ULTRASUITE® + STRUCTURE

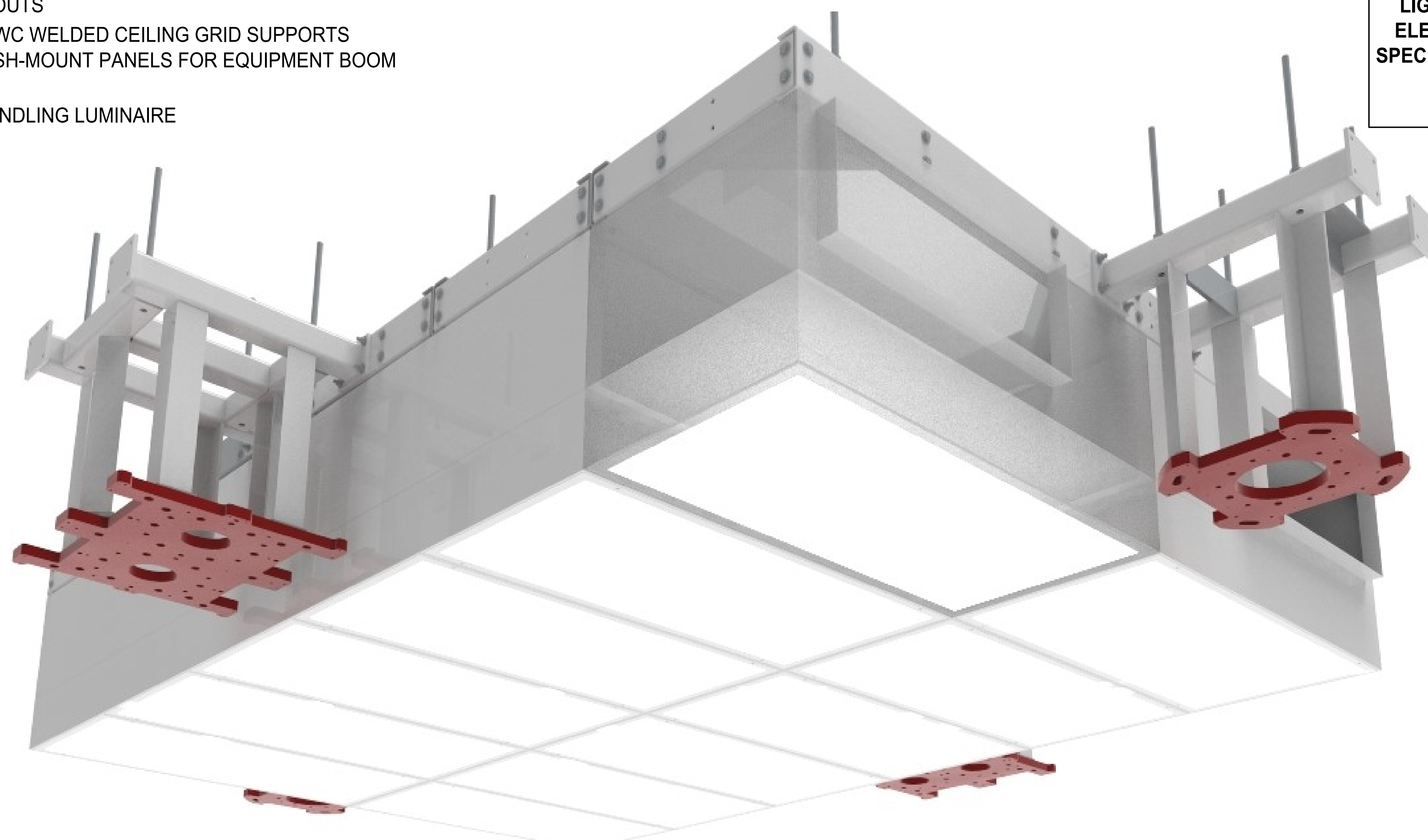
OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

EXAMPLE SYSTEM FOR A TRADITIONAL OR

FEATURES:

- LAMINAR FLOW DIFFUSER ARRAY WITH INTEGRATED HIGH-PERFORMANCE LED LIGHTS INSIDE EACH INDIVIDUAL MODULE AND HSS STRUCTURE FULLY CUSTOMIZABLE TO MATCH THE DEMANDING AND OFTEN CROWDED MODERN HOSPITAL AND CLEANROOM CEILING LAYOUTS
- OPTIONAL PERIMETER HGWC WELDED CEILING GRID SUPPORTS ACCESS PANELS AND FLUSH-MOUNT PANELS FOR EQUIPMENT BOOM INTEGRATION
- UL 1598 CERTIFIED, AIR-HANDLING LUMINAIRE

EXAMPLE SYSTEM		
AIRFLOW	2400	CFM
	20	ACH
LIGHTING & ELECTRICAL SPECIFICATIONS	5000K	COLOUR TEMPERATURE
	95	CRI
	100% TO 1%	DIMMING
	0-10V	
	277	INCOMING VOLTAGE



Intertek

PRICE | CRITICAL ENVIRONMENTS

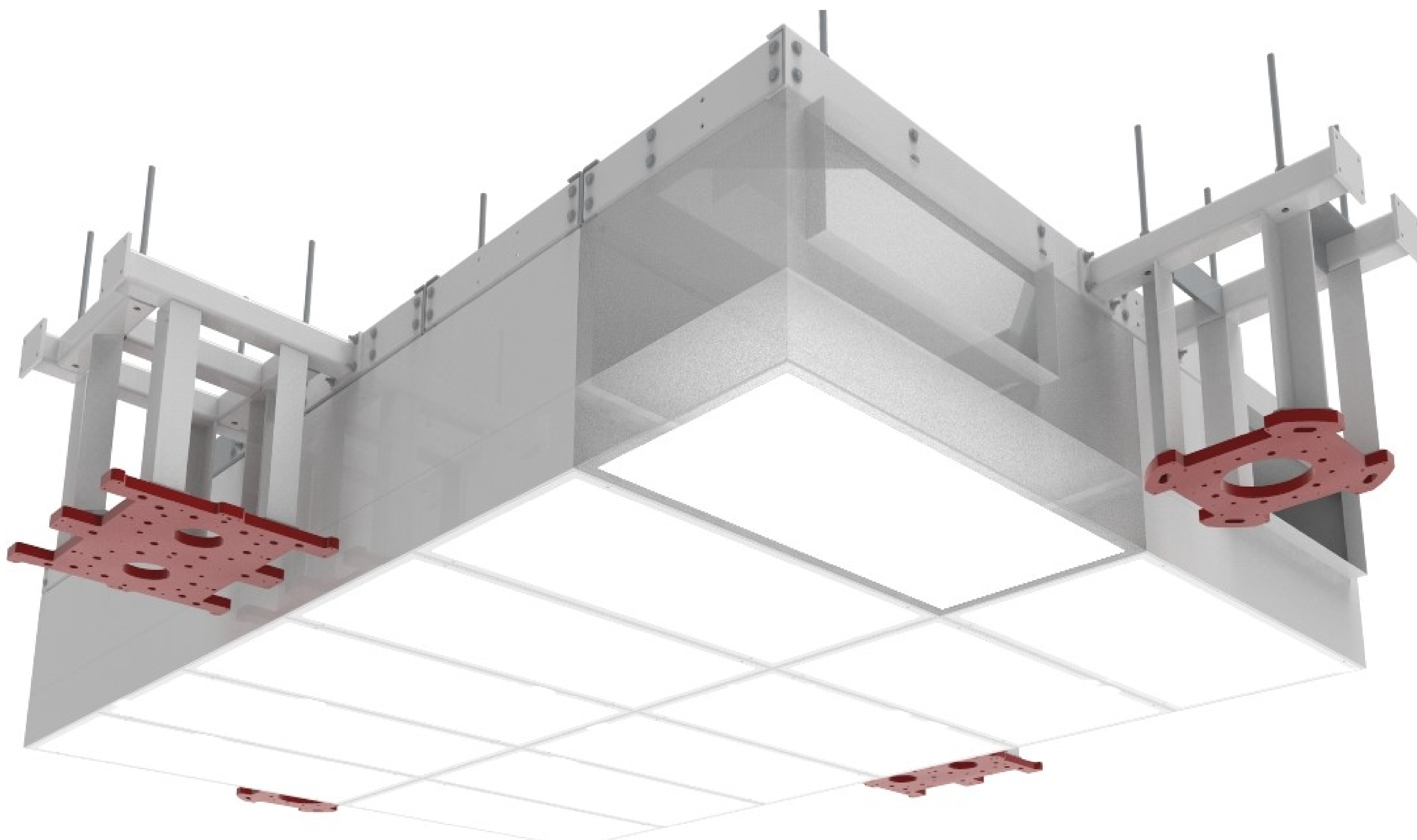
Project:

USASA-2-1	276328	Revision: 3A	05-17-2024

ULTRASUITE® + STRUCTURE 360°

OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

3D INTERACTIVE MODEL - TRADITIONAL OR



ORDER OF INSTALLATION
(CLICK BUTTONS TO TOGGLE VIEWS)

- **ULTRASUITE +STRUCTURE** (View A)
- **ULTRASUITE +STRUCTURE** (View B)
- **ULTRASUITE +STRUCTURE** (View C)
- **HGWC CEILING GRID** (View A)
- **HGWC CEILING GRID** (View B)
- **CP-SCF CEILING PANELS**
- **CP-SC CEILING PANELS**
- **FINAL INSTALLATION**

- USE THE SCROLL WHEEL TO ZOOM
- HOLD DOWN THE LEFT MOUSE BUTTON TO ROTATE
- HOLD DOWN CTRL AND LEFT MOUSE BUTTON TO MOVE

BOOM SUPPORT AND STRUCTURE PROVIDED BY PRICE
BOOM AND BOOM PLATE PROVIDED AND INSTALLED BY OTHERS

CLICK IMAGE TO ACTIVATE 3D PDF

REVIT

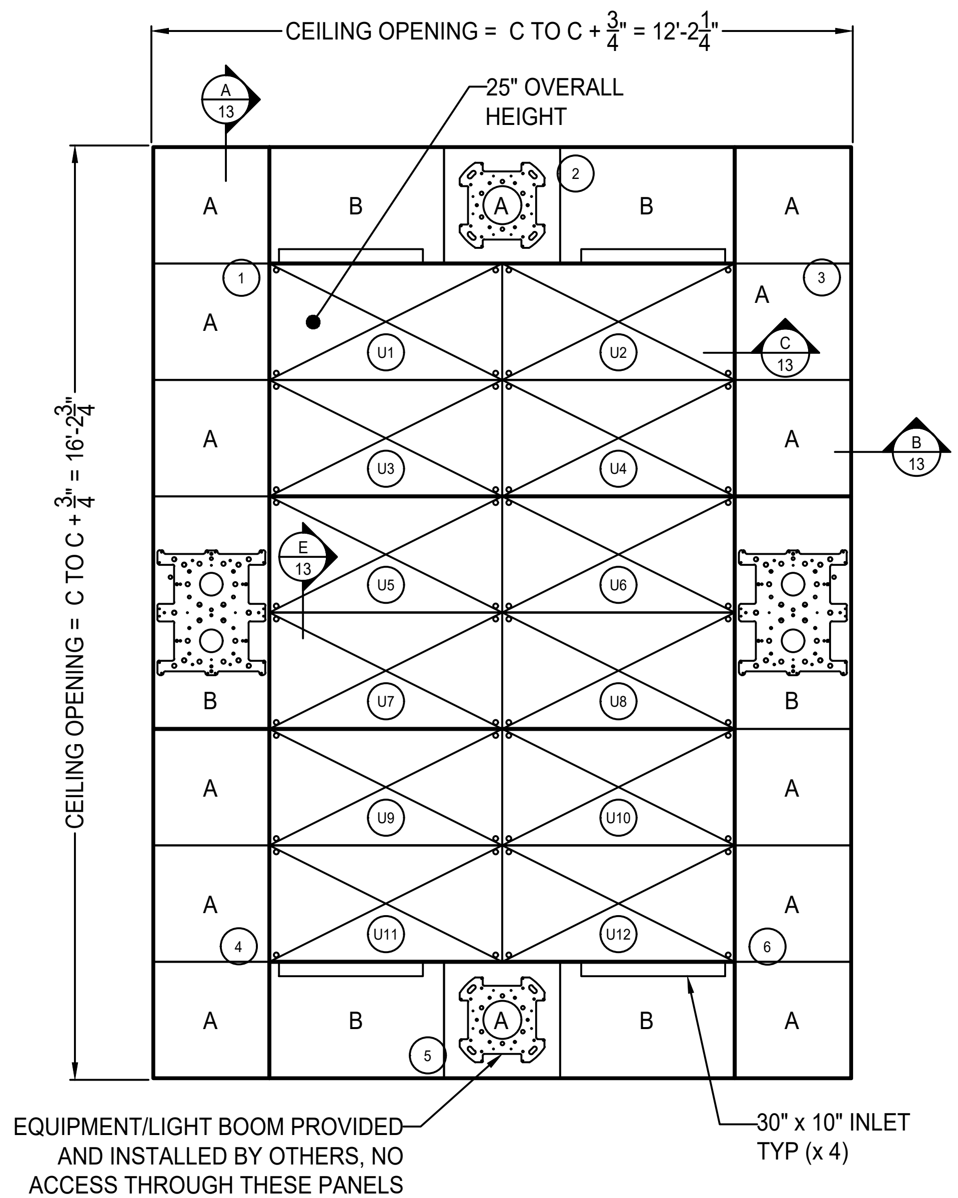
price | CRITICAL ENVIRONMENTS

Project:		
276328	Revision: 3A	05-17-2024

ULTRASUITE® + STRUCTURE

OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

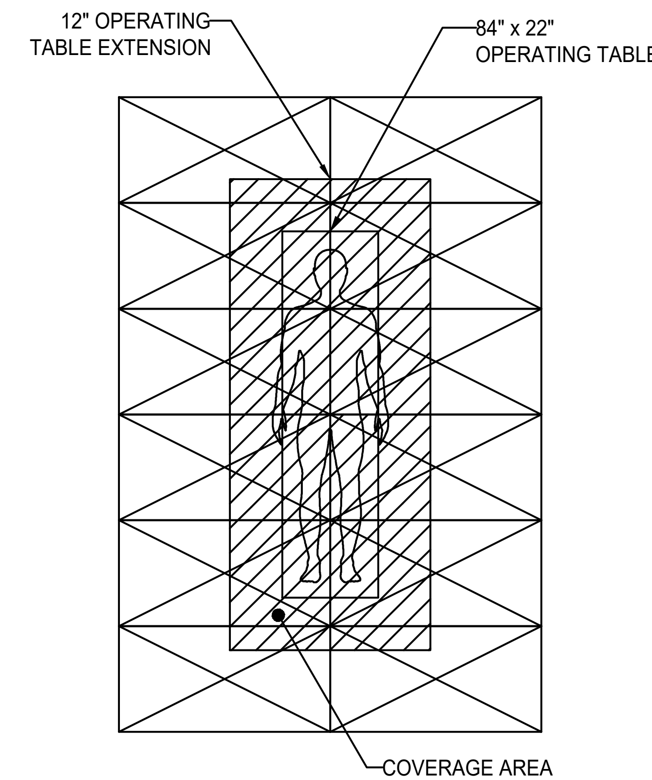
REFLECTED CEILING PLAN - TRADITIONAL OR



USA AREA = 96 sq. ft.	HGWC AREA = 96 sq. ft.

