, equipment and the like for the complete execution of all lawn establishment by sodding and related items as indicated on the Drawings and/or as specified herein.
- B. Work includes but is not limited to the following:
 - 1. Topsoil (loam borrow), fine grading and loaming;
 - 2. Plant Materials;
 - 3. Soil additives;
 - 4. Mulch;
 - 5. Hydroseeding Lawn Seed Mix;
 - 6. Maintenance, watering, and protection of plantings until final acceptance.

1.3 SPECIAL CONDITIONS

- A. No burning will be permitted on the project site.
- B. Prior to commencing work, the Contractor shall submit a plan for legal disposal of removed materials, acceptable to the Owner.

1.4 REFERENCES

- A. Examine all other Sections of the Specifications and all Drawings for the relationship of the work under this Section and the work of other trades. Cooperate with all other trades and all departments of the Town and coordinate all work under this Section therewith.
- B. Related items include but are not limited to work under the Sections listed below:
 - 1. Section 01 57 00 – Environmental Protections
 - 2. Section 02 41 00 – Demolition and Site Preparation
 - 3. Section 31 00 00 – Earthwork
 - 4. Section 32 10 00 – Bases, Ballast, Paving and Edging

1.5 SUBMITTALS

- A. Prior to ordering the below listed materials, submit representative samples to Owner's Representative for selection and approval, in accordance with requirements of General Condition and special provisions as follows. Do not order material until Owner's Representative approval has been obtained. Delivered materials shall closely match the approved samples.
 - 1. Topsoil: The Contractor shall provide a one (1) cubic foot representative sample from each proposed source for testing and approval as directed by the Landscape Architect. The Contractor shall deliver samples to testing laboratory prior to any loaming and shall have the testing report sent directly to the Owner's Representative, and pay all costs.
 - a. Mechanical and chemical (pH soluble salts) analysis shall be by public extension service agency or a certified private testing laboratory in accordance with the current standards of the Association of Official Agricultural Chemists.
 - b. Report shall be submitted at least one (1) month before any loaming is to be done. Soil tests shall be for Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Aluminum, Soluble Salts, and Lead, and show acidity and USDA classification of the soil.
 - 2. Submit a written guarantee of conformance to specifications for seed mixes.
 - 3. Submit material specifications and installation instructions where applicable attesting that soil additives meet the requirements specified.

1.6 DEFINITIONS

- A. The following related items are included herein and shall mean:
 - 1. S.S.H.B.: The Commonwealth of Massachusetts, Department of Public Works, Standard Specifications for Highways and Bridges, latest edition

2. A.O.A.C.: Association of Official Agricultural Chemists

3. A.A.N.: American Association of Nurserymen

1.7 PRODUCT DELIVERY AND HANDLING

- A. All topsoil, whether from stockpiles on site or loam borrow, shall be stored in piles not to exceed six feet in height, and shall not be handled when frozen or not in a friable condition.

1.8 CERTIFICATION OF ACCEPTANCE AND GUARANTEE

- A. The Contractor shall be responsible for maintenance until the LATER of: the acceptance of the project as substantially complete, or 90 days after installation. After the minimum ninety (90) day maintenance period and substantial completion of the project, the Contractor shall request of the Owner's Representative, in writing, an inspection to determine whether the lawns and plantings are acceptable. If the plant material and workmanship are acceptable, written notice will be given by the Owner's Representative to the Contractor stating that the guarantee period begins from the date of the Certificate of Acceptance. Acceptance shall be given only for the entire lawn area covered by the Contract, and for all plantings.
- B. Lawns shall exhibit a uniform, thick, well-developed stand of grass, which has received a minimum of three cuttings. Lawn areas shall have no bare spots in excess of four inches in diameter, and bare spots shall comprise no more than two percent of the total area of the lawn. No lawn areas shall exhibit signs of damage from erosion, washouts, gullies, or other causes.
- C. Lawns, shrubs, and perennials shall be guaranteed for a period of one calendar year after inspection and acceptance and shall be alive and in satisfactory growth at the end of the guarantee period. Trees 3" caliper or greater shall be guaranteed for a period of two calendar years after inspection and acceptance.
- D. At the end of the guarantee period, inspection will be made again. Any lawn area or planting covered under this contract that is dead or unsatisfactory shall be replaced according to the planting seasons called for herein, until the lawn or planting lives through one guarantee period. A final inspection for acceptance will be made after the replacement plantings have lived through one guarantee period. Contractor shall test soil and add fertilizer and lime as needed in the fall after installation.
- E. All replacements shall be the same turf mix (seed) or species and cultivar (plantings) as originally installed and accepted. The cost shall be borne by the Contractor.

