STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

JENNIFER COHAN
SECRETARY

VIA WEBSITE POSTING

October 13, 2017

Contract No. T201451604.01
Federal Aid Project No. TIGER-2014(02)
Newark Regional Transportation Center, Station Building
New Castle County

Ladies and Gentlemen:

Enclosed is Addendum No. 2 for the referenced contract consisting of the following:

1. The date for the receipt of bids has been moved to Tuesday, **October 24, 2017**, at 2:00 p.m.
2. The Bid Proposal Cover, revised, to be substituted for the same page in the Proposal.
3. The following Plan Sheets have been revised and replaced: 69, 70, 71, 72, 96, 97, 135, 137, 138, 139, 140, 141, 142, 143 and 146.
4. One hundred forty six (146) pages, Appendix A-Technical Specifications, (4 pages of the Table of Contents and 142 pages of the Appendix) have been revised, to be substituted for the same pages in the Proposal.

Please note the revisions listed above and submit your bid based upon this information.

Sincerely,

~signature on file~

Robert A. Kovacs
Competitively Bid Contracts Coordinator
Delaware Department of Transportation

Addendum No. 2
October 13, 2017

STATE OF DELAWARE

DEPARTMENT OF TRANSPORTATION

BID PROPOSAL

for

CONTRACT T201451604.01

FEDERAL AID PROJECT NO. TIGER-2014(02)

CFDA NO. 20.933

Newark Regional Transportation Center, Station Building

New Castle County

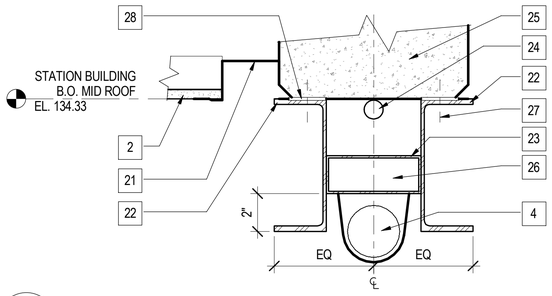
ADVERTISEMENT DATE: September 4, 2017

PROSPECTIVE BIDDERS ARE ADVISED THAT THERE WILL BE A PRE-BID MEETING TUESDAY SEPTEMBER 19, 2017 AT 3:30 P.M. IN THE DelDOT ADMINISTRATION BUILDING, 800 BAY ROAD, DOVER, DELAWARE, 19903.

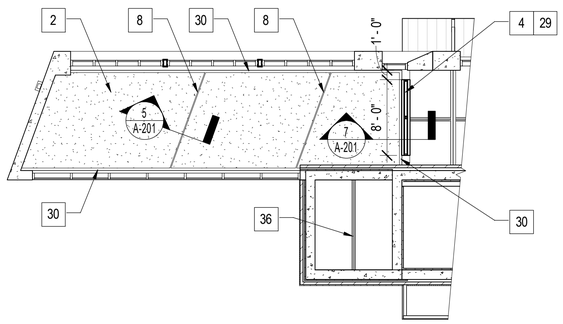
COMPLETION TIME: 453 Calendar Days

SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION
DELAWARE DEPARTMENT OF TRANSPORTATION
AUGUST 2001

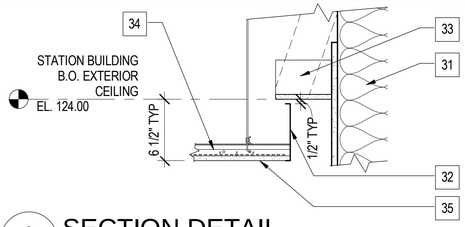
Bids will be received in the Bidder's Room at the Delaware Department of Transportation's Administration Building, 800 Bay Road, Dover, Delaware until 2:00 P.M. local time **October ~~10~~ 24, 2017**



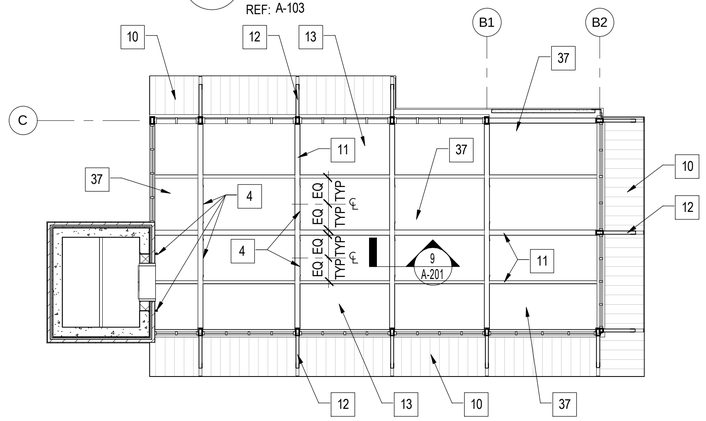
7 A-201 SECTION DETAIL
SCALE: 3" = 1'-0"
REF: A-201



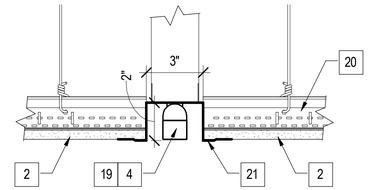
2 A-201 STATION BUILDING- PARTIAL RCP
SCALE: 1/8" = 1'-0"



8 A-201 SECTION DETAIL
SCALE: 1 1/2" = 1'-0"
REF: A-103



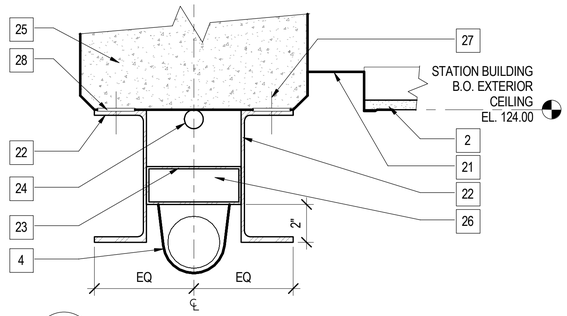
3 A-201 STATION BUILDING - CONCOURSE LEVEL - RCP
SCALE: 1/8" = 1'-0"



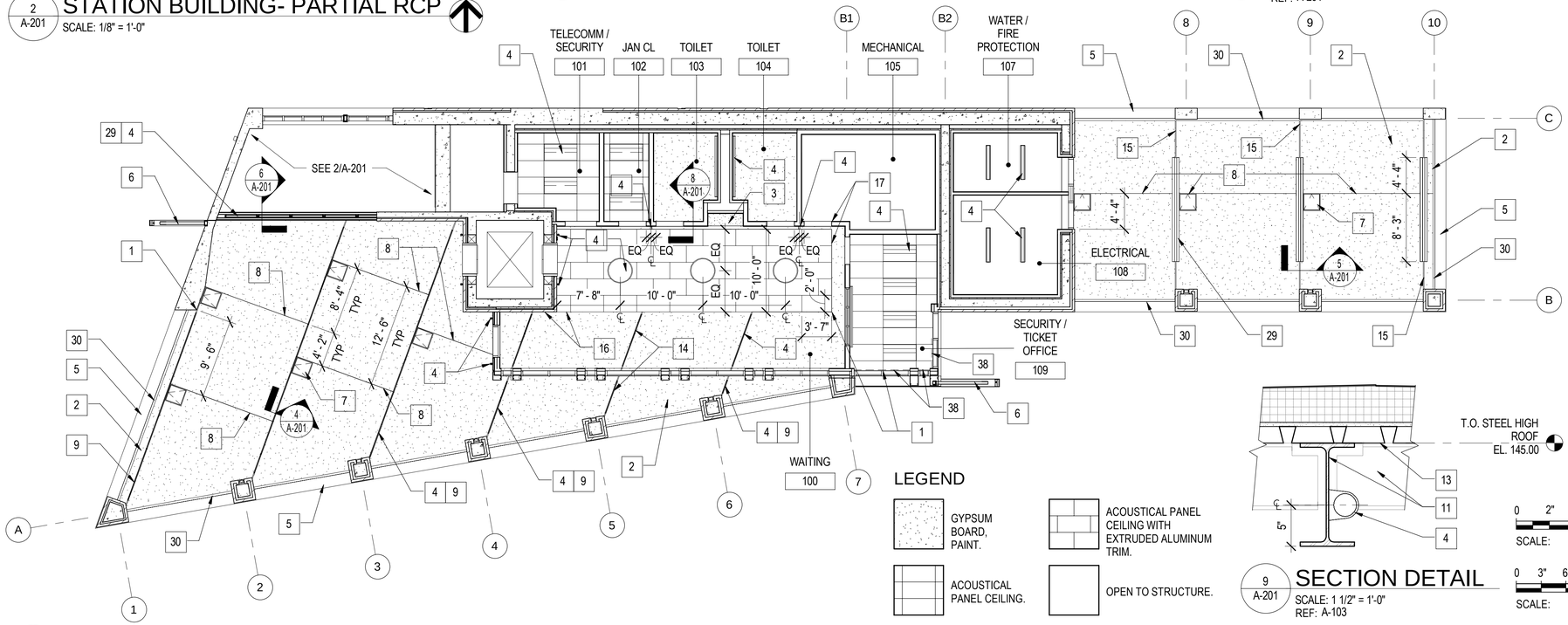
4 A-201 CEILING REVEAL
SCALE: 3" = 1'-0"
REF: A-201

5 A-201 CEILING REVEAL
SCALE: 3" = 1'-0"
REF: A-201

NOTE: SIMILAR TO 4/A-201 WITHOUT LIGHT FIXTURE.



6 A-201 SECTION DETAIL
SCALE: 3" = 1'-0"
REF: A-201



1 A-201 STATION BUILDING - LOWER LEVEL - REFLECTED CEILING PLAN
SCALE: 1/8" = 1'-0"

LEGEND

- GYPSUM BOARD, PAINT.
- ACOUSTICAL PANEL CEILING WITH EXTRUDED ALUMINUM TRIM.
- ACOUSTICAL PANEL CEILING.
- OPEN TO STRUCTURE.

9 A-201 SECTION DETAIL
SCALE: 1 1/2" = 1'-0"
REF: A-103

0 2" 4" 8"
SCALE: 3" = 1'-0"

0 3" 6" 1' 2'
SCALE: 1 1/2" = 1'-0"

GENERAL SHEET NOTES

1. CENTER ACOUSTICAL PANEL CEILING GRIDS IN ROOMS UNLESS NOTED OTHERWISE.
2. SEE STRUCTURAL DRAWINGS FOR LOCATIONS AND SIZES OF EXPOSED STRUCTURAL FRAMING.

CONSTRUCTION KEY NOTES

1. WORKING POINT.
2. EXTERIOR-GRADE GYPSUM BOARD CEILING, TYPICAL. PT-4.
3. SLOPED GYPSUM BOARD CEILING ABOVE ELECTRIC WATER COOLER, PAINT PT-1.
4. LIGHT FIXTURE, TYPICAL. SEE ELECTRICAL DRAWINGS E-202, E-203 AND E-204.
5. BOTTOM OF CAST-IN-PLACE ARCHITECTURAL CONCRETE BEAM. SEE STRUCTURAL DRAWINGS.
6. UNDERSIDE OF METAL BOX GUTTER.
7. 24" x 24" PREFINISHED METAL ACCESS PANEL, TYPICAL.
8. V-SHAPED CONTROL JOINT IN GYPSUM BOARD CEILING, TYPICAL.
9. CEILING REVEAL PARALLEL TO EDGE OF CONCRETE BEAM, TYPICAL.
10. PREFINISHED ALUMINUM SOFFIT PANELS - MTL-1, TYPICAL.
11. EXPOSED STRUCTURE WITH HIGH PERFORMANCE COATING - PT-1, TYPICAL.
12. PREFINISHED STRUCTURAL ALUMINUM BRACKETS - MTL-1, TYPICAL. REFERENCE STRUCTURAL DRAWING S-510. 2
13. EXPOSED STRUCTURAL STEEL DECKING, TYPICAL. ~~PAINT PT-1.~~ FACTORY-APPLIED COATING TO MATCH MTL-1. REFERENCE STRUCTURAL DRAWINGS.
14. ALIGN CEILING REVEALS, TYPICAL.
15. CEILING REVEAL ALIGNED WITH FACE OF COLUMN.
16. INSET EDGE OF CEILING IN 1" FROM FACE OF BRICK.
17. ALIGN EDGE OF CEILING AND DOOR FRAME.
18. ALIGN CEILING REVEALS WITH LOWER LEVEL REVEALS.
19. PROVIDE SUPPORT FOR LIGHT FIXTURE FROM STRUCTURE, TYPICAL.
20. GYPSUM BOARD CEILING SUPPORT SYSTEM, TYPICAL.
21. 3" CEILING REVEAL, PT-4.
22. PREFINISHED ALUMINUM CHANNEL CS 7 x 3.21, MTL-1.
23. PREFINISHED ALUMINUM TUBE 5 x 2 x 1/8, MTL-1. CONNECT TO CHANNEL WITH 1/4" WELD 2" IN LENGTH AT 2'-0" O.C.
24. CONDUIT, SEE ELECTRICAL DRAWING E-202.
25. CAST-IN-PLACE ARCHITECTURAL CONCRETE BEAM. SEE STRUCTURAL DRAWINGS.
26. PROVIDE ALUMINUM CLOSURE CAP AT EACH END OF FIXTURE MOUNT, MTL-1.
27. 1/4" DIAMETER POST-INSTALLED STAINLESS STEEL SCREW ANCHOR WITH MAXIMUM EMBEDMENT DEPTH OF 1-1/4" AT 2'-0" O.C., TYPICAL.
28. 2" DIAMETER DIELECTRIC SHIMS, 150 MIL THICK, TYPICAL.
29. PREFINISHED ALUMINUM LIGHT FIXTURE MOUNT - MTL-1, REFERENCE STRUCTURAL AND ELECTRICAL DRAWINGS.
30. 3" CEILING REVEAL AT EDGE OF GYPSUM BOARD CEILING AND CONCRETE BEAM, TYPICAL. PAINT, PT-4.
31. SCHEDULED PARTITION.
32. PREFINISHED EXTRUDED ALUMINUM TRIM, MTL-1.
33. COLD-FORMED STEEL STUD CEILING FRAMING. FRAME BACK TO ADJACENT PARTITION FRAMING.
34. ACOUSTICAL PANEL CEILING SYSTEM.
35. GYPSUM BOARD CEILING, PAINT.
36. ELEVATOR HOIST BEAM, SEE STRUCTURAL DRAWING S-105.
37. STORM AND FIRE PROTECTION PIPING, TYPICAL. SEE PLUMBING DRAWING P-101 AND FIRE PROTECTION DRAWING FP-101.
38. MOTORIZED WINDOW SHADE AND CEILING POCKET, REFERENCE ELECTRICAL DRAWINGS.

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DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS
2 REVISED KEY NOTE #13 - RJH 10/11/17

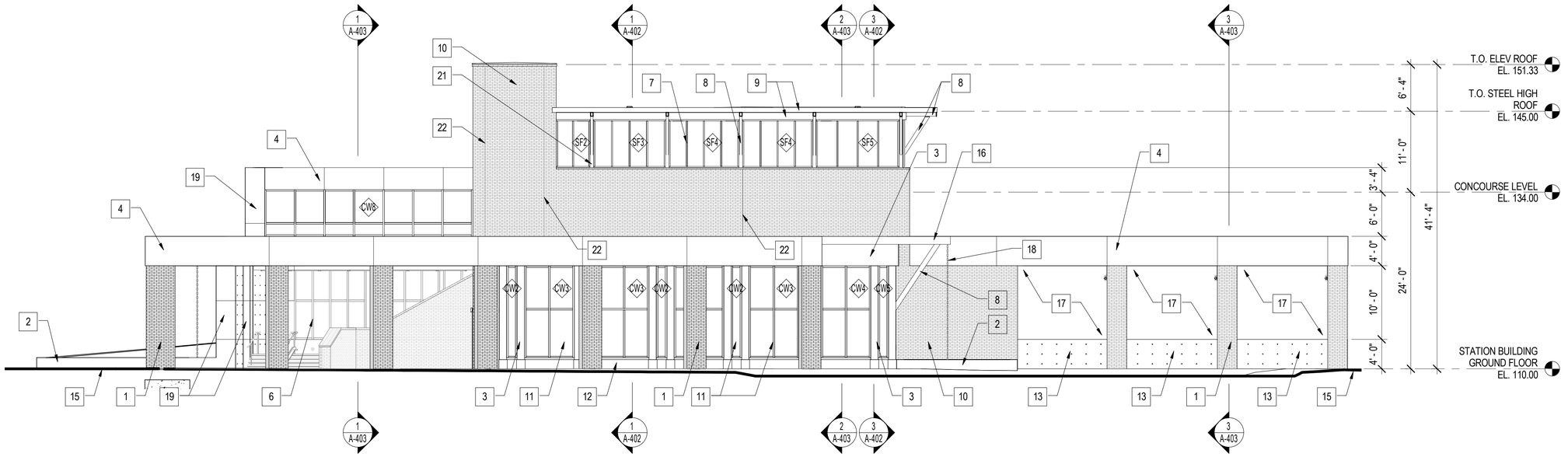
0 4' 8' 16'
SCALE: 1/8" = 1'-0"

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

CONTRACT	T201451604
COUNTY	NEW CASTLE
BRIDGE NO.	N/A
DESIGNED BY:	FAH/RJH
CHECKED BY:	DAK

REFLECTED CEILING PLANS AND DETAILS

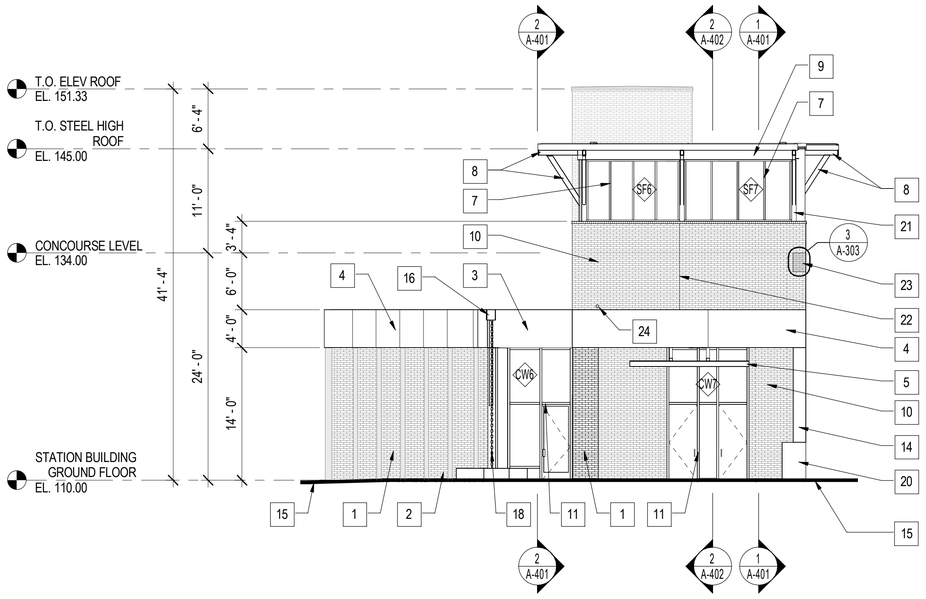
A-201	
SHEET NO.	69
TOTAL SHTS.	168



A
A-301

STATION BUILDING - SOUTH BUILDING ELEVATION

SCALE: 1/8" = 1'-0"
REF: A-101



B
A-301

STATION BUILDING - EAST BUILDING ELEVATION

SCALE: 1/8" = 1'-0"
REF: A-101

CONSTRUCTION KEY NOTES

1. MODULAR BRICK-CLAD COLUMN, TYPICAL. REFERENCE STRUCTURAL DRAWING S-501.
2. CAST-IN-PLACE ARCHITECTURAL CONCRETE PLANTER, SEE STRUCTURAL DRAWINGS.
3. PREFINISHED ALUMINUM COMPOSITE MATERIAL PANEL - MTL-1, TYPICAL.
4. CAST-IN-PLACE ARCHITECTURAL CONCRETE BEAM, SEE STRUCTURAL DRAWINGS.
5. PREFINISHED ALUMINUM LIGHT FIXTURE MOUNT - MTL-1, TYPICAL. REFERENCE STRUCTURAL DRAWING S-513 AND ELECTRICAL DRAWINGS E-202 AND E-602.
6. PREFINISHED ALUMINUM CURTAINWALL FRAMING BEYOND.
7. PREFINISHED ALUMINUM STOREFRONT FRAMING, TYPICAL.
8. PREFINISHED STRUCTURAL ALUMINUM BRACKET, TYPICAL. SEE STRUCTURAL DRAWING S-510.
9. PREFINISHED ALUMINUM COMPOSITE MATERIAL FASCIA, TYPICAL.
10. MODULAR FACE BRICK, TYPICAL.
11. PREFINISHED ALUMINUM CURTAIN WALL, TYPICAL.
12. CAST-IN-PLACE ARCHITECTURAL CONCRETE CURB WALL. SEE STRUCTURAL DRAWING S-101 AND S-102.
13. CAST-IN-PLACE ARCHITECTURAL CONCRETE CRASH WALL BEYOND, SEE STRUCTURAL DRAWINGS.
14. CAST-IN-PLACE ARCHITECTURAL CONCRETE COLUMN, TYPICAL. SEE STRUCTURAL DRAWINGS.
15. FINISH GRADE, SEE CIVIL DRAWINGS.
16. PREFINISHED ALUMINUM RAIN CHAIN BOX GUTTER - MTL-1, REFERENCE STRUCTURAL DRAWINGS S-515 AND S-516.
17. OPEN TO BEYOND.
18. STAINLESS STEEL RAIN CHAIN.
19. CAST-IN-PLACE ARCHITECTURAL CONCRETE WALL, SEE STRUCTURAL DRAWINGS.
20. CAST-IN-PLACE ARCHITECTURAL CONCRETE CRASH WALL, SEE STRUCTURAL DRAWINGS.
21. PREFINISHED ALUMINUM CHANNEL COLUMN COVER - MTL-1, TYPICAL. SEE STRUCTURAL DRAWING S-510.
22. BRICK CONTROL JOINT.
23. MODULAR FACE BRICK TO BE REMOVED DURING INSTALLATION OF FUTURE PEDESTRIAN BRIDGE.
24. RAIN LEADER DISCHARGE WITH PRECAST CONCRETE SPLASHBLOCK, REFERENCE PLUMBING DRAWING P-104.

EXTERIOR FINISH LIST

DESIGNATION	MATERIAL	MANUFACTURER - BASIS OF DESIGN	DESCRIPTION - BASIS OF DESIGN
BR-1	MODULAR FACE BRICK	REDLAND BRICK	CUSHWA; CAMDEN BLEND (170)
ARCH CONC-1	ARCHITECTURAL CONCRETE	-	-
GL-1	GLASS	PPG	SOLARBAN 60; CLEAR
CW-1	INSIDE GLAZED ALUMINUM CURTAIN WALL FRAMING / ENTRY DOOR FINISH	YKK AP	YCW 750 XT IG; COLOR: PPG, DURANAR "PERSIAN GREEN" (UC117574)
SF-1	INSIDE GLAZED ALUMINUM STOREFRONT FRAMING	YKK AP	YES 45 TU; COLOR: PPG, DURANAR "PERSIAN GREEN" (UC117574)
MTL-1	PREFINISHED ALUMINUM BRACKETS, ALUMINUM COMPOSITE MATERIAL, SOFFIT PANELS, FASCIA, CHANNELS	PPG	DURANAR ~~"BRIGHT WHITE" (UC55026)~~ "GRAHAM WHITE" (UC72638) (2)
MTL-2	EXPOSED METAL FLASHING	PPG	DURANAR ~~"BRIGHT WHITE" (UC55026)~~ "GRAHAM WHITE" (UC72638)

A-301

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DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS
2 REVISED EXTERIOR FINISH LIST - RJH 10/11/17

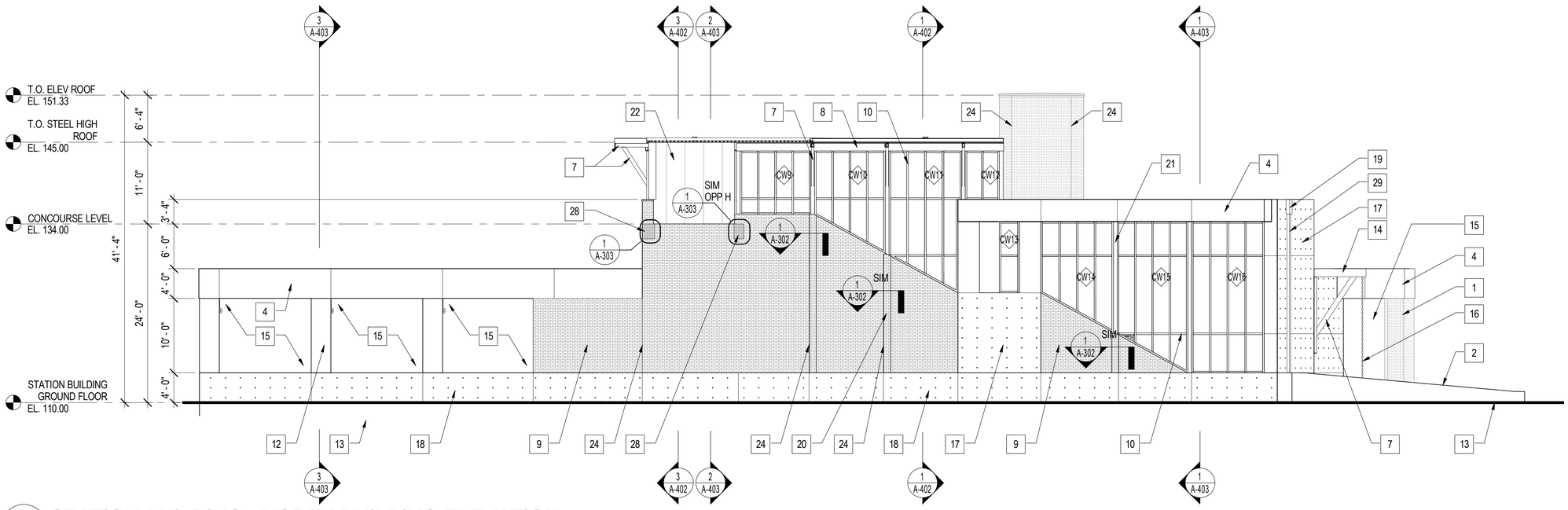
0 4' 8' 16'
SCALE: 1/8" = 1'-0"

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

CONTRACT	T201451604	BRIDGE NO.	N/A
COUNTY	NEW CASTLE	DESIGNED BY:	FAH/RJH
		CHECKED BY:	DAK

BUILDING ELEVATIONS

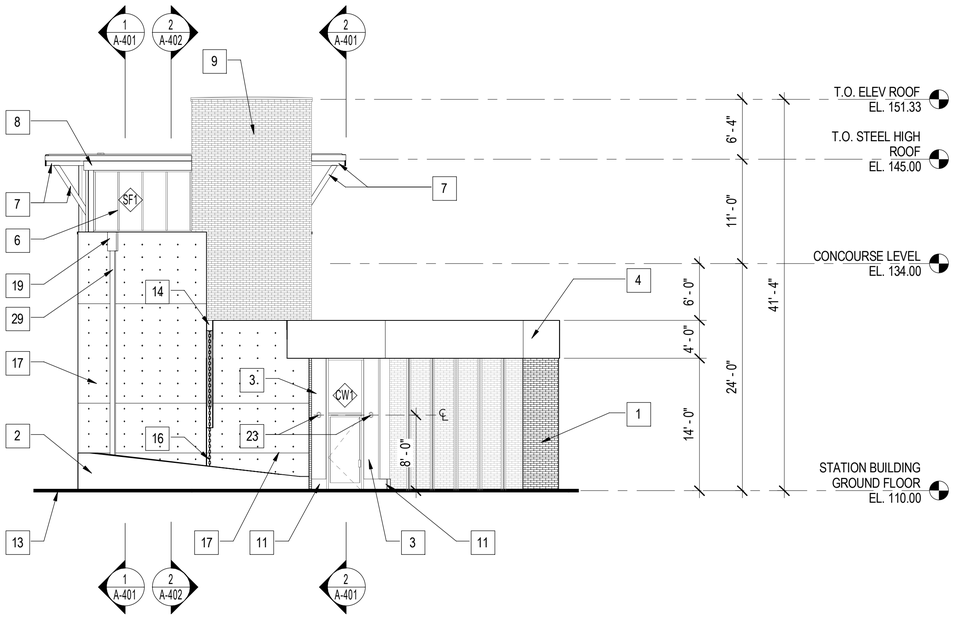
SHEET NO.	70
TOTAL SHTS.	168



STATION BUILDING - NORTH BUILDING ELEVATION

A / A-302

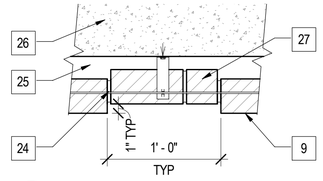
SCALE: 1/8" = 1'-0"
REF: A-101



STATION BUILDING - WEST BUILDING ELEVATION

B / A-302

SCALE: 1/8" = 1'-0"
REF: A-101



PLAN DETAIL

1 / A-302

SCALE: 1 1/2" = 1'-0"
REF: A-302

NOTE: REFERENCE BUILDING ELEVATIONS FOR CONTROL JOINT LOCATIONS.

EXTERIOR FINISH LIST

DESIGNATION	MATERIAL	MANUFACTURER - BASIS OF DESIGN	DESCRIPTION - BASIS OF DESIGN
BR-1	MODULAR FACE BRICK	REDLAND BRICK	CUSHWA; CAMDEN BLEND (170)
ARCH CONC-1	ARCHITECTURAL CONCRETE	-	-
GL-1	GLASS	PPG	SOLARBAN 60; CLEAR
CW-1	INSIDE GLAZED ALUMINUM CURTAIN WALL FRAMING / ENTRY DOOR FINISH	YKK AP	YCW 750 XT IG; COLOR: PPG, DURANAR "PERSIAN GREEN" (UC117574)
SF-1	INSIDE GLAZED ALUMINUM STOREFRONT FRAMING	YKK AP	YES 45 TU; COLOR: PPG, DURANAR "PERSIAN GREEN" (UC117574)
MTL-1	PREFINISHED ALUMINUM BRACKETS, ALUMINUM COMPOSITE MATERIAL, SOFFIT PANELS, FASCIA, CHANNELS	PPG 2	DURANAR ~~"BRIGHT WHITE" (UC55026)~~ "GRAHAM WHITE" (UC72638)
MTL-2	EXPOSED METAL FLASHING	PPG	DURANAR ~~"BRIGHT WHITE" (UC55026)~~ "GRAHAM WHITE" (UC72638)

CONSTRUCTION KEY NOTES

1. MODULAR BRICK-CLAD COLUMN, TYPICAL. REFERENCE STRUCTURAL DRAWING S-501.
2. CAST-IN-PLACE ARCHITECTURAL CONCRETE PLANTER, SEE STRUCTURAL DRAWING S-508.
3. PREFINISHED ALUMINUM COMPOSITE MATERIAL PANEL - MTL-1, TYPICAL.
4. CAST-IN-PLACE ARCHITECTURAL CONCRETE BEAM, SEE STRUCTURAL DRAWINGS.
5. NOT USED.
6. PREFINISHED ALUMINUM STOREFRONT FRAMING, TYPICAL.
7. PREFINISHED STRUCTURAL ALUMINUM BRACKET - MTL-1, TYPICAL. SEE STRUCTURAL DRAWING S-510.
8. PREFINISHED ALUMINUM COMPOSITE MATERIAL FASCIA - MTL-1, TYPICAL.
9. MODULAR FACE BRICK, TYPICAL.
10. PREFINISHED ALUMINUM CURTAIN WALL, TYPICAL.
11. CAST-IN-PLACE ARCHITECTURAL CONCRETE CURB WALL. SEE STRUCTURAL DRAWINGS S-101 AND S-102.
12. CAST-IN-PLACE ARCHITECTURAL CONCRETE COLUMN, TYPICAL. SEE STRUCTURAL DRAWING S-501.
13. FINISH GRADE, SEE CIVIL DRAWINGS.
14. PREFINISHED ALUMINUM RAIN CHAIN BOX GUTTER - MTL-1, SEE STRUCTURAL DRAWING S-514.
15. OPEN TO BEYOND.
16. STAINLESS STEEL RAIN CHAIN.
17. CAST-IN-PLACE ARCHITECTURAL CONCRETE WALL, SEE STRUCTURAL DRAWINGS.
18. CAST-IN-PLACE ARCHITECTURAL CONCRETE CRASH WALL, SEE STRUCTURAL DRAWINGS.
19. STAINLESS STEEL SCUPPER.
20. MODULAR FACE BRICK REVEAL CENTERED ON COLUMN ABOVE, TYPICAL.
21. PREFINISHED ALUMINUM CHANNEL COLUMN COVER - MTL-1, TYPICAL. SEE STRUCTURAL DRAWING S-510.
22. PREFINISHED INSULATED METAL WALL PANEL, MTL-1 (TO BE REMOVED DURING FUTURE CONTRACT).
23. LIGHT FIXTURE, SEE ELECTRICAL DRAWING E-602.
24. BRICK CONTROL JOINT.
25. AIR SPACE. PROVIDE CAVITY DRAINAGE MATERIAL AT ALL FLASHING LOCATIONS, TYPICAL.
26. CAST-IN-PLACE CONCRETE WALL, SEE STRUCTURAL DRAWINGS.
27. MASONRY VENEER TIES AND ANCHORS AT 16" O.C. EACH WAY, TYPICAL.
28. MODULAR FACE BRICK TO BE REMOVED DURING INSTALLATION OF FUTURE PEDESTRIAN BRIDGE.
29. 4"x6" STAINLESS STEEL DOWNSPOUT TO PRECAST CONCRETE SPLASHBLOCK.