USA - ULTRASUITE MODULES	SCF - SOLID CORE FLUSH MOUNT PANELS	SC - SOLID CORE ACCESS PANELS
24 x 48 (x 12)	A: 24 x 24 (x 12) B: 24 x 36 (x 4)	A: 24 x 24 (x 2) B: 24 x 48 (x 2)

ASHRAE 170-2021 TABLE COVERAGE VERIFICATION - TRADITIONAL OR



THIS LAYOUT COMPLIES WITH ASHRAE 170-2021 7.4.1.b.	
ASHRAE 170-2021 7.4.1.a. COMPLIANCE AIRFLOW RANGE	ASHRAE 170-2021 7.4.1.b. COMPLIANCE
2400 - 3360 CFM BASED ON 96 SQFT	0% OF THE 12" OPERATING TABLE EXTENSION USED FOR NON DIFFUSER USES

ASHRAE 170-2021

7.4.1.a. - THE AIRFLOW SHALL BE UNIDIRECTIONAL, DOWNWARDS, AND THE **AVERAGE VELOCITY OF THE DIFFUSERS SHALL BE 25 TO 35 CFM/SQFT** (127 TO 178 L/S/SQM). THE DIFFUSERS SHALL BE CONCENTRATED TO PROVIDE AN AIRFLOW PATTERN OVER THE PATIENT AND SURGICAL TEAM.

7.4.1.b. - THE COVERAGE AREA OF THE PRIMARY SUPPLY DIFFUSER ARRAY SHALL EXTEND A MINIMUM OF 12 IN. (305 mm) BEYOND THE FOOTPRINT OF THE SURGICAL TABLE ON EACH SIDE. WITHIN THE PORTION OF THE PRIMARY SUPPLY DIFFUSER ARRAY THAT CONSISTS **OF AN AREA ENCOMPASSING 12 IN. (305mm) ON EACH SIDE OF THE FOOTPRINT OF THE SURGICAL TABLE, NO MORE THAN 30% OF THIS PORTION OF THE PRIMARY SUPPLY DIFFUSER ARRAY AREA SHALL BE USED FOR NON DIFFUSER USES** SUCH AS LIGHTS, GAS COLUMNS, EQUIPMENT BOOMS, ACCESS PANELS, SPRINKLERS, ETC.

- B12 STANDARD WHITE FINISH
- PANEL CUTOUTS FOR BOOMS DONE IN FIELD BY OTHERS
- THE CEILING IS FACTORY PREMANUFACTURED TO SIZES AND TOLERANCE +/- $\frac{1}{16}$"
- SITE ADJUSTMENTS TO PERIMETER SOFFITS AND/OR DRYWALL MAY BE REQUIRED AND ARE THE RESPONSIBILITY OF THE INSTALLER
- ASHRAE 170 VERIFICATION IS SHOWN TO ASSIST IN PROJECT COORDINATION. FINAL ASHRAE 170 COMPLIANCE, AS WELL AS COMPLIANCE WITH ALL APPLICABLE LOCAL CODES AND REQUIREMENTS REMAINS THE RESPONSIBILITY OF THE EOR OR INSTALLER ON THE PROJECT

price | CRITICAL ENVIRONMENTS

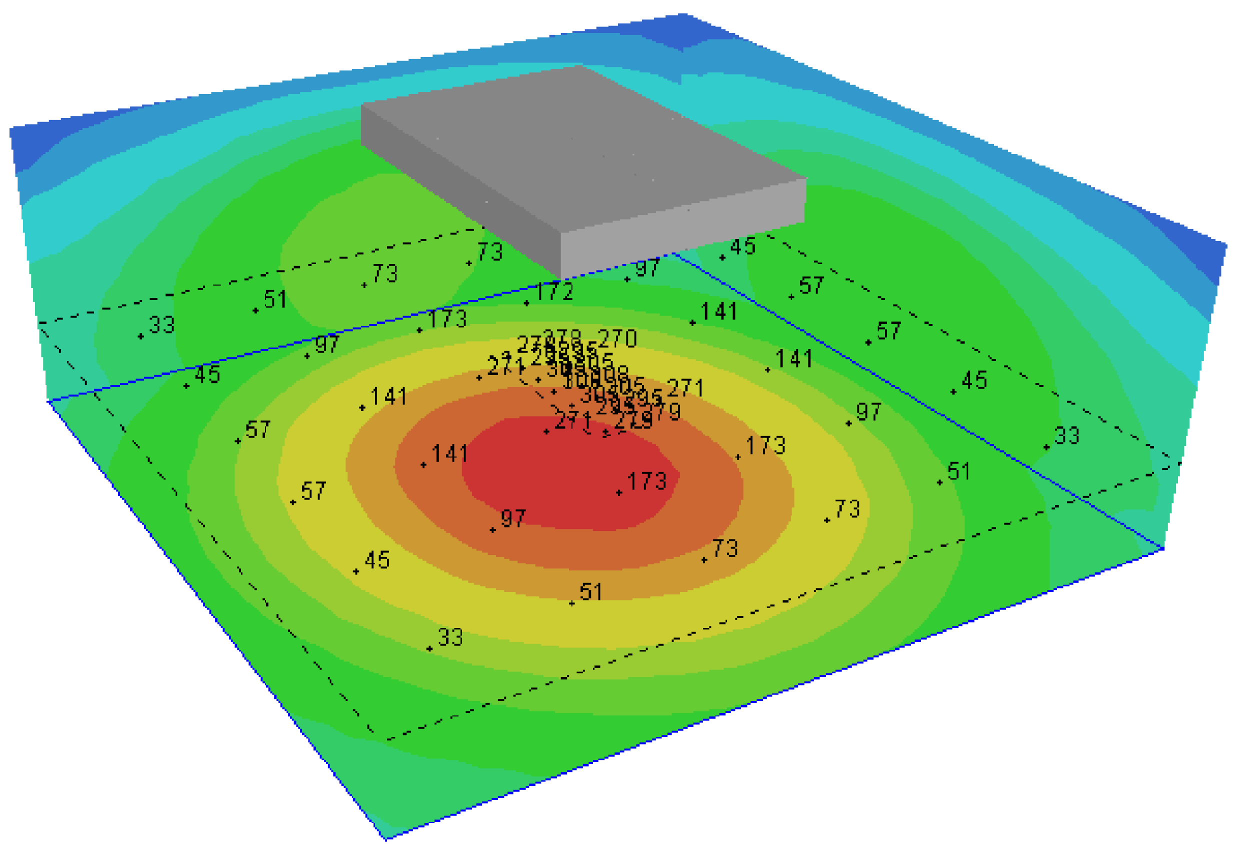
Project:

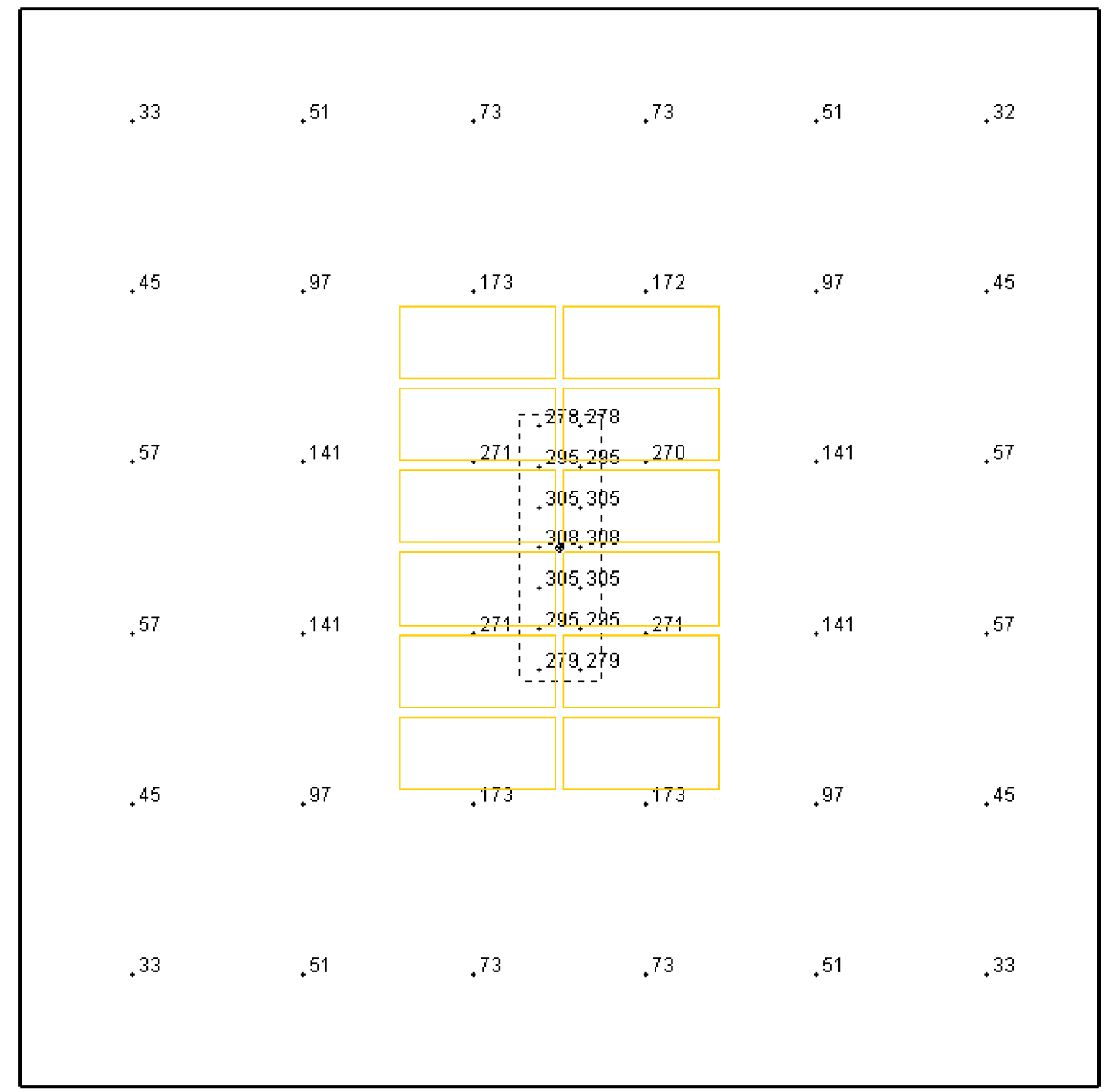
USASA-2-1	276328	Revision: 3A	05-17-2024

ULTRASUITE® + STRUCTURE

OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

PHOTOMETRIC ANALYSIS - TRADITIONAL OR





OPERATING TABLE		OPERATING AREA	
MAXIMUM	308 fc	MAXIMUM	271 fc
AVERAGE	295 fc	AVERAGE	104 fc

LUMINAIRE HEIGHT: 10 FT
CALCULATION ZONE: 3 FT

price | CRITICAL ENVIRONMENTS

Project:

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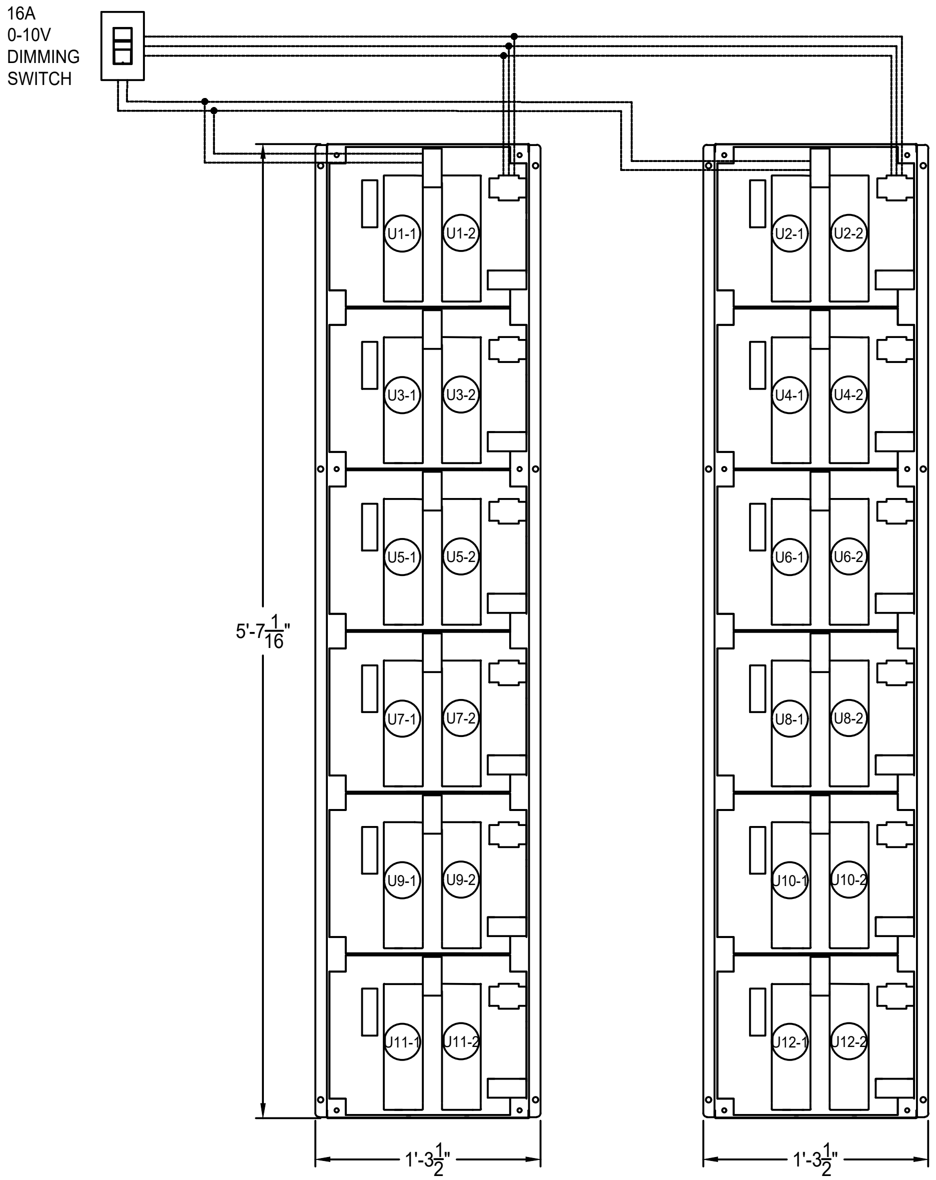
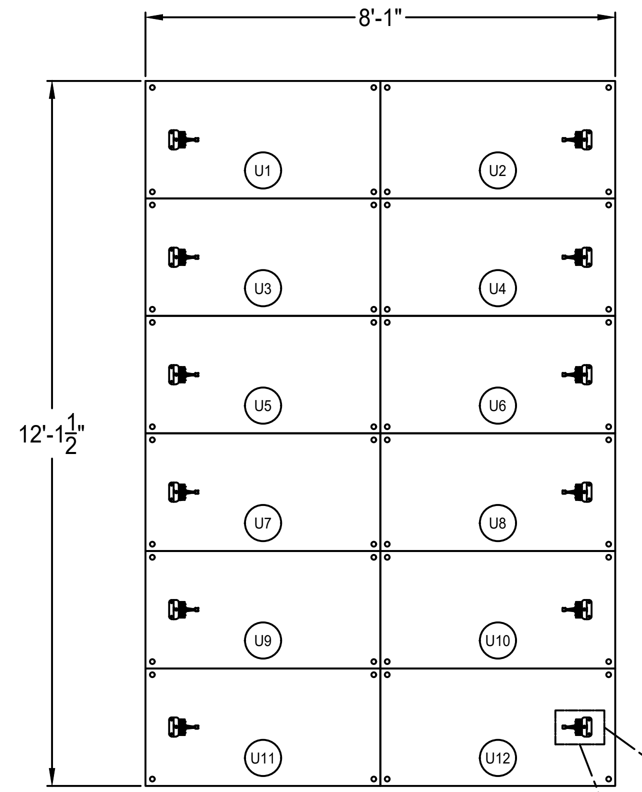
- PHOTOMETRIC ANALYSIS BASED ON A 3' CALCULATION ZONE, 720 ROOM SQFT & 10' CEILING HEIGHT.
- ANSI/IES RP-29-16 RECOMMENDS 3000 LUX (279 FC) AT THE OPERATING TABLE
- THE CALCULATED VALUES REFLECT ADDITIONAL SPACE LIGHTING BY OTHERS.
- LIGHTING ANALYSIS HAS BEEN PERFORMED USING THIRD PARTY LAB TESTED .IES FILES.
- THIS LAYOUT REFLECTS TWO ROWS OF 5000K, 90+ CRI LEDS PER MODULE. A THIRD ROW, HIGH OUTPUT OPTION IS AVAILABLE.
- LIGHTING CALCULATIONS ARE ESTIMATED USING BEST PRACTICE AND MAY DIFFER SLIGHTLY FROM ACTUAL FIELD CONDITIONS.

ULTRASUITE® + STRUCTURE

OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

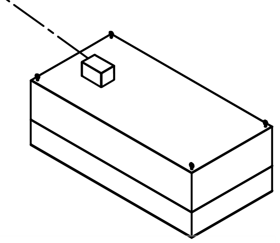
○ URDC ULTRA REMOTE DRIVER CABINETS - SINGLE DIMMING ZONE (100 TO 1% DIMMING) - TRADITIONAL OR



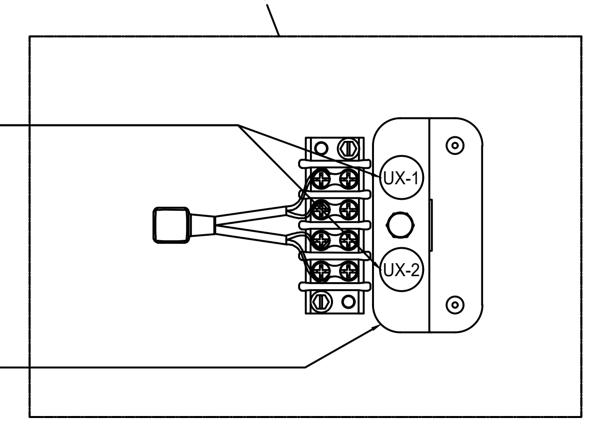


CABINET 1 - 1 OF 2 - CONTROLS 6 MODULES WITH 12 DRIVERS			
DRIVER TAG	LED WATTAGE	DRIVER TAG	LED WATTAGE
U1-1	88	U1-2	88
U3-1	88	U3-2	88
U5-1	88	U5-2	88
U7-1	88	U7-2	88
U9-1	88	U9-2	88
U11-1	88	U11-2	88
TOTAL WATTAGE:		AC CURRENT:	
1056		4.8A/277VAC	

CABINET 2 - 2 OF 2 - CONTROLS 6 MODULES WITH 12 DRIVERS			
DRIVER TAG	LED WATTAGE	DRIVER TAG	LED WATTAGE
U2-1	88	U2-2	88
U4-1	88	U4-2	88
U6-1	88	U6-2	88
U8-1	88	U8-2	88
U10-1	88	U10-2	88
U12-1	88	U12-2	88
TOTAL WATTAGE:		AC CURRENT:	
1056		4.8A/277VAC	



EACH STANDARD MODULE COMES WITH 2 ROWS OF LED LIGHTS AND EACH ROW OF LIGHTS IS NOTED BY A "UX-X" LABEL. THE "UX" CORRESPONDS TO AN INDIVIDUAL MODULE REFERENCED IN THE RCP AND THE "-1" AND "-2" CORRESPONDS TO THE ROW OF LEDS FOR THAT MODULE.
EACH "UX-X" LABEL CORRESPONDS TO ONE (+ & -) LOW VOLTAGE WIRE TO BE FIELD CONNECTED TO URDC DRIVER CABINET AS PER THE MATCHING LABELS.
EACH 100W DRIVER CAN POWER 1 ROW OF LEDS (ONE HALF OF A MODULE) AND EACH 600W DRIVER CAN CONTROL 6 ROWS OF LEDS (3 MODULES)



EACH STANDARD MODULE COMES WITH TWO ROWS OF LEDS THAT EACH REQUIRE ONE (+ & -) LOW VOLTAGE FIELD CONNECTION AND ARE NOTED BY A "UX-X" LABEL.
A THIRD ROW, HIGH OUTPUT OPTION IS AVAILABLE IF REQUIRED.

EACH MODULE COMES WITH A TOP MOUNTED TERMINAL BLOCK ENCLOSURE (COVER NOT SHOWN) FOR LOW VOLTAGE FIELD CONNECTIONS.
QUICK CONNECT FITTING IS SEALED THROUGH PLENUM AND ALL INTERNAL WIRING IS COMPLETED IN THE FACTORY. EACH ROW OF LEDS REQUIRES ONE (+&-) LOW VOLTAGE FIELD CONNECTIONS (TWO PER MODULE)

- INSTALLATION WORK AND ELECTRICAL WIRING MUST BE COMPLETED BY A CERTIFIED ELECTRICIAN AND/OR QUALIFIED PERSON(S) IN ACCORDANCE WITH APPLICABLE ELECTRICAL CODES AND STANDARDS

price | CRITICAL ENVIRONMENTS

Project:

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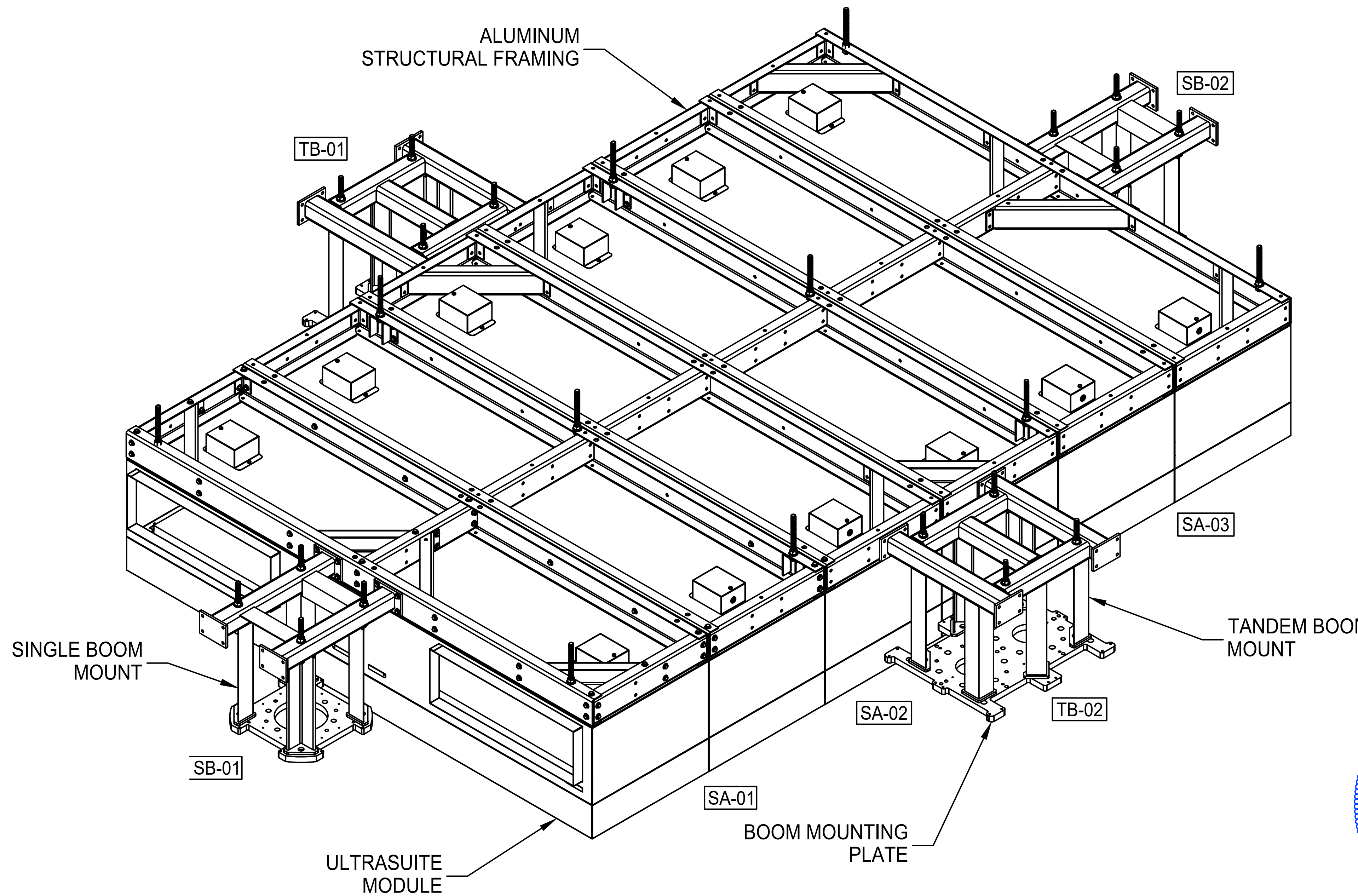
STRUCTURAL DETAILS - PAGE 1 OF 6 - ISOMETRIC VIEW - TRADITIONAL OR



- THE PROJECT ADDRESS IS 20 CRESTRIDGE DRIVE, SUWANNEE, GA 30024.
- THE USASA SUSPENDED FRAME IS DESIGNED FOR THE FOLLOWING CRITERIA:
  - SEISMIC PARAMETERS: I_P = 1.5 S_S = 0.197 S_{DS} = 0.121 S_1 = 0.087
  - SUPERIMPOSED DEAD LOAD: 792 lbs
  - SINGLE BOOM MOUNT LOADS: 1,100 lbf AND 5,650 ft-lbs
  - TANDEM BOOM MOUNT LOADS: 2,200 lbf AND 11,300 ft-lbs
- THE FOLLOWING GRADES OF MATERIAL WILL BE USED IN THE CONSTRUCTION OF THIS SUSPENDED SYSTEM:
  - ULTRASUITE MODULES: ASTM A653 CS TYPE B
  - ALUMINUM COLD FORMED MEMBERS: 5052-H32 ALUMINUM ALLOY
  - STRUCTURAL BOLTS: SAE J429 GR. 5, ZINC-PLATED
  - BOOM MOUNTS
    - HSS BEAMS: ASTM A500 GR. B OR C
    - ROLLED ANGLES: A36 OR EQUIVALENT
    - STRUCTURAL PLATES: A36 OR EQUIVALENT