1.9 SITE CONDITIONS

- A. All areas to be planted shall be inspected by the Contractor before starting work and any defects such as incorrect grading, etc., shall be reported to the Owner's Representative prior to beginning this work. The commencement of work by the Contractor shall

indicate his acceptance of the areas to be planted and he shall assume full responsibility.

- B. Environmental Requirements: Contractor shall not work on or with soils when they are dry, wet, or frozen. Field Test: Form soil in palm of hand; if soil retains shape and crumbles upon touching, then it may be worked (if it will not retain its shape, it is too dry; if it does not crumble, it is too wet). Owner's Representative shall be final authority on condition of soil.

1.10 PROTECTION

- A. The Contractor shall be liable for any damage to property caused by the work, and all areas disturbed shall be returned to their original condition to the satisfaction of the Owner's Representative. During all work of this section, the Contractor shall protect all site improvements from contact with agricultural chemicals, soil amendments, and fertilizers.
- B. The Contractor shall provide all erosion, sedimentation, and environmental controls necessitated by site and governing codes.
- C. Damage no plant to remain by burning, by pumping of water, by cutting of live roots or branches, or by any other means. No plant to be saved shall be used for crane stays, guys, or their fastenings. Vehicles shall not be parked within the dripline of trees to remain, or wherever damage may result to trees to be saved. Construction material shall not be stored beneath trees to be saved. See Drawings for Tree Protection.

PART 2 - PRODUCTS

2.1 TOPSOIL/LOAM

- A. Loam shall be a "fine sandy loam" or a "sandy loam" determined by mechanical analysis and based on the USDA classification system. It shall be of uniform composition, without admixture of subsoil. It shall be free of stones greater than one inch, lumps, plants and their roots, debris and other extraneous matter over one inch in diameter or excess of smaller pieces of the same materials as determined by the Owner's Representative. It shall not contain toxic substances harmful to plant growth. Loam shall contain not less than 4% nor more than 10% organic matter as determined by the loss on ignition of oven-dried samples. Test samples shall be oven-dried to a constant weight at a temperature of 230 F, plus or minus 9.
- B. Loam shall have an acidity range of pH 5.6 to pH 6.5.
- C. The amount of either sulfur or limestone required to adjust the planting loam to the proper pH range (above) shall be determined by the Owner's Representative on the basis of soil tests as specified herein.
- D. Soil tests for this area shall be through the University of Massachusetts Amherst Cooperative Extension Soil Testing Laboratory, with recommendations for both

Grasses/Lawns and Trees/Shrubs, or Approved Equal testing service (submit proposed alternative before testing).