0 3" 6" 1' 2'

SCALE: 1 1/2" = 1'-0"

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DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

2 REVISED EXTERIOR FINISH LIST - RJH 10/11/17

0 4' 8' 16'

SCALE: 1/8" = 1'-0"

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

CONTRACT	T201451604
COUNTY	NEW CASTLE
BRIDGE NO.	N/A
DESIGNED BY:	FAH/RJH
CHECKED BY:	DAK

BUILDING ELEVATIONS

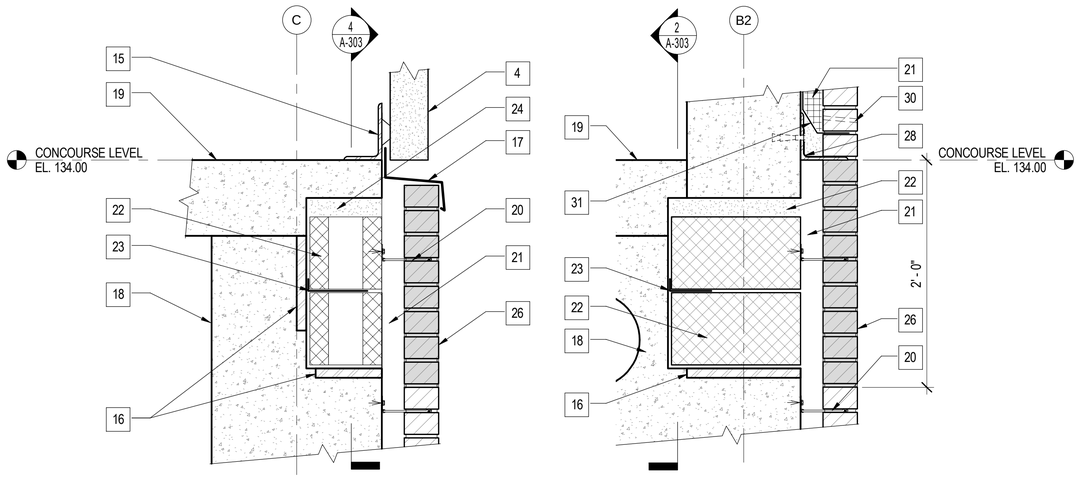
A-302

SHEET NO. 71

TOTAL SHTS. 168

EXTERIOR FINISH LIST

DESIGNATION	MATERIAL	MANUFACTURER - BASIS OF DESIGN	DESCRIPTION - BASIS OF DESIGN
BR-1	MODULAR FACE BRICK	REDLAND BRICK	CUSHWA; CAMDEN BLEND (170)
ARCH CONC-1	ARCHITECTURAL CONCRETE	-	-
GL-1	GLASS	PPG	SOLARBAN 60; CLEAR
CW-1	INSIDE GLAZED ALUMINUM CURTAIN WALL FRAMING / ENTRY DOOR FINISH	YKK AP	YCW 750 XT IG; COLOR: PPG, DURANAR "PERSIAN GREEN" (UC117574)
SF-1	INSIDE GLAZED ALUMINUM STOREFRONT FRAMING	YKK AP	YES 45 TU; COLOR: PPG, DURANAR "PERSIAN GREEN" (UC117574)
MTL-1	PREFINISHED ALUMINUM BRACKETS, ALUMINUM COMPOSITE MATERIAL, SOFFIT PANELS, FASCIA, CHANNELS	PPG 2	DURANAR ~~"BRIGHT WHITE" (UC55026)~~ "GRAHAM WHITE" (UC72638)
MTL-2	EXPOSED METAL FLASHING	PPG	DURANAR ~~"BRIGHT WHITE" (UC55026)~~ "GRAHAM WHITE" (UC72638)



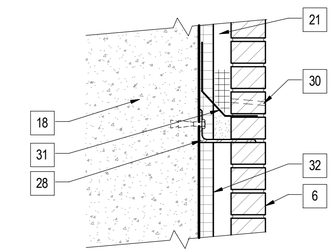
NOTE: REFERENCE DETAIL 3/A-408 FOR ATTACHMENT OF TEMPORARY METAL WALL PANEL.

2 A-303 SECTION DETAIL
SCALE: 1 1/2" = 1'-0"
REF: A-303

4 A-303 SECTION DETAIL
SCALE: 1 1/2" = 1'-0"
REF: A-303

CUSTOM BRICK SCHEDULE

NO.	SHAPE	LOCATION
1	7 1/2"± ; 7 1/2"±	COLUMN A1 *SEE A-600 SERIES SHEETS
2	11 1/2"± ; 11 1/2"±	COLUMN A1 *SEE A-600 SERIES SHEETS
3	7 3/4"± ; 7 3/4"±	COLUMN A1 *SEE A-600 SERIES SHEETS
4	4"± ; 4"±	COLUMN A1 *SEE A-600 SERIES SHEETS
5	3 5/8"± ; 7 5/8"	COLUMN A7 *SEE A-600 SERIES SHEETS
6	8"± ; 3 3/4"±	COLUMN A7 *SEE A-600 SERIES SHEETS
7	7 5/8" ; 6 3/4"±	STAIR *SEE A-700 SERIES SHEETS
8	4"± ; 3"±	STAIR *SEE A-700 SERIES SHEETS
9	5"± ; 7 1/4"±	STAIR *SEE A-700 SERIES SHEETS
10	9 1/4"± ; 3 5/8"	STAIR *SEE A-700 SERIES SHEETS

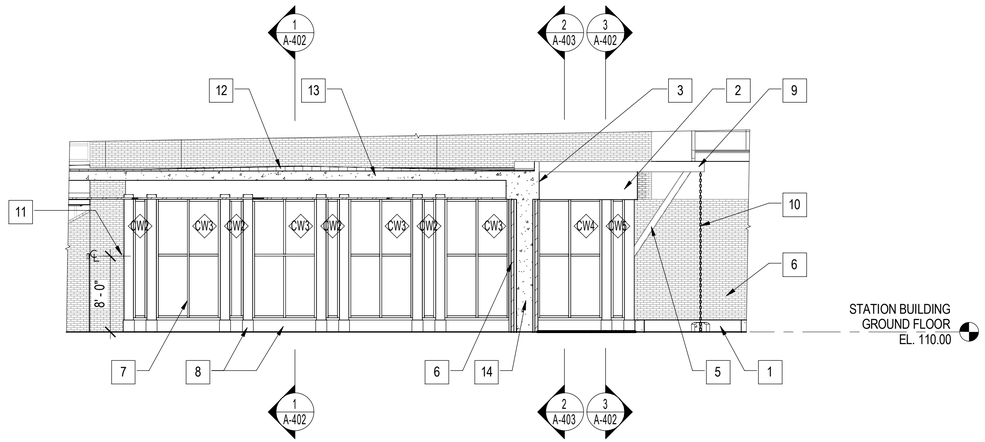


5 A-303 SECTION DETAIL
SCALE: 1 1/2" = 1'-0"

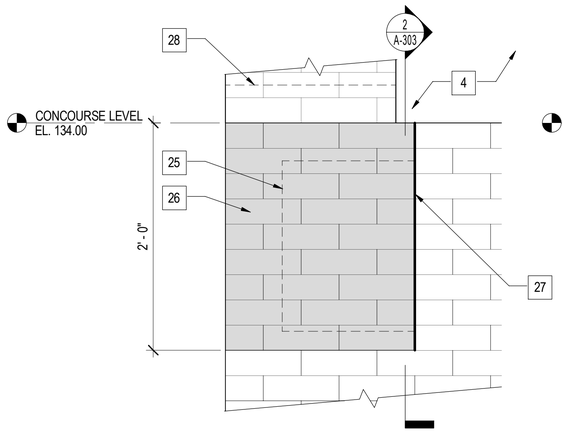
NOTE: TYPICAL FLASHING DETAIL AT SHELF ANGLE LOCATIONS. REFERENCE STRUCTURAL DRAWINGS.

CONSTRUCTION KEY NOTES

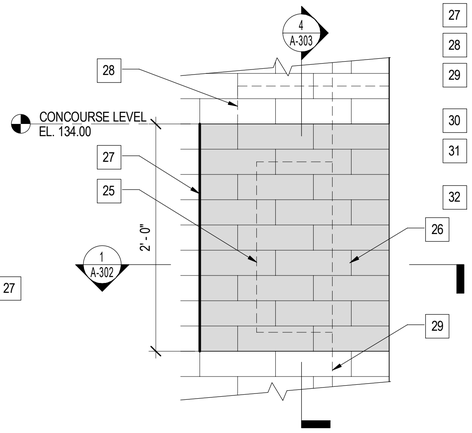
1. CAST-IN-PLACE ARCHITECTURAL CONCRETE PLANTER, SEE STRUCTURAL DRAWING S-508.
2. PREFINISHED ALUMINUM COMPOSITE MATERIAL PANEL - MTL-1, TYPICAL.
3. CAST-IN-PLACE ARCHITECTURAL CONCRETE BEAM, SEE STRUCTURAL DRAWINGS.
4. PREFINISHED INSULATED METAL WALL PANEL, MTL-1 (TEMPORARY).
5. PREFINISHED STRUCTURAL ALUMINUM BRACKET - MTL-1, TYPICAL. SEE STRUCTURAL DRAWING S-510.
6. MODULAR FACE BRICK, TYPICAL.
7. PREFINISHED ALUMINUM CURTAINWALL, TYPICAL.
8. CAST-IN-PLACE ARCHITECTURAL CONCRETE CURB WALL. SEE STRUCTURAL DRAWINGS S-101 AND S-102.
9. PREFINISHED ALUMINUM RAIN CHAIN BOX GUTTER - MTL-1, SEE STRUCTURAL DRAWINGS S-515 AND S-516.
10. STAINLESS STEEL RAIN CHAIN.
11. LIGHT FIXTURE, SEE ELECTRICAL DRAWING E-602.
12. TAPERED POLYISOCYANURATE INSULATION WITH ROOFING MEMBRANE AND GREEN ROOF SYSTEM.
13. CAST-IN-PLACE CONCRETE SLAB, SEE STRUCTURAL DRAWING S-103.
14. CAST-IN-PLACE CONCRETE COLUMN, SEE STRUCTURAL DRAWING S-501.
15. 6"x4" STEEL ANGLE, LONG LEG VERTICAL WITH 16 GAUGE CONTINUOUS HAT CHANNEL.
16. STEEL PLATE, SEE STRUCTURAL DRAWING S-512.
17. SILL CAP FLASHING (TEMPORARY).
18. CAST-IN-PLACE CONCRETE WALL, SEE STRUCTURAL DRAWINGS.
19. CAST-IN-PLACE ARCHITECTURAL CONCRETE SLAB, SEE STRUCTURAL DRAWING S-104.
20. MASONRY VENEER TIES AND ANCHORS AT 16" O.C. EACH WAY, TYPICAL.
21. AIR SPACE. PROVIDE CAVITY DRAINAGE MATERIAL AT ALL FLASHING LOCATIONS, TYPICAL
22. 8" NOMINAL CMU (TO BE REMOVED DURING FUTURE CONTRACT).
23. MASONRY VENEER TIE ATTACHED TO STEEL PLATE (TO BE REMOVED DURING FUTURE CONTRACT).
24. SPRAY FOAM INSULATION (TO BE REMOVED DURING FUTURE CONTRACT).
25. CAST-IN-PLACE CONCRETE WALL POCKET BEHIND FACE BRICK, SEE STRUCTURAL DRAWINGS.
26. MODULAR FACE BRICK TO BE REMOVED DURING INSTALLATION OF FUTURE PEDESTRIAN BRIDGE.
27. CONTROL JOINT AT EDGE OF FACE BRICK TO BE REMOVED IN FUTURE.
28. STEEL SHELF ANGLE, SEE STRUCTURAL DRAWINGS.
29. FACE OF CAST-IN-PLACE CONCRETE WALL BEHIND, SEE STRUCTURAL DRAWINGS.
30. WEEPS AT 16" O.C., TYPICAL.
31. EMBEDDED MASONRY THROUGH-WALL STAINLESS STEEL FLASHING. FULLY GROUT CAVITY BELOW FLASHING.
32. RIGID WALL INSULATION, REFERENCE SPECIFIC ARCHITECTURAL WALL SECTIONS.



A A-303 STATION BUILDING - PARTIAL SOUTH BUILDING ELEVATION
SCALE: 1/8" = 1'-0"
REF: A-101



1 A-303 ELEVATION DETAIL
SCALE: 1 1/2" = 1'-0"
REF: A-302



3 A-303 ELEVATION DETAIL
SCALE: 1 1/2" = 1'-0"
REF: A-301

0 3" 6" 1' 2'
SCALE: 1 1/2" = 1'-0"

A-303

10/10/2017 4:05:10 PM

DELAWARE
DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS
2 REVISED EXTERIOR FINISH LIST - RJH 10/11/17

0 4' 8' 16'
SCALE: 1/8" = 1'-0"

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

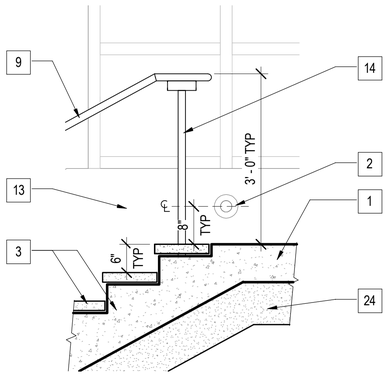
CONTRACT	BRIDGE NO.	N/A
T201451604	DESIGNED BY:	FAH/RJH
COUNTY	CHECKED BY:	DAK
NEW CASTLE		

BUILDING ELEVATIONS AND DETAILS

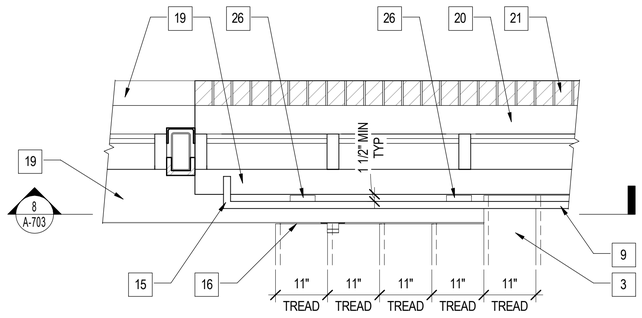
SHEET NO.	72
TOTAL SHTS.	168

CONSTRUCTION KEY NOTES

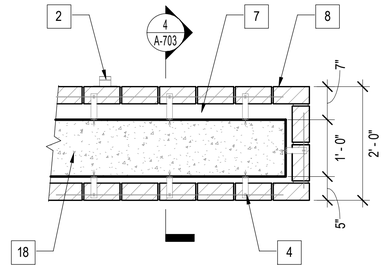
1. CAST-IN-PLACE ARCHITECTURAL CONCRETE LANDING, SEE STRUCTURAL DRAWINGS S-104 AND S-503.
2. LIGHT FIXTURE, TYPICAL. SEE ELECTRICAL DRAWINGS E-203, E-204 AND E-602.
3. CAST-IN-PLACE ARCHITECTURAL CONCRETE STAIRS WITH BLUESTONE TREADS, TYPICAL. REFERENCE STRUCTURAL DRAWING S-503.
4. MASONRY VENEER TIES AND ANCHORS AT 16" O.C. EACH WAY, TYPICAL.
5. EMBEDDED MASONRY THROUGH-WALL FLASHING. FULLY GROUT CAVITY BELOW FLASHING, TYPICAL.
6. WEEPS AT 16" O.C., TYPICAL.
7. AIR SPACE. PROVIDE CAVITY DRAINAGE MATERIAL AT ALL FLASHING LOCATIONS.
8. MODULAR FACE BRICK, TYPICAL.
9. 1-1/2" DIAMETER STAINLESS STEEL HANDRAIL, TYPICAL. PROVIDE 1-1/2" MINIMUM CLEAR SPACE BETWEEN HANDRAIL AND ADJACENT SURFACE, TYPICAL.
10. CUSTOM MODULAR FACE BRICK.
11. CUSTOM MODULAR FACE BRICK BELOW.
12. 1/2" MORTAR JOINT BETWEEN STAIR TREAD AND LANDING, TYPICAL.
13. CAST-IN-PLACE ARCHITECTURAL CONCRETE WALL, SEE STRUCTURAL DRAWINGS.
14. 1-1/2" x 1-1/2" x 3/16" MINIMUM STEEL TUBE BALUSTER - HIGH PERFORMANCE COATING ~~MTL-1~~ PT-1, TYPICAL. (2)
15. RETURN HANDRAIL EXTENSION TO WALL, TYPICAL.
16. 1/4" BETWEEN STAIR TREAD AND CONCRETE WALL, TYPICAL.
17. 1/4" BETWEEN STAIR TREAD AND BRICK WALL, TYPICAL.
18. CAST-IN-PLACE CONCRETE WALL, SEE STRUCTURAL DRAWINGS.
19. TOP OF CAST-IN-PLACE ARCHITECTURAL CONCRETE WALL, SEE STRUCTURAL DRAWINGS.
20. STAINLESS STEEL FLASHING SET IN CONTINUOUS SEALANT BED BELOW.
21. MODULAR FACE BRICK BELOW, TYPICAL.
22. CAST-IN-PLACE ARCHITECTURAL CONCRETE SLAB, SEE STRUCTURAL DRAWING S-104.
23. MODULAR SOLID BRICK HEADER WALL CAP, TYPICAL.
24. 9" OPEN CELL (VAPOR SEMI-PERMEABLE) SPRAY FOAM INSULATION, R-38 MINIMUM, TYPICAL.
25. 6" x 3-1/2" x 5/16" LLV STEEL ANGLE WITH 5/8" DIAMETER MECHANICAL ANCHOR WITH 3-1/8" MINIMUM EMBEDMENT AT 3'-0" MAXIMUM SPACING. PROVIDE LONG HORIZONTAL SLOTTED HOLES AT 18" SPACING TO ACCOMMODATE CONFLICTS WITH REBAR.
26. STEEL ANGLE 2" x 2" x 3/8" - HIGH PERFORMANCE COATING PT-1, TYPICAL.
27. STEEL BASEPLATE - HIGH PERFORMANCE COATING PT-1, TYPICAL. SEE STRUCTURAL DRAWING S-503 FOR BASEPLATE DETAILS.



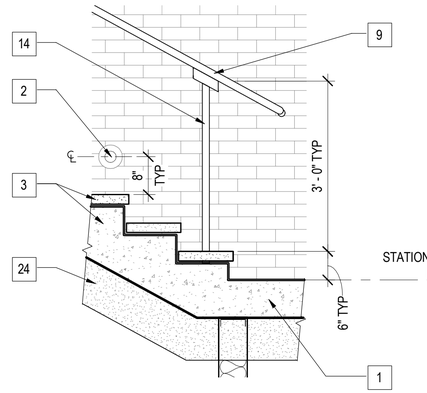
5 A-703 SECTION DETAIL
SCALE: 3/4" = 1'-0"
REF: A-701



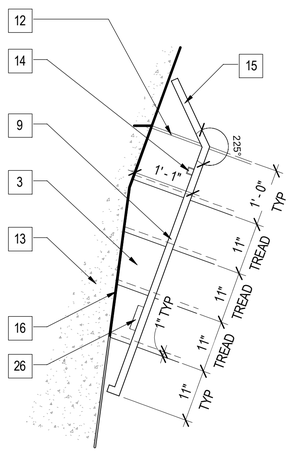
6 A-703 PLAN DETAIL
SCALE: 3/4" = 1'-0"
REF: A-701



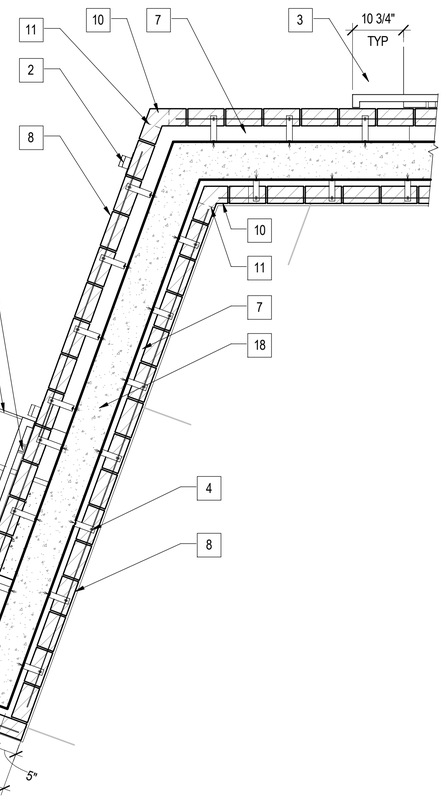
3 A-703 PLAN DETAIL
SCALE: 3/4" = 1'-0"
REF: A-701



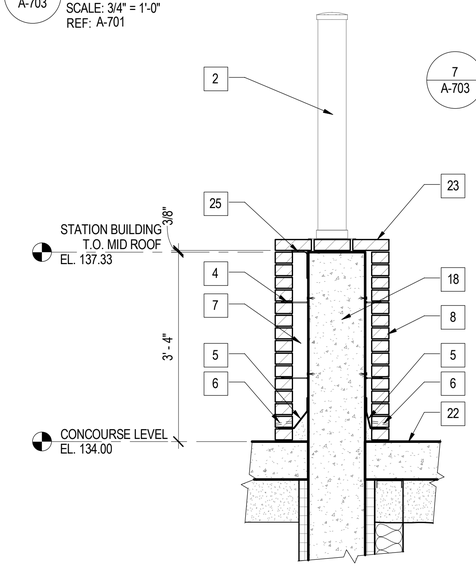
7 A-703 SECTION DETAIL
SCALE: 3/4" = 1'-0"
REF: A-702



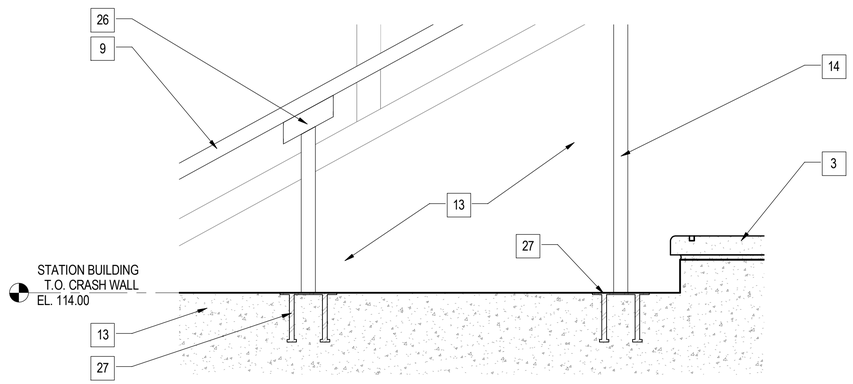
1 A-703 PLAN DETAIL
SCALE: 3/4" = 1'-0"
REF: A-701



2 A-703 PLAN DETAIL
SCALE: 3/4" = 1'-0"
REF: A-701



4 A-703 SECTION DETAIL
SCALE: 3/4" = 1'-0"
REF: A-703



8 A-703 SECTION DETAIL
SCALE: 1 1/2" = 1'-0"
REF: A-703

0 3" 6" 1' 2'
SCALE: 1 1/2" = 1'-0"

A-703

10/10/2017 4:05:12 PM

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

2	REVISED KEY NOTE #14 - RJH	10/11/17

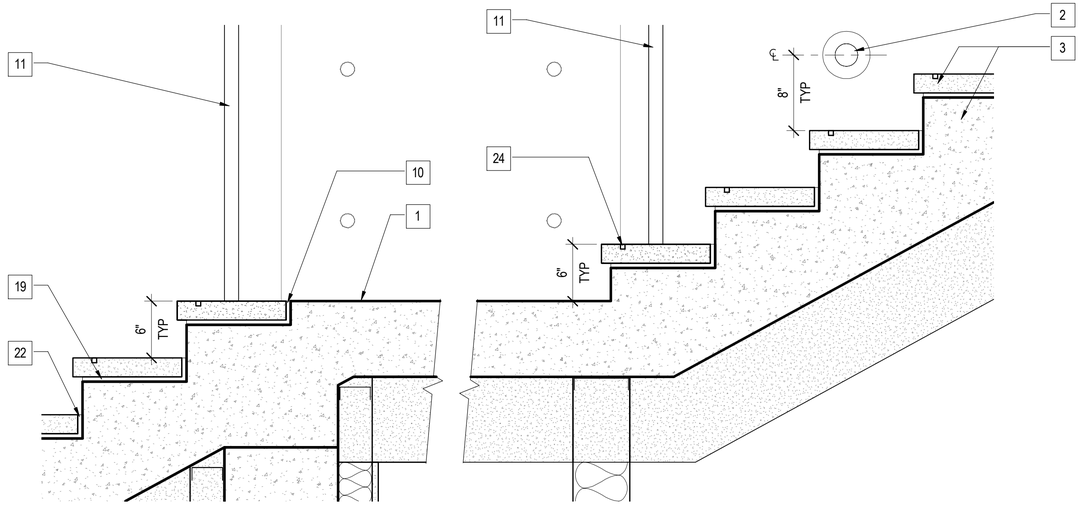
0 1' 2' 3'
SCALE: 3/4" = 1'-0"

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

CONTRACT	T201451604	BRIDGE NO.	N/A
COUNTY	NEW CASTLE	DESIGNED BY:	FAH/RJH
		CHECKED BY:	DAK

STAIR DETAILS

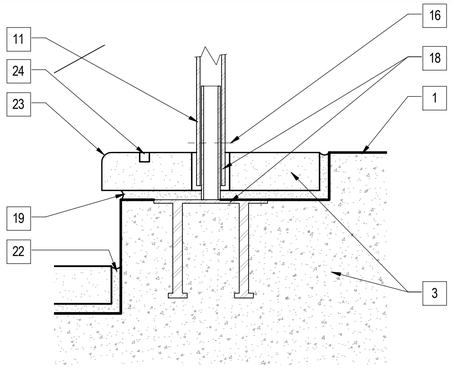
SHEET NO.	96
TOTAL SHTS.	168



2 A-704

TYPICAL STAIR TREAD / RISER AND LANDING DETAIL

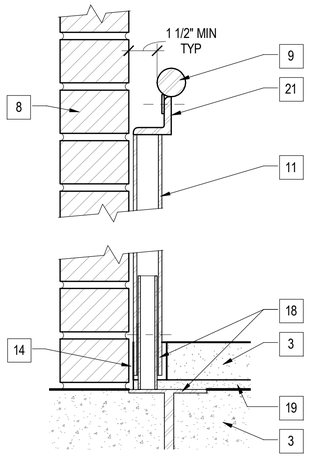
SCALE: 1 1/2" = 1'-0"
REF: A-701



7 A-704

SECTION DETAIL

SCALE: 3" = 1'-0"
REF: A-704



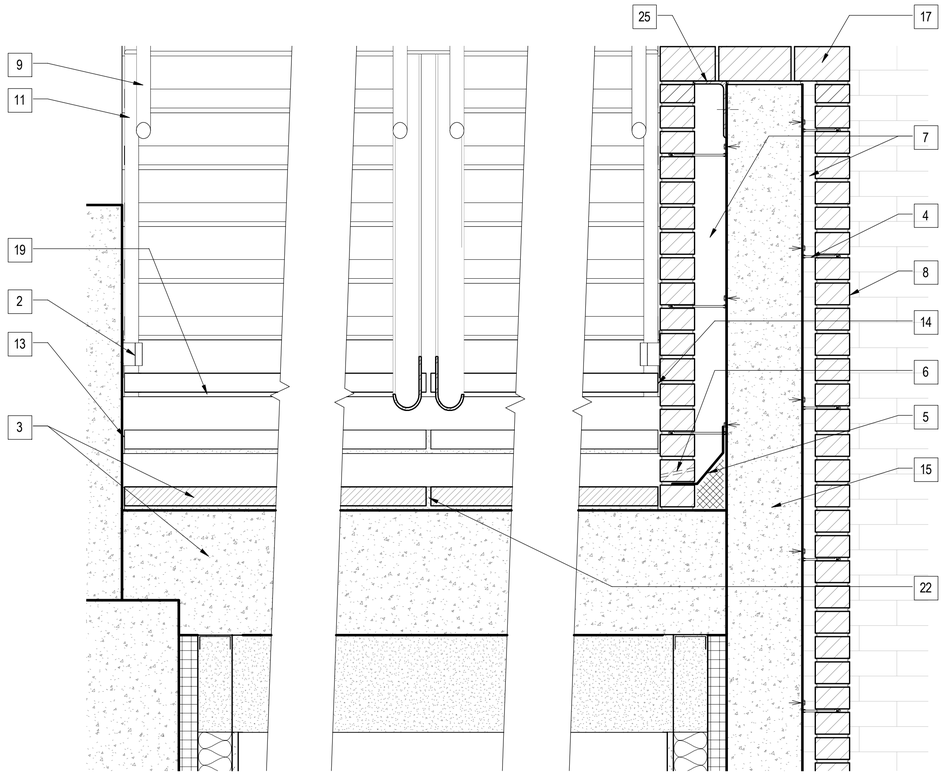
8 A-704

SECTION DETAIL

SCALE: 3" = 1'-0"
REF: A-704

CONSTRUCTION KEY NOTES

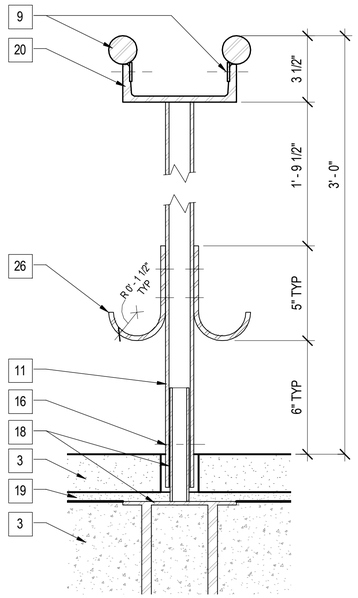
1. CAST-IN-PLACE ARCHITECTURAL CONCRETE LANDING, SEE STRUCTURAL DRAWING S-503.
2. LIGHT FIXTURE, TYPICAL. SEE ELECTRICAL DRAWINGS E-203 AND E-602.
3. CAST-IN-PLACE ARCHITECTURAL CONCRETE STAIRS WITH BLUESTONE TREADS, TYPICAL. REFERENCE STRUCTURAL DRAWING S-503.
4. MASONRY VENEER TIES AND ANCHORS AT 16" O.C. EACH WAY, TYPICAL.
5. EMBEDDED MASONRY THROUGH-WALL FLASHING. FULLY GROUT CAVITY BELOW FLASHING, TYPICAL.
6. WEEPS AT 16" O.C., TYPICAL.
7. AIR SPACE. PROVIDE CAVITY DRAINAGE MATERIAL AT ALL FLASHING LOCATIONS.
8. MODULAR FACE BRICK, TYPICAL.
9. 1-1/2" DIAMETER STAINLESS STEEL HANDRAIL WITH STAINLESS STEEL TABS, TYPICAL. ATTACHED TO PAINTED STEEL CHANNEL / ANGLE WITH TAMPER-PROOF SCREWS.
10. 1/2" MORTAR JOINT BETWEEN STAIR TREAD AND LANDING, TYPICAL.
11. 1-1/2" x 1-1/2" x 3/16" MINIMUM STEEL TUBE BALUSTER - HIGH PERFORMANCE COATING MTL-1, TYPICAL.
12. RETURN HANDRAIL EXTENSION TO WALL, TYPICAL.
13. 1/4" BETWEEN STAIR TREAD AND CONCRETE WALL, TYPICAL.
14. 1/4" BETWEEN STAIR TREAD AND BRICK WALL, TYPICAL.
15. CAST-IN-PLACE CONCRETE WALL, SEE STRUCTURAL DRAWINGS.
16. STEEL BALUSTER TUBE ATTACHED TO STEEL TUBE AND BASE PLATE, REFERENCE STRUCTURAL DRAWING S-503.
17. MODULAR BRICK ROWLOCK WALL CAP, TYPICAL.
18. 1" x 1" STEEL TUBE AND STEEL BASEPLATE - HIGH PERFORMANCE COATING MTL-1. SEE STRUCTURAL DRAWINGS FOR BASEPLATE DETAILS.
19. 1/2" MORTAR BED, TYPICAL.
20. STEEL CHANNEL C 6 x 10.5 - PAINT PT-1, TYPICAL.
21. STEEL ANGLE 2" x 2" x 3/8" - PAINT PT-1, TYPICAL.
22. 1/2" MORTAR JOINT, TYPICAL.
23. 1/2" MAXIMUM RADIUS NOSING, TYPICAL.
24. NON-SLIP INSERT, TYPICAL.
25. 6" x 3-1/2" x 5/16" LLV STEEL ANGLE WITH 5/8" DIAMETER MECHANICAL ANCHORS WITH 3-1/8" MINIMUM EMBEDMENT AT 3'-0" MAXIMUM SPACING. PROVIDE LONG HORIZONTAL SLOTTED HOLES AT 18" SPACING TO ACCOMMODATE CONFLICTS WITH REBAR.
26. CONTINUOUS STAINLESS STEEL BIKE RUNNEL, TYPICAL ON BOTH SIDES OF CENTER HANDRAIL. ~~PAINT, PT-1.~~ ATTACH AT EACH STEEL BALUSTER.