    (NOTE: BOOM MOUNT PLATES PROVIDED BY OTHERS)
- THREADED ROD HANGERS: 5/8" THREADED ROD (PROVIDED BY OTHERS) (F_{YMIN} = 55KSI)
  (NOTE: ANCHOR TO BUILDING STRUCTURE AND DETAILED DESIGN OF SUSPENSION SYSTEM IS BY OTHERS. REFER TO SUSPENSION LAYOUT PAGE FOR FURTHER DETAILS)
- BOOM MOUNT STRUCTURAL STEEL TO BE PAINTED WITH A CORROSION RESISTANT PAINT SYSTEM.

price | CRITICAL ENVIRONMENTS

Project:

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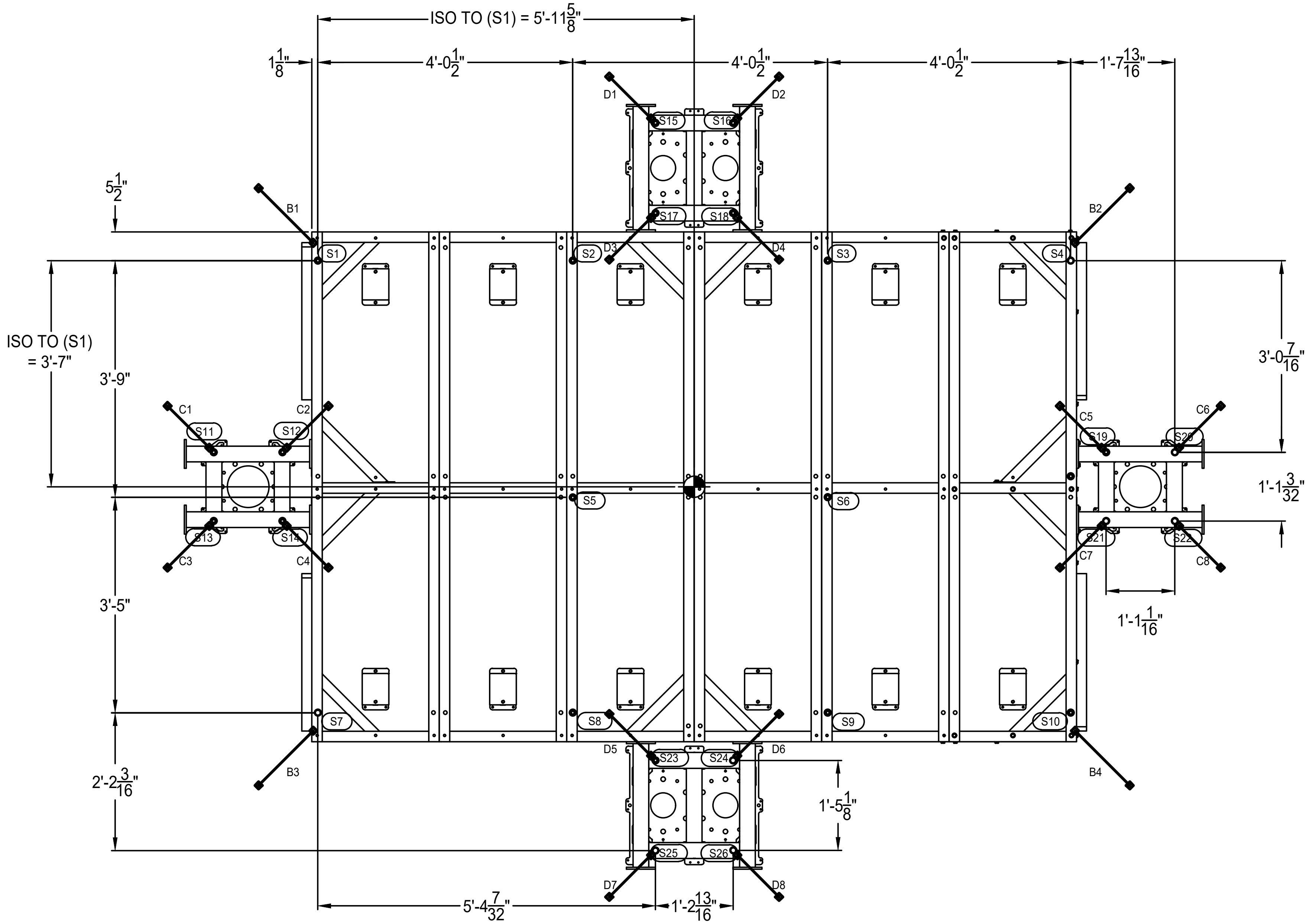
OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

STRUCTURAL DETAILS - PAGE 2 OF 6 - SUSPENSION LAYOUT - TRADITIONAL OR



ANCHORING AND SUSPENSION

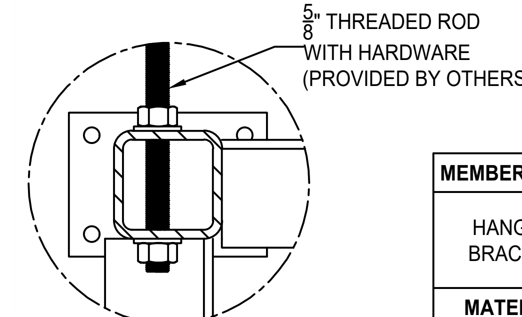
1. DESIGN OF ANCHORAGE TO BUILDING STRUCTURE, INCLUDING DETAILED DESIGN OF HANGERS AND BRACING TO BE CARRIED OUT BY A DESIGN PROFESSIONAL.
2. VERIFYING THE ADEQUACY OF THE MAIN BUILDING STRUCTURE TO RESIST LOADS IMPARTED BY THE SUSPENDED FRAME IS THE RESPONSIBILITY OF OTHERS.
3. THE STRUCTURAL PERFORMANCE OF THE SUSPENDED FRAME HAS BEEN VERIFIED BASED ON A NOMINAL SUSPENDED ANCHORAGE AND BRACING DESCRIBED HERE.
4. PROVIDE STRUCTURAL ATTACHMENTS AND BRACES TO SATISFY THE ASD HANGER AND HANGER BRACE FORCES IN TABLE 1 BELOW.

TABLE 1. MAXIMUM AXIAL FORCES*** [LBF]

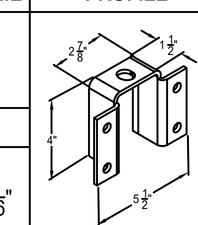
HANGERS	TENSION	COMPRESSION
S1, S4, S5, S6, S7, S10	450	300
S2*, S3*, S8*, S9*	1,100	850
S11-S14	2,550	2,050
S15-S18	4,150	3,150
S19-S22	2,550	2,050
S23-S26	4,150	3,150
HANGER BRACES**	TENSION	COMPRESSION
B1-B4	400	400
C1-C8	350	250
D1-D8	600	400

* SUSPENSION LOCATION REQUIRES HANGER BRACKET REINFORCEMENT (JOB SPECIFIC)
** HANGER BRACE AXIAL FORCES BASED ON 45 DEGREE ANGLE TO HORIZONTAL PLANE
*** FOR ASD LOAD COMBINATIONS PER DESIGN REPORT 2024002-DR01

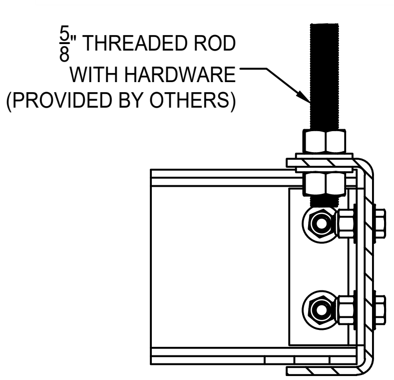
5. HANGERS ARE DESIGNED AS 5/8" GRADE 55 THREADED ROD AND COULD REQUIRE STIFFENING TO ATTAIN SUFFICIENT COMPRESSIVE CAPACITY FOR ROD LENGTHS EXCEEDING 12 INCHES (DESIGN BY OTHERS).
6. DESIGN OF HANGERS AND HANGER BRACES ASSUME UNRESTRAINED ROTATIONS (PINNED CONDITION) SUITABLE FOR EMBEDDING IN CONCRETE; ALTERNATE HANGER/BRACE DESIGN CAN BE EVALUATED UPON REQUEST.



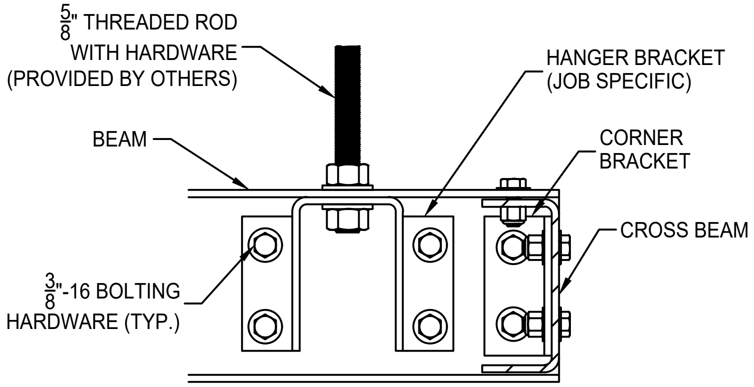
DETAIL A
BOOM MOUNT SUSPENSION
(CLOSE-UP VIEW)

MEMBER NAME	PROFILE
HANGER BRACKET	
MATERIAL	
ALUMINUM 5052-H32 3/16" THICK	

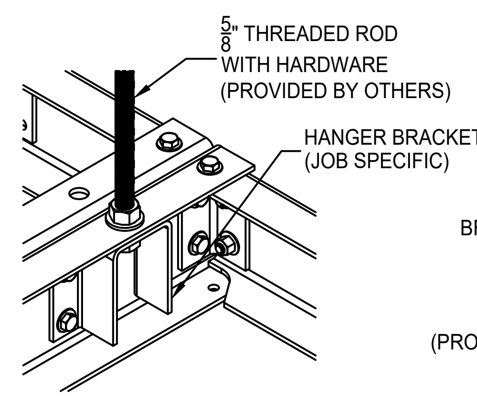
REGISTERED PROFESSIONAL ENGINEER
NAME:________
SAMPLE
DATE:________
STATE/PROVINCE/REGION



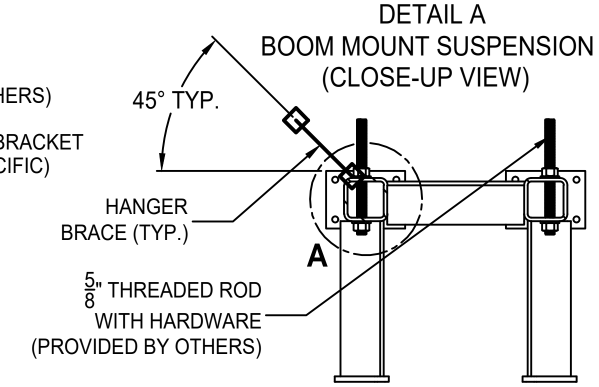
THREADED ROD DETAILS
(STRUCTURAL FRAME)



HANGER BRACKET DETAILS



HANGER BRACKET (ISO VIEW)



THREADED ROD DETAILS
(BOOM MOUNT)