2.2 PLANT MATERIALS

- A. The Contractor shall furnish and plant all plants shown on the Drawings, as specified, and in quantities listed on the Plant List. No substitutions will be permitted. All plants shall be nursery-grown unless specifically authorized to be collected.
- B. Plants shall be in accordance with the USA Standard for Nursery Stock of the American Association of Nurserymen, latest edition.
- C. All plants shall be typical of their species or variety and shall have a normal habit of growth and be legibly tagged with the proper name. Only plant stock grown within the hardiness Zones 1 through 6, as established by the United States Department of Agriculture, will be accepted. The Contractor's suppliers must certify in writing that the stock has actually been grown under Zone 6 or hardier conditions for a minimum of 2 years. Plants not so certified will not be accepted.
- D. The root system of each shall be well provided with fibrous roots. All parts shall be moist and show active green cambium when cut. They shall be sound, healthy, and vigorous, well-branched and densely foliated when in leaf. They shall be free of disease, insect pests, eggs or larvae.
- E. All plants must be moved with the root systems as solid units with balls of earth firmly wrapped with untreated eight (8) ounce burlap, firmly held in place by a stout cord or wire. The diameter and depth of the balls of earth must be sufficient to encompass the fibrous and root feeding system necessary for the healthy development of the plant. No plant shall be accepted when the ball of earth surrounding its roots has been badly cracked or broken preparatory to or during the process of planting or after the burlap, staves, ropes or platform required in connection with its transplanting have been removed. The plants and balls shall remain intact during all operations. All plants that cannot be planted at once must be heeled in by setting in the ground and covering the balls with soil and then watering them.
- F. The caliper of the trees shall be not less than the minimum size designated. Take caliper measurement six inches (6") above ground level up to and including four (4") caliper size and twelve inches (12") above ground for larger sizes. The trunk of each tree shall be a single trunk growing from a single unmutated crown of roots. No part of the trunk shall be conspicuously crooked as compared with normal trees of the same variety. The trunk shall be free from sunscald, frost cracks, or wounds resulting from abrasions, fire or other causes. No pruning wounds shall be present having a diameter exceeding two inches (2") and such wounds must show vigorous bark on all edges. Plants shall not be pruned prior to delivery.
- G. Plants delivered by truck and plants requiring storage on site shall be properly wrapped and covered to prevent wind-drying and desiccation of branches, leaves or buds; plant balls should be firmly bound, unbroken, reasonably moist to indicate watering prior to delivery and during storage and tree trunks should be free from fresh scars and damage in handling. No trees with double-leaders or twin-heads shall be acceptable without the written approval of the Owner's Representative. The Contractor shall reject such plants

at time of delivery by the nursery/supplier unless such plants were selected by the Owner's Representative as indicated by tags and seals. No plant material from cold storage will be accepted.

2.3 SOIL ADDITIVES

- A. Soil additive use shall be only as permitted under the Order of Conditions within resource areas.
- B. Commercial fertilizer, humus or other additives shall be used to counteract soil deficiencies as recommended by the soil analysis and as directed by the Owner's Representative.
 - 1. Commercial fertilizer shall be a product complying with the State and United States Fertilizer Laws. Deliver to the site in the original unopened containers which shall bear the manufacturer's Certificate of Compliance covering analysis which shall be furnished to the Owner's Representative. At least 50% by weight of the Nitrogen content shall be derived from organic materials. Fertilizer shall contain the percentages of weight of ingredients as follows, or as recommended by the soil analysis when that is significantly different:

<u>Nitrogen</u>	<u>Phosphorus</u>	<u>Potash</u>	
10%	10%	10%	For all plants

- C. Ground dolomite limestone shall be an approved agricultural limestone containing not less than 85% of total calcium or magnesium carbonates. Limestone shall be ground to such fineness that 50% will pass through a 100 mesh sieve and 90% will pass through a 20 mesh sieve.
- D. Humus shall be natural humus, reed peat or sedge peat. It shall be free from excessive amounts of zinc, low in wood content, free from hard lumps and in a shredded or granular form. According to the methods of testing of A.O.A.C., latest edition, the acidity range shall be approximately 5.5 pH to 7.6 pH and the organic matter shall be not less than 85% as determined by loss on ignition. The minimum water absorbing ability shall be 200% by weight on an oven-dry basis.
- E. Superphosphate: Superphosphate shall be composed of finely ground phosphate rock as commonly used for agricultural purposes containing not less than 18% available phosphoric acid.
- F. Water retention gel shall be used where appropriate. Mix with soil per manufacturer's directions.

2.4 BARK MULCH

- A. Mulch for planting beds and tree pits shall be pine bark aged a minimum of six (6) months. The mulch shall be dark brown in color, free of chunks and pieces of wood thicker than one-quarter inch (1/4"). Mulch must be free of stringy material over three

inches (3") in length and shall not contain, in the judgment of the Owner's Representative, an excess of fine particles. Mulch shall be 98% organic matter with the pH range of 3.5 to 4.5. Moisture content of packaged material shall not exceed 35%. Submit sample for the Owner's Representative's approval.