1 A-704

TYPICAL SECTION AT STAIR

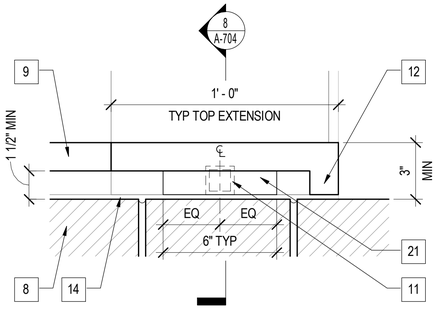
SCALE: 1 1/2" = 1'-0"
REF: A-701



5 A-704

SECTION DETAIL

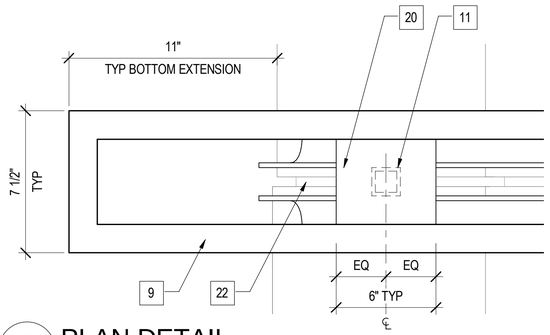
SCALE: 3" = 1'-0"
REF: A-704



6 A-704

PLAN DETAIL

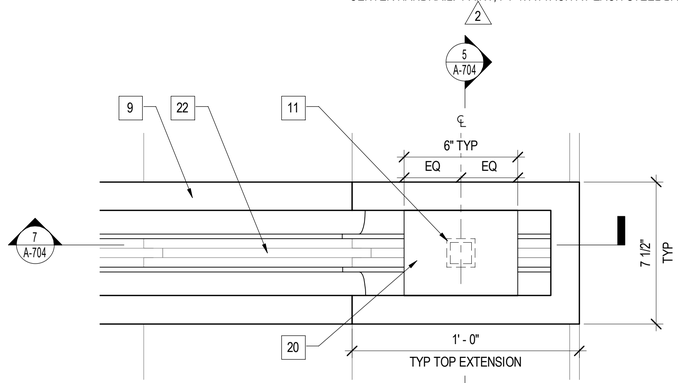
SCALE: 3" = 1'-0"



3 A-704

PLAN DETAIL

SCALE: 3" = 1'-0"
REF: A-701



4 A-704

PLAN DETAIL

SCALE: 3" = 1'-0"
REF: A-701

0 2" 4" 8"
SCALE: 3" = 1'-0"

A-704

10/10/2017 4:05:14 PM

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS		
2	REVISED KEY NOTE #26 - RJH	10/11/17

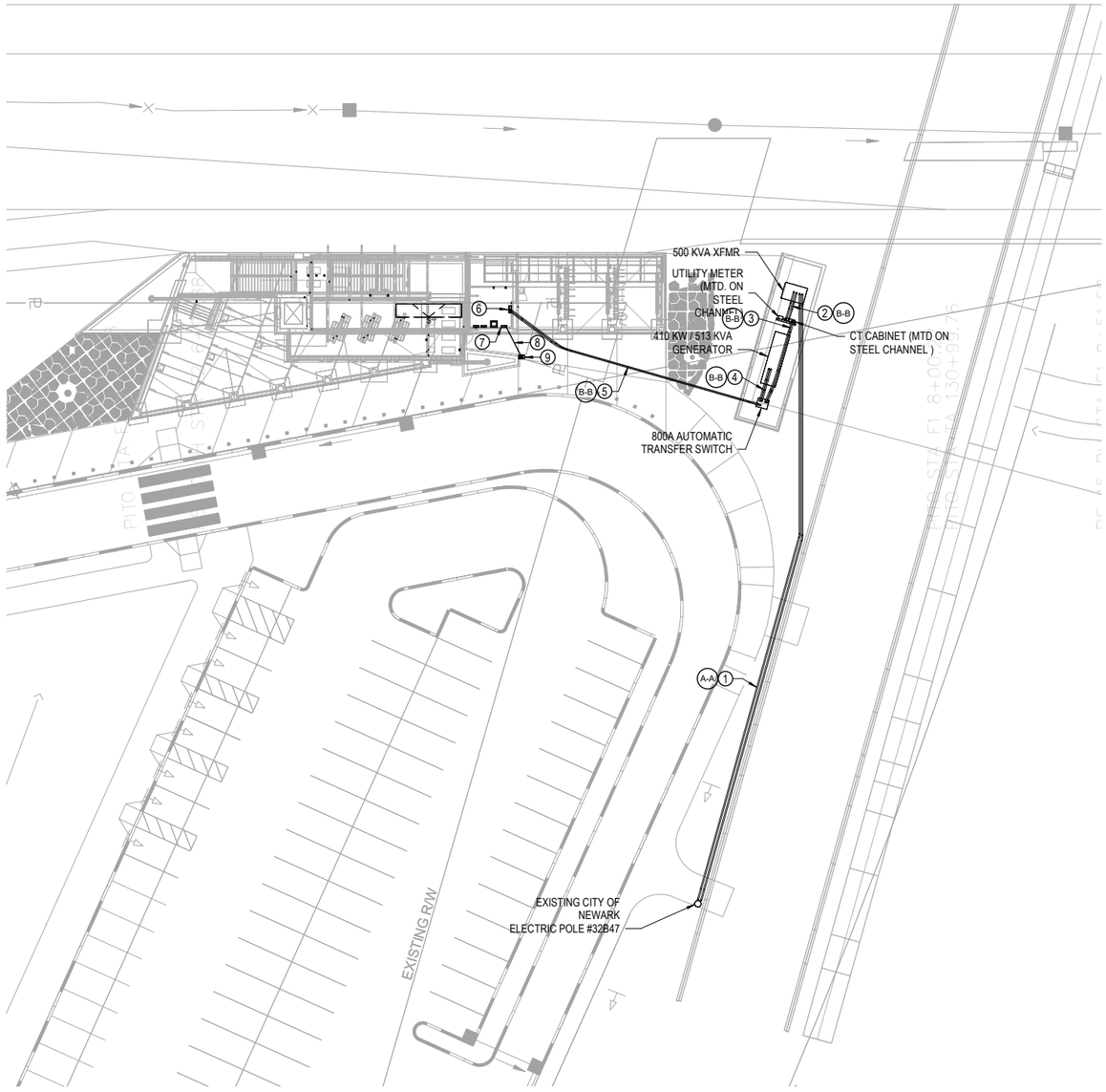
0 3" 6" 1' 2'
SCALE: 1 1/2" = 1'-0"

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

CONTRACT	T201451604
COUNTY	NEW CASTLE
BRIDGE NO.	N/A
DESIGNED BY:	FAH/RJH
CHECKED BY:	DAK

STAIR DETAILS

SHEET NO.	97
TOTAL SHTS.	168



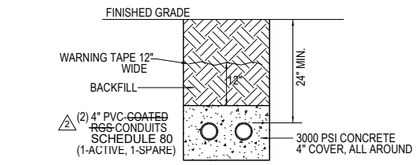
1 E-002 POWER SITE PLAN
SCALE: 1" = 20'-0"

GENERAL SHEET NOTES

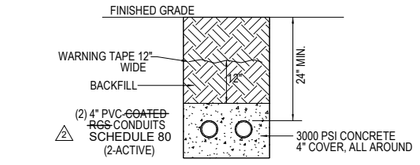
1. SEE PLATFORM DWGS FOR PLATFORM FOUNDATIONS AND PRECAST CONCRETE PANEL LAYOUT.
2. REFER TO DRAWING E-001 FOR GENERAL NOTES, ABBREVIATIONS AND SYMBOLS.
3. REFER TO DRAWING E-501 FOR SINGLE LINE DIAGRAM.

KEYED NOTES

1. (2) 4" CONDUITS PROVIDED BY ELECTRICAL CONTRACTOR. CONDUCTORS BY UTILITY COMAPANY. COORDINATE UTILITY REQUIRMENTS WITH UTILITY COMPANY PRIOR TO INSTALLATION.
2. (2) 4" CONDUIT FROM 500kVA TRANSFORMER TO CT CABINET.
3. (2) 4" CONDUIT FROM CT CABINET TO ATS.
4. (2) 4" CONDUIT FROM GENERATOR TO ATS.
5. (2) 4" CONDUIT FROM ATS TO 'MDP' LOCATED IN ELECTRIC ROOM 108.
6. 'MDP' LOCATED IN ELECTRIC ROOM 108.
7. 'MMP' LOCATED IN ELECTRIC ROOM 108.
8. 3/4" CONDUIT, 3#10, 1#10 GROUND, FROM 'MMP' TO QUAZITE PULL BOX.
9. QUAZITE PULL BOX FOR INTERCONNECTION TO SEWAGE EJECTOR PUMP.



2 E-002 DUCTBANK A-A
SCALE: NOT TO SCALE
REF:



3 E-002 DUCTBANK B-B
SCALE: NOT TO SCALE
REF:

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DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS
2 REVISED CONDUIT TYPE - MCT/AAS 10-11-17

0 10' 20' 40'
SCALE: 1" = 20'-0"

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

CONTRACT T201451604
COUNTY NEW CASTLE
BRIDGE NO. N/A
DESIGNED BY: JP
CHECKED BY: MKA

POWER SITE PLAN

E-002
SHEET NO. 135
TOTAL SHTS. 168

GENERAL SHEET NOTES

1. REFER TO DRAWING E-001 FOR GENERAL NOTES, ABBREVIATIONS AND SYMBOLS.
2. REFER TO DRAWING E-501 FOR SINGLE LINE DIAGRAM.
3. REFER TO DRAWING E-601 FOR PANEL SCHEDULE.
4. ALL CIRCUITRY SHALL BE 2 #12, 1 #12 GND., IN 3/4" ~~EMT~~ (2) CONDUIT MINIMUM UNLESS OTHERWISE NOTED. RIGID

KEYED NOTES

(1) NEMA L5-30R RECEPTACLE MOUNTED ON SIDE OF CABLE TRAY ABOVE DATA RACK, FOR UPS.

(2) GFCI QUAD RECEPTACLE LOCATED 4' ABOVE FINISHED FLOOR ELEVATOR PIT.

(3) CEILING MOUNTED JUNCTION BOX FOR CONNECTION TO DAKTRONICS LCD SCREEN.

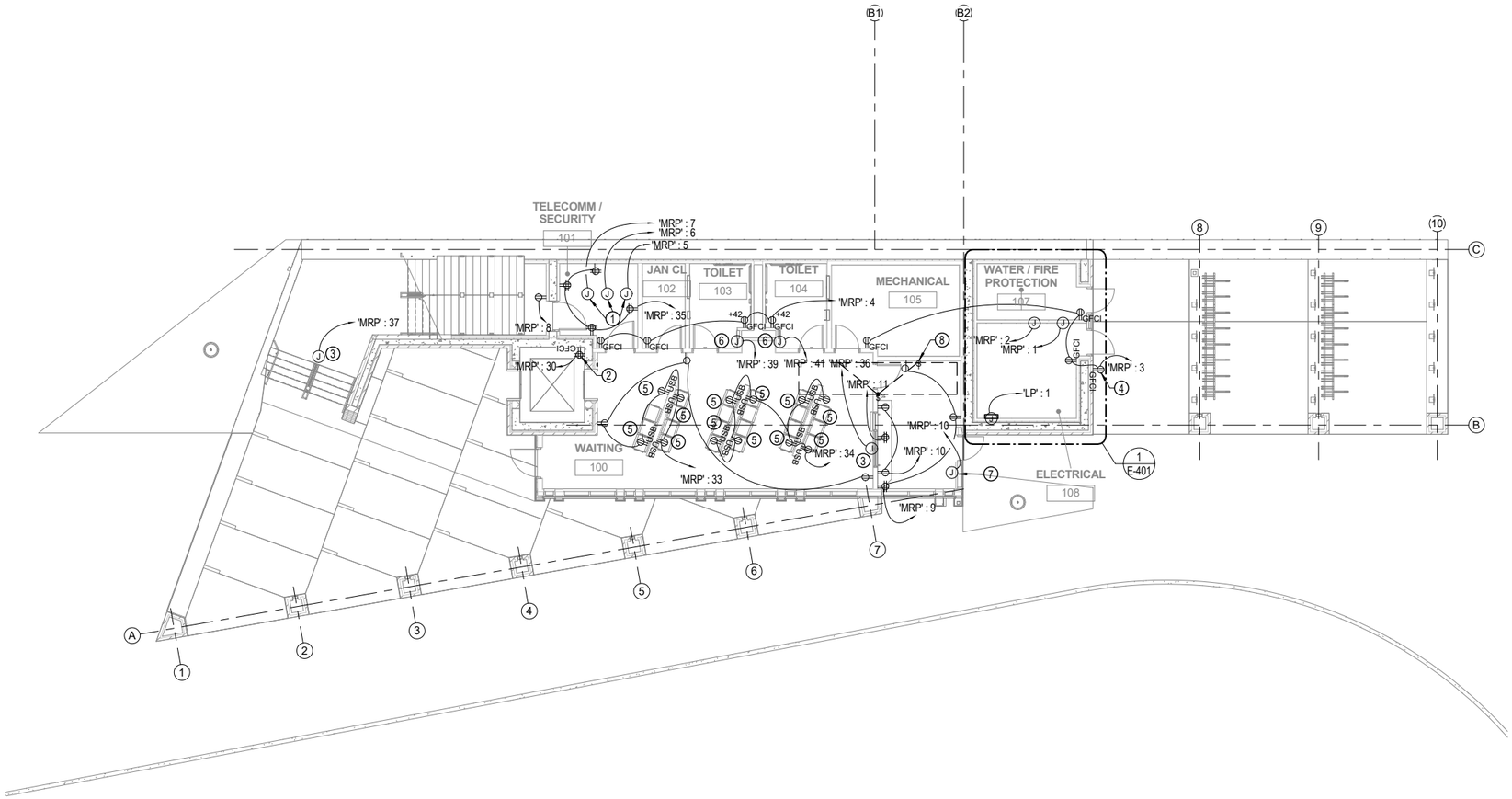
(4) PROVIDE A GFCI DUPLEX RECEPTACLE WITH LOCKABLE COVER AT THIS LOCATION.

(5) PROVIDE DUPLEX RECEPTACLE LOCATED 4' ABOVE FINISHED FLOOR. COORDINATE EXACT LOCATIONS WITH ARCHITECT TO ENSURE RECEPTACLES ARE ACCESSIBLE BEHIND SEATS.

(6) JUNCTION BOX FOR CONNECTION TO HAND DRYER.

(7) PROVIDE CONNECTION TO MOTORIZED SHADES. COORDINATE EXACT QUANTITY AND LOCATION OF CONNECTION POINTS WITH APPROVED MOTORIZED SHADE SHOP DRAWING.

(8) PROVIDE MOTORIZED SHADE CONTROL SWITCH IN COMMON FACEPLATE WITH ROOM LIGHTING CONTROL SWITCH. MAKE ALL FINAL CONNECTIONS AS REQUIRED TO MOTORIZED SHADES PER MANUFACTURER'S INSTRUCTIONS.



12 / E-101 STATION BUILDING LOWER LEVEL POWER PLAN

SCALE: 1/8" = 1'-0"

10/10/2017 4:22:10 PM

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS		
2	REVISED CONDUIT TYPE - MCT/AAS	10-11-17

0 4' 8' 16'

SCALE: 1/8" = 1'-0"

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

CONTRACT	T201451604	BRIDGE NO.	N/A
COUNTY	NEW CASTLE	DESIGNED BY:	JP
		CHECKED BY:	MKA

STATION BUILDING LOWER LEVEL POWER PLAN

	E-101
SHEET NO.	137
TOTAL SHTS.	168

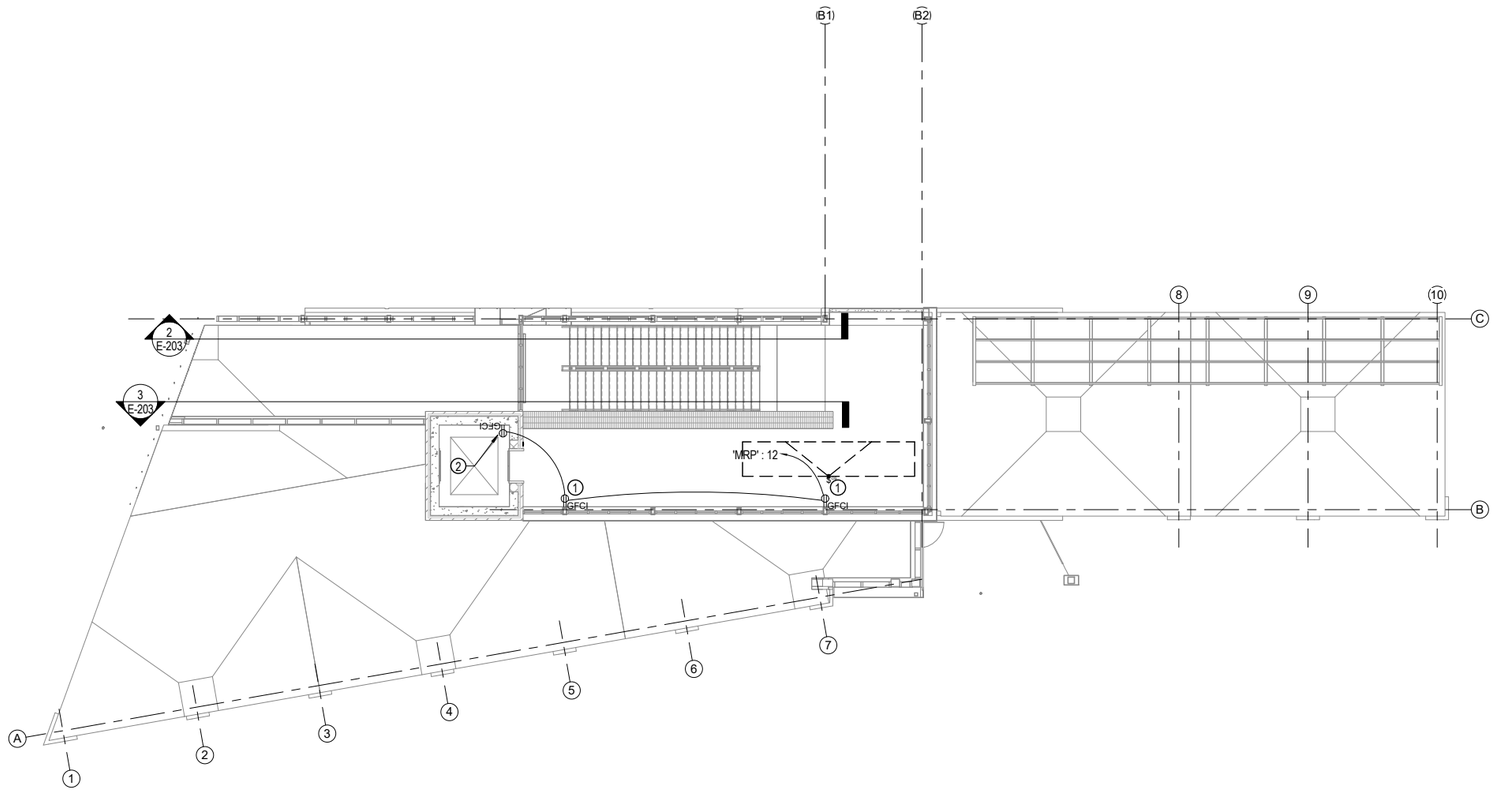
GENERAL SHEET NOTES

1. SEE PLATFORM DWGS FOR PLATFORM FOUNDATIONS AND PRECAST CONCRETE PANEL LAYOUT.
2. SEE TRACK DWGS FOR TRACK LAYOUT AND ASSOCIATED WORK.
3. REFER TO DRAWING E-001 FOR GENERAL NOTES, ABBREVIATIONS AND SYMBOLS.
4. REFER TO DRAWING E-601 FOR PANEL SCHEDULE.
5. ALL CIRCUITRY SHALL BE 2 #12, 1 #12 GND., IN 3/4" ~~EMT~~ RIGID CONDUIT MINIMUM UNLESS OTHERWISE NOTED. (2)

KEYED NOTES

(1) PROVIDE A GFCI RECEPTACLE WITH LOCKABLE COVER AT THIS LOCATION.

(2) PROVIDE A GFCI RECEPTACLE LOCATED IN ELEVATOR SHAFT 10' ABOVE FINISHED FLOOR OF CONCOURSE LEVEL.



1 E-102 STATION BUILDING CONCOURSE POWER PLAN

SCALE: 1/8" = 1'-0"
REF:

10/10/2017 4:22:12 PM

DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS		
(2) REVISED CONDUIT TYPE - MCT/AAS	10-11-17	

0 4' 8' 16'
SCALE: 1/8" = 1'-0"

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

CONTRACT	T201451604	BRIDGE NO.	N/A
COUNTY	NEW CASTLE	DESIGNED BY:	JP
		CHECKED BY:	MKA

STATION BUILDING CONCOURSE POWER PLAN

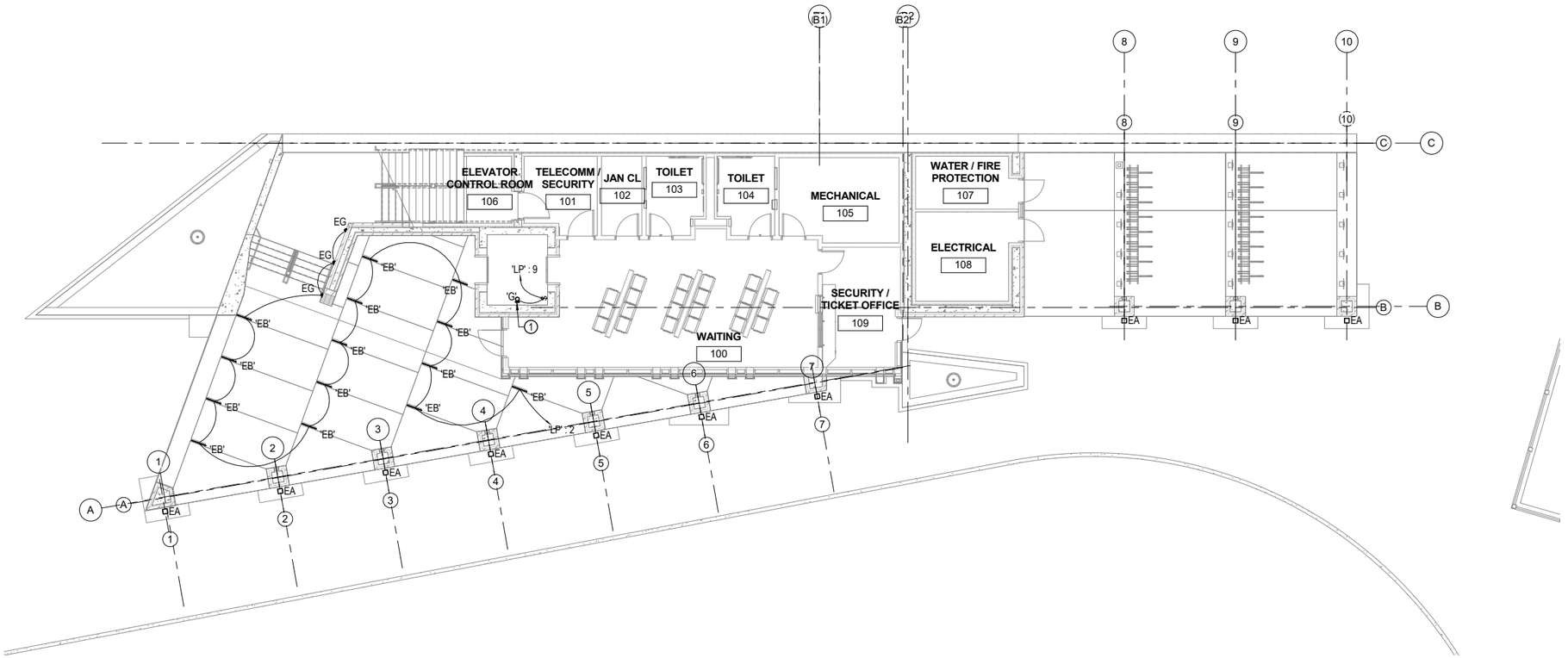
	E-102
SHEET NO.	138
TOTAL SHTS.	168

GENERAL SHEET NOTES

1. REFER TO DRAWING E-001 FOR GENERAL NOTES, ABBREVIATIONS AND SYMBOLS.
2. REFER TO DRAWING E-602 FOR LUMINAIRE SCHEDULE.
3. REFER TO DRAWING E-601 FOR PANEL SCHEDULE.
4. ALL CIRCUITRY SHALL BE 2 #10, 1 #10 GND., IN 3/4" ~~EMT~~ RIGID CONDUIT UNLESS OTHERWISE NOTED. (2)

KEYED NOTES

(1) TYPE 'G' LIGHT FIXTURE LOCATED 4' ABOVE FINISHED FLOOR IN ELEVATOR PIT.



1 / E-201 STATION BUILDING IN-FLOOR LIGHTING PLAN

SCALE: 1/8" = 1'-0"
REF:

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DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS (2) REVISED CONDUIT TYPE - MCT/AAS 10-11-17	0 4' 8' 16' SCALE: 1/8" = 1'-0"	NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING	CONTRACT T201451604 COUNTY NEW CASTLE	BRIDGE NO. N/A DESIGNED BY: JP CHECKED BY: MKA	STATION BUILDING IN-FLOOR LIGHTING PLAN	E-201 SHEET NO. 139 TOTAL SHTS. 168

GENERAL SHEET NOTES

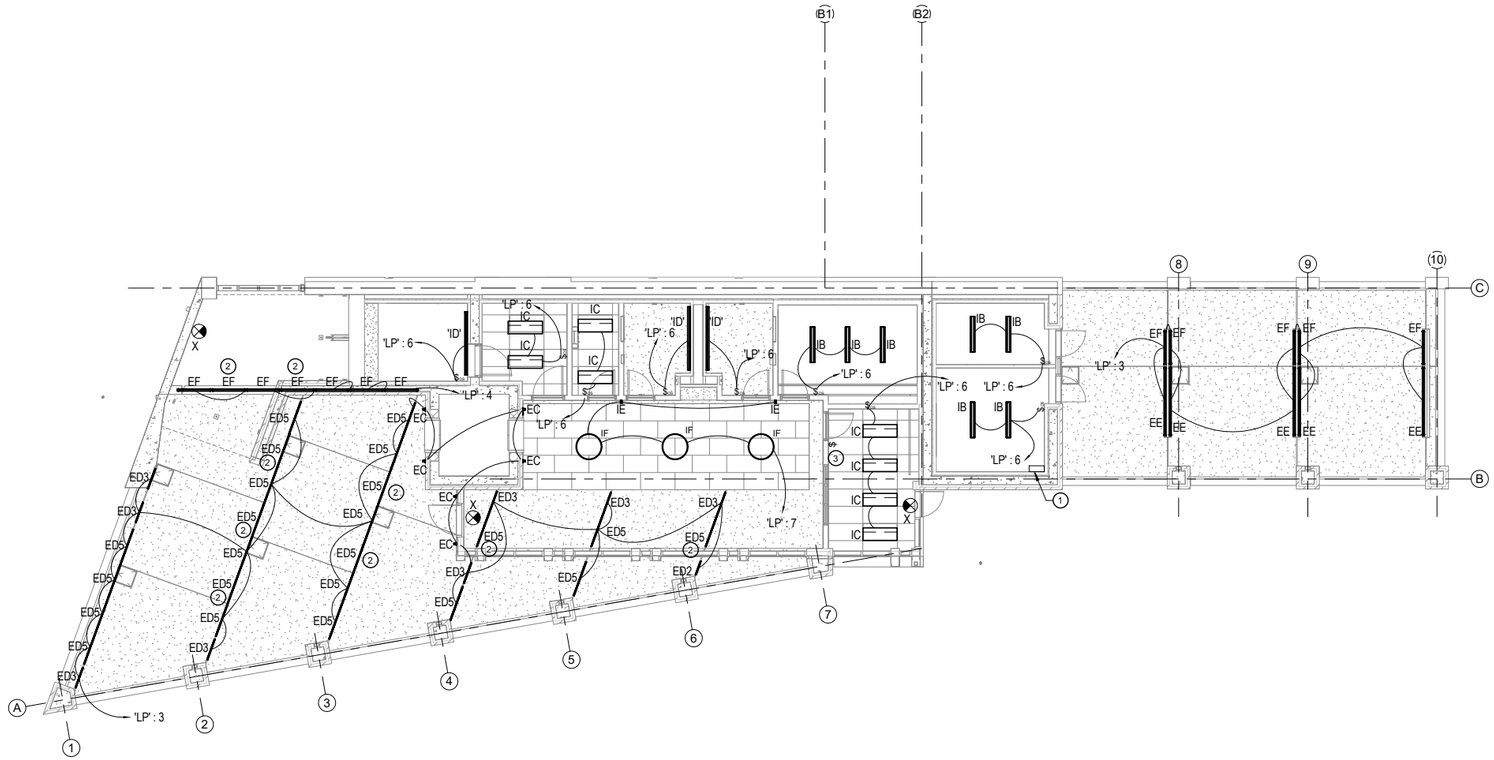
1. REFER TO DRAWING E-001 FOR GENERAL NOTES, ABBREVIATIONS AND SYMBOLS.
2. REFER TO DRAWING E-603 FOR LUMINAIRE SCHEDULE.
3. REFER TO DRAWING E-601 FOR PANEL SCHEDULE.
4. ALL TYPE 'X' EXIT SIGNS SHALL BE INTERCONNECTED TO LIGHTING CIRCUIT AHEAD OF LOCAL SWITCH SERVING AREA WHICH THEY ARE LOCATED IN.
5. ALL CIRCUITRY SHALL BE 2 #10, 1 #10 GND., IN 3/4" ~~EMT~~ (2) RIGID CONDUIT UNLESS OTHERWISE NOTED.
6. FURNISH AND INSTALL THE ALUMINUM STRUCTURE TO SUPPORT LIGHT FIXTURES TYPE EE AND EF. REFER TO DRAWING S-513 FOR DETAILS.