PRICE | CRITICAL ENVIRONMENTS

Project:		
276328	Revision: 3A	05-17-2024

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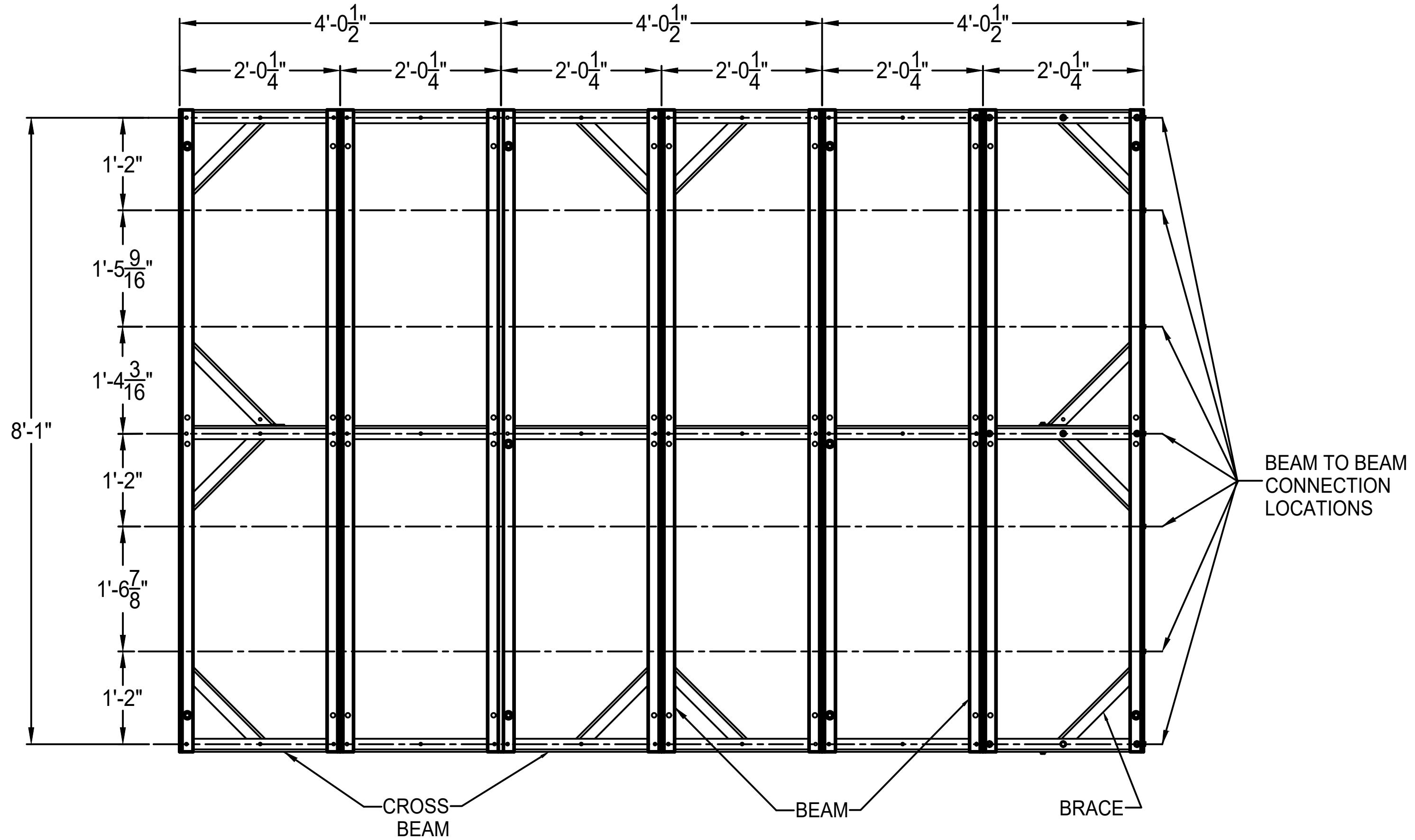
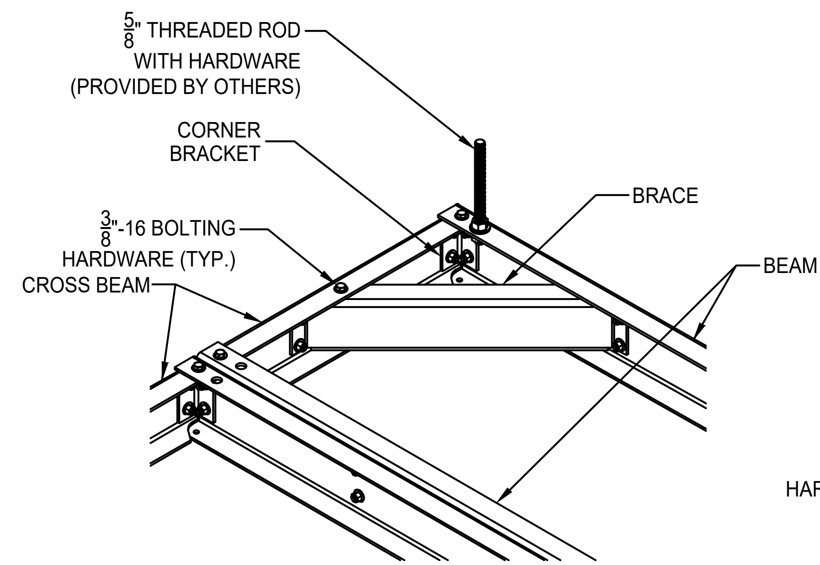
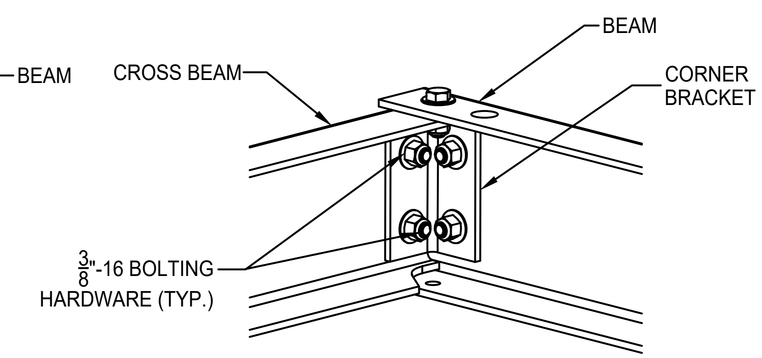
STRUCTURAL DETAILS - PAGE 3 OF 6 - ALUMINUM FRAMING - TRADITIONAL OR

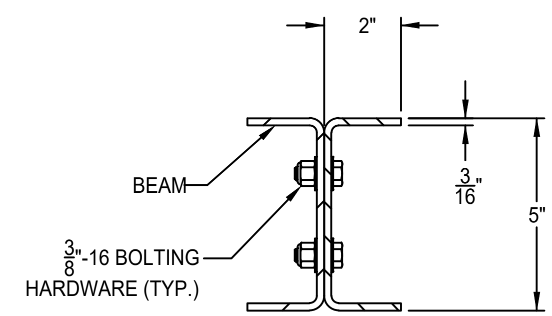




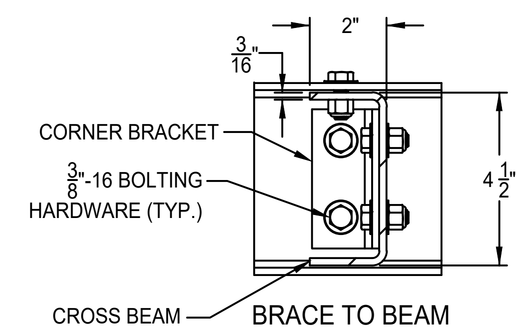
ASSEMBLED FRAMING VIEW



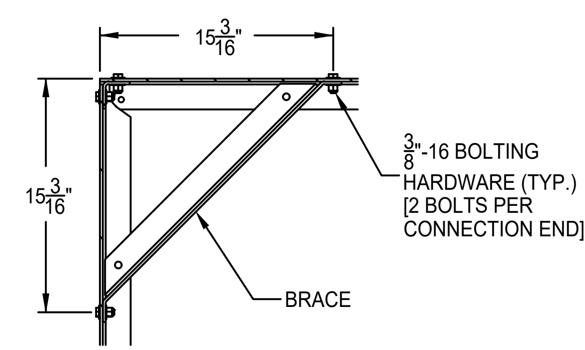
FRAMING CORNER ASSEMBLY DETAILS



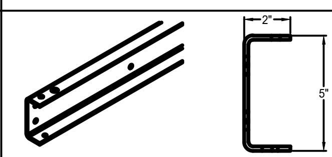
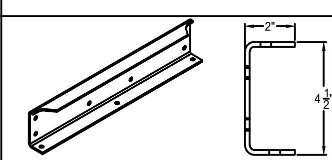
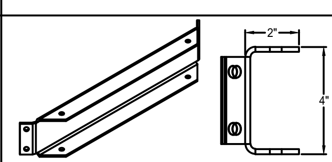
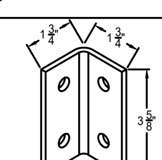
BEAM TO BEAM ASSEMBLY DETAILS

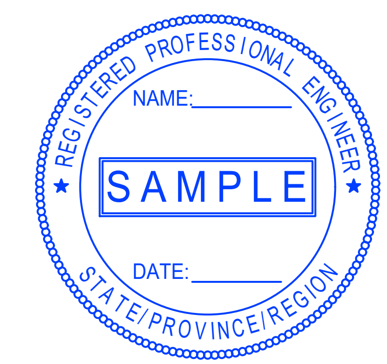


BRACE TO BEAM ASSEMBLY DETAILS - MID SPAN



BRACE TO BEAM AND/OR CROSS BEAM ASSEMBLY DETAILS - TOP VIEW

MEMBER NAME	SHAPE	PROFILE	MATERIAL
BEAM	C5" X 2" X 3/16"		ALUMINUM 5052H32
CROSS BEAM	C4-1/2" X 2" X 3/16"		
BRACE	C4" X 2" X 3/16"		
CORNER BRACKET	L1 3/4" X 1 3/4" X 3/16"		



price | CRITICAL ENVIRONMENTS

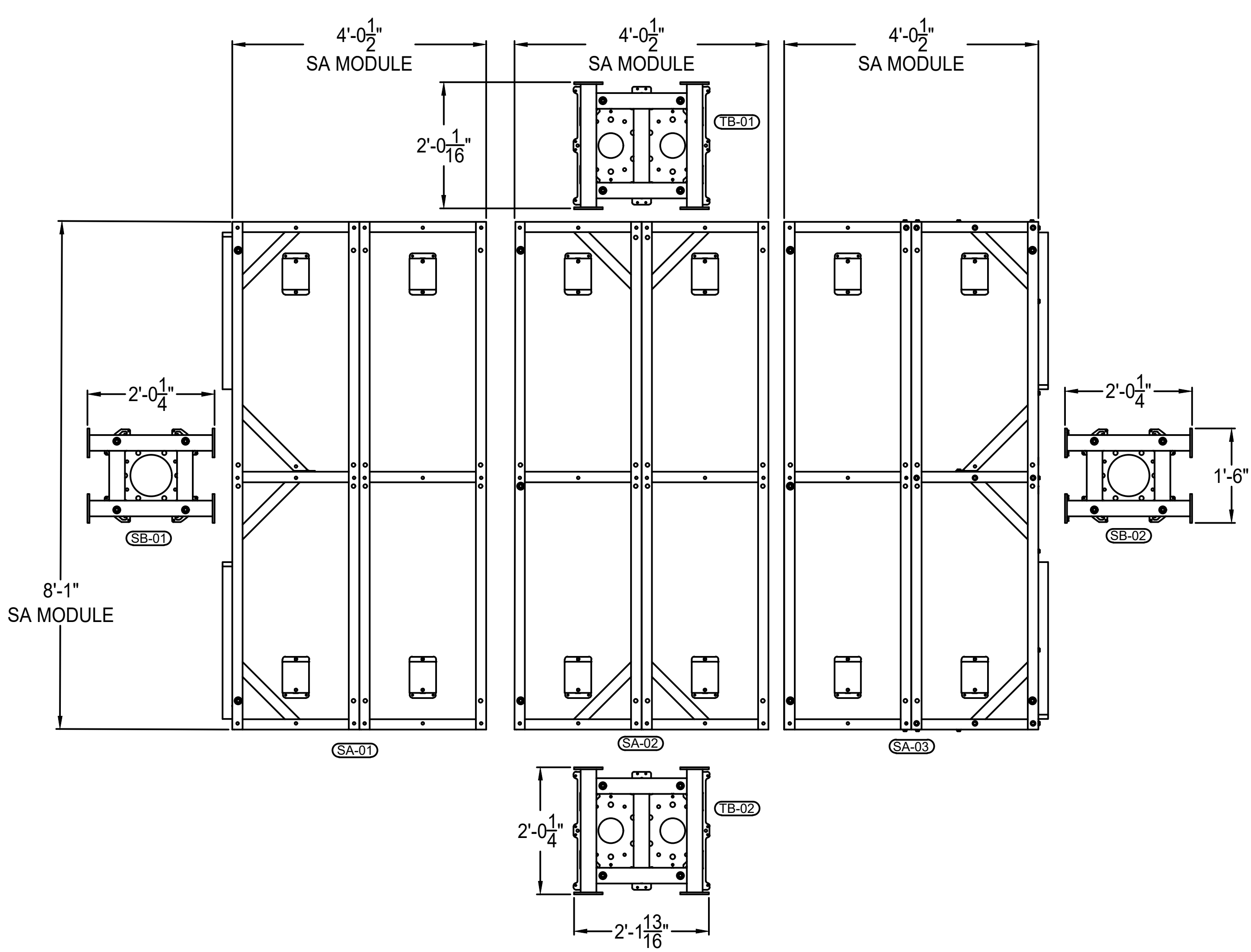
Project:

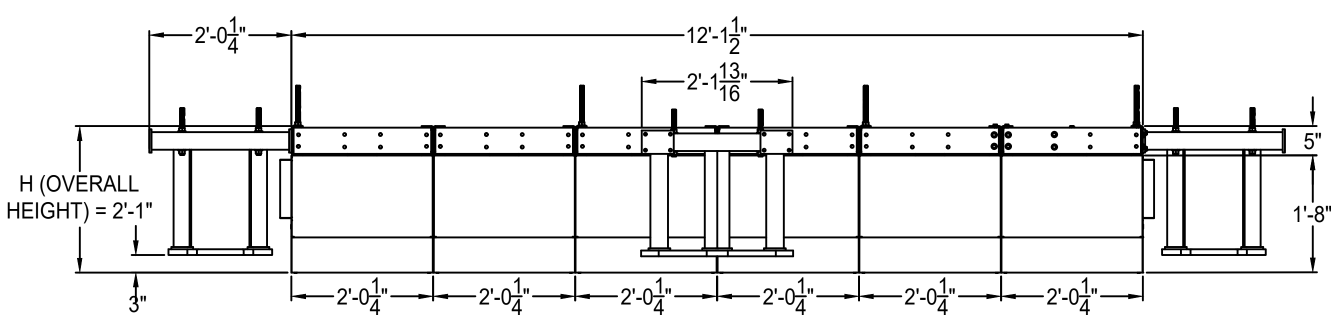
276328	Revision: 3A	05-17-2024

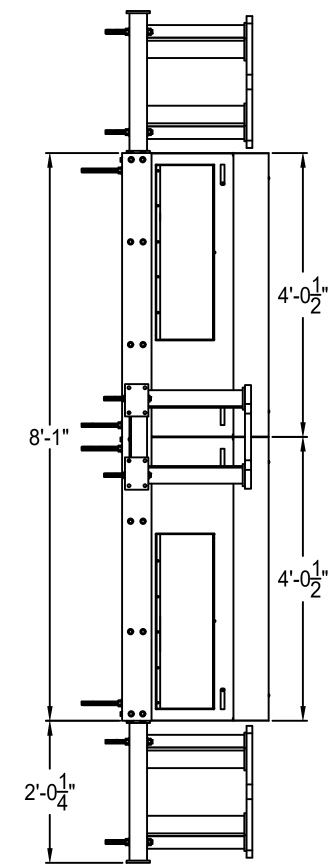
ULTRASUITE® + STRUCTURE

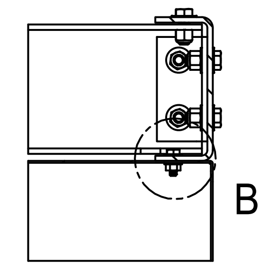
OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