- B. Non diseased and non invasive woody material to be removed shall be chipped and spread on disturbed areas (at edges of wooded areas) not to receive new lawn or seed, paving, or other finishes; locations to be as directed by Owner's Representative in field. Excess woods chips shall be removed from site.

2.5 WOOD CELLULOSE FIBER MULCH

- A. Mulch to cover hydroseeded areas shall be fiber processed from whole wood chips manufactured specifically for standard hydraulic mulching equipment. Fiber shall not be produced from recycled material such as sawdust, paper, or cardboard.
- B. Moisture content shall not exceed 10%, plus or minus 3%, as defined by the pulp and paper industry standards. Fiber shall have a water holding capacity of not less than 900 grams water per 100 grams fiber.
- C. The mulch shall be of such character that the fiber will be dispersed into a uniform slurry when mixed with water. It shall be nontoxic to plant or animal life.
- D. For Lawn areas, the mulch shall contain a non-petroleum based organic tackifier and a green dye to allow for easy visual metering during application but shall not be injurious to plant growth. Tackifier shall be Hydrotack or approved equal. (Wildflower Mix and Restoration Mix areas are not expected to include a tackifier due to seed suppliers' recommendations for the respective seed mix.)

2.6 LAWN GRASS SEED MIX

- A. Seed Mix shall be "Black Beauty Ultra" by Jonathan Green Co. of Reading, PA or Approved Equal low-fertilizer-requirement mix designed to minimize need for irrigation.
- B. Grass seed for lawn areas shall be fresh, clean, dry, new crop seed, which meets the standard of the Federal Seed Act. Seed shall be mixed in proportion by weight and testing the minimum percentages of purity and germination. Seed shall be nursery grown seed composed of grasses grown from the following seed mixtures.

Lawn Areas:

<u>Approx % by Wt.</u>	<u>Common Name of Grass</u>	<u>% Germination</u>
70	Tall Fescues	92
20	Perennial Ryegrass	92
10	Kentucky Bluegrass	85

- C. Weed seed shall not exceed 0.1% by weight. Tall Fescue shall be a mix of "Tonto," "Montana," "Dorado," or similar cultivar tall fescues. Bluegrass shall be "Madison," "Deepblue," "Prosperity," or similar cultivar Kentucky bluegrass. Perennial Rye shall be "Frontier," "Singular," or similar cultivar Perennial Ryegrass.

2.7 INSECTIDE

- A. No insecticide shall be used except as specifically approved in writing by the Owner's Representative and the Owner's Representative.

2.8 WATER

- A. The Contractor shall be responsible to furnish his/her own supply of water to the site at no extra cost.
- B. All work injured or damaged due to the lack of water, or the use of too much water, shall be the Contractor's responsibility to correct. Water shall be free from impurities injurious to vegetation.
- C. All new or transplanted trees shall be furnished with a Portable Drip Irrigation System (PDIS) water bag, "Gator Bags" or Approved Equal. PDIS water bags shall be UV-treated, reinforced polyethylene bags with a nylon toothed zipper extending from top to bottom of bag, capable of holding a minimum of 20 gallons of water, constructed so that they can be attached to the trees, which provide water from a minimum of three drip points.