KEYED NOTES

(1) PROVIDE TWO (2) 350W CENTRAL EMERGENCY POWER SYSTEM BATTERY INVERTERS, UL924 LISTED, LVS CATALOG #CEPS-350-277V. CONNECT TO PANEL LP, CIRCUIT 10.

(2) EMERGENCY EGRESS LIGHT FIXTURE. CONNECT TO CENTRAL EMEGENCY POWER SYSTEM. MAXIMUM LOAD PER EACH INVERTER IS 350W.

(3) PROVIDE CONTROL SWITCH FOR LIGHTING CONTROL PANEL. PROVIDE CONNECTION TO RELAY FOR TIMECLOCK OVERRIDE.



1 E-202 STATION BUILDING LIGHTING PLAN

SCALE: 1/8" = 1'-0"
REF:

10/10/2017 4:22:19 PM

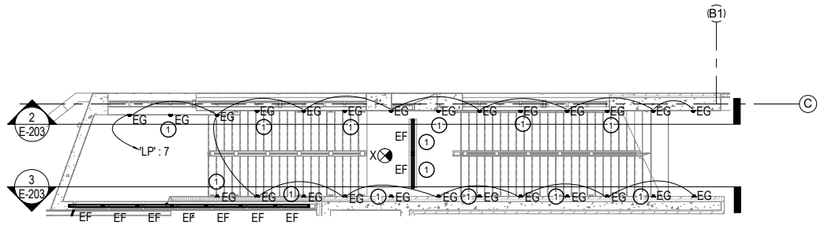
DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS 2 REVISED CONDUIT TYPE - MCT/AAS 10-11-17	0 4' 8' 16' SCALE: 1/8" = 1'-0"	NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING	CONTRACT T201451604 COUNTY NEW CASTLE	BRIDGE NO. N/A DESIGNED BY: JP CHECKED BY: MKA	STATION BUILDING LIGHTING PLAN	E-202 SHEET NO. 140 TOTAL SHTS. 168

GENERAL SHEET NOTES

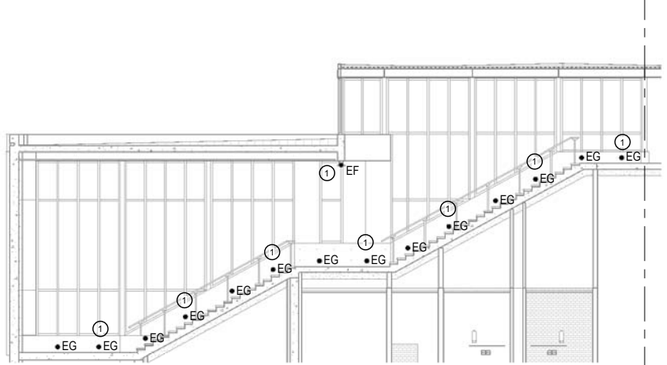
1. REFER TO DRAWING E-001 FOR GENERAL NOTES, ABBREVIATIONS AND SYMBOLS.
2. REFER TO DRAWING E-602 FOR LUMINAIRE SCHEDULE.
3. REFER TO DRAWING E-601 FOR PANEL SCHEDULE.
4. ALL TYPE 'X' EXIT SIGNS SHALL BE INTERCONNECTED TO LIGHTING CIRCUIT AHEAD OF LOCAL SWITCH SERVING AREA WHICH THEY ARE LOCATED IN.
5. ALL CIRCUITRY SHALL BE 2 #10, 1 #10 GND., IN 3/4"~~EMT~~ (2) RIGID CONDUIT UNLESS OTHERWISE NOTED.
6. FURNISH AND INSTALL THE ALUMINUM STRUCTURE TO SUPPORT LIGHT FIXTURES TYPE EE AND EF. REFER TO DRAWING S-513 FOR DETAILS.

KEYED NOTES

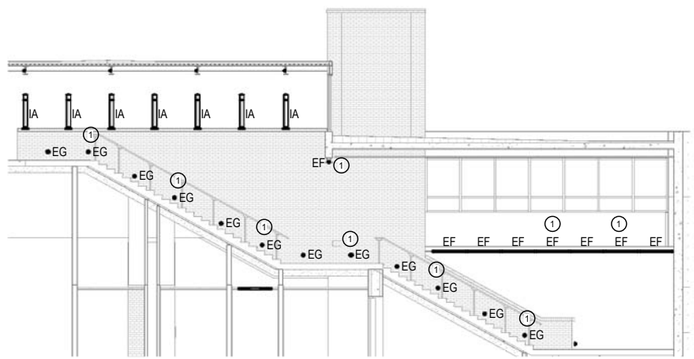
(1) EMERGENCY EGRESS LIGHT FIXTURE. CONNECT TO CENTRAL EMEGENCY POWER SYSTEM. MAXIMUM LOAD PER EACH INVERTER IS 350W.



1 / E-203 LIGHTING STATION BUILDING STAIR PLAN
SCALE: 1/8" = 1'-0"
REF:



2 / E-203 LIGHTING STAIR ELEVATION NORTH
SCALE: 1/8" = 1'-0"
REF: E-102



3 / E-203 LIGHTING STAIR ELEVATION SOUTH
SCALE: 1/8" = 1'-0"
REF: E-102

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DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

2	REVISED CONDUIT TYPE - MCT/AAS	10-11-17

0 4' 8' 16'
SCALE: 1/8" = 1'-0"

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

CONTRACT T201451604
COUNTY NEW CASTLE
BRIDGE NO. N/A
DESIGNED BY: JP
CHECKED BY: MKA

STATION BUILDING STAIR LIGHTING

E-203
SHEET NO. 141
TOTAL SHTS. 168

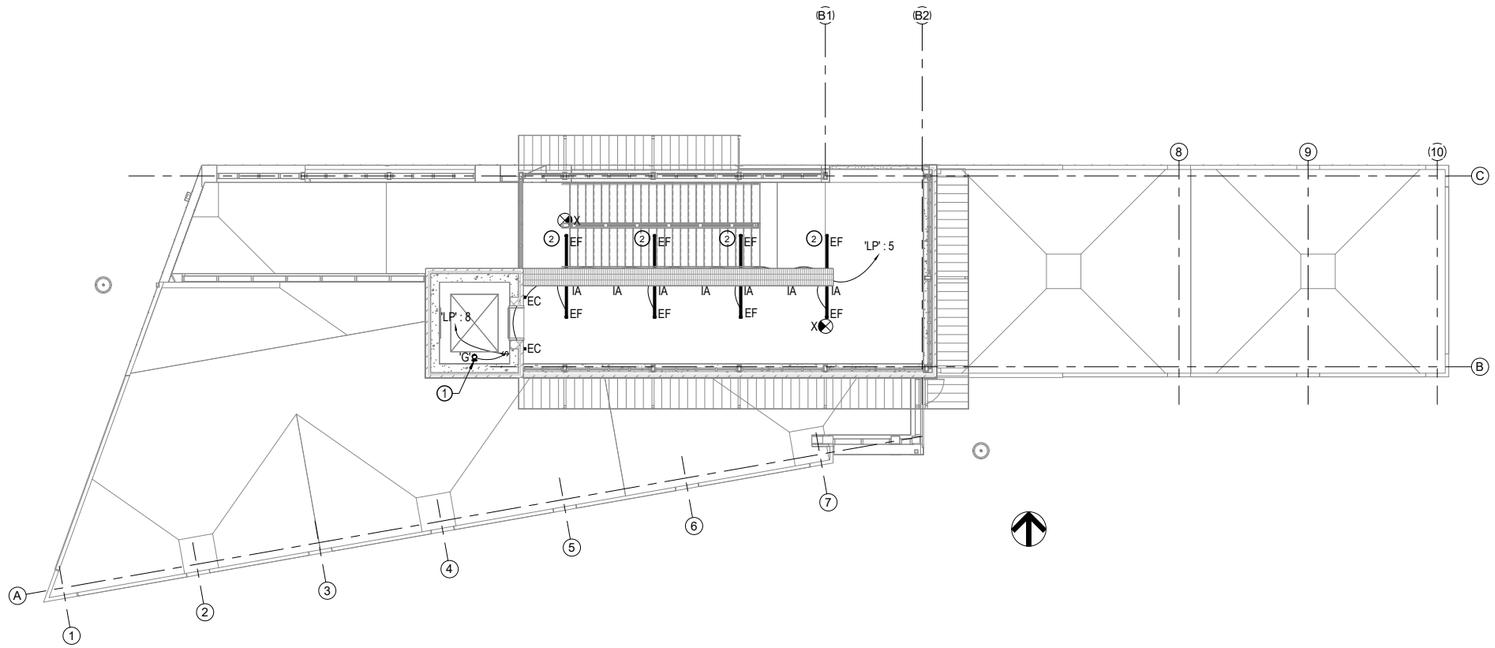
GENERAL SHEET NOTES

1. REFER TO DRAWING E-001 FOR GENERAL NOTES, ABBREVIATIONS AND SYMBOLS.
2. REFER TO DRAWING E-602 FOR LUMINAIRE SCHEDULE.
3. REFER TO DRAWING E-601 FOR PANEL SCHEDULE.
4. ALL TYPE 'X' EXIT SIGNS SHALL BE INTERCONNECTED TO LIGHTING CIRCUIT AHEAD OF LOCAL SWITCH SERVING AREA WHICH THEY ARE LOCATED IN.
5. ALL CIRCUITRY SHALL BE 2 #10, 1 #10 GND., IN 3/4" ~~EMT~~ RIGID CONDUIT UNLESS OTHERWISE NOTED. (2)
6. FURNISH AND INSTALL THE ALUMINUM STRUCTURE TO SUPPORT LIGHT FIXTURES TYPE EE AND EF. REFER TO DRAWING S-513 FOR DETAILS

KEYED NOTES

(1) TYPE 'G' LIGHT FIXTURE LOCATED 10' ABOVE CONCOURSE LEVEL FINISHED FLOOR.

(2) EMERGENCY EGRESS LIGHT FIXTURE. CONNECT TO CENTRAL EMEGENCY POWER SYSTEM. MAXIMUM LOAD PER EACH INVERTER IS 350W.



1 / E-204 STATION BUILDING CONCOURSE LIGHTING PLAN

SCALE: 1/8" = 1'-0"
REF:

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DELAWARE
DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS		
2	REVISED CONDUIT TYPE - MCT/AAS 10-11-17	

0 4' 8' 16'
SCALE: 1/8" = 1'-0"

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

CONTRACT	T201451604
COUNTY	NEW CASTLE
BRIDGE NO.	N/A
DESIGNED BY:	JP
CHECKED BY:	MKA

STATION BUILDING CONCOURSE LIGHTING PLAN

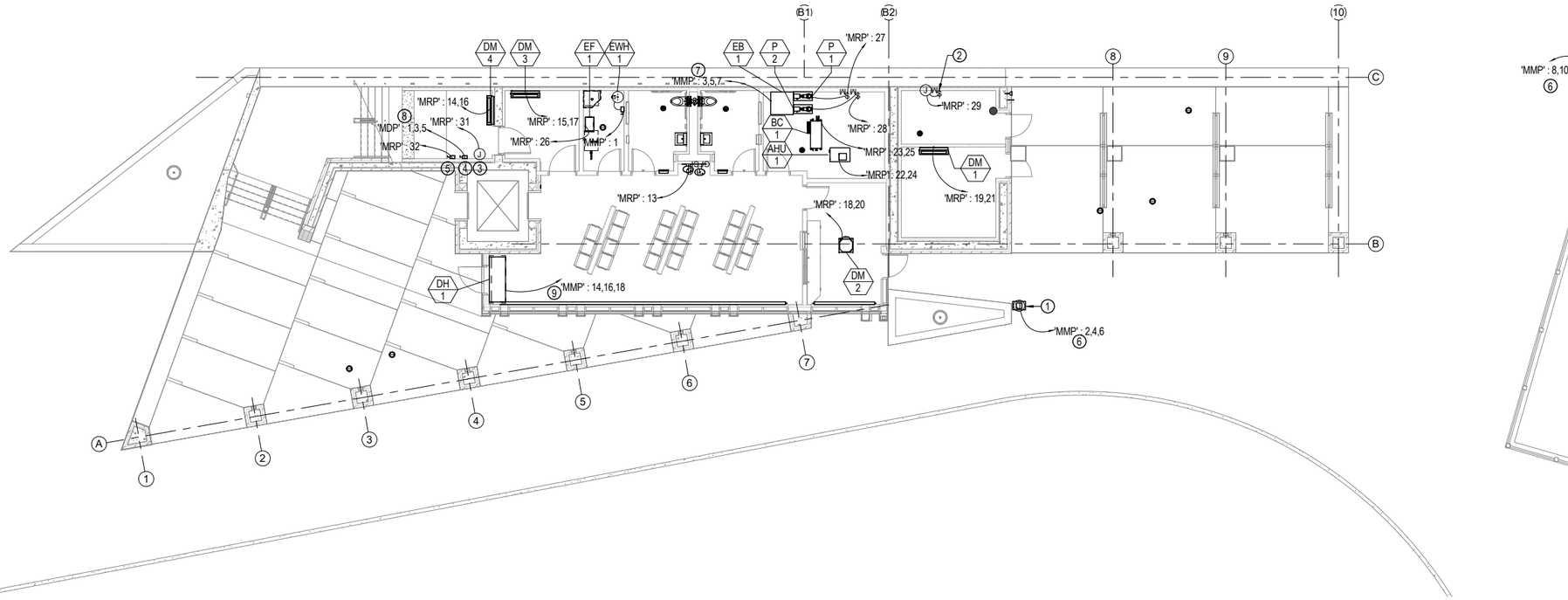
	E-204
SHEET NO.	142
TOTAL SHTS.	168

GENERAL SHEET NOTES

1. REFER TO DRAWING E-001 FOR GENERAL NOTES, ABBREVIATIONS AND SYMBOLS.
2. COORDINATE MECHANICAL REQUIRMENTS WITH SHOP DRAWINGS PRIOR TO COMMENCING ANY WORK.
3. ALL MECHANICAL EQUIPMENT SHALL BE SUPPLIED WITH VENDORS DISCONNECTING MEANS UNLESS SHOWN ON DRAWING.
4. ALL CIRCUITRY SHALL BE 2 #10, 1 #10 GND., IN 3/4" ~~EMT~~ CONDUIT UNLESS OTHERWISE NOTED. (2) RIGID
5. EC SHALL COORDINATE WITH ELEVATOR CONTRACTOR & ELEVATOR MANUFACTURER FOR EXACT REQUIREMENTS & MAKE ADJUSTMENTS AS REQUIRED.
6. THE FEEDER & BRANCH CIRCUIT OCPD SHALL BE SELECTED TO MEET THE REQUIREMENTS OF 620.62 (SELECTIVE COORDINATION).
7. THERE SHALL BE BRANCH CIRCUITS INSTALLED PER THE REQUIREMENTS OF 620.22, 620.23, 620.24 & 620.53.
8. THE ENTIRE ELEVATOR INSTALLATION MUST MEET THE REQUIREMENTS OF NEC ARTICLE 620.

KEYED NOTES

1. TEIR 22 POLYMER CONCRETE PULL BOX FOR CONNECTION TO SEWAGE EJECTOR PUMP. QUAZITE BOX ASSEMBLY #PG1118D18, WITH 2-BOLT COVER #PG1118HH00017, OR APPROVED EQUAL.
2. PROVIDE A 20A/1P MOTOR RATED TOGGLE SWITCH FOR DISCONNECTING MEANS TO FIRE PROTECTION AIR COMPRESSOR. COORDINATE LOCATION IN FIELD.
3. JUNCTION BOX FOR INTERCONNECTION TO ELEVATOR CONTROL PANEL.
4. 150A/3P ELEVATOR DISCONNECT SWITCH. THE DISCONNECTING MEANS SHALL MEET THE REQUIREMENTS OF 620.51 & COORDINATE WITH THE BUILDING FIRE ALARM SYSTEM AS REQUIRED. PROVIDE COOPER BUSSMAN POWER MODULE WITH SHUNT TRIP FUSIBLE SWITCH OR APPROVED EQUAL.
5. 30A/1P ELEVATOR CAB LIGHT DISCONNECT SWITCH.
6. CIRCUITRY SHALL BE 3 #10, 1 #10 GND., IN 3/4" ~~PVC COATED RGS CONDUIT.~~ (2) 2" SCHEDULE 80 ENCASED IN CONCRETE. SIMILAR TO E.002 DETAIL 2-E002.
7. CIRCUITRY SHALL BE 3 #10, 1 #10 GND., IN 3/4" ~~EMT~~ CONDUIT. (2) RIGID
8. CIRCUITRY SHALL BE 3 #1/0, 1 #6 GND., IN 1-1/2" ~~EMT~~ CONDUIT. (2) RIGID
9. CIRCUITRY SHALL BE 3#6, 1#10GND., IN 1" ~~EMT~~ CONDUIT. (2) RIGID

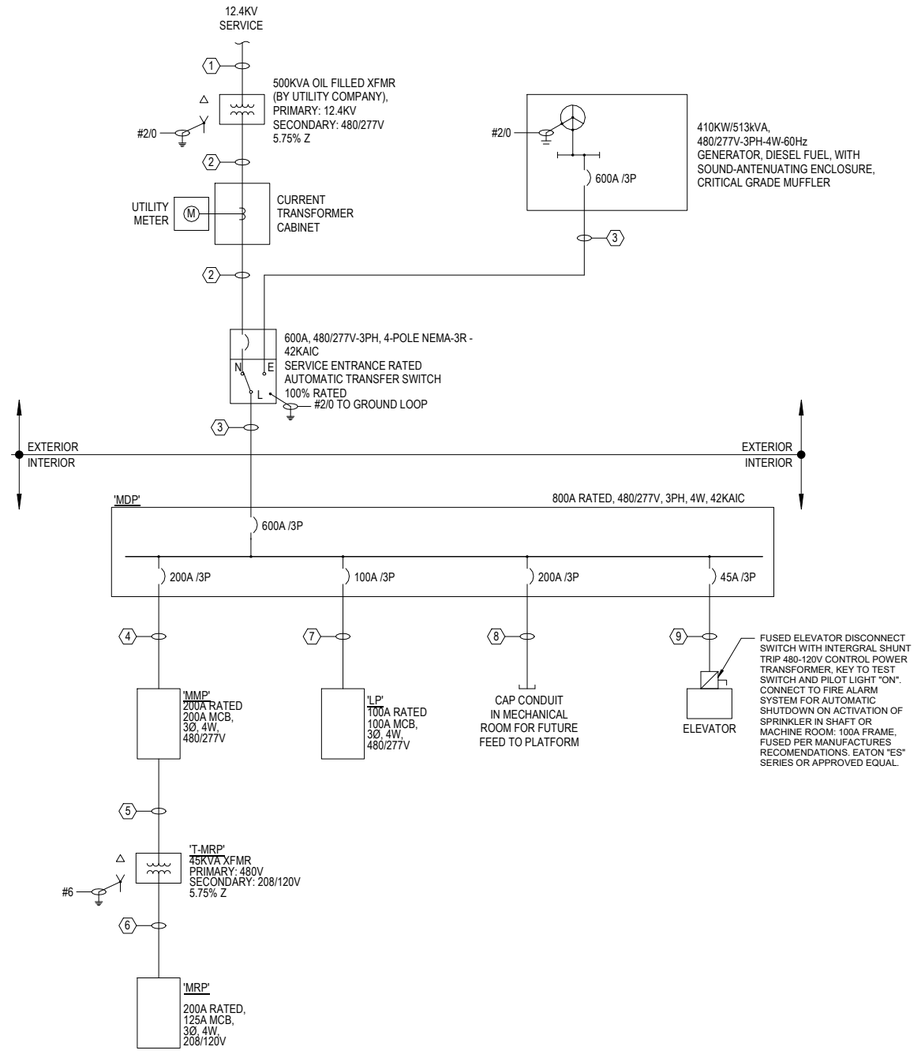


1 / E-301 MECHANICAL CONNNECTIONS STATION BUILDING LOWER LEVEL

SCALE: 1/8" = 1'-0"
REF:

10/10/2017 4:22:31 PM

DELAWARE DEPARTMENT OF TRANSPORTATION	ADDENDUMS / REVISIONS (2) REVISED CONDUIT TYPE - MCT/AAS 10-11-17	0 4' 8' 16' SCALE: 1/8" = 1'-0"	NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING	CONTRACT T201451604 COUNTY NEW CASTLE	BRIDGE NO. N/A DESIGNED BY: JP CHECKED BY: MKA	STATION BUILDING MECHANICAL INTERCONNNECTION PLAN	E-301 SHEET NO. 143 TOTAL SHTS. 168



1 E-501 ELECTRICAL SINGLE LINE DIAGRAM

SCALE: NOT TO SCALE
REF:

FEEDER SCHEDULE

FEEDER NUMBER	QUANTITY OF SETS	QUANTITY OF CONDUCTORS	600 VOLT COPPER CONDUCTOR SIZE	600 VOLT COPPER GROUND CONDUCTOR SIZE	CONDUIT TRADE SIZE	NOTES
1	1	3	#2 (15KV RATED)	-	4" PVC	(CONDUCTORS BY UTILITY COMPANY) PROVIDE A SPARE 4" CONDUIT (CAPPED) CONCRETE ENCASED CONDUITS
2	2	4	#350 kCMIL	-	4" PVC	CONCRETE ENCASED CONDUITS
3	2	4	#350 kCMIL	#2/0	4" PVC	CONCRETE ENCASED CONDUITS
4	1	4	#3/0	#6	2 2" ~~EMT~~	-
5	1	3	#4	#8	2 1" ~~EMT~~	-
6	1	4	#1	#6	2 1-1/2" ~~EMT~~	-
7	1	4	#1	#8	2 1-1/2" ~~EMT~~	-
8	1	-	-	-	2 2" ~~EMT~~	SPARE CONDUIT CAPPED FOR FUTURE FEEDER TO PLATFORM
9	1	3	#8	#10	2 1" ~~EMT~~	-

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DELAWARE DEPARTMENT OF TRANSPORTATION

ADDENDUMS / REVISIONS

2	REVISED CONDUIT TYPE - MCT/AAS	10-11-17

NEWARK REGIONAL TRANSPORTATION CENTER, STATION BUILDING

CONTRACT T201451604
COUNTY NEW CASTLE
BRIDGE NO. N/A
DESIGNED BY: JP
CHECKED BY: MKA

ELECTRICAL SINGLE LINE DIAGRAM

E-501
SHEET NO. 146
TOTAL SHTS. 168

TABLE OF CONTENTS

DIVISION 01 – GENERAL REQUIREMENTS

Division 100 General Provisions of the Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated ~~2004~~ 2016, including all revisions up to the date of advertisement, apply to this section.

DIVISION 03 – CONCRETE

DIVISION 04 - MASONRY

DIVISION 05 - METALS

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

DIVISION 08 - OPENINGS

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated ~~2001~~ 2016, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by Contract Documents.
3. Work under separate contracts.
4. Access to site.
5. Work restrictions.
6. Specification and Drawing conventions.

~~B. Related Requirements:~~

~~1. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Owner's facilities.~~

1.3 PROJECT INFORMATION

A. Project Identification: Newark Regional Transportation Center, Station Building

1. Project Location: Newark, DE.

B. Owner: Delaware Transportation Corporation.

1. Owner's Representative: Mr. Mark C. Tudor, P.E.
   Delaware Department of Transportation
   Assistant Director North Project Development

C. Architect:

1. Whitman Requardt Associates, LLP 801 South Caroline Street, Baltimore, Maryland 21231.

D. Architect's Consultants: Architect has retained the following design professionals who have prepared designated portions of the Contract Documents:

1. Arora Engineers, Inc., 61 Wilmington-West Chester Pike, Suite 100, Chadds Ford, PA.

Bridge, which will be affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.7 WORK RESTRICTIONS

A. Work Restrictions, General: Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.

~~B. On-Site Work Hours: Limit work in the existing building to normal business working hours of 6:00 a.m. to 6:00 p.m., Monday through Friday, unless otherwise indicated.~~

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:

1. Notify Owner and City of Newark not less than two days in advance of proposed utility interruptions.
2. Obtain Owner's written permission before proceeding with utility interruptions.

D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Owner occupancy with Owner.

1. Notify Owner and City of Newark not less than two days in advance of proposed utility interruptions.
2. Obtain Owner's written permission before proceeding with utility interruptions.

E. Restricted Substances: Use of tobacco products and other controlled substances within any building on Project site is not permitted.

1.8 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.

B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

C. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Regulatory requirements that supplement and add to the regulatory requirements stipulated in the Agreement and General Conditions.
2. Requirements for Quality Assurance (QA) and Quality Control (QC) program activities to be performed during the Contract including quality requirements for the following:
   a. Management responsibility.
   b. A documented quality management system.
   c. Design control.
   d. Document control.
   e. Purchasing, including requirements for Supplier quality assurance.
   f. Product identification and traceability.
   g. Process control.
   h. Inspection and testing.
   i. Inspection, measuring, and test equipment.
   j. Inspection and test status.
   k. Nonconformance reporting.
   l. Corrective action procedures.
   m. Quality records, including logs, reports, and forms.
   n. Quality Audits.
   o. Training.
3. Requirement for a Contractor's Quality Assurance Plan (CQAP).
4. Requirements and qualifications for an independent certified Testing and Inspection Agency and an Approved Agency required by the ICC International Building Code.
5. Requirements for an Inspection and Test Plan.
6. Quality requirements for inspection and test procedures, control of measuring and test equipment, and tracking inspection and test status.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM):
1. ASTM E 329, Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

B. International Code Council (ICC):
1. ICC International Building Code 2012 (IBC).

C. U. S. Government:
1. Code of Federal Regulations (CFR):

a. 29 CFR 1910, Department of Labor, Occupational Safety and Health Administration (OSHA), Part 1910 Occupational Safety and Health Standards.
b. 29 CFR 1926, Department of Labor, Occupational Safetyand Health Administration (OSHA), Part 1926 Safety and Health Regulations for Construction.

2. United States Code (USC):
   a. 49 USC 601, Department of Transportation, Pipelines, Safety.
      1) Amendment of Title 49, United States Code (H.R. 5782), Pipeline Inspection, Protection, Enforcement, and Safety Act of 2006.
3. Federal Transit Administration (FTA):
   a. FTA IT-90-5001-02.1, Quality Assurance and Quality Control Guidelines.

1.3 PERFORMANCE REQUIREMENTS

A. Quality Control (QC) Program:
1. The Contractor is responsible for all quality control for this Contract, with the exception of those tests or inspections specifically identified as being performed by others.
2. Omissions and errors in the Contract Document descriptions do not relieve the Contractor of his responsibility to perform the tests/inspections required within the scope of this Contract.
3. Inspections and tests performed by the Engineer are for the Owner's Quality Assurance and do not relieve the Contractor from the responsibility of meeting the specified requirements.
   a. Inspections and tests performed by the Engineer are not to be considered a guarantee for acceptance of materials that will be delivered subsequent to the time the items were inspected or tested.

B. Quality Assurance (QA) Program:
1. Before starting the other Work of this Contract, develop and implement an approved Contractor's Quality Assurance Plan (CQAP) for this Contract that incorporates the requirements of the Federal Transportation Administration's 15 quality elements as described in FTA IT-90-5001-02.1, referred to as the FTA Guidelines, and the additional requirements in this Contract's Specifications.
   a. The CQAP must include the specified requirements of all 15 quality elements listed in the FTA Guidelines.
   b. Submit the Contractor's Quality Assurance Plan (CQAP) to the Engineer for approval.

C. Contractor Quality Assurance Plan (CQAP):
1. Management Responsibility:
   a. Define your organizations quality policy in the CQAP.

1) Provide a statement that shows your organization's commitment to the quality policy extends to the highest level.
   a) Your organization's management must declare and document its commitment to quality within a Quality Policy Statement to be included at the beginning of the CQAP.
2) In the CQAP, show how your quality policy extends to all levels of your organization.

b. Within 15 days of the Notice to Proceed, submit to the Engineer a list that identifies all of the Contractor's principal staff assignments and consultants, and that lists their addresses and other contact information.

c. Contactor's Principal Construction Staff:
   1) Contractor's Superintendent:
      a) Employ a superintendent with the qualifications specified in Subparagraph 1.05.A.2 and who is empowered to represent and to act for the Contractor.
   2) Contractor's Safety Representative:
      a) Designate a member of the Contactor's full-time on-site construction staff who has the qualifications specified in Subparagraph 1.05.A.4 to be the Contractor's Safety Representative, and submit his or her resume showing his or her qualifications and experience to the Engineer for approval.
      b) Empower the Contractor's Safety Representative with the responsibility for supervising the safety of persons on or about the Work and the property affected by these persons as stipulated in Contract Documents; and direct the Contractor's Safety Representative to report and submit required paperwork relating to on-the-job injuries to the Engineer within 24 hours of the incident causing the injury.
      c) The Contractor may not replace the approved Contractor's Safety Representative without written permission from the Engineer.

d. Quality Assurance and Control Personnel:
   1) Identify those persons responsible for the quality assurance and control functions in the CQAP; and define in writing the responsibility, authority, and interrelation of those persons.
      a) Include an Organization Chart detailing the quality assurance and control organization and reporting responsibilities.

b) Identify a Contractor Quality Assurance Manager, and show that his position is independent of the Contractor's construction staff.

c) Show the Contractor Quality Assurance Manager's staff, and clear lines of authority and responsibility for quality management.

2) Place the Quality Assurance Manager and other assigned quality assurance personnel on the Contractor's direct payroll, but do not assign them to any other positions under this Contract.

a) Have the Quality Assurance Manager report directly to the highest level of the Contractor's management, such as the corporate principal or corporate quality assurance manager, and not to any project level manager.