STRUCTURAL DETAILS - PAGE 4 OF 6 - MODULE BREAKDOWN VIEW - TRADITIONAL OR

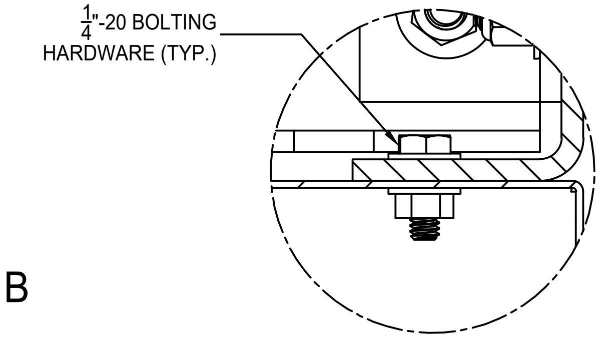




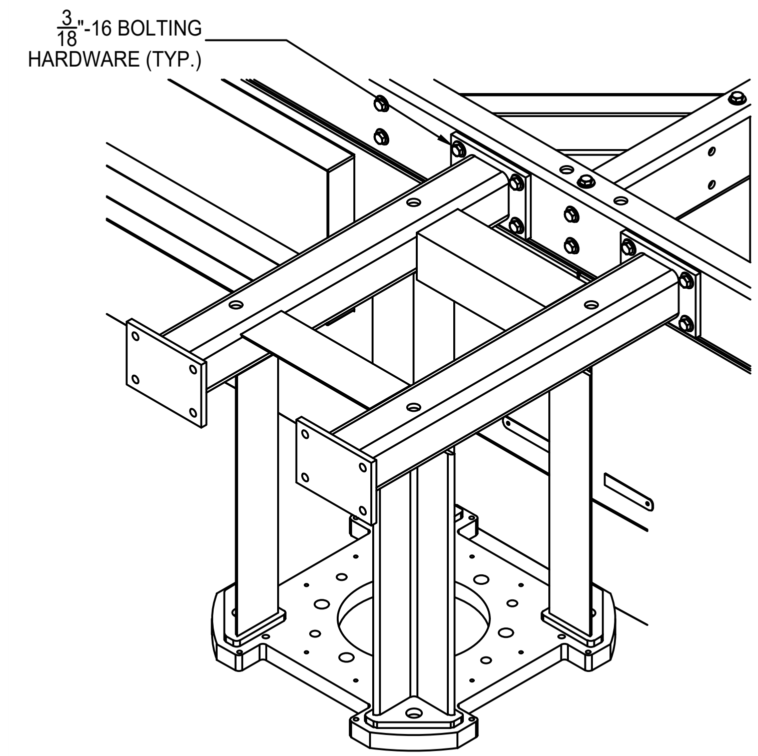




ULTRASUITE MODULE ATTACHMENT
TO STRUCTURAL FRAMING



DETAIL B
ULTRASUITE ATTACHMENT
(CLOSE-UP VIEW)



BOOM MOUNT
ATTACHMENT DETAILS

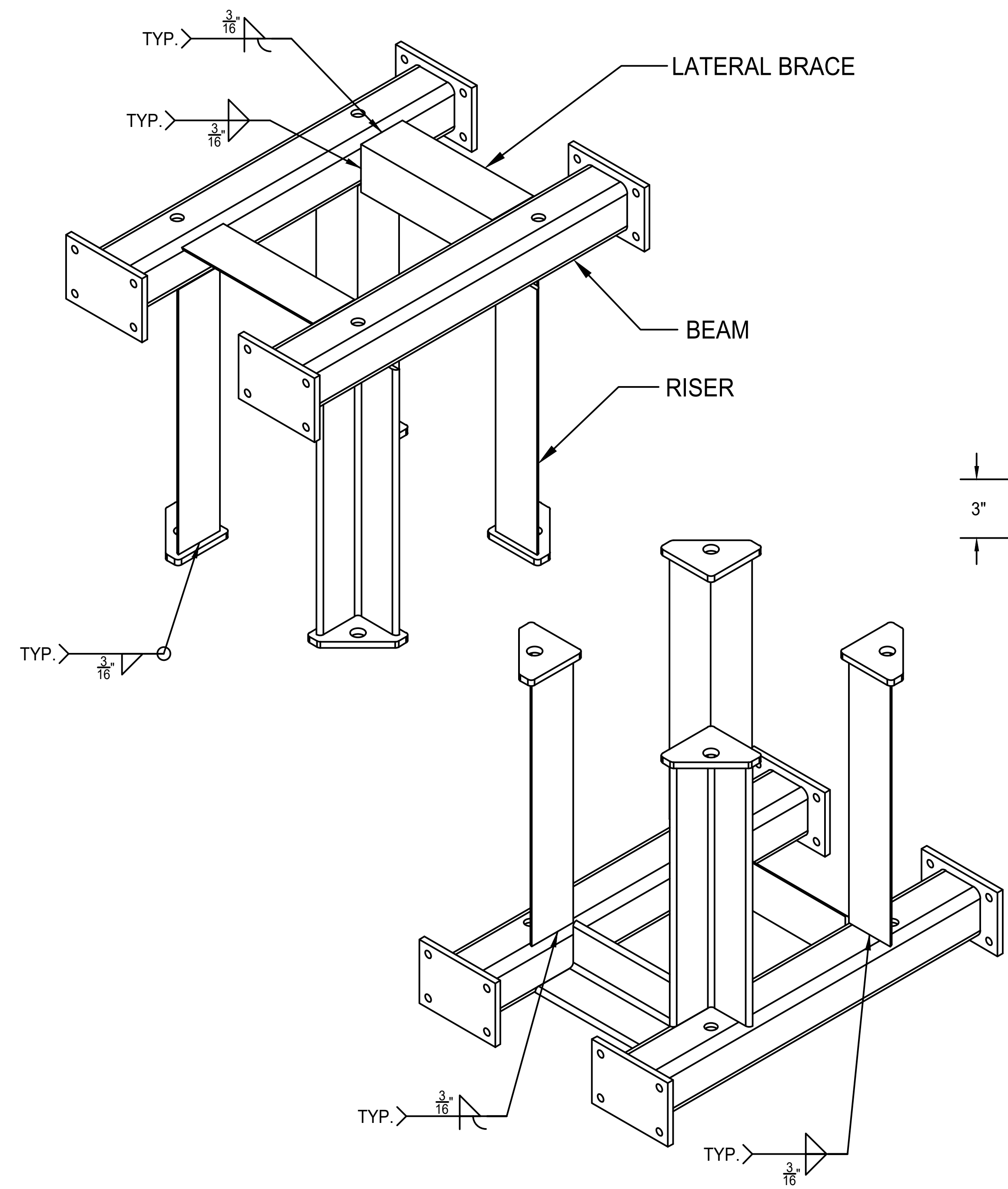
Price | CRITICAL ENVIRONMENTS

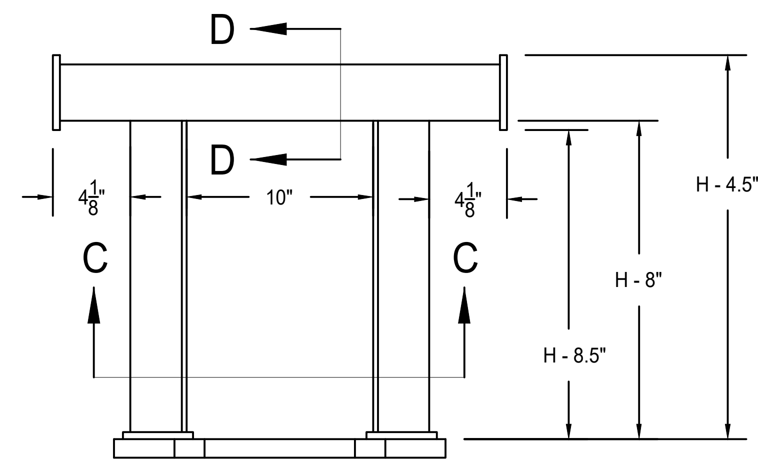
Project:

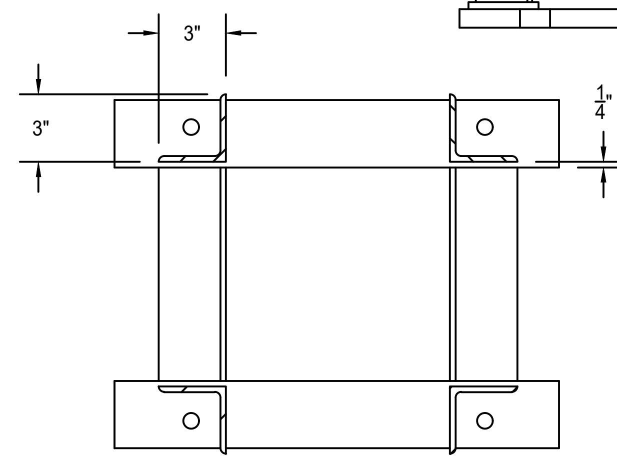
276328	Revision: 3A	05-17-2024

ULTRASUITE® + STRUCTURE

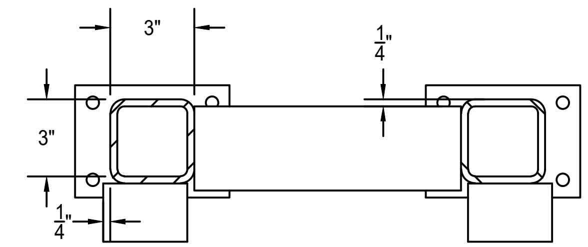
OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT



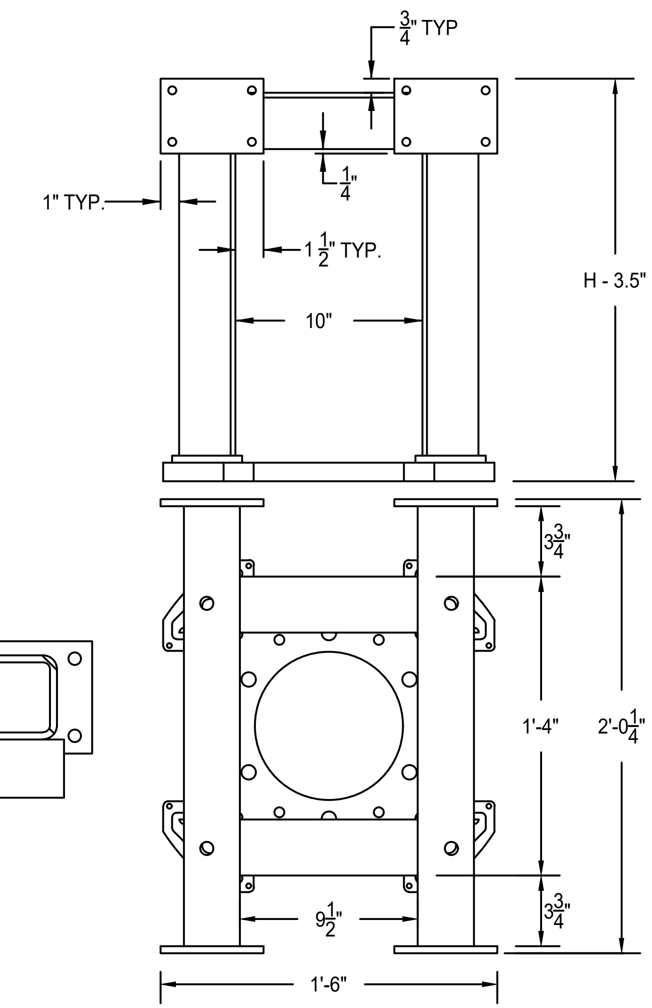


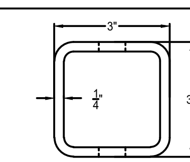
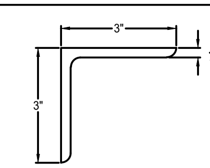


SECTION C-C



SECTION D-D



MEMBER NAME	SHAPE	PROFILE	MATERIAL
BEAM	HSS3" X 3" X 1/4"		ASTM A500 GR. B OR C
LATERAL BRACE AND RISER	L3" X 3" X 1/4"		A36 OR EQUIVALENT

OVERALL HEIGHT = H

price | CRITICAL ENVIRONMENTS

Project:

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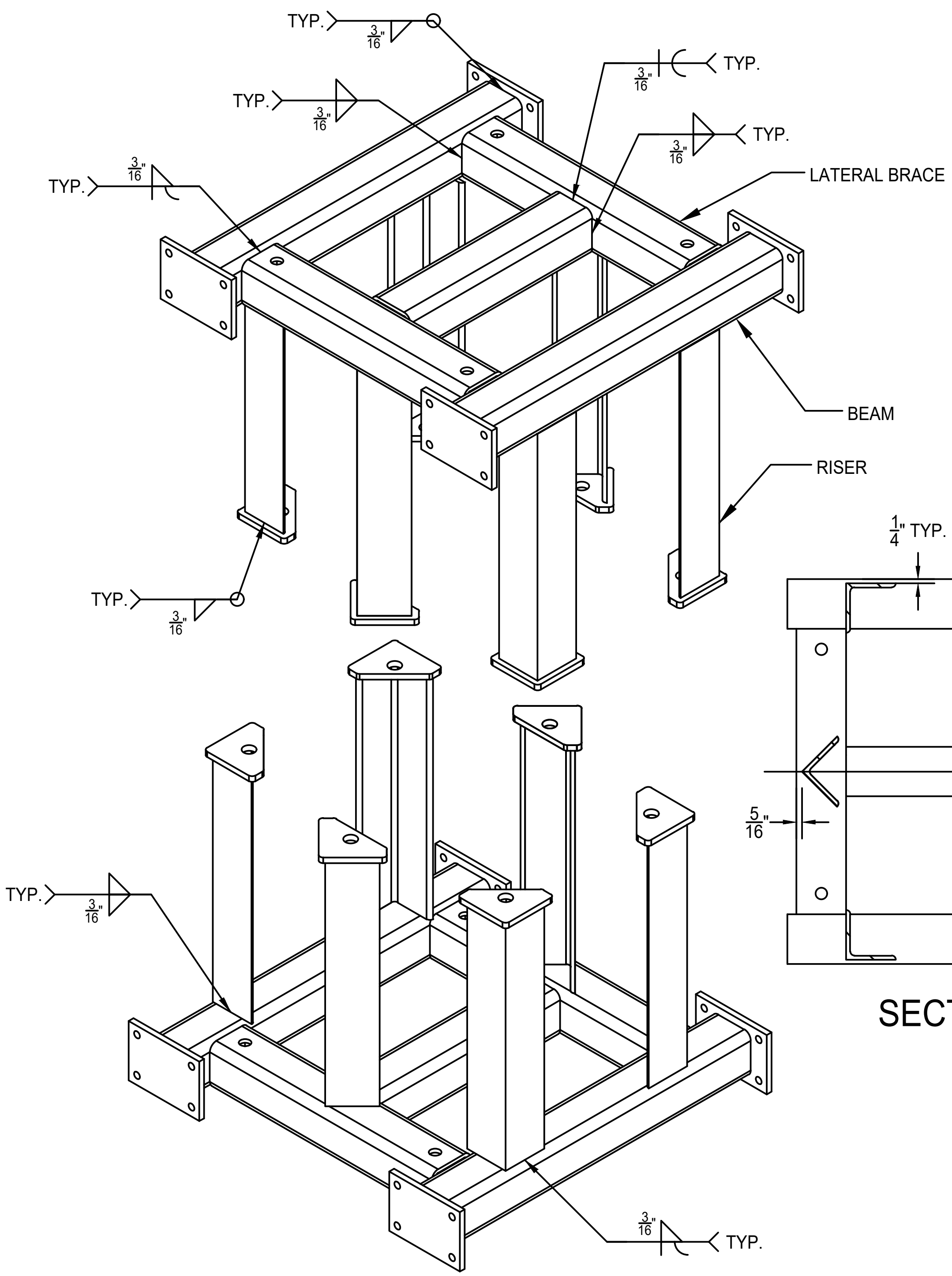
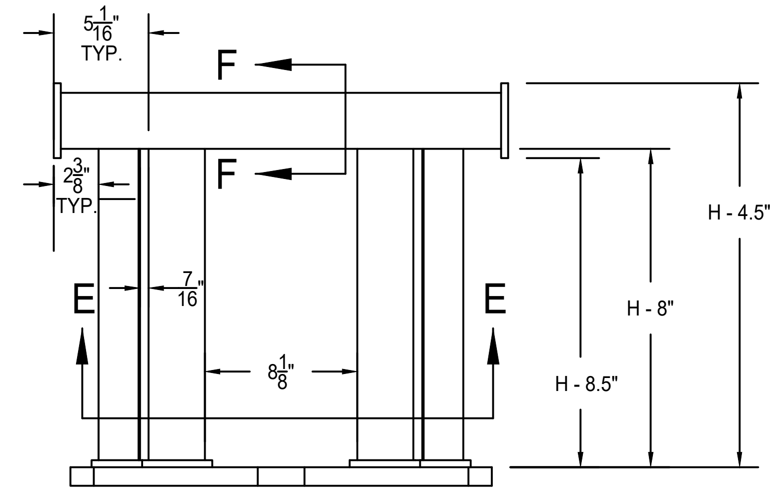
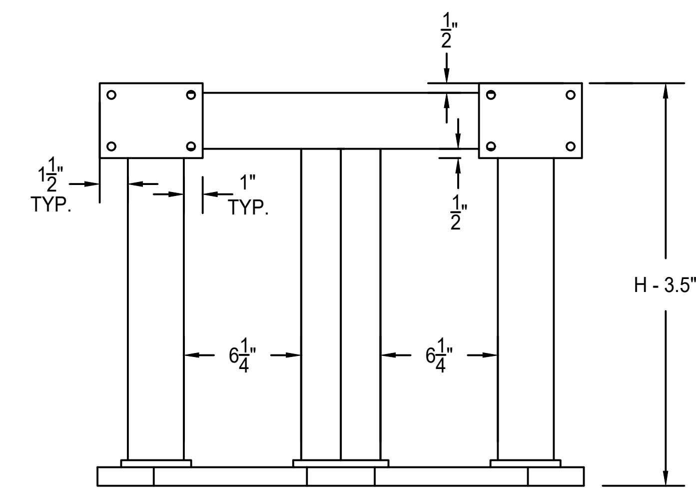
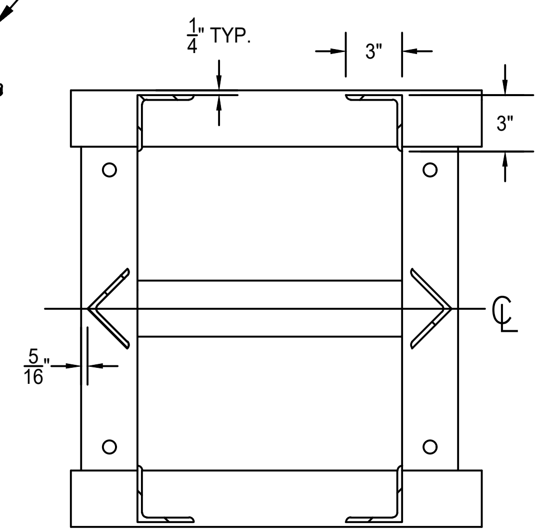
OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

STRUCTURAL DETAILS - PAGE 6 OF 6 - TANDEM BOOM MOUNT DETAILS

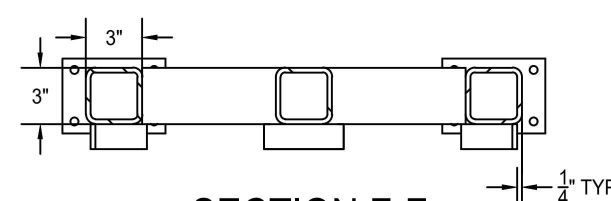




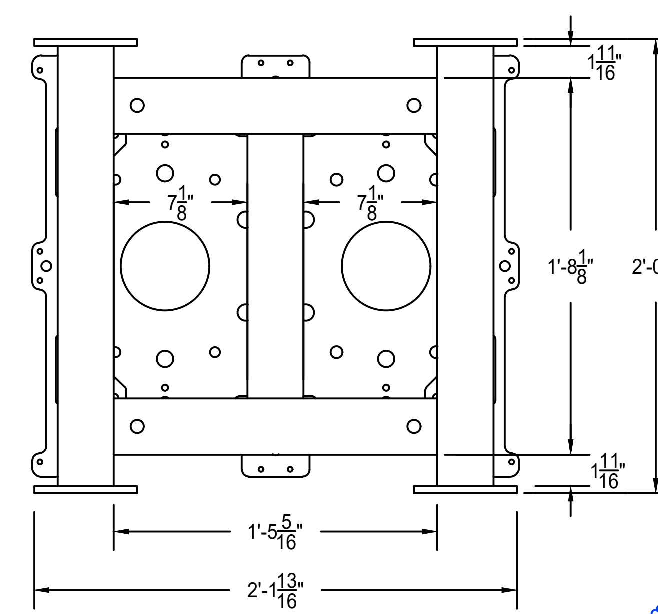




SECTION E-E



SECTION F-F



MEMBER NAME	SHAPE	PROFILE	MATERIAL
BEAM AND LATERAL BRACE	HSS3" X 3" X 1/4"	3" / 3" / 1/4"	ASTM A500 GR. B OR C
RISER	L3" X 3" X 1/4"	3" / 3" / 1/4"	A36 OR EQUIVALENT

OVERALL HEIGHT = H

Price | CRITICAL ENVIRONMENTS

Project:

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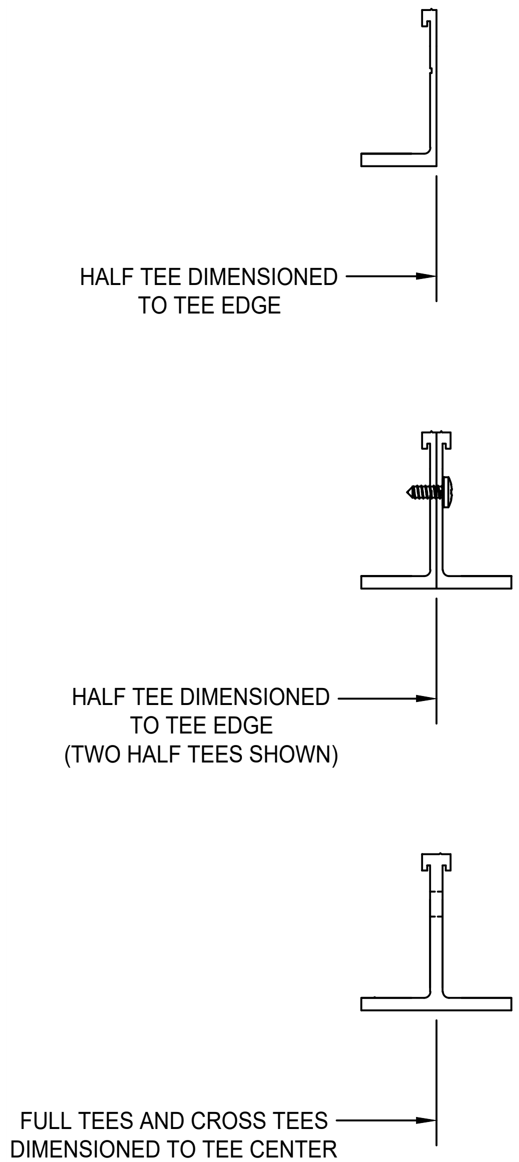
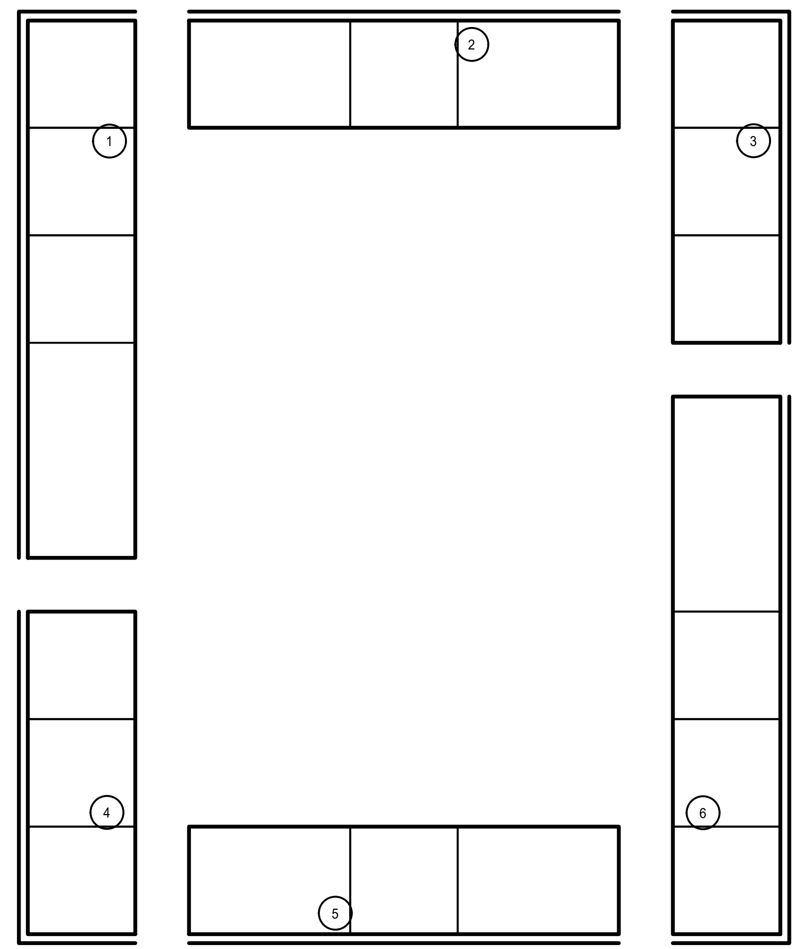
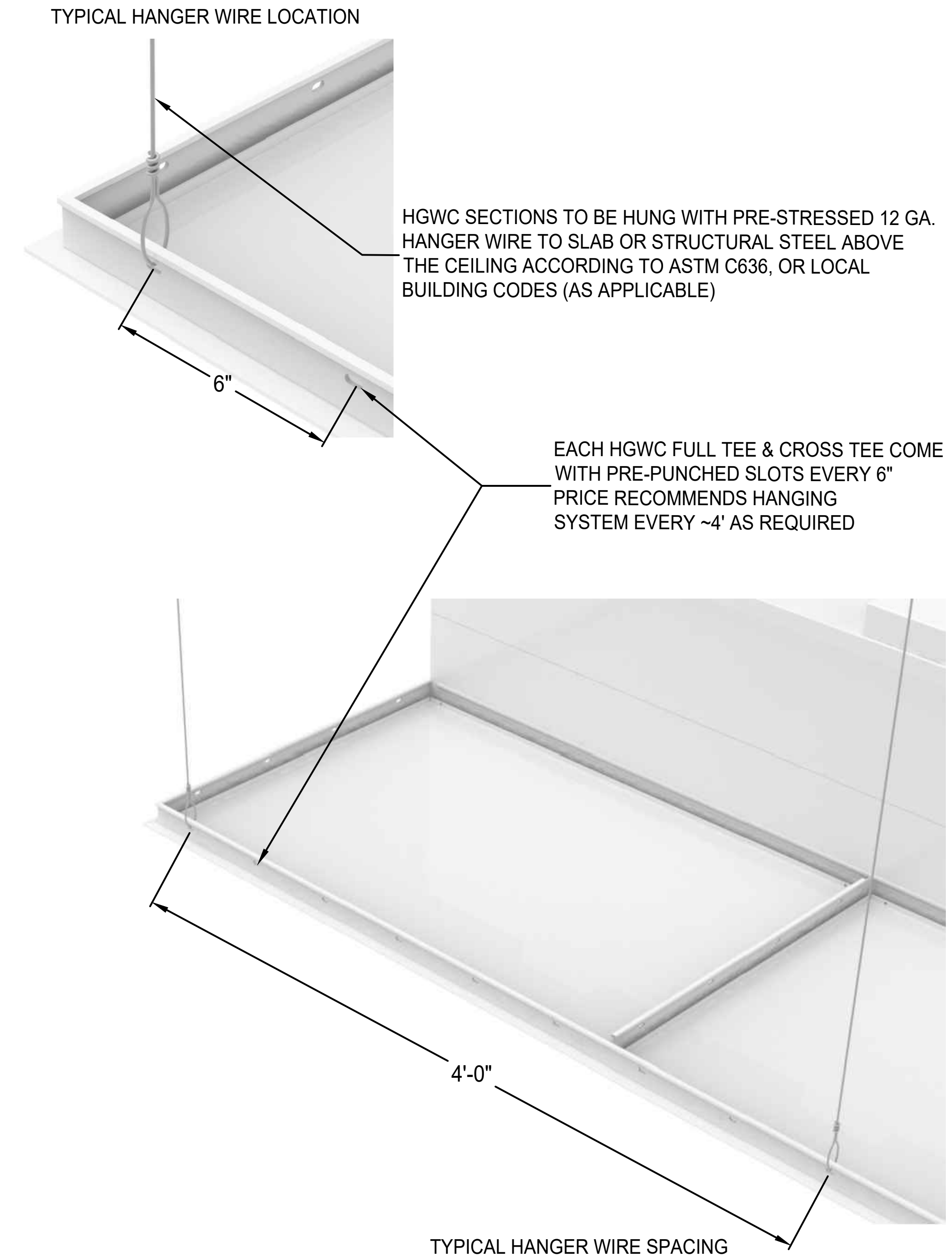
ULTRASUITE® + STRUCTURE