PART 3 - EXECUTION

3.1 FINE GRADING AND LOAM

- A. After the areas to be loamed have been brought to subgrade, and immediately prior to dumping and spreading the loam, the subgrade shall be loosened by disking or rototilling to a depth of at least three inches (3") to permit bonding of the loam to the subsoil. Remove all stones greater than two inches (2") and all debris or rubbish. Such material shall be removed from the site.
- B. Loam shall be placed and spread over approved areas to a depth sufficiently greater than six inches (6") so that after natural settlement and light rolling, the completed work will conform to the lines, grading and elevations indicated. Supply additional loam, after testing and approval, as may be needed to give the specified depths and finished grades under the contract without additional cost to the Owner.
- C. No subsoil or loam shall be handled in any way if it is in a wet, dry, or frozen condition.
- D. Sufficient grade stakes shall be set for checking the finished grades. Grades shall be established which are accurate to one-tenth (1/10th) of a foot either way. Connect contours and spot elevations with an even slope.
- E. After lime, fertilizer, and humus if required have been spread and incorporated into the bed, it shall be carefully prepared by scarifying or harrowing and hand raking. All large stiff clods, lumps, brush, roots, stumps, litter and other foreign matter, and stones over one inch (1") in diameter shall be removed from the loam. Loam shall also be free of smaller stones in excessive quantities as determined by the Owner's Representative.

- F. The whole surface shall then be rolled with a hand roller weighing not more than 100 lbs. per foot of width. During the rolling, all depressions caused by settlement or rolling shall be filled with additional loam and the surface shall be regraded and rolled until presenting a smooth and even finish to the required grade. The finish grades shall be inspected by the Owner's Representative for approval before final acceptance.

3.2 PLANTING

- A. Furnishing and planting of any plant material includes the digging of the holes, provision of soil additives and loam, furnishing the plants of specified size with roots in the specified manner, the labor of planting and mulching and guying and staking where called for.

1. For transplanting of existing plant material, see Section 02960, "Tree Pruning, Removal, and Transplanting."

B. Season for Planting

1. Spring:

- a. Deciduous materials March 21 through May 15
- b. Evergreen materials April 15 through June 1

2. Fall:

- a. Deciduous materials October 1 through December 1
- b. Evergreen materials August 15 through October 15

C. Planting

1. Location for all plants and outlines for planting areas shall be staked on the ground by the Contractor for approval by the Owner's Representative before any plant pits or plant beds are dug.
2. At least fifteen (15) days prior to the expected planting date, the Contractor shall request that the Owner's Representative provide a representative to select and tag stock to be planted under this Section. The Contractor shall provide for the transportation and overnight accommodations, if necessary, for the Owner's Representative's representative during the period of time required to select and tag the plant material, at no extra cost to the Owner.
3. Plants shall be selected by the Owner's Representative at the place of growth for conformity to specification requirements as to quality, size, and variety. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work. Cost of replacement shall be borne by the Contractor.
4. Plant pits shall be circular pits with sloping sides, except for plants specifically indicated to be planted in beds. Holes for trees and shrubs shall be at least two feet

- (2') greater in diameter than the ball, and shall be at least three (3) times the diameter of the ball for trees where space allows, and shall be of a depth that maintains the plant's prior relation to finish grade. Bottom of pit shall be flat or deepest at the perimeter. If pit is dug deeper than required to maintain plant's relation to finish grade, then soil replaced under rootball shall be compacted to prevent subsequent settling of tree or shrub. If soil at bottom of pit is impermeable or poorly drained, pit shall be dug one extra foot, backfilled with planting soil mix, and compacted before installing plant.
5. After excavation, fill pit twice successively with water. If water does not drain out of pit at a minimum of two inches per hour, provisions for drainage must be made. Contractor shall document drainage test results for review by Owner's Representative.
 6. Topsoil, organic material and fertilizer mix for planting soil mix shall be thoroughly premixed in the proportions of one (1) part of organic material with four (4) parts of topsoil together with fertilizer at the rate determined by soil test. The organic material to be added shall be as directed by the Owner's Representative. One part of existing soil shall be mixed with two parts of planting soil mix for use in backfilling around rootball. Maintain at all times during the planting operations one or more stockpiles of approved planting soil mix.
 7. Install slow release fertilizer packets per manufacturers' directions with each newly planted tree.
 8. All plant roots and earth balls must be damp and thoroughly protected from sun and wind from the beginning of the digging operation, during transportation and on the ground until the final planting. The plants shall be planted in the center of the holes and at the same depth as they previously grew (see a. below). Set plants upright, plumb, and faced to give the best appearance or relationship to each other or adjacent structures. Remove burlap, rope, wires, etc., from the sides and tops of root balls. Do not pull burlap out from under root balls. Any girdling roots or badly damaged roots must be cleanly pruned off. Planting soil mix shall be backfilled in layers of not more than six inches (6") and each layer watered sufficiently to settle before the next layer is put in place. Enough planting soil mix shall be used to bring the surface to finish grade when settled. A saucer shall be formed around each plant at a depth of six inches (6") for trees.
 - a. The Root Flare of each plant shall be located at the finish grade and visible. All planting depths shall be inspected by the Owner's Representative, and if not at the proper depth shall be corrected at the Contractor's expense.
- D. All plants shall be flooded with water twice within the first 24 hours of the time of planting and all plants during the maintenance period shall be watered at least twice each week. At each watering the soil around each plant shall be thoroughly saturated. If sufficient moisture is retained in the soil, as determined by the Owner's Representative, the required watering may be reduced. Trees will require a minimum of ten (10) gallons of water each.
- E. Mulch material shall be placed over entire saucer areas of individual trees and over the entire area of planting beds to a depth of three inches (3") after settlement, not later