(1) Set up the Contractor Quality Assurance Manager position to be independent of the Contract's construction staff.

3) Contractor Quality Assurance Manager:

a) Employ a Contractor Quality Assurance Manager with the qualifications specified in Subparagraph 1.05.A.3 and empowered with full authority and responsibility to represent and act for the Contractor on all quality related matters for this Contract.

(1) Give the Quality Assurance Manager the authority and responsibility for ensuring that the quality policy is communicated, implemented, and maintained.

(2) At all times that any work is in progress, insure that the Quality Assurance Manager, or his designated substitute, is on the Site and available.

(3) Delegate responsibility for coordinating inspections and testing to be performed by the Testing and Inspecting Agencies to the Quality Assurance Manager, and empower the Quality Assurance Manager with the authority to stop further construction of non-conforming Work pending completion of required corrective action.

4) Quality Control Inspectors and Test Personnel:

a) Employ, at a minimum, one qualified full-time Quality Control inspector to be on-site during the installation and testing phase of the Contract.

b) Assign or designate additional Contractor Quality Control personnel to perform inspections and test the Work as required.

c) Submit resumes showing the names, qualifications, and experience of all quality control personnel that are assigned to the Quality Control Manager to the Engineer for approval.

5) Do not remove any Contractor quality assurance personnel from their duties on this Contract without prior written notice to the Engineer.

a) If the Contractor plans to remove or replace the Quality Assurance Manager or other key quality control personnel identified on the organization chart, the Contractor must notify the Engineer in writing before replacing these personnel.

b) Submit the resumes of replacements for the Quality Assurance Manager and other key quality control personnel showing their qualifications to the Engineer for approval.

2. Documented Quality Management System:

a. Establish and document a quality management system within the Contractor Quality Assurance Plan (CQAP) to ensure that Contract quality objectives are satisfied, and maintain the quality management system during the life of the Contract.

1) Develop, implement, and maintain a quality management system consistent with the requirements of this Section; and FTA-IT-90-5001-02.1 to assure that the equipment and materials provided conform to the applicable requirements of every Section of the Contract Specifications.

2) Provide a quality management system to assure accuracy and consistency in production, installation, and construction processes by providing documented work instructions where needed to ensure quality.

3) Do not begin Work covered by the Contractor's Quality Assurance Plan (CQAP) until the Engineer reviews and approves the plan.

4) Extend the quality management system requirements to Suppliers and Subcontractors as appropriate.

b. Establish, implement, and maintain a Quality Procedure Development Plan (QPDP) to develop procedures and instructions for implementing the Contractor's Quality Assurance Plan (CQAP).

1) Develop written procedures and instructions for activities affecting quality in design, procurement, manufacturing, and construction activities as applicable to the Work being performed under this Contract.

a) Each procedure must contain a statement giving its purpose, scope, applicability, and assigned responsibilities.
(1) Assign specific responsibilities, and clearly delineate individual job authorities and responsibilities.

b) Describe sequential processes to be followed to accomplish quality objectives; and contain references to codes, standards, specifications, and related or interfacing procedures.
(1) Prescribe inspection and testing techniques with written procedures, and keep them up-to-date.
(2) If new inspection or testing techniques are being used for construction or manufacturing, allow adequate time to develop appropriate quality procedures for the new techniques.
(3) Include formats for the quality records needed to ensure that the procedures and instructions are followed and that documentation requirements are understood.

c) In developing the quality procedures, give consideration to identifying and acquiring any inspection equipment, skills, or special quality processes needed to ensure quality performance.

2) Include an index of all procedures and instructions to provide a comprehensive account of the quality controls that are required to implement the Contractor Quality Assurance Plan (CQAP).

c. Daily Quality Management Reports:
1) Prepare Daily Quality Management Reports for each day any Work is performed and which at a minimum identify material deliveries, Work accomplished, tests conducted, results of inspection and tests, nonconforming work and its disposition, causes of nonconforming work, and corrective actions taken to prevent the recurrence of similar nonconforming work.
2) Submit the Daily Quality Management Reports to the Engineer for review on a daily basis.

d. Certification of Payment Requests:
1) Submit each Application for Payments in accordance with the requirements of Division 100 General Provisions.

e. Certification of Completion of the Work:

1) When all obligations under the Contract have been fulfilled, submit written notice to the Engineer in accordance with the requirements of Division 100 General Provisions.

3. Design Control:

a. Establish appropriate written procedures within the Contractor's Quality Assurance Plan (CQAP) for identifying, documenting, and reviewing and approving all changes and modifications to the original design.

1) Establish and maintain procedures to control and verify the design of systems in order to ensure that the design criteria, other specified requirements, and requirements of the relevant regulatory agencies are met.

2) Extend this responsibility to those responsible for developing "as-built" documents as part of the design documentation at the end of the Contract, and to construction or manufacturing to ensure compliance with the design requirements.

b. Plan the design interfaces and design verification activities to ensure that the design requirements are understood, and control design changes through Contract completion.

1) Prepare a Design Plan that identifies the individuals responsible for different design parts and who has the responsibility to assure the quality of the design.

a) Identify, document, and review design input requirements; and have the requirements reviewed by the designer and those responsible for developing the requirements.

b) Assign competent individuals to verify the quality of the design.

2) Verify and document that the design output complies with the design input requirements.

a) Design output includes acceptance criteria, conformance to regulatory requirements whether or not these have been stated in the design output requirements, and identifying those aspects of the design that are crucial to the safe and proper functioning of the final product or system.

b) Identify the various organizational interfaces required between various groups producing and commenting on the design, and specify the information to be documented, transmitted, and regularly reviewed.

c) Perform the following design verification activities, as appropriate:

(1) Alternative calculations.

(2) Independent checks of design calculations, specifications, drawings, and Contract Documents.
(3) Conducting and documentingdesign reviews.
(4) Undertaking qualification tests and demonstrations.
(5) Comparing the design with similar proven designs, if available.
(6) Design reviews for constructability, operability, and maintainability.

3) Specify within the Design Plan how the operating and maintenance departments of the Owner would interface with those producing the design.

4. Document Control:

a. Establish and maintain written procedures for the control of Contract documents, and record these procedures within the Contractor's Quality Assurance Plan (CQAP).

1) Develop document control procedures that provide controls for the drawings, specifications, Contract data, special work instructions, operational procedures, and receipt and transmittal ofsubmittals.
2) Provide procedures for the distribution and storage of documents related to the Contract.
a) Promptly eliminate obsolete documents fromeach work location.
b) Retain superseded documents in Contract files, and clearly identify each as such.
3) Examples of the types of Contract documents requiring control include, but are not limited to:
a) Contract Drawings.
b) Specifications.
c) Special work instructions.
d) Operational procedures.
e) Quality assurance program procedures.

b. Develop document control measures to assure that all relevant documents are current and available to all users who require them.

1) Develop procedures to ensure that documents are reviewed by the relevant authorized personnel.
a) Provide procedures to ensure that changes to documents are reviewed and approved by the same authorized individuals that reviewed and approved the original documents.
b) Control changes to Contract documents, and promptly distribute those changes to allrequired

locations together with a master list enumerating the current revisions of each document.

2) Develop procedures to assure that all documents required are received and distributed in a timely manner, and contain the necessary technical information.

a) Distribute and make available copies of documents to all locations needing them to assure that the quality management system functions effectively.

5. Purchasing:

a. Establish and maintain procedures to assure that purchased services and products conform to specified requirements.

b. Provide written procedures within the Contractor's Quality Assurance Plan (CQAP) that address at a minimum the following:

1) Evaluation and selection of Suppliers using specified evaluation criteria including supplier quality programs.

a) Generate a list of qualified Suppliers with the descriptions of the scope of services that they have been qualified to provide for the Contract.

(1) Prior to procurement of items and materials, submit to the Engineer a list of Suppliers and Subcontractors that includes a description of the items to be supplied, and/or other pertinent information, as appropriate, for approval.

b) Select Suppliers based on their ability to meet Contract requirements.

2) Transmission of applicable design, manufacturing, quality, and other associated technical requirements in purchase documents.

3) Review and approval of purchasing documents by a designated authority to verify the adequacy of the requirements specified prior to release.

4) Periodic assessment of Supplier performance; e.g., inspection and testing at the source, and/or auditing of the Supplier by the Contractor.

5) Evaluation of the adequacy of the products procured at the time of receipt and/or at the point of manufacture to verify compliance with purchasing documents.

c. Extend the quality requirements of this Section to Suppliers and Subcontractors as appropriate to the work being performed.

1) Within procurement documents, impose the same quality control requirements upon Suppliers and Subcontractors, including inspection and test procedures, as imposed on the Contractor by this Section, other Contract Specifications, and referenced standards.

6. Product Identification and Traceability:
   a. Establish and maintain measures for identifying and controlling items of production such as batches, materials, parts, and components, to prevent the use of incorrect or defective items, and to assure that only correct and acceptable items are used or installed.
      1) Develop documented procedures within the Contractors' Quality Assurance Plan (CQAP) to assure that procured items, equipment, and materials are physically identified.
         a) Insure that items are traceable to required documents during all phases of production from receipt of raw materials, components, or subassemblies through the construction process, to delivery of final products.
            (1) Insure identification and traceability of items throughout all inspections, test activities, and record keeping.
            (2) Develop and maintain a documented system to clearly identify the inspection and test status of materials and equipment throughout construction.
            (3) For stored items, preserve each item's identification and traceability consistent with the expected duration and type of storage.
         b) Physically identify and control items to the extent possible from the time of receipt inspection through installation and testing.
            (1) Insure the identity of items by placing markings on or with the items, or by placing the items in specifically identified physical locations.
               (a) Facilitate identification by means of stamps, tags, or other control devices attached to or accompanying the material or equipment.
               (b) Employ physical separation, procedural control, or other appropriate means where physical identification is impractical.
            (2) Mark, track, and control equipment and materials that require inspection or testing within specific time intervals.
            (3) Establish procedures to control the use of status tags, including logging, installation, and removal.

(4) Define who is authorized to apply and remove status tags.

2) Serialization Plans:

a) Develop a comprehensive plan for tracking the serial numbers of equipment provided under this Contract.

(1) Include the proposed numbering scheme, method for assigning numbers, and tracking tools and procedures.

(2) Include the proposed organization of the serial number database.

b) Maintain the serial number database and use it to track inventory and to establish equipment reliability.

3) Intentional unauthorized removal of non-conformance status tags will result in immediate dismissal and removal from the Work Site of all personnel responsible for the unauthorized removal.

4) Segregate items that do not have identification, items for which record traceability has been lost, and items that do not conform to the requirements of the Contract to prevent their inadvertent incorporation into the Work of this Contract.

b. Establish and maintain procedures for receiving incoming products, and for final inspection and testing.

1) Specify and implement the procedures for receiving incoming products and for final inspection and testing, and document the results of these procedures.

a) Conform with the requirements specified in Division 100, General Provisions, and establish material control procedures to ensure that equipment and materials accepted through receiving inspection comply with the procurement documents, and to assure that equipment and materials are properly received, inspected, stored, maintained, installed, and used.

2) Receiving Inspection:

a) Implement documented receiving inspection procedures for purchased items such as materials, parts, or equipment delivered to the Contractor.

b) Receiving Inspection Records:

(1) Develop and maintain Receiving Inspection Records, which at a minimum must include a Receiving Inspection Log containing the following information for each item received:

(a) Purchase order number.

(b) Item number.

(a) Supplier name.
(b) Quantity.
(c) Item description.
(d) Reference to applicable Contract requirements.
(e) Date received.
(f) Heat number, serial number, or other identification, as applicable.
(g) Inspection records for in-transit damage and gross defects.
(h) Verification of receipt of all required supporting documentation, including Certificates of Compliance and Certified Material Test Reports, and verification that these documents are traceable to the items received.
(i) Acceptability (accept/reject) and nonconformance report number, if applicable.
(j) Quality control person's signature and date.

7. Process Control:

a. Identify and plan the production and installation processes that directly affect quality, and ensure these processes are performed under controlled conditions.

1) Handle, store, and preserve procured items, equipment, and materials from the time of receipt to the time of installation and testing to prevent damage, deterioration, distortion of shape or dimension, loss, degradation, loss of identification, or substitution.

2) Use special devices, e.g., crates, boxes, containers, dividers, slings, material handling and transportation equipment, and other facilities, for handling material; and insure that these special devices are maintained and periodically inspected.

3) Provide only new materials for incorporation into the Work except where specified otherwise.

4) Develop work instructions for production and installation processes that include:

a) Sequencing work operations where the work is complex or when there are multi-discipline interfaces, including hold and witness points for required examinations, inspections, and tests.

(1) Hold points are mandatory.

(2) Witness points may be waived by the establishing individual.

b) Using suitable equipment.
c) Providing a suitable work environment.
d) Using qualified personnel, and stating qualification requirements, e.g. certifications, credentials, or licenses.
e) Conforming to referenced and other applicable codes, standards, and quality plans.
f) Controlling and monitoring work processes during manufacturing, installation, and construction.

b. Continuously monitor special processes, the result of which cannot be verified by subsequent inspection and testing.
1) Conduct continuous monitoring and/or assure conformance with documented procedures during special processes such as welding, nondestructive examination, and heat treatment where the results cannot be verified during subsequent work operations.
2) Use personnel approved by the Engineer and that have the experience, training, certification, and where required the license commensurate with the scope, complexity, or nature of the activity whenever performing special processes, i.e., welding, brazing; or inspection/test tasks.
3) Special process procedures at a minimum must include the following.
a) Requirements for the qualification of special process procedures.
b) Personnel qualifications required for performing the special process including certifications, credentials, or licenses.
c) Orientation into the quality program requirements.
d) Training in the applicable special process procedures.
e) Evaluation (initial and periodic) of the personnel performing special processes.

8. Inspection and Testing:
a. Testing and Inspection Agencies:
1) Employ the services of one or more independent certified material testing laboratories, hereafter referred to as the Testing and Inspection Agency or Testing and Inspection Agencies, having the qualifications specified in Subparagraph 1.04.A.1 to perform materials testing, control testing, and inspections of the materials to be incorporated into the Work of this Contract.
a) The Testing and Inspection Agencies retained by the Contractor will not be responsible for performing

the special inspections required by the ICC International Building Code.

2) Dismissal and replacement of any of these independent certified Testing and Inspection Agencies by the Contractor requires written notice to and the approval from the Engineer.

b. Code-Required Approved Agency for Performing Special Inspections:

1) To perform the special inspections required by the ICC International Building Code (IBC) which are listed for convenience in Section 01453, Code-Required Special Inspections and Procedures, the Owner or Engineer acting as the Owner's agent will employ an independent Approved Agency, as defined in the Code, that has the following qualifications:

a) Established, recognized, and regularly engaged in conducting tests or furnishing inspection services.

b) Demonstrating competence to the satisfaction of the building official having jurisdiction over the Work of the Contract.

c) Conforming to the quality standards for testing laboratories of the nationally recognized associations and agencies that promulgate the test standards specified, particularly to the requirements of ASTM E 329 and the standards referenced in other Sections of this Contract.

d) Capable of performing the reviews, inspections, and testing required by this Contract.

c. Inspection, Sampling, and Testing:

1) For the duration of this Contract, materials and fabrication procedures will be subject to inspection, sampling, and testing in the mill, shop, and field by the Engineer, the building official, the Testing and Inspection Agency or Agencies, and by the code-required Approved Agency for performing special inspections.

a) The Engineer and/or the code-required Approved Agency may elect to perform inspections and/or tests of materials at the place of manufacture, the shipping point, or at the destination to verify compliance with applicable Specification requirements.

b) Inspection and tests, conducted by persons or agencies other than the Contractor, do not in any way relieve the Contractor of responsibility for providing materials and fabrication procedures in

compliance with specified requirements and for meeting the requirements of all Specifications and the referenced standards.

2) When material furnished or work performed by the Contractor fails to conform to the Contract Documents, the Testing and Inspection Agency or the code-required Approved Agency for performing special inspections, whichever was responsible for performing the testing or inspection revealing the nonconformance of the materials or work, is responsible for immediately reporting such deficiency to the Engineer and the Contractor.

3) The Testing and Inspection Agency and the code-required Approved Agency for performing special inspections must submit certified written reports that document the results of all tests and inspections performed directly to the Engineer immediately after the work is performed.

a) The reports must state whether the tested and inspected items comply with specified requirements or deviate from them.

d. Inspection and Test Plan:

1) Develop an Inspection and Test Plan, consistent with the requirements of this Section, to plan inspection and testing procedures as necessary to verify the quality of the Work of this Contract.

a) Identify all required inspections and tests required by each Specification Section, the required frequency of each, the accept/reject criteria of each, records required to document compliance, and the procedures or instruction to be used for control of each activity.

b) Provide sufficient detail to allow the Engineer, or any agency having jurisdictional authority over the Work, to find the operations to be inspected by that organization in the plan.

c) Provide written inspection and test procedures that address at a minimum the following:

(1) Test prerequisites.
(2) Required tools, equipment, and instrumentation.
(3) Personnel qualification requirements.
(4) Necessary environmental conditions.
(5) Acceptance criteria.
(6) Nonconformance reporting requirements.
(7) Data to be recorded.
(8) Test Results reporting forms.

(9) Identification of items inspected or tested.

2) Submit the Inspection and Test Plan to the Engineer for approval, and do not commence inspection or test activities until the Engineer's approval is granted.

3) Implement and maintain the approved Inspection and Test Plan for the duration of this Contract.

a) Using the Contractor's quality control personnel or an approved Testing and Inspecting Agency as appropriate, perform in-process testing and inspection in accordance with the documented procedures reviewed and approved by the Engineer to verify conformance of each item or work activity to specified requirements.

(1) Make procedures and instructions readily available to inspection and test personnel at the time and place of the inspection or test.

(2) Perform acceptance testing and inspection using qualified personnel other than those performing the Work being tested or inspected.

(3) When methods of inspection and/or testing are changed, reflect the revisions in methodology in approved written procedures prior to implementing the change on any Work.

(4) Immediately report inspection/test results indicating nonconformance with specified requirements (failure) to the Engineer.

b) Perform both inspections and process monitoring to ensure that the requirements specified for controlling work processes and the quality of the item are being achieved.

(1) Verify that the methods and processes reflected in approved work procedures and instructions are completely and continuously followed.

(2) Perform inspections and tests as necessary to verify the quality of the Work on items such as the following:

(a) Items of the Work affecting safety.
(b) Items that affect system reliability.
(c) Items that affect service life.
(d) Long lead-time items and custom manufactured items.
(e) Items in high visibility areas.

(f) ADA compliance items.

c) Prepare and submit records (reports) of inspection and test activities that address at a minimum the following:

(1) Name of the item(s) inspected/tested.
(2) Specification reference by Section and Paragraph, and where applicable revision level or revision date.
(3) Quantity of items.
(4) Location of the item(s).
(5) Inspection/test procedure reference.
(6) Date of inspection or test activities.
(7) Name of the inspector/tester.
(8) Observations/comments of the inspector/tester.
(9) Specified requirements referenced to the appropriate Specification Section/Paragraph number.
(10) Deviations/non-conformances.
(11) Corrective action.
(12) Evaluation of results.
(13) Acceptability.
(14) Signature of authorized inspection and test personnel.

e. Certificates of Compliance and Certified Material Test Reports:

1) Materials may be accepted by the Engineer on the basis of a Certificate of Compliance or Certified Material Test Report.
2) Materials accepted on the basis of a Certificate of Compliance may be sampled and inspected/tested by the Engineer, or his designee, at any time.
3) The fact that the materials were accepted on the basis of certification does not relieve the Contractor of his responsibility to provide materials and equipment that comply with the Specifications.
4) Submit the Certificate of Compliance/Certified Material Test Report to the Engineer prior to incorporation of the item into the Work.

f. Refer to Division 100, General Provisions, for additional testing and inspection requirements.

9. Inspection, Measuring, and Test Equipment (M&TE):

a. Identify, control, calibrate, and maintain inspection, measuring, and test equipment (M&TE) required to perform inspections, tests, and measurements in order to demonstrate conformance of Work to the specified requirements.

1) Establish and maintain a system to identify, control, calibrate, and maintain all inspection, measuring, and test equipment prior to its use to demonstrate that construction conforms to the requirements of the Contract Documents.
   a) Identify each piece of inspection, measuring, and test equipment with a unique identification label permanently and directly affixed to the equipment.
   b) Affix calibration labels to inspection, measuring, and test equipment that show the date the equipment was last calibrated and the date recalibration is due.
2) Use only inspection, measuring, and test equipment of the proper type and accuracy for the required measurement, and store and use equipment under suitable environmental conditions.
   a) Inspections or tests performed using inspection, measuring, and test equipment that is subsequently found to be out-of-tolerance, or that is damaged during use, or that is lost are considered nonconforming until all characteristics previously inspected or tested using the equipment have been reassessed and re-verified as correct, re-inspected, or re-tested as necessary.
      (1) A nonconformance report for out-of-tolerance or damaged inspection, measuring, and test equipment must be processed in accordance with the requirements of Nonconformance Reporting as specified in Subparagraph 1.03.C.11.

b. Make provisions for the recalibration of inspection, measuring, and test equipment in a timely manner.
   1) Either the Contractor or an agency/vendor must perform and document the calibration of inspection, measuring, and test equipment using calibration standards traceable to the National Institute of Standards and Technology (NIST), and the calibrations must be performed at the intervals specified in the calibration procedures to assure the accuracy of inspection, measuring, and test equipment.
      a) NIST information is accessible at ts.nist.gov.
   2) In the event that no national standards exist for the calibration of an item of inspection, measuring, and test equipment, document the basis used for the calibration of the item.
   3) Recall and recalibrate inspection, measuring, and test equipment at pre-prescribed intervals, and maintain records of calibration performed.

10. Inspection and Test Status:
    a. Provide a means for identifying the inspection and test status of work during its production and installation.
        1) Maintain the inspection and test status of the work by means of marking, stamps, tags, labels, routing cards, inspection records, test software, physical location, or other suitable means.
        2) Status identification must indicate the conformance or nonconformance of each item with regard to inspections and tests performed.
    b. Establish controls to assure that only work that has passed the required inspections and tests are accepted.
        1) Prepare Daily Quality Control Reports for each day that Work is performed, and which at a minimum identify the tests conducted and the results of inspections and tests.
            a) Record the status of completed, tested, and inspected items or construction work in Daily Quality Control Reports.
            b) Submit the Daily Quality Control Reports to the Engineer in a timely manner for information.
        2) Document nonconforming items or construction work in nonconformance reports that are issued in accordance with the requirements for nonconformance reporting specified in Subparagraph 1.03.C.11.
11. Nonconformance Reporting:
    a. A nonconformance exists when material furnished or work performed does not comply with the requirements of the Contract Drawings, Specifications, codes, standards, or any other Contract requirements; and such nonconforming work is therefore considered defective.
        1) Nonconforming work also exists when either material or equipment exhibits a deficiency in physical inspection, test characteristics, or documentation.
    b. Establish and maintain documented procedures to identify and control nonconforming work in order to ensure that only conforming Work is used for construction.
        1) Establish written procedures to define the methods and responsibilities for the identification, documentation, control, and processing of nonconforming equipment and material.
        2) Apply this system for identifying and controlling nonconforming work to the actions associated with installation and construction, and to all material and equipment that, for any reason, fails to conform to the

Specifications or other applicable and approved product descriptions.

a) Develop a mode of operation that emphasizes the identification, correction, and prevention of nonconforming work.

3) The Contractor quality control personnel have the authority to stop that portion of the work that does not comply with the Contract requirements.

c. Nonconformance Procedure:

1) Comply with the requirements regarding nonconforming and defective work in Division 100, General Provisions, and with the requirements for nonconforming Work specified in this Section.

2) To identify and prevent the use of nonconforming items/materials, develop nonconformance procedures that address and include the following:

a) Definition of "nonconformance".

b) Methods of identifying non-conformances.

c) Nonconformance reporting requirements that include immediate verbal notification to the Engineer followed by submission of a written Nonconformance Report to the Engineer.

d) Application and removal of nonconformance status tags.

e) Evaluations/recommendations.

f) Physical segregation, removal from the Site, or reassignment of nonconforming items to lesser applications.

(1) Nonconformance items to be reassigned to lesser applications must be previously approved for the new application by the Engineer.

g) Cause of non-conformance.

h) Corrective action to be taken.

3) Nonconformance Report Log:

a) Develop, maintain, and periodically submit a Nonconformance Report Log to the Engineer that contains the following information, at a minimum, to enable tracking of all Nonconformance Reports:

(1) Sequential, unique nonconformance report number.

(2) Date issued.

(3) Originator.

(4) System affected/drawing number/serial number.

(5) Brief description of the nonconformance and its source (e.g. Supplier, Subcontractor, welder).
(6) Recommended and approved disposition.
(7) Verification of corrective action.
(8) Date closed.
(9) Contractor Quality Control Manager's initials.
(10) Remarks, as applicable.

b) The disposition of all Nonconformance Reports must conform to the requirements of the required corrective action as specified in Subparagraph 1.03.C.12.

12. Corrective Action:

a. The resolution of nonconforming item/material issues must be approved by the Engineer with input from the Contractor's project management and quality assurance personnel.

1) Assign corrective action dispositions to Nonconformance Reports as follows:

a) REPAIR – Nonconforming items or work that are restored to a conforming condition by alternative means.
b) REWORK – Nonconforming items or work that are restored through additional normalprocessing.
c) USE-AS-IS – Nonconforming items or work that are to be used in its current condition.
d) SCRAP – Nonconforming items that do not meet requirements and cannot be practically assigned REWORK or REPAIR dispositions to meet requirements.

2) Re-inspect items having Nonconformance Reports assigned either a REPAIR or REWORK disposition in accordance with the original requirements.
3) Submit Nonconformance Reports with dispositions of REPAIR or USE-AS-IS to the Engineer for approval prior to the implementation of corrective action.

a) The Owner may seek compensation for items assigned either a REPAIR or USE-AS-IS disposition.

4) Immediately segregate items assigned a SCRAP disposition from conforming material, and remove them from the Site within 24 hours of assigning a SCRAP disposition, as practicable.

b. Establish and maintain written procedures of investigating the cause of nonconforming work and for the corrective action needed to prevent recurrence of nonconforming work.
   1) Investigate the root cause of nonconforming conditions and take the corrective actions needed to prevent recurrence.
   2) Ensure that corrective actions are completed in a timely fashion and that they are effective.
   3) Provide measures for analyzing processes to detect and eliminate potential causes of nonconforming work.
   4) Initiate preventative actions to deal with problems at a level corresponding to the risks encountered.
   5) Include measures for implementing and recording changes in procedures resulting from corrective action.

13. Quality Records:
   a. Establish and maintain written procedures for quality records to identify which records are to be kept; responsibility for their production and collection; and responsibility for indexing, filing, storage, maintenance, and disposition of quality records.
      1) Identify every type of quality record to be generated as a result of implementing the CQAP, and specify the retention time for each.
      2) Quality records requiring control include, but are not limited to:
         a) Inspection Reports.
         b) Test Data.
         c) Certification Records.
         d) Personnel Qualifications.
         e) Submittals, Value Engineering Change Proposals (VECP), Change Orders, and Requests for Interpretation/Information (RFI).
         f) Calibration Records.
         g) Nonconformance Reports.
         h) Corrective Action Reports.
         i) Quality Audit Reports.
      3) Include Supplier, Contractor, and Subcontractor quality records.
      4) Ensure that a level of authority commensurate with the nature of the quality records verifies the adequacy of records on a systematic basis.
   b. Index, file, and maintain all quality records in a manner that provides for timely retrieval, traceability to, identification with, and acceptability of, material, equipment and systems.
      1) Quality records must be legible and specify the work involved.

2) Only complete, legible, and properly authenticated documents can be considered quality records.
3) Maintain quality records to provide objective evidence that all activities conform to the CQAP requirements specified, to show that the quality management system is properly functioning, and to document the basis of decisions.
4) Maintain quality records in a manner that minimizes deterioration and damage.
5) Index of Quality Control Records:
a) Prepare and submit an index of all quality control records that will be accumulated and maintained during the progress of the Work.

c. Make quality records available to the Engineer upon request.
d. Retention time for all quality records will be not less than 3 years after the date of Final Acceptance, except as modified below.
1) Sample retention:
a) Retain all Samples of materials, products, or assemblies to be incorporated into the Work for a minimum period of 1 year after the date of the Certificate of Final Acceptance.
2) Provide 30 days notice to the Engineer of intent to discard or destroy quality records, including Samples as may be in the possession of the Contractor or his Subcontractors, subsequent to this retention time.

14. Quality Audits:
a. Establish and implement written procedures for the performance of internal quality audits to assure that the elements of the quality management system are functioning as intended.
1) Quality audits are not the same as financial audits.
b. Quality Audit Schedule:
1) Establish a Quality Audit Schedule denoting the locations, organizations to be audited, topics, and scheduled dates.
2) Schedule audits based upon the status and importance of the activity being audited.
a) At a minimum, perform audits at 90-day intervals or as necessary to verify that all elements of the Quality Management System are functioning as intended.
3) Update the audit schedule at 90-day intervals beginning on the date of approval of the initial schedule by the Engineer.
c. Quality Audit Plan:
1) Prepare and submit quality audit plans to the Engineer for each audit.
a) Address the audit scope, location, and dates.
b) Include the audit checklists to be used.
d. Quality Audit Procedure:

1) Perform scheduled internal audits to verify that quality assurance procedures are being enforced and are functioning as intended to ensure total compliance with the Specifications, Contract Drawings, and all reference standards.
2) Conduct Audit Entrance Meetings with the audited organization's responsible management personnel.
3) Use procedures, standards, and audit checklists to assure substantive audit results.
4) Identify records examined, activities witnessed, and personnel interviewed during the audit.
5) Thoroughly investigate problems and clarify misunderstandings during the course of the audit.
6) Document quality problems uncovered in Audit Finding Reports.
7) Conduct Audit Exit Meetings with responsible personnel; and discuss audit results, problems noted, required corrective action, and schedules for completion of corrective actions.

e. Quality Audit Personnel:
1) Use qualified personnel having no direct responsibilities in the area audited.
2) Document the basis of audit personnel qualification.

f. Quality Audit Reports:
1) Document audit results within a Quality Audit Report.
a) Report areas/topics audited.
b) Identify the audited organization and report any problems found.
c) Address the root causes that led to any nonconforming conditions, and recommend actions to prevent recurrence of the nonconformance.
2) Distribute Quality Audit Reports and Audit Finding Reports to personnel having responsibility for the areas audited within 10 working days following the completion of the audit.
3) Submit all Quality Audit Reports to the Engineer for approval no later than 30 days after each audit.
4) Maintain records of quality audits as quality records, and make them available to the Engineer upon request.

g. Quality Audit Follow-Up:
1) Assure that responses to Audit Fining Reports are complete and accurate.
2) Track and verify corrective action, and close problem reports resulting from audits in a timely fashion.

3) Re-audit deficiency areas on an accelerated basis to verify effectiveness of corrective action and actions to preclude recurrence of problems.

h. Owner Audits:

1) Quality audits of Contractor, Subcontractor, and Supplier activities may be performed by the Owner's representatives to verify compliance with the Specifications and referenced standards.

2) Upon notice by the Engineer, provide timely access to facilities, locations, records, and personnel by the Owner's auditors to facilitate performing Owner audits.

3) Assure cooperation with the Owner's auditors by all Contract personnel.

4) Provide timely and thorough responses to Owner-identified quality problems.

15. Training:

a. Establish and maintain documented procedures for identifying training needs and to provide for the training of all personnel performing activities affecting quality.

1) Training must include, but not be limited to, procedures to identify potential quality problems in either the Work or materials; and must include appropriate direction for identifying, reporting, and resolving quality problems.

2) Train the Contractor's quality assurance and quality control personnel so they are qualified for their assigned quality tasks based on having the appropriate education, training, or experience required.

3) Train the workers, Subcontractors, Suppliers, and others who perform tasks affecting quality to comply with the various quality-related procedures defined in the CQAP as they relate to the individual's responsibilities.

4) Develop and maintain a training matrix that lists the following:

a) Project personnel by title.

(1) Include consultant, Contractor, and Subcontractor personnel.

b) Applicable procedures, standards, specifications, or other training materials.

c) Type of training (classroom or required reading).

D. Contractor's Failure to Perform:

1. In the event the Contractor fails to adequately perform any or all of the provisions of this Section, the Owner, at its sole discretion, reserves the right to have the Engineer perform any or all of the provisions in this

Section and back charge the Contractor for the actual cost to the Owner of such services.

a. This remedy for the Contractor's failure to perform is in addition to any other right or remedy available to the Owner under this Contract.

2. Refer to Division 100, General Provisions, for additional information regarding the Owner's remedies.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Testing and Inspection Agency Qualifications:

a. Each Testing and Inspection Agency must be independent, certified, [must be accredited by one of the accreditation agencies listed in FTA IT-90-5001-02.1 to perform the specific tests or types of tests or calibrations required by the Specifications,] and comply with the quality standards for testing laboratories of the nationally recognized associations and agencies that promulgate the test standards specified and with the basic requirements of ASTM E 329 and other standards specified in individual Specification Sections.

b. Each Testing and Inspection Agency must be capable of performing the reviews, inspections, and testing required of them by this Contract; including but not limited to the following:

1) Inspecting, sampling, and testing proposed materials and production as required by the Engineer for compliance with the Contract Documents.

2) Capable of securing production samples of materials at plants or stockpiles during the course of the work, and testing the samples for compliance with the Contract Documents.

c. The Testing and Inspection Agency must be approved by the Engineer, and must also be accepted by the local jurisdictions responsible for building inspection.

d. Submit the qualifications and certifications of the proposed Testing and Inspection Agencies to the Engineer for approval.

2. Contractor's Superintendent's Qualifications:

a. Employ a superintendent having a minimum of 5 years of construction-related experience with a minimum of 2 years in supervision or management of construction work, and empowered to represent and to act for the Contractor.

b. Submit the proposed Contractor's superintendent's resume showing his or her qualifications and experience to the Engineer for approval by the Owner.

3. Contractor's Safety Representative's Qualifications:

a. Employ a Safety Representative having specialized training, certification, and substantial experience in construction safety supervision, including a working knowledge of applicable U.S. Department of Labor (OSHA) regulations, the ability to develop and conduct safety training courses, and familiarity with the industrial hygiene equipment and testing required for the protection of employees.

b. The Contractor's Safety Representative must be acceptable to the Engineer, and his performance will be reviewed on a continuing basis; the Engineer reserves the right to revoke the approval of the Safety Representative and require a replacement.

c. Submit the proposed Contractor's Safety Representative's resume showing his name, qualifications, and experience to the Engineer for approval.

4. Contractor's Quality Assurance Manager's Qualifications:

a. Employ a Contractor's Quality Assurance Manager having a minimum of 5 years of construction-related Quality Assurance experience with a minimum of 2 years in supervision or management of Quality Assurance work.

b. The Contractor Quality Assurance Manager must be acceptable to the Engineer.

c. Submit the proposed Contractor's Quality Assurance Manager's resume showing his name, qualifications, and experience to the Engineer for approval.

B. Regulatory Requirements:

1. Codes and Reference Standards:

a. Fully comply with the applicable requirements of the codes and reference standards specified or indicated in the Contract Documents.

b. The versions and editions of the codes and reference standards that are applicable to this Contract are as stipulated on the Contract Documents

1) The applicable versions or editions of the codes and reference standards may not be the most recently published version if the authority having jurisdiction over the Work has adopted some earlier version or edition by regulation, or if newer versions or editions are published after the Contract is awarded.

2. Rules, Laws, and Regulations:

a. Comply with the applicable federal, state, and local rules, laws, and regulations whether such rules, laws, and regulations are specifically identified in the Contract Documents or not.

1) Governmental Safety Regulations:

a) Comply with all applicable U.S. Department of Labor safety regulations, including those stipulated in 29 CFR 1910 and 29 CFR 1926.

b) Utility Regulations:

(1) In accordance with the Pipeline Inspection, Protection, Enforcement, and Safety Act of 2006 (Title 49 of the United States Code as amended by H.R. 5782) and, the Contractor is required to dial "811" within the state in which the Site is located to identify and locate underground utilities and interferences; and is responsible for notifying affected underground utility owners prior to all excavations and for coordinating utility interconnections and interfaces with the utilities.

(2) The Contractor is required to notify public utilities operating overhead power lines whenever construction operations are within clearance envelopes established by statute.

(3) For the cranes and similar equipment proposed for use in support of construction and capable of encroachment, submit sketches that define the operation of the equipment and calculations demonstrating that the crane capacities are adequate for the loads applied to the Engineer.

(a) Show planned locations and movements of the equipment, the relationship of the equipment footprint to the movement of the crane boom and loads relative to existing structures and surrounding buildings, support grillages and the protection of existing utilities and facilities, and other pertinent details as required by the Engineer.

b. Comply with the applicable rules and regulations of other regulatory bodies having jurisdiction over the Work of this Contract.

3. Fees, Royalties, and Taxes:

a. Unless specifically indicated otherwise, pay all applicable patent and other fees, royalties, and taxes pertaining to the Work of this Contract.

4. Permits and Licenses:

a. Unless specifically indicated otherwise, procure and pay for all permits and licenses applicable to the Work of this Contract.

C. Field Samples and Mock-Ups:

1. When specified, provide Samples and mock-ups that illustrate functional and aesthetic characteristics similar in every way to the actual materials or equipment to be incorporated into the work.
   a. Provide office Samples of sizes and quantities that clearly illustrate the full color range and functional characteristics of products and materials, including attachment devices.
   b. Furnish required Samples and mock ups at no additional cost to the Owner.
2. Erect field Samples and mock-ups at the Work Site as specified in individual Specification Sections, and as may be necessitated by the Contractor submitting value engineering proposals, at locations acceptable to the Engineer.
   a. Do not incorporate the Sample or mock-up material or equipment into the Work until approval to do so is received from the Engineer.

1.5 EXISTING CONDITIONS

A. Obtain full knowledge through personal and careful examination of the existing conditions at the Site that may affect the Work, accept the existing conditions, and assume the responsibility, including any related costs, for failure of the Contractor to obtain full knowledge of the existing conditions.

1. Information regarding existing conditions at the Site as indicated on the Contract Drawings or in the Specifications is given only for the convenience of the Bidders and Contractors, and to present a general representation of present conditions.
   a. The Contract Drawings may not reflect actual details or dimensions, and should not be relied on for accurate layout, design, or estimating purposes.
2. Bidders and Contractors assume responsibility for the costs arising from their failure to note variations between the information presented on the Contract Drawings or in the Specifications and the actual existing conditions.

PART 2 PRODUCTS

2.1 SOURCE QUALITY CONTROL

A. Perform source quality control functions for this Contract in accordance with the approved Contractor Quality Assurance Plan (CQAP), the requirements of Division 100, General Provisions, and of individual Specification Sections.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

A. Perform field quality control function for this Contract in accordance with the approved Contractor Quality Assurance Plan (CQAP), the requirements of Division 100, General Provisions, and of other individual Specification Sections.

END OF SECTION 014000

SECTION 014530 - SPECIAL INSPECTION SERVICES

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 REFERENCES

A. American Concrete Institute (ACI)

1. ACI 318 “Building Code Requirements for Structural Concrete” (2014)

B. American Institute of Steel Construction (AISC):

1. AISC 360 “Steel Construction Manual – 14th Edition” (2010)

C. American Society of Civil Engineers (ASCE):

1. ASCE 7 “Minimum Design Loads for Buildings and Other Structures” (2010)
2. ACI 530 Building Code Requirements for Masonry Structures (2013)
3. ACI 530.1 “Specification for Masonry Structures” (2013)

D. American Welding Society (AWS)

1. B5.1: Specification for the Qualification of Welding Inspectors (AWS B5.1).
2. D1.1: Structural Welding Code – Steel (AWS D1.1/D1.1M).
3. D1.3: Structural Welding Code – Sheet Steel (AWS D1.3).
4. D1.4: Structural Welding Code – Reinforcing Steel (AWS D1.4).

E. Steel Deck Institute (SDI)

1. SDI-QA/QC “Standard for Quality Control and Quality Assurance for Installation of Steel Deck” (2011)

F. Steel Joist Institute (SJI)

1. SJI-JG “Standard Specification for Joist Girders” (2010)
2. SJI-K “Standard Specification for Open Web Steel Joists, K-Series” (2010)
3. SJI-LH/DLH “Standard Specification for Longspan Steel Joists, LH-Series and Deep Longspan Steel Joists, DLH-Series” (2010)

G. Code of the ~~Town of Ocean City, MD~~ City of Newark, DE

H. International Code Council:

1. 2015 International Building Code (IBC).

1.3 DEFINITIONS

A. Approved Agency: An established and recognized agency that is regularly engaged in conducting tests or furnishing inspection services, where such agency has been approved by the Building Official.

B. Approved Fabricator: An established and qualified person, firm, or corporation approved by the Building Official per the qualifications required in this Section.

C. Architect of Record (AR): The Registered Design Professional retained by the Owner to design and specify architectural construction and whose signature and seal appears on the Owner-approved architectural construction documents.

D. Building Official: The officer or other designated authority charged with the administration and enforcement of the Code of the ~~Town of Ocean City, MD~~ City of Newark, DE, or a duly authorized representative.

E. Certificate of Compliance: A certificate stating that materials and products meet specified standards or that work was done in compliance with approved construction documents.

F. Certification: A statement of professional opinion by a registered design professional that indicates that the item(s) under consideration meet the requirement of the approved construction document. Certifications shall bear the original seal and signature of the design professional making the statement.

G. Completion Letter: A certification letter signed and sealed by the design professional(s) of record who performed special inspections stating that the construction elements specified for special inspections have been inspected and conform to the approved Construction Documents and specifications.

H. Construction Documents: Plans, specifications, and other documents prepared for the purposes of obtaining a building permit.

I. Owner-Approved Documents: Construction documents approved by the Owner and Building Official.

J. Fabrication and Erection Documents: Written, graphic and pictorial documents prepared or assembled after issuance of a building permit describing the design, location and physical characteristics of building components or materials necessary for fabrication, assembly or erection of project elements.

K. Final Report of Special Inspections: A certification by the Special Inspector (SI) indicating that specified special inspections are completed and meet the requirements of the approved construction documents and project specifications.

L. Inspection: The observation of work and the performance of tests for certain building or structure components.

M. Inspection and Testing Agency: Agency or agencies retained by the Owner and approved by the Building Official to perform special inspections and materials testing as required by IBC and the Building Official. Contractors are barred from retaining the services of inspection and testing agencies for Special Inspections.

N. Mechanical Engineer of Record (MER): The registered mechanical engineer retained by the owner to have ultimate responsibility to design or specify mechanical systems and specifications.

O. Non-Structural Elements: Elements of a building that are not primary or secondary structural elements such as exterior curtain walls and cladding, non-load-bearing partitions, stair railings, etc.

P. Quality Control Inspector (QCI): Individual designated by the erector or fabricator to perform controls and inspections implemented by the erector or fabricator, as applicable, to ensure that the material provided and work performed meet the requirements of the approved construction documents and referenced standards.

Q. Special Inspection: Inspection of construction requiring the expertise of an approved Special Inspector in order to ensure compliance with the Code of the ~~Town of Ocean City, MD~~ City of Newark, DE and the approved Construction Documents.

1. Continuous Special Inspection: Special Inspection by the Special Inspector who is present when and where the work to be inspected is being performed.
2. Periodic Special Inspection: Special Inspection by the Special Inspector who is intermittently present where the work to be inspected has been or is being performed.

R. Special Inspector: A qualified person employed or retained by an Approved Agency, hired by the Owner, and approved by the Building Official as having the competence necessary to inspect a particular type of construction requiring Special Inspection.

S. Statement of Special Inspections (SSI): A statement prepared by the Owner and appropriate registered design professionals in responsible charge and submitted by the permit applicant for review and approval by the Building Official. The SSI indicates the scope of special inspections applicable to a construction project and identifies the names and qualifications of the design professionals and inspection and testing agencies that will provide those services.

T. Structural Engineer of Record (SER): The registered structural engineer retained by the Owner to have ultimate responsibility to design or specify structural documents and specifications.

1.4 SUMMARY

A. This Section includes the following:

1. Administrative and procedural requirements for Special Inspection services.
2. Statement of Special Inspections, including a Schedule of Special Inspections

B. Requirements for Special Inspections are outlined in the Statement and Schedule of Special Inspections included in this Section.

C. The Owner will procure and bear all costs of the Special Inspections and Special Inspector's testing laboratory, except as otherwise noted. The Special Inspector will be the manager of the Special Inspection process. The Special Inspector checks the certification of all other inspecting agents required by Special Inspections and coordinates their activities. The Special Inspector carries the exclusive responsibility for assuring that the inspections indicated are performed. The Statement of Special Inspections will be required by the Building Official as a condition for building permit issuance.

D. Special Inspections are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with Contract Document requirements.

1.5 STRUCTURES AND BUILDING ELEMENTS SUBJECT TO SPECIAL INSPECTIONS

A. This section shall apply to newly constructed building elements and modifications to existing building elements, newly constructed and modifications to foundation elements, and element fabrication procedures that are subject to special inspections as required by the IBC. Special inspections are required for:

1. Inspection of fabricators in accordance with IBC 1704.2.5
2. Structural steel construction in accordance with IBC 1705.2.1 and the quality assurance inspection requirements of AISC 360.
3. Steel construction other than structural steel in accordance with IBC 1705.2.2
4. Concrete construction in accordance with IBC 1705.3.
5. Masonry construction in accordance with IBC 1705.4 and the quality assurance inspection requirements of TMS 402/ACI 530/ASCE 5 and TMS 602/ACI 530.1/ASCE 6.
6. Soils and foundation construction in accordance with IBC 1705.6.
7. Cast-in-place foundations in accordance with IBC 1705.8.
8. Special inspections for seismic resistance in accordance with IBC 1705.11.
9. Testing and qualification for seismic resistance in accordance with IBC 1705.12.
10. Sprayed fire-resistant materials in accordance with IBC 1705.13.
11. Mastic and intumescent fire-resistant coatings in accordance with IBC 1705.14.
12. Exterior Insulation and Finish Systems (EIFS) in accordance with IBC 1705.15.
13. Fire-resistant penetrations and joints in accordance with IBC 1705.16.
14. Smoke Control Systems in accordance with IBC 1705.17 and DPS requirements.

B. Special inspections shall also be required for proposed work that is, in the opinion of the building official, unusual in its nature, such as, but not limited to, the following examples:

1. Construction materials and systems that are alternatives to materials and systems prescribed by this code.
2. Unusual design applications of materials described in this code.
3. Materials and systems required to be installed in accordance with additional manufacturer's instructions that prescribe requirements not contained in this code or in standards referenced by this code.
4. Sheeting and shoring, underpinning, curtain walls, facade, light gage metal framing, etc.

C. Repair and protection is Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or similar services.

~~END OF SECTION 014530~~

NEW CASTLE COUNTY

DEPARTMENT OF LAND USE
87 READS WAY, NEW CASTLE, DE 19720
PHONE: 302-395-5400 • WWW.NCCDELU.ORG

Statement of Special Inspections

REV. 11/05/2015

Permit Number: _____

This Schedule of Special Inspections / Quality Assurance Plan include the following building systems and should accompany the Statement Special Inspections Form:

- ☐ Soils and Foundations
- ☐ Cast-in-Place Concrete
- ☐ Precast Concrete
- ☐ Masonry
- ☐ Structural Steel
- ☐ Cold-Formed Steel Framing
- ☐ Spray Fire Resistant Material
- ☐ Wood Construction
- ☐ Exterior Insulation and Finish System
- ☐ Mechanical & Electrical Systems
- ☐ Architectural Systems
- ☐ Special Cases

Special Inspection Agencies	**Firm** **Address, Telephone, E-Mail**	**Responsibility**
1. Special Inspection Coordinator		
2. Inspector		
3. Inspector		
4. Testing Agency		
5. Testing Agency		
6. Other		

END OF SECTION 014530

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes. For concrete exposed to view in its final condition, additional requirements of Section 033300 “Architectural Concrete” also apply.

B. Related Requirements:

1. Section 033300 "Architectural Concrete" for general building applications of specially finished formed concrete.
2. ~~Section 312000 “Earth Moving” for drainage fill under slabs-on-grade.~~
3. ~~Section 321313 “Concrete Paving” for concrete pavement and walks.~~
4. Section ~~014560~~ 14530 “Special Inspection Services”.

1.3 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.

B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

   a. Contractor's superintendent.
   b. Independent testing agency responsible for concrete design mixtures.
   c. Ready-mix concrete manufacturer.
   d. Concrete Subcontractor.

2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures,

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete manufacturer.
d. Cast-in-place architectural concrete Subcontractor.

2. Review concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction joints, forms and form-removal limitations, reinforcement accessory installation, concrete repair procedures, and protection of cast-in-place architectural concrete.
3. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Formwork Shop Drawings: Show formwork construction, including form-facing joints, ~~rustications,~~ construction and contraction joints, form joint-sealant details, form tie locations and patterns, inserts and embedments, cutouts, cleanout panels, and other items that visually affect cast-in-place architectural concrete.

D. Placement Schedule: Submit concrete placement schedule before start of placement operations. Include locations of all joints, including construction joints.

E. Samples: For each of the following materials:

1. Form-facing panels.
2. Form ties.
3. Form liners.
4. Exposed aggregates.
5. Coarse- and fine-aggregate gradations.
~~6.~~ Chamfers ~~and rustications.~~

F. Samples for Verification: Architectural concrete Samples, cast vertically, approximately 18 by 18 by 2 inches, of finishes, colors, and textures to match design reference sample. Include Sample sets showing the full range of variations expected in these characteristics.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and testing agency.

B. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.

C. Form-Facing Panels for As-Cast Finishes: Exterior-grade plywood panels, nonabsorptive, that will provide continuous, true, and smooth architectural concrete surfaces, high-density overlay, Class 1, or better medium-density overlay, Class 1, or better, or mill-applied release agent and edge sealed, complying with DOC PS 1. Use of a formliner is required with plywood panels.

D. Form Liners: Smooth face formliner for all architectural concrete. Furnish with manufacturer's recommended liquid-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent surface treatments of concrete. Seams are not to be visable on final concrete element unless otherwise noted.

~~E. Rustication Strips: Metal or rigid plastic, or with sides beveled and back kerfed; nonstaining; in longest practicable lengths.~~

F. Chamfer Strips: Metal, rigid plastic, elastomeric rubber, or dressed wood, 3/4 by 3/4 inch, minimum; nonstaining; in longest practicable lengths.

G. Form Joint Tape: Compressible foam tape; pressure sensitive; AAMA 800; minimum 1/4 inch thick.

H. Form Joint Sealant: Elastomeric sealant complying with ASTM C 920, Type M or Type S, Grade NS, that adheres to form joint substrates.

~~I. Sealer: Penetrating, clear, polyurethane wood form sealer formulated to reduce absorption of bleed water and prevent migration of set-retarding chemicals from wood.~~

J. Form-Release Agent: Commercially formulated, colorless form-release agent that will not bond with, stain, or adversely affect architectural concrete surfaces and will not impair subsequent treatments of those surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

K. Surface Retarder: Chemical liquid set retarder, for application on form-facing materials, capable of temporarily delaying final hardening of newly placed concrete surface to depth of reveal specified.

L. Form Ties: Factory-fabricated, glass-fiber-reinforced plastic, internally disconnecting or removable ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish ties with tapered tie cone spreaders that, when removed, will leave holes 1-1/4 inches in diameter on concrete surface.
2. Furnish internally disconnecting ties that will leave no metal closer than 1-1/2 inches from the architectural concrete surface.
3. Furnish glass-fiber-reinforced plastic ties, not less than 1/2 inch in diameter, of color selected by Architect from manufacturer's full range.

2.3 STEEL REINFORCEMENT AND ACCESSORIES

A. General: Comply with Section 033000 "Cast-in-Place Concrete" for steel reinforcement and other requirements for reinforcement accessories.

2.5 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

~~1. For concrete indicated to be sealed, curing compound shall be compatible with sealer.~~

2.6 REPAIR MATERIALS

A. Bonding Agent: ASTM C 1059/C 1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.

B. Epoxy Bonding Adhesive: ASTM C 881/C 881M two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements.

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.7 CONCRETE MIXTURES

A. Obtain each color, size, type, and variety of concrete mixture from single manufacturer with resources to provide cast-in-place architectural concrete of consistent quality in appearance and physical properties.

B. Prepare design mixtures for each type and strength of cast-in-place architectural concrete proportioned on basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed design mixtures based on laboratory trial mixtures.

C. Cementitious Materials: For cast-in-place architectural concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements. Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Admixtures: Use admixtures according to manufacturer's written instructions.

F. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

G. Concrete Mixtures:

1. Compressive Strength (28 Days): 4500 psi.
2. Maximum W/C Ratio: 0.45.
3. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.

2.8 CONCRETE MIXING

A. Ready-Mixed or Site-Mixed Architectural Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94 and furnish batch ticket information.

1. Clean equipment used to mix and deliver cast-in-place architectural concrete to prevent contamination from other concrete.
2. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. General: Comply with Section 033000 "Cast-in-Place Concrete" for formwork, embedded items, and shoring and reshoring.

B. Limit deflection of form-facing panels to not exceed ACI 303.1 requirements.

C. In addition to ACI 303.1 limits on form-facing panel deflection, limit cast-in-place architectural concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch.

D. Construct forms to result in cast-in-place architectural concrete that complies with ACI 117 (ASI 117M).

E. Construct forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast-in-place surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf ~~wood rustications,~~ keyways, reglets, recesses, and the like, for easy removal.

1. Seal form joints and penetrations at form ties with form joint tape or form joint sealant to prevent cement paste leakage.
2. Do not use rust-stained steel form-facing material.

F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

G. Chamfer exterior corners and edges of cast-in-place architectural concrete with ¾" chamfer.

~~H. Coat contact surfaces of wood rustications and chamfer strips with sealer before placing reinforcement, anchoring devices, and embedded items.~~

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

M. Coat contact surfaces of forms with surface retarder, according to manufacturer's written instructions, before placing reinforcement.

N. Place form liners accurately to provide finished surface indicated. Provide solid backing and attach securely to prevent deflection and maintain stability of liners during concreting. Prevent form liners from sagging and stretching in hot weather. Seal joints of form liners and form-liner accessories to prevent mortar leaks. Coat form liner with form-release agent.

3.2 REINFORCEMENT AND INSERT INSTALLATION

A. General: Comply with Section 033000 "Cast-in-Place Concrete" for fabricating and installing steel reinforcement. Securely fasten steel reinforcement and wire ties against shifting during concrete placement.

B. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

3.3 REMOVING AND REUSING FORMS

A. Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Schedule form removal to maintain surface appearance that matches approved mockups.

B. Leave formwork for beam soffits, joists, slabs, and other structural elements that support weight of concrete in place until concrete has achieved 28-day design compressive strength. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

C. Clean and repair surfaces of forms to be reused in the Work. Do not use split, frayed, delaminated, or otherwise damaged form-facing material. Apply new form-release agent.

D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for cast-in-place architectural concrete surfaces.

3.4 JOINTS

A. Construction Joints: Install construction joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated.
2. ~~Align construction joint within rustications attached to form-facing material.~~
3. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.

B. Control Joints: Form weakened-plane control joints true to line, with faces perpendicular to surface plane of cast-in-place architectural concrete, so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

3.5 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, form-release agent, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously between construction joints. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 303.1.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. Do not permit vibrators to contact forms.

3.6 FINISHES, GENERAL

A. Architectural Concrete Finish: Match Architect's design reference sample, identified and described as indicated, to satisfaction of Architect.

B. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces.

1. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

C. Maintain uniformity of special finishes over construction joints unless otherwise indicated.

3.7 AS-CAST FORMED FINISHES

A. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Remove fins and other projections exceeding specified limits on formed-surface irregularities. Repair and patch tie holes and defects unless otherwise noted. Patch tie hole with tie hole plug with ¼" reveal. Plug color to match concrete. Provide A54 Snaplug by Dayton Superior or approved equal.

B. Rubbed Finish: Apply the following to smooth-form-finished as-cast concrete where indicated:

~~1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.~~

2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix 1 part portland cement to 1-1/2 parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

~~3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix 1 part portland cement and 1 part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches, so color of dry grout matches adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.~~

C. Form-Liner Finish: Produce a textured surface free of pockets, streaks, seam lines, and honeycombs, and of uniform appearance, color, and texture.

3.8 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 for hot-weather protection during curing.

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details” dated ~~2001~~ 2016, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Clay face brick.
3. Mortar and grout.
4. Steel reinforcing bars.
5. Masonry-joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.

B. Products Installed but not Furnished under This Section:
1. Steel lintels in unit masonry.
2. Steel shelf angles for supporting unit masonry.
3. Cavity wall insulation.

C. Related Requirements:
1. Section 072100 "Thermal Insulation" for cavity wall insulation.
2. Section 076200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

A. CMU(s): Concrete masonry unit(s).

B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For the following:

4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
7. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
8. Clean stone trim to comply with stone supplier's written instructions.
9. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

3.15 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.

1. Crush masonry waste to less than 4 inches in each dimension.
2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. ~~Fill material is specified in Section 312000 "Earth Moving."~~
3. Do not dispose of masonry waste as fill within 18 inches of finished grade.

C. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.

D. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

C. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
   1. As-Milled Finish: Standard one-side bright.
   2. Exposed Coil-Coated Finish:
      a. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   3. Color: As selected by Architect from manufacturer's full range.
   4. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

2.3 UNDERLAYMENT MATERIALS

A. Self-Adhering, High-Temperature Sheet: Minimum 30 mils thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.
   1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F or higher.
   2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F or lower.

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners**,** solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal **or** manufactured item unless otherwise indicated.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.

   1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.

      a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
      b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
      c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
   2. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.

C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

D. Elastomeric Sealant: ASTM C 920, elastomeric [**polyurethane**] [**polysulfide**] [**silicone**] polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.

F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

G. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.

H. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
2. Obtain field measurements for accurate fit before shop fabrication.
3. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
4. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

D. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

E. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

F. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

G. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.

H. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

~~I.~~ Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

~~J.~~ Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.

K. Do not use graphite pencils to mark metal surfaces.

2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

A. Downspouts: Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors.

1. Fabricated Hanger Style: Fig 1-35B according to SMACNA's "Architectural Sheet Metal Manual."
2. Fabricate from the following materials:
   a. Stainless Steel: 0.024 inch.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing (Gravel Stop): Fabricate in minimum 96-inch- long, but not exceeding 12-foot- long sections. Furnish with 6-inch- wide, joint cover plates.

1. Joint Style: Overlapped, 4 inches wide.
   a.
   b. Stainless Steel: 0.019 inch thick.

B. Roof-to-Roof Edge-Flashing (Gravel-Stop) Transition Expansion-Joint Cover: Fabricate from the following materials:
1. Stainless Steel: 0.024 inch thick.

C. Roof-Penetration Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.019 inch thick.

D. Roof-Drain Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.016 inch thick.

2.8 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- long, but not exceeding 12-foot- long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch- high, end dams. Fabricate from the following materials:
1. Stainless Steel: 0.016 inch thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, according to manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.

B. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches -staggered 24 inches-between courses. Overlap side edges not less than 3-1/2 inches. Roll laps and edges with roller. Cover underlayment within 14 days.

3.3 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.

2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
3. Space cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
5. Torch cutting of sheet metal flashing and trim is not permitted.
6. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.

1. Coat concealed side of uncoated-aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.

C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
2. Use lapped expansion joints only where indicated on Drawings.

D. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

E. Seal joints as required for watertight construction.

1. Use sealant-filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."

3.4 ROOF-DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof-drainage items to produce complete roof-drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof-drainage system.

B. Parapet Scuppers: Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.

1. Anchor scupper closure trim flange to exterior wall and solder to scupper.
2. Loosely lock front edge of scupper with conductor head.

3.5 ROOF FLASHING INSTALLATION

A. General: Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3-inch centers.

C. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals' listing for required windstorm classification.

D. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with sealant and clamp flashing to pipes that penetrate roof.

3.6 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

3.7 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

B. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.8 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean off excess sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

SECTION 099113 - EXTERIOR PAINTING

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes surface preparation and the application of paint systems on exterior substrates.
   1. Gypsum board.

1.3 DEFINITIONS

A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

D. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

E. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

F. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

   1. Include printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
   2. Indicate VOC content.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and each color and gloss of topcoat.

   1. Submit Samples on rigid backing, 8 inches square.
   2. Apply coats on Samples in steps to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to products listed in the Exterior Painting Schedule for the paint category indicated.

2.2 PAINT, GENERAL

A. MPI Standards: Products shall comply with MPI standards indicated and shall be listed in its "MPI Approved Products Lists."

B. Material Compatibility:

1. Materials for use within each paint system shall be compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.

C. Colors: To match color and texture of adjacent architectural cast in place concrete..

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
1. Gypsum Board: 12 percent.

C. Exterior Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

3.3 APPLICATION

A. Apply paints per manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
4. Paint entire exposed surface of window frames and sashes.
5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.

1. Contractor shall touch up and restore painted surfaces damaged by testing.
2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. Exterior Gypsum Board Substrates:

1. Exterior Latex System:

a. Prime Coat: Primer, latex for exterior wood (reduced).

b. Intermediate Coat: Latex, exterior, matching topcoat.
c. Topcoat: Latex, exterior, flat (MPI Gloss Level 1).

END OF SECTION 099113

SECTION 129300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Seating.
2. Bicycle racks.
3. Trash receptacles.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

C. Samples for Verification: For each type of exposed finish, not less than 6-inch long linear components and 4-inch- square sheet components.

D. Product Schedule: For site furnishings.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 SEATING

A. Basis of Design: Landscape Forms, Inc. Plexus, Backless Bench with end and intermediate arm rests.

B. Frame: Steel.

C. Seat:

1. Material:
   a. Steel: Wire Mesh..

2. Seat Height: Manufacturer’s standard.
3. Seat Surface Shape: Contoured or dished.
4. Overall Width: As indicated.
5. Overall Depth: As indicated.

   a. Arm Material: Match frame.

D. Steel Finish: Powder coated.

1. Color: As selected by Architect from manufacturer's full range.

2.2 BICYCLE RACKS Horizontal

A. Basis of Design: Landscape Forms, Inc. Compact CBR4SC.

B. Bicycle Rack Construction:

1. Frame: Steel.

2. Style: Double-side parking.
   a. Capacity: As indicated in drawings.

3. Security: Designed to lock wheel and frame.
4. Installation Method: Manufacturer’s standard.

C. Steel Finish: Galvanized.

2.3 BICYCLE RACKS Vertical

A. Basis of Design: Landscape Forms, Inc. Compact BR2101.

B. Bicycle Rack Construction:

1. Frame: Steel.

2. Style: Double-side parking.
   a. Capacity: As indicated in drawings.

3. Security: Designed to lock wheel and frame.
4. Installation Method: Manufacturer’s standard.

2.4 BICYCLE RACKS Repair Station

A. Basis of Design: Landscape Forms, Inc. BBRS01

B. Bicycle Rack Construction:

PART 3 - EXECUTION

~~3.1 EARTHWORK~~

~~A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.~~

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."