- than one (1) week after planting. No mulch shall be applied prior to the first watering of plant materials. Mulch shall be pulled back two inches (2") from tree trunks.
- F. Portable Drip Irrigation System watering bags shall be installed as directed by the bag manufacturer, and shall be kept filled as necessary to maintain optimum health.
 - G. Antidesiccant shall be applied to all plants before digging at the nursery and/or as directed by the Owner's Representative once the plants have been delivered to the site.
 - H. Antidesiccant shall be applied to all evergreen plants in the late fall as directed by the Owner's Representative.
 - I. If planting is done after lawn preparation or installation proper protection of lawn areas shall be provided and any damage resulting from planting operations shall be repaired immediately at no cost to the Owner.
 - J. In the event that rock or underground construction work or obstructions are encountered in any plant pit or bed excavation work to be done under this Contract, alternate locations may be selected by the Owner's Representative.
 - K. Absolutely no debris may be left on the site. Excavated material shall be removed as directed by the Owner's Representative. Repair any damage to site or structures to restore them to their original condition as directed by the Owner's Representative, at no cost to the Owner.

3.3 SOIL ADDITIVES

- A. Follow all recommendations for soil additives as determined by an approved Soil Testing Laboratory, and all manufacturers' instructions pertaining to additives.

3.4 BARK MULCH

- A. Contractor shall install approved bark mulch material to the limits and depths shown on the Drawings and specified herein.
- B. Non diseased and non invasive woody material to be removed shall be chipped and spread on disturbed areas (at edges of wooded areas) not to receive new lawn or seed, paving, or other finishes; locations to be as directed by Owner's Representative in field. Excess woods chips shall be removed from site.

3.5 HYDROSEEDING

- A. Limit of seeding shall be shown on the Drawings. All areas on the plan shall be loamed and seeded only after written approval of the finished grading or as directed by the Owner's Representative. All seeded areas are to be hydroseeded.

The actual planting of seed shall be done, however, only during periods within this season which are normal for such work as determined by weather conditions and be accepted practice in this locality. At his/her option and on his/her responsibility the Contractor may plant seed under unseasonable conditions without additional

compensation, but subject to the Owner's Representative's approval as to time and methods.