H. Install domestic water piping level without pitch and plumb.

I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

M. Install piping to permit valve servicing.

3) Wilkins.
4) Zurn Industries, LLC.

b. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 125 psig minimum at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Capitol Manufacturing Company.
2) Watts; a Watts Water Technologies company.
3) Wilkins.
4) Zurn Industries, LLC.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 125 psig minimum at 180 deg F.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Advance Products & Systems, Inc.
2) Calpico, Inc.
3) Pipeline Seal and Insulator, Inc.

b. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

PART 3 - EXECUTION

~~3.1 EARTH MOVING~~

~~A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."~~

b. Fernco Inc.
c. Tyler Pipe; a subsidiary of McWane Inc.

2. Standards: ASTM C 1277 and CISPI 310.
3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. MG Piping Products Company.

2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

PART 3 - EXECUTION

~~3.1 EARTH MOVING~~

~~A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."~~

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

4. Cast-epoxy-resin sheath seal kit with wraparound mold and packaged, two-part, epoxy-resin casting material.

C. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.

1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone-rubber, insulator modules; shield ground strap; and compression-type connector.
2. ~~Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.~~
3. ~~Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.~~
4. ~~Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.~~
5. ~~Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape; cold-shrink-rubber sleeve; or heat-shrink, plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.~~
6. ~~Class 3 Terminations: Kit with stress cone and compression-type connector.~~

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. 3M.
2. TE Connectivity Ltd.
3. Thomas & Betts Corporation; A Member of the ABB Group.

C. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

D. Load-Break Cable Terminators: Elbow-type units with 200-A-load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. ~~Dead-Break Cable Terminators: Elbow-type unit with 600-A continuous-current rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.~~

F. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details” dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. ~~Aluminum building wire rated 600 V or less.~~
3. Metal-clad cable, Type MC, rated 600 V or less.
4. ~~Armored cable, Type AC, rated 600 V or less.~~
5. ~~Photovoltaic cable, Type PV, rated 2000 V or less.~~
6. ~~Mineral-insulated cable, Type MI, rated 600 V or less.~~
7. Connectors, splices, and terminations rated 600 V and less.

~~B. Related Requirements:~~

~~1. Section 260513 "Medium-Voltage Cables" for single-conductor and multiconductor cables, cable splices, and terminations for electrical distribution systems with 601 to 35,000 V.~~

1.3 DEFINITIONS

~~A. PV: Photovoltaic.~~

B. RoHS: Restriction of Hazardous Substances.

~~C. VFC: Variable-frequency controller.~~

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer's authorized service representative.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, provide products by the following provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Alpha Wire Company.
2. Belden Inc.
3. Southwire Company.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Conductor Insulation:

~~1. Type NM: Comply with UL 83 and UL 719.~~
~~2. Type RHH and Type RHW-2: Comply with UL 44.~~
~~3. Type USE-2 and Type SE: Comply with UL 854.~~
~~4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.~~
5. Type THHN and Type THWN-2: Comply with UL 83.
~~6. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.~~
~~7. Type UF: Comply with UL 83 and UL 493.~~
8. Type XHHW-2: Comply with UL 44.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Alpha Wire Company.
2. Belden Inc.
3. Southwire Company.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and multicircuit with color-coded conductors.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

H. Armor: Aluminum, interlocked.

I. Jacket: PVC applied over armor.

~~2.3 ARMORED CABLE, TYPE AC~~

~~A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.~~

~~B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:~~

~~1. Alpha Wire Company.~~
~~2. Belden Inc.~~
~~3. Southwire Company.~~

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Comply with UL 4.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Circuits:

1. Single circuit and multicircuit with color-coded conductors.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

E. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

F. Ground Conductor: Insulated.

G. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.

H. Armor: Aluminum, interlocked.

2.4 PHOTOVOTAIC CABLE, TYPE PV

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Encore Wire Corporation.
2. Service Wire Co.
3. Southwire Company.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

E. Conductor Insulation: Comply with UL 44 and UL 4703.

2.5 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. 3M Electrical Products.
2. O-Z/Gedney; a brand of Emerson Industrial Automation.
3. Thomas & Betts Corporation; A Member of the ABB Group.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

~~E. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.~~

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway, ~~Armored cable, Type AC, Metal-clad cable, Type MC.~~

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway ~~Armored cable, Type AC,~~ Metal-clad cable, Type MC.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

H. VFC Output Circuits: Type XHHW-2 in metal conduit.

~~I. PV Circuits: Type USE-2 for PV source circuits rated at 600 V or less.~~

~~J. PV Circuits: Type PV for PV source circuits rated at 600 V.~~

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

~~G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.~~

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

~~1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.~~

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

~~A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.~~

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors.

3. Perform each of the following visual and electrical tests:

    a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    b. Test bolted connections for high resistance using one of the following:

        1) A low-resistance ohmmeter.
        2) Calibrated torque wrench.
        3) Thermographic survey.

    c. Inspect compression-applied connectors for correct cable match and indentation.
    d. Inspect for correct identification.
    e. Inspect cable jacket and condition.
    f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    g. Continuity test on each conductor and cable.
    h. Uniform resistance of parallel conductors.

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details” dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. ~~Aluminum slotted support systems.~~
3. ~~Nonmetallic slotted support systems.~~
4. Conduit and cable support devices.
5. ~~Support for conductors in vertical conduit.~~
6. ~~Structural steel for fabricated supports and restraints.~~
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

B. Related Requirements:

1. Section 260548.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.
f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.

6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. ~~Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.~~

1. ~~Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:~~

   a. ~~Cooper Industries, Inc.~~
   b. ~~Thomas & Betts Corporation; A Member of the ABB Group.~~
   c. ~~Unistrut; Part of Atkore International.~~

2. ~~Standard: Comply with MFMA-4 factory-fabricated components for field assembly.~~
3. ~~Channel Material: 6063-T5 aluminum alloy.~~
4. ~~Fittings and Accessories Material: 5052-H32 aluminum alloy.~~
5. ~~Channel Width: Selected for applicable load criteria.~~
6. ~~Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.~~
7. ~~Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.~~
8. ~~Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.~~

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. ~~Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.~~

~~a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:~~

~~1) Hilti, Inc.~~
~~2) MKT Fastening, LLC.~~
~~3) Simpson Strong-Tie Co., Inc.~~

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

   a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

      1) B-line, an Eaton business.
      2) Hilti, Inc.
      3) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA 101
3. NECA 102.
4. NECA 105.
5. NECA 111.

B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. ~~Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.~~
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts and Spring-tension clamps.
7. To Light Steel: Sheet metal screws.

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details” dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. ~~Metal wireways and auxiliary gutters.~~
4. ~~Nonmetal wireways and auxiliary gutters.~~
5. ~~Surface raceways.~~
6. Boxes, enclosures, and cabinets.
7. Handholes and boxes for exterior underground cabling.

B. Related Requirements:

1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

B. IMC: Intermediate metal conduit.

1.4 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

H. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

I. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
1. Fittings for EMT:

a. Material: Steel.
b. Type: Setscrew.

2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

J. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. AFC Cable Systems; a part of Atkore International.
2. CertainTeed Corporation.
3. Thomas & Betts Corporation; A Member of the ABB Group.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

~~C. ENT: Comply with NEMA TC 13 and UL 1653.~~

D. RNC: Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

E. Rigid HDPE: Comply with UL 651A.

F. Coilable HDPE: Preassembled with conductors or cables, and complying with ASTM D 3485.

G. RTRC: Comply with UL 2515A and NEMA TC 14.

H. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

I. Fittings for LFNC: Comply with UL 514B.

J. Solvents and Adhesives: As recommended by conduit manufacturer.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

~~G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.~~

~~1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.~~

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep or 4 inches by 2-1/8 inches by 2-1/8 inches deep.

L. Gangable boxes are allowed.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

N. Cabinets:

1. NEMA 250, Type 1 or Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC RNC, Type EPC-80-PVC.
2. Concealed Conduit, Aboveground: GRC ~~or EMT~~.
3. Underground Conduit: RNC, Type EPC-40-PVC, concrete encased.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed and Subject to Severe Physical Damage: GRC.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
5. Damp or Wet Locations: GRC.
6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

C. Minimum Raceway Size: 3/4-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

L. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

~~S. Surface Raceways:~~

~~1. Install surface raceway with a minimum 2-inchradius control at bend points.~~
~~2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.~~

T. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

U. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

CC. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

DD. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

EE. Set metal floor boxes level and flush with finished floor surface.

FF. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

~~3.3 INSTALLATION OF UNDERGROUND CONDUIT~~

~~A. Direct-Buried Conduit:~~

~~1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.~~
~~2. Install backfill as specified in Section 312000 "Earth Moving."~~
~~3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."~~
~~4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.~~
~~5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.~~

~~a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.~~
~~b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.~~

~~6. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits but a minimum of 6 inches below grade. Align planks along centerline of conduit.~~
~~7. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."~~

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. ~~Fiberglass handholes and boxes with polymer concrete cover.~~
8. ~~Fiberglass handholes and boxes.~~
9. ~~High-density plastic boxes.~~
10. Precast manholes.
11. Cast-in-place manholes.
12. Utility structure accessories.

1.3 DEFINITIONS

A. ~~Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.~~

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

~~2.6 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER~~

~~A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.~~

~~B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:~~

~~1. Carson Industries LLC.~~
~~2. Quazite: Hubbell Power Systems, Inc.~~
~~3. Synertech Moulded Products.~~

~~C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.~~

~~D. Color: Gray.~~

~~E. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.~~

~~F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.~~

~~G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.~~

~~H. Cover Legend: Molded lettering, "ELECTRIC."~~

~~I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.~~

~~J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.~~

~~K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.~~

~~2.7 FIBERGLASS HANDHOLES AND BOXES~~

~~A. Description: Molded of fiberglass-reinforced polyester resin, with covers made of polymer concrete.~~

~~B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:~~

~~1. Carson Industries LLC.~~
~~2. Christy Concrete Products.~~
~~3. Quazite: Hubbell Power Systems, Inc.~~

~~C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.~~

~~D. Color: Gray.~~

~~E. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.~~

~~F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.~~

~~G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.~~

~~H. Cover Legend: Molded lettering, "ELECTRIC."~~

~~I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.~~

~~J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.~~

~~K. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.~~

2.8 PRECAST MANHOLES

A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Christy Concrete Products.
2. Oldcastle Precast, Inc.
3. Utility Vault Co.

C. Comply with ASTM C 858.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

~~A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.~~

B. Restoration: Replace area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."

E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.5 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 36 inches, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated

to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch.

I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

K. Pulling Cord: Install 200-lbf-test nylon cord in empty ducts.

L. Concrete-Encased Ducts and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. ~~Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches in nominal diameter.~~
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct

heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

M. Direct-Buried Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
8. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

    a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab.

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be minimum 4 inches above finished floor and no less than 3 inches from conduit side to edge of slab.

11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand

tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.

a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
b. Place minimum 6 inches of engineered fill above concrete encasement of duct.

N. Warning Planks: Bury warning planks approximately 12 inches above direct-buried duct, placing them 24 inches o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

O. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below frost line, below grade.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details” dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. ~~Standalone daylight-harvesting switching and dimming controls~~.
4. Indoor occupancy and vacancy sensors.
5. Switchbox-mounted occupancy sensors.
6. ~~Digital timer light switches.~~
7. ~~High-bay occupancy sensors.~~
8. ~~Extreme temperature occupancy sensors.~~
9. ~~Outdoor motion sensors.~~
10. Lighting contactors.
11. Emergency shunt relays.

B. Related Requirements:

1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

   a. Occupancy sensors.
   b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. NSi Industries LLC.

B. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
2. Contact Configuration: SPST.
3. Contact Rating: 30-A inductive or resistive, 240-V ac.
4. Programs: Eight on-off set points on a 24-hour schedule.
5. Programs: Two on-off set points on a 24-hour schedule, allowing different set points for each day of the week.
6. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
7. Astronomic Time: All channels.
8. Automatic daylight savings time changeover.
9. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

~~C. Electromechanical-Dial Time Switches: Comply with UL 917.~~

~~1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.~~
~~2. Contact Configuration: SPST.~~
~~3. Contact Rating: 30-A inductive or resistive, 240-V ac.~~
~~4. Circuitry: Allows connection of a photoelectric relay as a substitute for the on-off function of a program.~~
~~5. Astronomic time dial.~~
~~6. Eight-Day Program: Uniquely programmable for each weekday and holidays.~~
~~7. Skip-a-day mode.~~
~~8. Wound-spring reserve carryover mechanism to keep time during power failures, minimum of 16 hours.~~

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. NSi Industries LLC.

SECTION 261216 - DRY-TYPE, MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section includes dry-type, medium-voltage transformers, with primary and secondary bushings within or without air-terminal enclosures.

1.3 DEFINITIONS

A. BAS: Building Automation System.

B. BIL: Basic Impulse Insulation Level.

C. VPE: Vacuum Pressure Encapsulation.

D. VPI: Vacuum Pressure Impregnation.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For dry-type, medium-voltage transformers.

1. Include plans and elevations showing major components and features.

a. Include a plan view and cross section of equipment base, showing clearances, manufacturer's recommended workspace, and locations of penetrations for grounding and conduits.

2. Include details of equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include single-line diagram.
4. Include list of materials.

5. Include nameplate legends.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawing:

1. Location plan, showing heavy equipment or truck access paths for maintenance and replacement.
2. Dimensioned concrete base, outline of transformer, conduit entries, and grounding equipment locations.
3. Support locations, type of support, and weight on each support. Locate structural supports for structure-supported raceways, cabletrays.
4. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.

B. Qualification Data: For testing agency.

C. Seismic Qualification Certificates: For transformer assembly, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Product Certificates: For transformers, signed by product manufacturer.

E. Source quality-control reports.

F. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Eaton.
2. General Electric Company.
3. Square D; by Schneider Electric.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2.

C. Comply with IEEE C57.12.01.

2.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: The transformers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the transformer will remain in place without separation of any parts when subjected to the seismic forces specified and the transformer will be fully operational after the seismic event."
2. Component Importance Factor: 1.5.
3. Component Amplification Factor: 2.5.
4. Component Response Modification Factor: 6.0.

B. Windings Material: Copper.

C. Surge Arresters: Comply with IEEE C62.11, Distribution Class; metal-oxide-varistor type, connected in each phase of incoming circuit and ahead of any disconnecting device.

D. Cooling Systems: Comply with IEEE C57.12.01 for cooling class.

1. Self-Cooled Rating, Class <**Insert letters**>: <**Insert number**> kVA.
2. Future Forced-Air-Cooled Rating, Class <**Insert letters**>:

E. Coils Insulation Systems:

1. Primary and secondary coil assemblies shall be manufactured using polyester VPI system.

F. Winding Connections: Connection of windings and terminal markings shall comply with IEEE C57.12.70.

G. Efficiency: Comply with 10 CFR 431, Subpart K.

H. Bushings shall comply with IEEE C57.19.01 requirements for impulse and low-frequency insulation levels.

I. Tap Changer: External, for de-energized operation.

J. Enclosure:

1. Provide with provisions for lifting and anchoring frame to concrete pad.
2. With an integral skid-mounting frame, suitable to allow skidding or rolling of transformer in any direction.
3. Outdoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard color, corrosion resistant complying with IEEE C57.12.28.
4. Indoor Transformer Enclosure Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.
5. Special Corrosion-Resistant Enclosure Finish: Factory-applied, corrosion-resistant finish in manufacturer's standard color that withstands 480 hours of exposure to salt-spray test specified in ASTM B 117 without loss of paint or release of adhesion of paint primer coat to metal surface in excess of 1/16 inch from test mark. Scribed test mark and test evaluation shall be according to ASTM D 1654 with a rating of not less than 7 according to Table 1 (Procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel, or mill-galvanized sheet steel shall be coated with a manufacturer's standard zinc-rich paint.
6. Taps: Two 2-1/2-percent, full-capacity taps above and two 2-1/2-percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.36 requirements.

K. Sound level shall comply with requirements of NEMA TR 1.

L. Capacities and Characteristics:

1. Enclosure: Ventilated power transformer, NEMA 250 Type 3R enclosure.
2. Additional IEEE Standards: Comply with IEEE C57.12.50 IEEE C57.12.55.
3. Comply with UL 1562 listing requirements.
4. Service Conditions: The transformers shall be suitable for operation under service conditions specified as usual service conditions in IEEE C57.12.01, except for the following:

    a. Altitudes above 3,300 feet.
    b. Cooling air or water temperature exceeds limits.
    c. Excessive load current harmonic factor.
    d. Operation above rated voltage or below rated frequency.
    e. Exposure to explosive environments.
    f. Exposure to fumes, vapors, or dust.
    g. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
    h. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
    i. Exposure to excessively high or low temperatures.
    j. Unusual transportation or storage conditions.
    k. Unusual grounding resistance conditions.
    l. Unusual space limitations.

5. Connections:

a. Primary: Air-filled terminal cabinet for cable connection.
b. Secondary: Air-filled terminal cabinet for cable connection.

6. Transformer Ratings.

a. Impedance: Not less than 5.75 percent.
b. Temperature Rise: 150 deg C.
c. Coils Connection:

1) High-Voltage Winding: Delta.
2) Low-Voltage Winding: Wye.

d. Voltage and BIL Ratings:

1) Nominal primary phase-to-phase voltage and BIL: 12 400 V, 60 kV.
2) Nominal secondary voltage and BIL: 480Y/277 V, 10 kV.

7. Taps: Two 2-1/2-percent, full-capacity taps above and two 2-1/2-percent, full-capacity taps below rated voltage. Comply with IEEE C57.12.51 requirements.
8. Transformer Accessories:

a. Dial-type analog thermometer with alarm contacts.
b. At least four stainless-steel ground connection pads.
c. Provisions for jacking, lifting, and towing.
d. Machine-engraved nameplate made of anodized aluminum or stainless steel.

2.4 CONTROL NETWORK

A. Controllers: Support serial MS/TP and Ethernet IP communications, and able to communicate directly via RS-485 serial networks and Ethernet 10Base-T networks as a native device.

2.5 WARNING LABELS AND SIGNS

A. Comply with requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

1. Warning signs shall be made of baked enamel.
2. Equipment Identification Labels: Engraved, laminated-acrylic or -melamine label.

2.6 SOURCE QUALITY CONTROL

A. Provide manufacturer's certificate that the transformer design tests comply with IEEE C57.12.91.

B. Perform the following factory-certified routine tests on each transformer 500 kVA and less for this Project:

1. Turns ratio, polarity, and phase relation on rated voltage connection.
2. Transformer no-load losses and excitation current at 100 percent of ratings. This test may be based on a statistical sample.
3. Applied voltage and induced voltage.
4. Partial discharge.
5. Impedance voltage and load loss at rated current and rated frequency on rated voltage connection and at tap extremes.
6. Temperature rise at minimum and maximum ratings.
7. Impulse.
8. Insulation power factor.
9. Insulation resistance.
10. Audible sound level.
11. Short-circuit capability.
12. Operation of all devices.
13. Control (auxiliary) and consumption loss data values.

C. Perform the following factory-certified tests on each transformer 500 kVA and larger for this Project. Reports shall comply with the minimum information requirements of IEEE C57.12.01:

1. Resistance measurements of all windings on rated voltage tap and at tap extremes.
2. Turns ratio, polarity, and phase relation on rated voltage connection.
3. Transformer no-load losses and excitation current at 100 percent of ratings.
4. Impedance voltage and load loss at rated current and rated frequency on rated voltage connection and at tap extremes.
5. Applied voltage and induced voltage.
6. Partial discharge.
7. Leak test.
8. Temperature rise at minimum and maximum ratings.
9. Impulse.
10. Insulation power factor.
11. Insulation resistance.
12. Audible sound level.
13. Short-circuit capability.
14. Operation of all devices.
15. Control (auxiliary) and consumption loss data values.

D. Owner will witness required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine dry-type, medium-voltage transformers upon delivery.

1. Upon delivery of transformers and prior to unloading, inspect equipment for any damage that may have occurred during shipment or storage.

2. Verify that tie rods and chains are undamaged and tight, and that all blocking and bracing is tight. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's recommendations.
3. Verify that there is no indication of external damage and no dents or scratches in doors and sill, tank walls, radiators and fins, or termination provisions.
4. Compare transformers and accessories received with bill of materials to verify that shipment is complete. Verify that transformers and accessories conform to manufacturer's quotation and shop drawings. If shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
5. Unload transformers carefully, observing all packing label warnings and handling instructions.
6. Open termination compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.

B. Handling:

1. Handle transformers carefully, in accordance with manufacturer recommendations, to avoid damage to enclosure, termination compartments, base, frame, and internal components. Do not subject transformers to impact, jolting, jarring, or rough handling.
2. Protect transformer against entrance of dust, rain, and snow.
3. Transport transformers upright, to avoid internal stresses on core and coil mounting assembly and transformer case.
4. Verify that transformer weights are within rated capacity of handling equipment.
5. Use only manufacturer-recommended points for lifting, jacking, and pulling. Use all lifting lugs when lifting transformers.
6. Use jacks only at corners of base plate of transformer case.
7. Use nylon straps of same length to balance and distribute weight when handling transformers with a crane.
8. Use spreaders or a lifting beam to obtain a vertical lift and to protect transformer from straps bearing against enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
9. Exercise care not to damage base structure of case when handling transformer using skids or rollers. Use skids to distribute stresses over case base when using rollers under large transformers.

C. Storage:

1. Store transformers in accordance with manufacturer's recommendations.
2. Transformers may be stored outdoors. If possible, store transformers at final installation locations on concrete pads. If dry concrete surfaces are unavailable, use pallets of adequate strength to protect transformers from direct contact with ground. Ensure transformer is level.
3. Ensure that transformer storage location is clean and protected from severe conditions. Protect transformers from dirt, water, contamination, and physical damage. Do not store transformers in presence of corrosive or explosive gases. Protect transformers from weather when stored for more than three months.
4. Store transformers with compartment doors closed.
5. Regularly inspect transformers while in storage and maintain documentation of storage conditions, noting any discrepancies or adverse conditions. Visually check for rust spots.

D. Examine areas and space conditions for compliance with requirements for dry-type, medium-voltage transformers and other conditions affecting performance of the Work.

E. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer, and no feeders will cross section barriers to reach load or line lugs.

F. Examine walls, floors, roofs, and concrete bases for suitable conditions for transformer installation.

G. Pre-Installation Checks:

1. Verify removal of any shipping bracing after placement.

H. Verify that ground connections are in place and that requirements in Section 260526 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at transformer location.

I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

B. Transformer shall be installed level and plumb and shall tilt less than 1.5 degrees while energized.

C. Comply with requirements for vibration isolation and seismic control devices specified in Section 260529 "Hangers and Supports for Electrical Systems" and Section 260548.16 "Seismic Controls for Electrical Systems."

D. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. At Interior Locations: For grounding to grounding electrodes, use bare copper cable not smaller than No. 4/0 AWG. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep leads as short as practicable, with no kinks or sharp bends. Make joints in grounding conductors and loops by exothermic weld or compression connector.
2. At Exterior Locations:

a. For counterpoise, use tinned bare copper cable not smaller than No. 4/0 AWG, buried not less than 30 inches below grade interconnecting grounding electrodes. Bond surge arrester and neutrals directly to transformer enclosure and then to grounding electrode system with bare copper conductors. Keep lead lengths as short as practicable, with no kinks or sharp bends.
b. Fence and equipment connections shall not be smaller than No. 4 AWG. Ground fence at each gate post and corner post and at intervals not exceeding 10 ft. Bond each gate section to fence post using 1/8 by 1 inch tinned flexible braided copper strap and clamps.
c. Make joints in grounding conductors and loops by exothermic weld or compression connector.

3. Terminate all grounding and bonding conductors on a common equipment grounding terminal on transformer enclosure. Install supplemental terminal bars, lugs, and bonding jumpers as required to accommodate number of conductors for termination.
4. Complete transformer tank grounding and lightning arrester connections prior to making any other electrical connections.

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

1. Maintain air clearances between energized live parts and between live parts and ground for exposed connections in accordance with manufacturer recommendations.
2. Bundle associated phase, neutral, and equipment grounding conductors together within transformer enclosure. Arrange conductors such that there is not excessive strain that could cause loose connections. Allow adequate slack for expansion and contraction of conductors.

C. Terminate medium-voltage cables in incoming section of substations according to Section 260513 "Medium-Voltage Cables."

3.4 SIGNS AND LABELS

A. Comply with installation requirements for labels and signs specified in Section 260553 "Identification for Electrical Systems."

B. Install warning signs as required to comply with 29 CFR 1910.269.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections:

1. General Field-Testing Requirements:

a. Comply with provisions of NFPA 70B, Ch. "Testing and Test Methods."
b. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
c. After installing transformer but before primary is energized, verify that grounding system at substation is tested at specified value or less.
d. After installing transformer and after electrical circuitry has been energized, test for compliance with requirements.
e. Visual and Mechanical Inspection:

1) Verify equipment nameplate data complies with Contract Documents.
2) Inspect bolted electrical connections for high resistance using one of the following two methods:

a) Use a low-resistance ohmmeter to compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
b) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In absence of manufacturer's published data, use NETA ATS, Table 100.12.

f. Remove and replace malfunctioning units and retest.
g. Prepare test and inspection reports. Record as-left set points of all adjustable devices.

2. Medium-Voltage Surge Arrester Field Tests:

a. Visual and Mechanical Inspection:

1) Inspect physical and mechanical condition.
2) Inspect anchorage, alignment, grounding, and clearances.
3) Verify arresters are clean.
4) Verify that ground lead on each device is individually attached to a ground bus or ground electrode.
5) Verify that stroke counter is correctly mounted and electrically connected if applicable. Record stroke counter reading.

b. Electrical Test:

1) Perform an insulation-resistance test on each arrester, phase terminal-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Replace units that fail to meet recommended minimum insulation resistance listed in that table.
2) Perform a watts-loss test. Evaluate watts-loss values by comparison with similar units and test equipment manufacturer's published data.

3. Dry-Type Transformer Field Tests:

a. Visual and Mechanical Inspection:

1) Test dew point of tank gases if applicable.
2) Inspect anchorage, alignment, and grounding.
3) Verify that resilient mounts are free and that any shipping brackets have been removed.
4) Verify bushings are clean.
5) Verify that alarm, control, and trip settings on temperature and level indicators are set and operate within manufacturer's recommended settings.
6) Verify that cooling fans operate correctly and have appropriate overcurrent protection.
7) Perform specific inspections and mechanical tests recommended by manufacturer.
8) Verify that as-left tap connections are as specified.

b. Electrical Tests:

1) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index; the value of the index shall not be less than 1.0.
2) Perform power-factor or dissipation-factor tests on all windings according to test equipment manufacturer's published data.
3) Perform a power-factor or dissipation-factor tip-up test on windings greater than 2.5 kV.
4) Perform turns-ratio tests at tap positions. Turns-ratio test results shall not deviate by more than one-half percent from either adjacent coils or calculated ratio. If test fails, replace transformer.
5) Perform an excitation-current test on each phase. The typical excitation-current test data pattern for a three-legged core transformer is two similar current readings and one lower current reading. Investigate and correct if test shows a different pattern.
6) Measure resistance of each winding at each tap connection, and record temperature-corrected winding-resistance values in Operations and Maintenance Manual.
7) Perform an applied-voltage test on high- and low-voltage windings-to-ground. Comply with IEEE C57.12.91 provisions for field-deployed dielectric teats. Measurements shall be made only when voltage and current have reached a stable value. Test shall be discontinued immediately in the event the current begins to increase without stabilizing. Record test values in Operations and Maintenance Manual.
8) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.

3.6 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each transformer. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

    a. Adjust transformer taps.
    b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action is performed, until satisfactory results are obtained.
4. Report:

    a. Prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Inspection: Perform survey during periods of maximum possible loading. Remove all necessary covers prior to inspection.

1. After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared inspection of transformer's electrical power connections.
2. Instrument: Inspect distribution systems with imaging equipment capable of detecting a minimum temperature difference of 1 deg C at 30 deg C.
3. Record of Infrared Inspection: Prepare a certified report that identifies testing technician and equipment used, and lists results as follows:

    a. Description of equipment to be tested.
    b. Discrepancies.
    c. Temperature difference between area of concern and reference area.
    d. Probable cause of temperature difference.
    e. Areas inspected. Identify inaccessible and unobservable areas and equipment.
    f. Identify load conditions at time of inspection.
    g. Provide photographs and thermograms of deficient area.

4. Act on inspection results according to recommendations of NETA ATS, Table 100.18. Correct possible and probable deficiencies as soon as Owner's operations permit. Retest until deficiencies are corrected.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.

END OF SECTION 261216

SECTION 262713 - ELECTRICITY METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section includes work to accommodate utility company revenue meters, and Owner's electricity meters used to manage the electrical power system.

1.3 DEFINITIONS

A. KY or KYZ Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity (kWh) that is based on a relay opening and closing in response to the rotation of the disk in the meter. Electronic meters generate pulses electronically.

1.4 ACTION SUBMITTALS

A. Product Data:

1. For each type of meter.
2. For metering infrastructure components.
3. For metering software.

B. Shop Drawings: For electricity-metering equipment.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Include diagrams for power, signal, and control wiring.
3. Wire Termination Diagrams and Schedules: Include diagrams for power, signal, and control wiring. Identify terminals and wiring designations and color-codes to facilitate installation, operation, and maintenance. Indicate recommended types, wire sizes, and circuiting arrangements for field-installed wiring, and show circuit protection features. Differentiate between manufacturer-installed and field-installed wiring.
4. Include series-combination rating data for modular meter centers with main disconnect device.
5. Block Diagram: Show interconnections between components specified in this Section and devices furnished with power distribution system components. Indicate data communication paths and identify networks, data buses, data gateways, concentrators,

and other devices used. Describe characteristics of network and other data communication lines.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Submit evidence that meters are compatible with connected monitoring and control devices and systems .

1. Show interconnecting signal and control wiring, and interface devices to show compatibility of meters.
2. For reporting and billing interfaces and adapters, list network protocols and provide statements from manufacturers that input and output devices comply with interoperability requirements of the protocol.

B. Qualification Data: For testing agency.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

1. Application and operating software documentation.
2. Software licenses.
3. Software service agreement.
4. Device address list.
5. Hard copies of manufacturer's operating specifications, user's guides for software and hardware, and PDF files on a USB storage device of hard-copy Submittal.
6. Meter data sheet for each meter, listing nameplate data and serial number, accuracy certification, and test results.
7. Meter installation and billing software startup report.

1.7 FIELD CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Construction Manager shall be notified and issued written permission no fewer than two days in advance of proposed interruption of electrical service.

1.8 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of metering equipment that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Damage from transient voltage surges.

2. Warranty Period: Cost to repair or replace any parts for two years from date of Substantial Completion.
3. Extended Warranty Period: Cost of replacement parts (materials only, f.o.b. the nearest shipping point to Project site), for eight years, that failed in service due to transient voltage surges.

1.10 COORDINATION

A. Electrical Service Connections:

1. Coordinate with utility companies and utility-furnished components.

a. Comply with requirements of utility providing electrical power services.
b. Coordinate installation and connection of utilities and services, including provision for electricity metering components.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 916.

2.2 UTILITY METERING INFRASTRUCTURE

A. Install metering accessories furnished by the utility company, complying with its requirements.

B. Utility-Furnished Meters: Connect data transmission facility of metering equipment installed by the Utility.

1. Data Transmission: Transmit pulse data over control-circuit conductors, classified as Class 1 per NFPA 70, Article 725. Comply with Section 260523 "Control-Voltage Electrical Power Cables."

C. Current-Transformer Cabinets: Comply with requirements of electrical-power utility company.

D. Meter Sockets:

1. Comply with requirements of electrical-power utility company.
2. Meter Sockets: Steady-state and short-circuit current ratings shall meet indicated circuit ratings.

E. Modular Meter Center: Factory-coordinated assembly of a main service terminal box with lugs only, wireways, meter socket modules, and feeder circuit breakers arranged in adjacent vertical sections complete with interconnecting buses.

1. Comply with requirements of utility company for meter center.

    a. Comply with UL 67.

2. Housing: NEMA 250, Type 3R enclosure.
3. Meter Socket Rating: Coordinated with connected feeder circuit rating.
4. Minimum Short-Circuit Rating: 65,000 A symmetrical at rated voltage.
5. Steady-state and short-circuit current ratings shall have ratings that match connected circuit ratings.
6. Main Disconnect Device: Circuit breaker, series-combination rated for use with downstream feeder and branch circuit breakers and having an adjustable magnetic trip setting for circuit-breaker frame sizes of 250 A and larger. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Circuit breakers shall be operable from outside the enclosure to disconnect the unit. Configure cover so it can be opened only when the disconnect switch is open.
7. Main Disconnect Device: Fusible switch, UL 98 Type GD, series-combination rated by fuse manufacturer to protect downstream feeder and branch circuit breakers. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers." Switch shall be operable from outside the enclosure to disconnect the unit. Configure cover so that it can be opened only when the disconnect switch is open.
8. Feeder Circuit Breakers: Series-combination-rated molded-case units, rated to protect downstream circuit breakers and to house load centers and panelboards that have 22,000-A interrupting capacity.

    a. Identification: Complying with requirements in Section 260553 "Identification for Electrical Systems."
    b. Physical Protection: Tamper resistant, with hasp for padlock.

9. Surge Protection for Main Disconnect: Factory installed, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
10. Surge Protection at Main Disconnect: Field-mounted external to the device, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
11. Surge Protection at Main Terminal Box: Factory installed, integrally mounted, UL 1449 Type 1. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."
12. Surge Protection at Main Terminal Box: Field-mounted external to the device, UL 1449 Type 2, with integral disconnect and overcurrent protective device. Comply with Section 264313 "Surge Protection for Low-Voltage Electrical Power Circuits."

F. Arc-Flash Warning Labels;

1. Labels: Comply with requirements for "Arc-Flash Warning Labels" in Section 260574 "Overcurrent Protective Device Arc-Flash Study." Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis.
2. Labels: Comply with requirements for "Self-Adhesive Equipment Labels" and "Signs" in Section 260553 "Identification for Electrical Systems." Apply a 3-1/2-by-5-inch thermal transfer label of high-adhesion polyester for each work location included in the analysis. Labels shall be machine printed, with no field-applied markings.

    a. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:

        1) Location designation.
        2) Nominal voltage.
        3) Flash protection boundary.
        4) Hazard risk category.
        5) Incident energy.
        6) Working distance.
        7) Engineering report number, revision number, and issue date.

2.3 ELECTRICITY METERS

A. System Description: Able to meter designated activity loads, with or without external alarm, control, and communication capabilities, or other optional features.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Eaton.
2. General Electric Company.
3. Square D; by Schneider Electric.

    a. Circuit: 120/240-V ac, 100 A.

    b. Measure: kWh, onboard LED display.
    c. Remote-Reading Options: None.

C. General Requirements for Meters:

1. Billing Meters Accuracy: 0.2 percent of reading, complying with ANSI C12.20.
2. Meters Certification: Certified by as complying with 4 CCR 4027, Article 2.2.
3. Certify that meters comply with ANSI C12.20 requirements by a laboratory accredited by the National Voluntary Laboratory Accreditation Program (NVLAP) of the National Institute of Standards and Technology (NIST). The laboratory shall use test equipment that is certified annually and is traceable to NIST standards.
4. Enclosure: Supplied by meter manufacturer, NEMA 250, Type 3R minimum, with provisions for locking or sealing.
5. Identification: Comply with requirements in Section 260553 "Identification for Electrical Systems."
6. Onboard Nonvolatile Data Storage: kWh, until reset.

7. Sensors: Current-sensing type, supplied by electronic meter manufacturer, with current or voltage output, selected for optimum range and accuracy for meters indicated for this application.

a. Type: Split and solid core, complying with recommendation of meter manufacturer.

D. kWh Meter: Electronic three-phase meters, measuring electricity use.

1. Voltage and Phase Configuration: Meter shall be designed for use on circuits with voltage rating and phase configuration indicated for its application.
2. Display: LCD with characters not less than 0.25 inch high, indicating accumulative kWh and current kilowatt load. Retain accumulated kWh in a nonvolatile memory, until reset.
3. Display: Digital electromechanical counter, indicating accumulative kWh.

E. Current-Transformer Cabinet: Size and configuration as recommended by metering equipment manufacturer for use with indicated connected feeder and sensors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with equipment installation requirements in NECA 1.

B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written instructions. Provide empty conduits for metering leads and extend grounding connections as required by utility company.

C. Install modular meter center according to switchboard installation requirements in NECA 400.

D. Install arc-flash labels as required by NFPA 70.

E. Wiring Method:

1. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
2. Install unshielded, twisted-pair cable for control and signal transmission conductors, complying with Section 271513 "Communications Copper Horizontal Cabling."
3. Minimum conduit size shall be 1/2 inch.

3.2 IDENTIFICATION

A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Series Combination Warning Label: Self-adhesive labels, with text as required by NFPA 70.

2. Equipment Identification Labels: Self-adhesive labels with clear protective overlay. For residential meters, provide an additional card holder suitable for typewritten card with occupant's name.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Tests and Inspections:

1. Equipment and Software Setup:

a. Set meter date and time clock.
b. Test, calibrate, and connect pulse metering system.
c. Set and verify billing demand interval for demand meters.
d. Report settings and calibration results.
e. Set up reporting and billing software, insert billing location names and initial constant values and variable needed for billing computations.

2. Connect a load of known kilowatt rating, 1.5 kW minimum, to a circuit supplied by metered feeder.
3. Turn off circuits supplied by metered feeder and secure them in off condition.
4. Run test load continuously for eight hours minimum, or longer, to obtain a measurable meter indication. Use test-load placement and setting that ensures continuous, safe operation.
5. Check and record meter reading at end of test period and compare with actual electricity used, based on test-load rating, duration of test, and sample measurements of supply voltage at test-load connection. Record test results.
6. Generate test report and billing for each tenant or activity from the meter reading tests.

F. Electricity metering will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.4 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.5 DEMONSTRATION

A. Train Owner's clerical and maintenance personnel to use, adjust, operate, and maintain the electronic metering and billing software.

END OF SECTION 262713

SECTION 263213.14 - DIESEL ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation “Standard Specifications”, dated August 2001 and the Delaware Department of Transportation “Standard Construction Details” dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section includes packaged engine generators used to supply non-emergency power, with the following features:

1. Diesel engine.
2. Diesel fuel-oil system.
3. Control and monitoring.
4. Generator overcurrent and fault protection.
5. Generator, exciter, and voltage regulator.
6. ~~Load banks.~~
7. Outdoor engine generator enclosure.
8. ~~Remote radiator motors.~~
9. Vibration isolation devices.
10. Finishes.

B. Related Requirements:
1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.3 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Include thermal damage curve for generator.
3. Include time-current characteristic curves for generator protective device.

N. Engine Generator Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: 10 seconds.

~~O. Engine Generator Performance for Sensitive Loads:~~

~~1. Oversizing generator compared with the rated power output of the engine is permissible to meet specified performance.~~

~~a. Nameplate Data for Oversized Generator: Show ratings required by the Contract Documents rather than ratings that would normally be applied to generator size installed.~~

~~2. Steady-State Voltage Operational Bandwidth: 1 percent of rated output voltage from no load to full load.~~
~~3. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 0.5 second.~~
~~4. Steady-State Frequency Operational Bandwidth: Plus or minus 0.25 percent of rated frequency from no load to full load.~~
~~5. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.~~
~~6. Transient Frequency Performance: Less than 2-Hz variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within three seconds.~~
~~7. Output Waveform: At no load, harmonic content measured line to neutral shall not exceed 2 percent total with no slot ripple. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.~~
~~8. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 300 percent of rated full-load current for not~~

~~less than 10 seconds and then clear the fault automatically, without damage to winding insulation or other generator system components.~~

~~9. Excitation System: Performance shall be unaffected by voltage distortion caused by nonlinear load.~~

~~a. Provide permanent magnet excitation for power source to voltage regulator.~~

~~10. Start Time: 10 seconds.~~

~~P. Parallel Engine Generators:~~

~~1. Automatic reactive output power control and load sharing between engine generators operated in parallel.~~
~~2. Automatic regulation, automatic connection to a common bus, and automatic synchronization, with manual controls and instruments to monitor and control paralleling functions.~~
~~3. Protective relays required for equipment and personnel safety.~~
~~4. Paralleling suppressors to protect excitation systems.~~
~~5. Reverse power protection.~~
~~6. Loss of field protection.~~

2.4 DIESEL ENGINE

A. Fuel: ASTM D 975, diesel fuel oil, Grade 2-D S15.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid-mounted.

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499.

E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.

4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.

    a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

~~F. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine driven coolant pump. Comply with requirements in Section 232113 "Hydronic Piping" for coolant piping.~~

~~1. Configuration: Vertical air discharge.~~
~~2. Radiator Core Tubes: Aluminum.~~
~~3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.~~
~~4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.~~
~~5. Fan: Driven by multiple belts from engine shaft.~~
~~6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.~~
~~7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.~~

G. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 78 dBA or less.

H. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

I. Starting System: 12 or 24-V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: 60 seconds.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.

18. Generator overcurrent-protective-device not-closed alarm.

M. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.

N. Remote Emergency-Stop Switch: Flush; wall mounted unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.

B. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator output rating.
3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
4. Mounting: Adjacent to, or integrated with, control and monitoring panel.

~~C. Generator Disconnect Switch: Molded-case type; 100 percent rated.~~

~~1. Trip Rating: Matched to generator output rating.~~
~~2. Shunt Trip: Connected to trip switch when signaled by generator protector or by other protective devices.~~

D. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other engine generator protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator 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 engine generator malfunction alarms. Contacts shall be available for load shed functions.
2. Under single- or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

D. Seismic Design: Comply with seismic requirements in Section 260548.16 "Seismic Controls for Electrical Systems."

E. Fire Protection: Provide fire protection according to Section 211316 "Dry-Pipe Sprinkler Systems." Provide smoke detector in enclosure; mounted according to NFPA 72.

F. Hinged Doors: With padlocking provisions.

G. Space Heater: Thermostatically controlled and sized to prevent condensation.

H. Lighting: Provide weather-resistant LED lighting with 30 fc (330 lx) average maintained.

I. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

J. Muffler Location: Within enclosure.

K. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

L. Interior Lights with Switch: Factory-wired, vaporproof luminaires within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

M. Convenience Outlets: Factory-wired, GFCI. Arrange for external electrical connection.

~~2.10 REMOTE RADIATOR MOTORS~~

~~A. Description: NEMA MG 1, Design B, medium-induction, random-wound, squirrel-cage motor.~~

~~B. Efficiency: Energy efficient, as defined in NEMA MG 1.~~

~~C. Service Factor: 1.15.~~

~~D. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.~~

~~E. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.~~

~~F. Temperature Rise: Match insulation rating.~~

~~G. Code Letter Designation:~~

~~1. Motors 15 HP and Larger: NEMA starting Code F or Code G.~~
~~2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.~~

~~H. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.~~

~~I. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections~~.

2.11 VIBRATION ISOLATION DEVICES

A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.

1. Material: Standard neoprene separated by steel shims.
2. Shore A Scale Durometer Rating: 30.
3. Number of Layers: One.
4. Minimum Deflection: 1 inch (25 mm).

B. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Minimum Deflection: 1 inch (25 mm).

C. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.

D. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.

E. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.12 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

SECTION 263600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated ~~2001~~ 2016, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section includes automatic transfer switches rated 600 V and less, including the following:

1. Bypass/isolation switches.
2. Remote annunciator system.
3. Remote annunciator and control system.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
2. Include material lists for each switch specified.
3. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
4. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer-authorized service representative.

B. Seismic Qualification Certificates: For transfer switches, accessories, and components, from manufacturer.

L. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

M. Neutral Terminal: Solid and fully rated unless otherwise indicated.

N. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

O. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

P. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable with printed tape markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
4. Accessible via front access.

Q. Enclosures: General-purpose NEMA 250, Type 3R, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Caterpillar, Inc.; Electric Power Division.
2. Cummins Power Generation.
3. Eaton.
4. Emerson Electric Co.

B. Comply with Level 1 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: Hard-drawn copper, 98 percent conductivity.

6. Main and Neutral Lugs: Compression type.
7. Ground Lugs and Bus-Configured Terminators: Compression type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.

D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

E. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.

1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
3. Fully automatic break-before-make operation with center off position.
4. Fully automatic break-before-make operation with transfer when two sources have near zero phase difference.

~~F. Automatic Closed-Transition Transfer Switches: Connect both sources to load momentarily. Transition is controlled by programming in the automatic transfer-switch controller.~~

~~1. Fully automatic make-before-break operation when transferring between two available power sources.~~
~~2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.~~
~~3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.~~

~~a. Initiation occurs without active control of generator.~~
~~b. Automatic transfer-switch controller takes active control of generator to match frequency, phase angle, and voltage.~~
~~c. Controls ensure that closed-transition load transfer closure occurs only when the two sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.~~

~~4. Failure of power source serving load initiates automatic break-before-make transfer.~~

G. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

~~H. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.~~

I. Electric Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

J. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

K. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

L. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30

minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
b. Push-button programming control with digital display of settings.
c. Integral battery operation of time switch when normal control power is unavailable.

M. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.3 MOLDED-CASE-TYPE AUTOMATIC TRANSFER SWITCHES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Comply with Level 1 equipment according to NFPA 110.

C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using contactor-based components are unacceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching.
4. Conductor Connectors: Suitable for use with conductor material and sizes.
5. Material: Hard-drawn copper, 98 percent conductivity.
6. Main and Neutral Lugs: Compression type.
7. Ground Lugs and Bus-Configured Terminators: Compression type.
8. Ground bar.
9. Connectors shall be marked for conductor size and type according to UL 1008.

D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.

1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.

E. Automatic Delayed-Transition Transfer Switches: Pauses or stops in intermediate position to momentarily disconnect both sources, with transition controlled by programming in the automatic transfer-switch controller. Interlocked to prevent the load from being closed on both sources at the same time.

1. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals for alternative source. Adjustable from zero to six seconds, and factory set for one second.
2. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
3. Fully automatic break-before-make operation with center off position.
4. Fully automatic break-before-make operation with transfer when two sources have near zero phase difference.

F. Automatic Closed-Transition Transfer Switches: Connect both sources to load momentarily. Transition is controlled by programming in the automatic transfer-switch controller.

1. Fully automatic make-before-break operation when transferring between two available power sources.
2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.
3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

a. Initiation occurs without active control of generator.
b. Automatic transfer-switch controller takes active control of generator to match frequency, phase angle, and voltage.
c. Controls ensure that closed-transition load transfer closure occurs only when the two sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

G. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

H. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

I. Electric Switch Operation: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

J. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.

K. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.

L. Transfer Switches Based on Molded-Case Switch Components: Comply with UL 489 and UL 869A.

M. Automatic Transfer-Switch Controller Features:

1. Controller operates through a period of loss of control power.
2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.

b. Push-button programming control with digital display of settings.
c. Integral battery operation of time switch when normal control power is unavailable.

N. Large-Motor-Load Power Transfer:

1. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
2. Motor Disconnect and Timing Relay Controls: Designated starters in loss of power scenario shall disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters shall be through wiring external to automatic transfer switch. Provide adjustable time delay between 1 and 60 seconds for reconnecting individual motor loads. Provide relay contacts rated for motor-control circuit inrush and for actual seal currents to be encountered.
3. Programmed Neutral Switch Position: Switch operator with programmed neutral position arranged to provide a midpoint between the two working switch positions, with an intentional, time-controlled pause at midpoint during transfer. Adjustable pause from 0.5 to 30 seconds minimum, and factory set for 0.5 second unless otherwise indicated. Time delay occurs for both transfer directions. Disable pause unless both sources are live.

2.4 NONAUTOMATIC TRANSFER SWITCHES

A. <Double click here to find, evaluate, and insert list of manufacturers and products.>

B. Electrically Operated: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Switch shall be capable of transferring load in either direction with either or both sources energized.

C. Manual and Electrically Operated: Electrically actuated by push buttons designated "Normal Source" and "Alternative Source." Manual handle provides quick-make, quick-break manual-switching action. Switch shall be capable of electrically or manually transferring load in either direction with either or both sources energized. Control circuit disconnects from electrical operator during manual operation.

D. Double-Throw Switching Arrangement: Incapable of pauses or intermediate position stops during switching sequence.

E. Pilot Lights: Indicate source to which load is connected.

F. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and alternative-source sensing circuits.

1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
2. Emergency Power Supervision: Red light with nameplate engraved "Alternative Source Available."

G. Unassigned Auxiliary Contacts: Switch shall have one set of normally closed contacts for each switch position, rated 10 A at 240 V ac.

H. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.
2. Contacts: Silver composition or silver alloy for load-current switching.
3. Conductor Connectors: Suitable for use with conductor material and sizes.
4. Material: Hard-drawn copper, 98 percent conductivity.
5. Main and Neutral Lugs: Compression type.
6. Ground Lugs and Bus-Configured Terminators: Compression type.
7. Ground bar.
8. Connectors shall be marked for conductor size and type according to UL 1008.

2.5 TRANSFER SWITCH ACESSORIES

A. Bypass/Isolation Switches:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Comply with requirements for Level 1 equipment according to NFPA 110.
3. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

a. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. Interlocks shall prevent transfer-switch operation, except for testing or maintenance, while automatic transfer switch is isolated.
b. Provide means to make power available to transfer-switch control circuit for testing and maintenance purposes.
c. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations. Transfer switch and bypass/isolation switch shall be in isolated compartments.
d. Transition: Provide closed-transition operation when transferring from main transfer switch to bypass/isolation switch on the same power source.
e. Transition: Provide open-transition operation when transferring between power sources.
f. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
g. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.
h. Manual Control: Constructed so load bypass and transfer-switch isolation can be performed by one person in no more than two operations in 15 seconds or less. Operating handles shall be externally operated.
i. Automatic and Nonautomatic Control: Automatic transfer-switch controller shall also control the bypass/isolation switch.

j. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.
k. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

4. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

B. Remote Annunciator System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Functional Description: Remote annunciator panel shall annunciate conditions for indicated transfer switches.
3. Annunciation panel display shall include the following indicators:

a. Sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
b. Switch position.
c. Switch in test mode.
d. Failure of communication link.

4. Annunciator Panel: LED-lamp type with audible signal and silencing switch.

a. Indicating Lights: Grouped for each transfer switch monitored.
b. Label each group, indicating transfer switch it monitors, location of switch, and identity of load it serves.
c. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
d. Lamp Test: Push-to-test or lamp-test switch on front panel.

C. Remote Annunciator and Control System:

1. Source Limitations: Same manufacturer as transfer switch in which installed.
2. Include the following functions for indicated transfer switches:

a. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
b. Indication of switch position.
c. Indication of switch in test mode.
d. Indication of failure of digital communication link.
e. Key-switch or user-code access to control functions of panel.
f. Control of switch-test initiation.
g. Control of switch operation in either direction.
h. Control of time-delay bypass for transfer to normal source.

3. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.

4. ~~Remote Annunciation and Control Panel: Solid-state components. Include the following features:~~

   a. ~~Controls and indicating lights grouped together for each transfer switch.~~
   b. ~~Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.~~
   c. ~~Digital Communication Capability: Matched to that of transfer switches supervised.~~
   d. ~~Mounting: Flush, modular, steel cabinet unless otherwise indicated.~~

2.6 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

B. Prepare test and inspection reports.

1. For each of the tests required by UL 1008, performed on representative devices, for standby systems. Include results of test for the following conditions:

   a. Overvoltage.
   b. Undervoltage.
   c. Loss of supply voltage.
   d. Reduction of supply voltage.
   e. Alternative supply voltage or frequency is at minimum acceptable values.
   f. Temperature rise.
   g. Dielectric voltage-withstand; before and after short-circuit test.
   h. Overload.
   i. Contact opening.
   j. Endurance.
   k. Short circuit.
   l. Short-time current capability.
   m. Receptacle withstand capability.
   n. Insulating base and supports damage.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Floor-Mounting Switch: Anchor to floor by bolting.

1. Install transfer switches on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for seismic control devices specified in Section 260548.16 "Seismic Controls for Electrical Systems."

3. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
4. Provide workspace and clearances required by NFPA 70.

~~B. Annunciator and Control Panel Mounting: Flush in wall unless otherwise indicated.~~

C. Identify components according to Section 260553 "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

E. Comply with NECA 1.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, control, and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.

1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.

D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

F. Connect twisted pair cable according to Section 260523 "Control-Voltage Electrical Power Cables."

G. Connect twisted pair cable according to Section 271513 "Communications Copper Horizontal Cabling."

H. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.

I. Brace and support equipment according to Section 260548.16 "Seismic Controls for Electrical Systems."

J. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 18 inches in length.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing equipment, test for compliance with requirements according to NETA ATS.
2. Visual and Mechanical Inspection:

    a. Compare equipment nameplate data with Drawings and Specifications.
    b. Inspect physical and mechanical condition.
    c. Inspect anchorage, alignment, grounding, and required clearances.
    d. Verify that the unit is clean.
    e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
    f. Verify that manual transfer warnings are attached and visible.
    g. Verify tightness of all control connections.
    h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:

        1) Use of low-resistance ohmmeter.
        2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.

    i. Perform manual transfer operation.
    j. Verify positive mechanical interlocking between normal and alternate sources.
    k. Perform visual and mechanical inspection of surge arresters.
    l. Inspect control power transformers.

        1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
        2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
        3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

    a. Perform insulation-resistance tests on all control wiring with respect to ground.
    b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
    c. Verify settings and operation of control devices.
    d. Calibrate and set all relays and timers.
    e. Verify phase rotation, phasing, and synchronized operation.
    f. Perform automatic transfer tests.
    g. Verify correct operation and timing of the following functions:

1) Normal source voltage-sensing and frequency-sensing relays.
2) Engine start sequence.
3) Time delay on transfer.
4) Alternative source voltage-sensing and frequency-sensing relays.
5) Automatic transfer operation.
6) Interlocks and limit switch function.
7) Time delay and retransfer on normal power restoration.
8) Engine cool-down and shutdown feature.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

   a. Check for electrical continuity of circuits and for short circuits.
   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
   c. Verify that manual transfer warnings are properly placed.
   d. Perform manual transfer operation.

5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.

   a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
   b. Simulate loss of phase-to-ground voltage for each phase of normal source.
   c. Verify time-delay settings.
   d. Verify pickup and dropout voltages by data readout or inspection of control settings.
   e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
   f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
   g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

   a. Verify grounding connections and locations and ratings of sensors.

D. Coordinate tests with tests of generator and run them concurrently.

E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

F. Transfer switches will be considered defective if they do not pass tests and inspections.

G. Remove and replace malfunctioning units and retest as specified above.

H. Prepare test and inspection reports.

I. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
3. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.

B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.

C. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 264113 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 100 General Provisions of the Delaware Department of Transportation "Standard Specifications", dated August 2001 and the Delaware Department of Transportation "Standard Construction Details" dated 2001, including all revisions up to the date of advertisement, apply to this section.

1.2 SUMMARY

A. Section includes lightning protection system for ordinary structures.

~~B. Section includes lightning protection system for the following:~~

~~1. Ordinary structures.~~

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include layouts of the lightning protection system, with details of the components to be used in the installation.
2. Include raceway locations needed for the installation of conductors.
3. Details of air terminals, ground rods, ground rings, conductor supports, splices, and terminations, including concealment requirements.
4. Include roof attachment details, coordinated with roof installation.
5. Calculations required by NFPA 780 for bonding of metal bodies.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Lightning protection system Shop Drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lightning protection cabling attachments to roofing systems and accessories.
2. Lightning protection strike termination device attachment to roofing systems, coordinated with the roofing system manufacturer.
3. Lightning protection system components penetrating roofing and moisture protection systems and system components, coordinated with the roofing system manufacturer.

B. Qualification Data: For Installer.

C. Product Certificates: For each type of roof adhesive for attaching the roof-mounted air terminal assemblies, approved by the roofing-material manufacturer.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For lightning protection system to include in maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:

a. Dimensioned site plan showing dimensioned route of the ground loop conductor and the ground rod locations. Comply with requirements of Section 017839 "Project Record Documents."
b. A system testing and inspection record, listing the results of inspections and ground resistance tests, as recommended by NFPA 780, Annex D.

B. Completion Certificate:

1. UL Master Label Certificate and LPI Master Certificate.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: UL-listed installer, category OWAY or LPI Master Installer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Advanced Lightning Technology, Ltd.
2. East Coast Lightning Equipment Inc.
3. ERICO International Corporation.
4. Heary Bros. Lightning Protection Co. Inc.
5. Independent Protection Co.
6. National Lightning Protection.
7. Thompson Lightning Protection, Inc.

2.2 PERFORMANCE REQUIREMENTS

A. NFPA Lightning Protection Standard: Comply with NFPA 780 requirements for Class I buildings.

B. UL Lightning Protection Standard: Comply with UL 96A requirements for Class I buildings.

C. Lightning Protection Components, Devices, and Accessories: Listed and labeled by a qualified testing agency as complying with UL 96, and marked for intended location and application.

2.3 MATERIALS

A. Air Terminals:

1. Aluminum unless otherwise indicated.
2. 3/8-inch (10-mm) diameter by 15 inches (380 mm) long.
3. Rounded tip.
4. Integral base support.

B. Air Terminal Bracing:

1. Aluminum.
2. 1/4-inch (6-mm) diameter rod.

C. Class 1 Main Conductors:

1. Aluminum: 98,600 circular mils in diameter.

D. Secondary Conductors:

1. Stranded Copper: 26,240 circular mils in diameter.

E. Ground Loop Conductor: Stranded copper.

F. Ground Rods:

1. Material: Stainless steel.
2. Diameter: 3/4 inch (19 mm).
3. Rods shall be not less than 120 inches (3050 mm) long.

G. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically operated tools, or exothermic welds, approved for use with the class type.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Install conductors with direct paths from air terminals to ground connections. Avoid bends less than 90 degrees and 8 inches (203 mm) in radius and narrow loops.

C. Conceal conductors within normal view from exterior locations at grade within 200 feet (60 m) of building. Comply with requirements for concealed installations in UL 96A and concealed systems in NFPA 780.

1. Roof penetrations required for down conductors and connections to structural-steel framework shall be made using listed through-roof fitting and connector assemblies with solid rods and appropriate roof flashings. Use materials approved by the roofing manufacturer for the purpose. Conform to the methods and materials required at roofing penetrations of the lightning protection components to ensure compatibility with the roofing specifications and warranty.
2. Install conduit where necessary to comply with conductor concealment requirements.
3. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

D. Ground Ring Electrode: The conductor shall be not less than the main-size lightning conductor.

3.2 CONNECTIONS

A. Aboveground concealed connections, and connections in earth or concrete, shall be done by exothermic welds or by high-compression fittings listed for the purpose.

B. Aboveground exposed connections shall be done using the following types of connectors, listed and labeled for the purpose: high compression.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.3 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:

1. Perform inspections as required to obtain a UL Master Label for system.
2. ~~Perform inspections to obtain an LPI certification.~~

B. Prepare test and inspection reports and certificates.

END OF SECTION 264113

SECTION 323119 – ALUMINUM LOUVER FENCES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Aluminum Fixed Louver Fences.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fencing and gates.

1. Include plans, elevations, sections, and attachment details.

C. Samples: For each fence material and for each color specified.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Product test reports.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Wind Loading: Comply with ASCE/SEI 7 requirements for fence height, wind exposure, design wind speed, and design wind pressure.

B. Lightning-Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

2.2 ALUMINUM FIXED LOUVER FENCES

A. Aluminum Fixed Louver Fences: Fences made from aluminum extrusions.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Fence Company.
b. Ametco Manufacturing Corporation.
c. Industrial Louvers Inc.

B. Posts: Square extruded tubes. 4 by 4 inches.

C. Fixed Louver Blades: Extruded tubular aluminum louver blades, inclined at 45 degrees, and spaced at 3.4 inches to provide 80 percent direct visual screening. Size: 1/2 by 4 inches. Material thickness: 0.09 inches. Panel sizes: As indicated on the Drawings.

D. Fasteners: Manufacturer's standard corrosion-resistant, color-coated fasteners matching fence components.

E. Fabrication: Assemble fences into sections by fastening panels to rails.

F. Finish: Baked enamel or powder coating.

2.3 ALUMINUM

A. Extrusions: ASTM B 221, Alloy 6063-T5.

B. Tubing: ASTM B 429/B 429M, Alloy 6063-T6.

C. Castings: ASTM B 26/B 26M, Alloy A356.0-T6.

2.4 STEEL AND IRON

A. Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Bars (Pickets): Hot-rolled, carbon steel complying with ASTM A 29/A 29M, Grade 1010.

C. Tubing: ASTM A 500/A 500M, cold-formed steel tubing.

D. Bar Grating: NAAMM MBG 531.

E. Uncoated Steel Sheet: Cold-rolled steel sheet, ASTM A 1008/A 1008M, Structural Steel, Grade 50.

F. Galvanized-Steel Sheet: ASTM A 653/A 653M, structural quality, Grade 50, with G90 coating.

G. Aluminum-Zinc, Alloy-Coated Steel Sheet: ASTM A 792/A 792M, structural quality, Grade 50, with AZ60 coating.

2.5 COATING MATERIALS

A. Epoxy Zinc-Rich Primer for Uncoated Steel: Complying with MPI #20 and compatible with coating specified to be applied over it.

B. Epoxy Primer for Galvanized Steel: Epoxy primer recommended in writing by topcoat manufacturer.

C. Intermediate Coat for Uncoated Steel: Epoxy or polyurethane intermediate recommended in writing by primer and topcoat manufacturer.

D. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.

2.6 MISCELLANEOUS MATERIALS

A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 033000 "Cast-in-Place Concrete" with a minimum 28-day compressive strength of 3000 psi, 3-inch slump, and 1-inch maximum aggregate size.

2.7 GROUNDING MATERIALS

A. Comply with requirements of Section 260526 "Grounding and Bonding for Electrical Systems."

B. Grounding Conductors: Size as indicated on Drawings. Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.

1. Material above Finished Grade: Copper.
2. Material on or below Finished Grade: Copper.

C. Grounding Connectors and Grounding Rods: Comply with UL 467.

2.8 ALUMINUM FINISHES

A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 2 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

1. Color and Gloss: As selected by Architect from manufacturer's full range.

PART 3 - EXECUTION

3.1 ALUMINUM FIXED LOUVER FENCE INSTALLATION

A. Install fences per manufacturer's written instructions.

B. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times post size and a depth of not less than 24 inches plus 3 inches for each foot or fraction of a foot that fence height exceeds 4 feet.

C. Post Setting: Set posts in concrete with mechanical anchors at indicated spacing into firm, undisturbed soil.

1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
2. Concrete Fill: Place concrete around posts and sleeves and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
3. Posts Set in Concrete: Extend post to within 6 inches of specified excavation depth, but not closer than 3 inches to bottom of concrete.
4. Mechanically Driven Posts: Drive into soil to depth of 36 inches. Protect post top to prevent distortion.
5. Space posts uniformly at 8 feet o.c.

3.2 GROUNDING AND BONDING

A. Comply with Section 260526 "Grounding and Bonding for Electrical Systems."

END OF SECTION 323119