- B. Seeding may be done between August 15 and October 15, or between April 15 and June 15.
- C. Soil additives shall be spread and thoroughly incorporated into the later of loam and the upper 1 inch of the underlying subsoil by harrowing or other methods approved by the Owner's Representative. The following soil additives shall be incorporated as needed:
 - 1. Ground limestone as required by soil analysis to achieve a pH of 6.0 to 6.5.
 - 2. Fertilizer as required by soil analysis.
 - 3. Superphosphate at the rate of 20 lbs. Per 1,000 square feet.
 - 4. Humus as required by soil analysis.
 - 5. Compost at a rate of 1 part compost per 4 parts planting loam.
- D. Seeding of lawns shall be done only by experienced workmen under the supervision of qualified foreman. Seeding shall consist of soil preparation, rolling, hydroseeding, weeding, fertilizing, watering and otherwise providing all labor and materials necessary to secure the establishment of acceptable turf.
- E. The soil on which the seed is spread shall be reasonably moist and shall be watered, if directed by the Owner's Representative. The seeded areas shall be watered evenly and at a rate of 5 gallons per square yard, unless otherwise directed by the Owner's Representative.
- F. Contractor shall place and maintain barriers (in a neat condition) around hydroseeded areas to keep people off during the first sixty (60) days.
- G. The actual seeding of lawns shall be done only during periods within the season which are normal for such work as determined by weather conditions and by accepted practice in this locality, except as approved by the Owner's Representative.
- H. The application of grass seed, fertilizer, limestone, and a suitable wood fiber or other mulch shall be accomplished in one operation for hydroseeding.
- I. Hydroseeding shall be done by use of an approved spraying machine, which shall be operated only by personnel thoroughly familiar with this type of seeding operation.
- J. Prior to starting work, Contractor shall furnish the Owner's Representative with a certified statement as to the number of pounds of materials to be used per 100 gallons of water and the number of square feet to be covered with the quantity of solution in the hydroseeder.
 - 1. Materials shall be mixed with water in the machine and kept in an agitated state in order that the materials may be uniformly suspended in the water.
 - 2. Solution shall be sprayed evenly over the area so that resulting deposits of all materials shall equal the required rates.

3. Spraying equipment shall be thoroughly cleaned and flushed prior to start of work and after every ten acres.
4. When inoculum is required, if the inoculum is left in the solution with fertilizer for longer than thirty minutes, a fresh charge of inoculum shall be added to the mixture.

3.6 MAINTENANCE AND PROTECTION OF PLANTS AND LAWN AREAS

- A. Maintenance shall begin immediately after an area is planted or seeded and shall continue until final acceptance. The minimum maintenance period shall be ninety (90) calendar days after completion of all plant installations. Watering and mowing shall be done by the Contractor for the full 90 days.
- B. Maintenance shall include replacement of trees and/or shrubs, mowing, watering, weeding, re-seeding if needed, and fertilizing.
- C. Watering of Lawn Areas:
 1. First week: The Contractor shall provide all labor and arrange for all watering necessary for rooting of the plant materials. In the absence of adequate rainfall, watering shall be performed daily or as often as necessary during the first week and in sufficient quantity to maintain moist soil to a depth of at least 4 inches. Watering shall not be done during the heat of the day to help prevent wilting.
 2. Second and Subsequent weeks: The Contractor shall water the lawn and plantings as required to maintain adequate moisture, until final acceptance, in the upper 4 inches of soil.
 3. Watering shall be done in a manner that will provide uniform coverage, prevent erosion due to application of excessive quantities over small areas, and prevent damage to the finished surface by the watering equipment. The Contractor shall furnish sufficient watering equipment to apply one (1) complete coverage to the lawn areas and plantings in an eight (8) hour period.
- D. Watering of Tree Plantings:
 1. Portable Drip Irrigation System watering bags shall be kept filled as needed to maintain optimal plant health. Bags shall be filled a minimum of once each week regardless of rain conditions. The contractor shall be responsible for ensuring that watering bags are kept full for one full growing season after installation.
- E. Mowing: The first mowing of lawn areas shall not be attempted until the lawn is firmly rooted and secure in place. Not more than 40% of the grass leaf shall be removed by initial or subsequent mowings. Grass height shall be maintained between 2 inches and 2-1/2 inches unless otherwise specified. Thereafter grass shall be maintained at 2 inches until acceptance.
- F. Fertilizing: A second application of fertilizer, as specified herein and as outlined in the fertilizing schedule to be submitted by the Contractor, shall be applied approximately 6 weeks after the sod has been installed as directed by the Owner's Representative.

Fertilizer shall be applied at the rate of 10 pounds per 1,000 square feet or as otherwise approved as part of the fertilizing schedule.

END OF SECTION