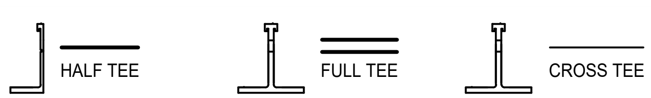
OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

HGWC SHIP SECTION BREAKDOWN & HANGING DETAILS - TRADITIONAL OR









- THE HGWC GRID IS SUPPLIED IN MULTIPLE FACTORY ASSEMBLED SECTIONS NO LARGER THAN 10'x4'
- THE CEILING IS FACTORY PRE-MANUFACTURED TO SIZES AND TOLERANCE +/- $\frac{1}{16}$"

PRICE | CRITICAL ENVIRONMENTS

Project:		
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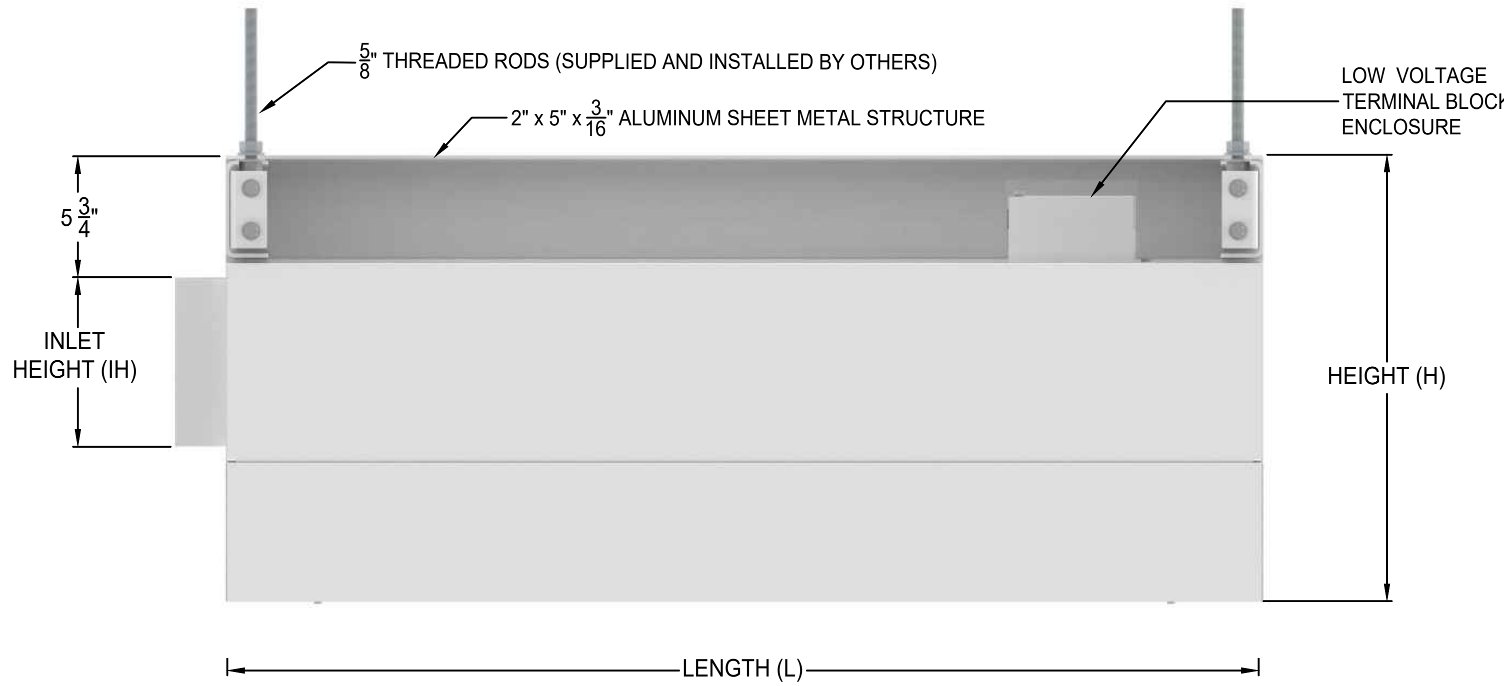
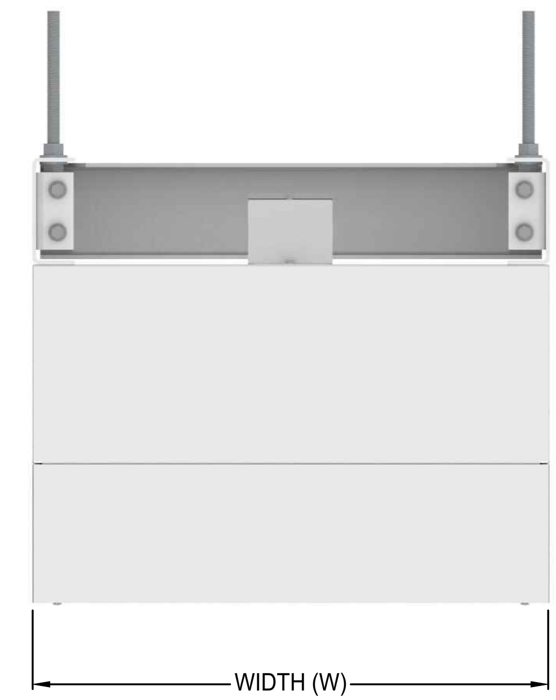
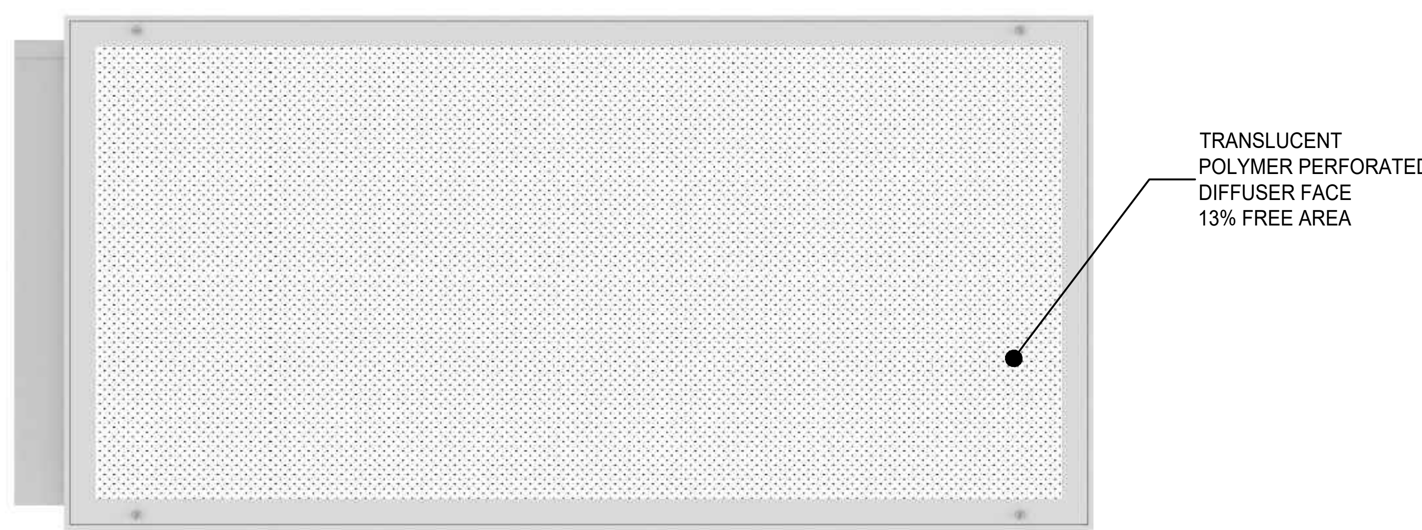
ULTRASUITE® + STRUCTURE

OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT







STANDARD CONSTRUCTION

- 14 GA (.064" THICK) ALUMINUM PLENUM
- EXTRUDED ALUMINUM OUTER FRAME AND DIFFUSER FACE FRAME
- 5 GA (.188" THICK) SHEET METAL ALUMINUM STRUCTURE
- ROOM-SIDE ADJUSTABLE APERTURE PLATE DAMPER
- TWO STAINLESS STEEL RETAINER CABLES PER DIFFUSER FACE
- DIFFUSER FACE SECURED WITH $\frac{1}{4}$ TURN FASTENERS

LED LIGHTING SPECIFICATIONS

- LED LIGHTING INTEGRATED INTO EACH DIFFUSER MODULE
- IP67 RATED LED STRIP WITH QUICK CONNECTORS
- COLOR RENDERING INDEX (CRI) 95
- L80>60,000 HRS
- FOR IES PHOTOMETRIC FILES VISIT:
- www.priceindustries.com/criticalenvironments/products/ultrasuite

FINISH

- B12 WHITE
- OPTIONAL AMB12 ANTI-MICROBIAL WHITE

LED COLOR TEMPERATURE

- 5000K (W935)
- OPTIONAL 4000K (W930)

LISTINGS

- **UL 1598/CSA C22.2 #250.0** - AIR-HANDLING LUMINAIRES
- **UL 2043** - FIRE TEST FOR HEAT AND VISIBLE SMOKE RELEASE FOR DISCRETE PRODUCTS AND THEIR ACCESSORIES INSTALLED IN AIR-HANDLING SPACES
- **UL 2108/CSA 22.2#250.0** - LOW VOLTAGE LIGHTING SYSTEM
- **UL 8750/CSA-C22.2 #250.13** - LIGHT EMITTING DIODE (LED) EQUIPMENT FOR USE IN LIGHTING PRODUCTS
- **UL 1310/CSA C22.2 #223-M91** - CLASS 2 POWER UNITS
- **UL 94** - FLAMMABILITY OF PLASTIC MATERIALS FOR PARTS IN DEVICES AND APPLIANCES
- **IP 67** - RATED INGRESS PROTECTION AGAINST DUST AND LIQUIDS
- **MIL-STD-461** - ELECTROMAGNETIC COMPATIBILITY

STANDARD MODULE SIZING CHART

NOMINAL (W)	NOMINAL (L)	ACTUAL (W)	ACTUAL (L)	HEIGHT (H)	
				MIN	MAX
24.000	24.000	24.250	24.250	15	25
24.000	36.000	24.250	36.375	15	25
24.000	48.000	24.250	48.500	15	25

- STANDARD HEIGHT (H) = 20"
- MINIMUM HEIGHT WITH HEPA FILTER = 17"
- MINIMUM WIDTH WITH HEPA FILTER = 13"
- MAX INLET HEIGHT (IH) = HEIGHT (H) - 12"
- MAX INLET HEIGHT (IH) WITH HEPA = HEIGHT (H) - 13"

PRICE CEILING SYSTEM WEIGHTS

PRICE SUPPLIED COMPONENTS	TOTAL SQUARE FEET =308 SQ.FT.	1713 lbs.
STRUCTURE	116 SQ.FT.	921 lbs.
USA	96 SQ.FT.	672 lbs.
HGWC+PANELS	96 SQ.FT.	120 lbs.

price | CRITICAL ENVIRONMENTS

Project:

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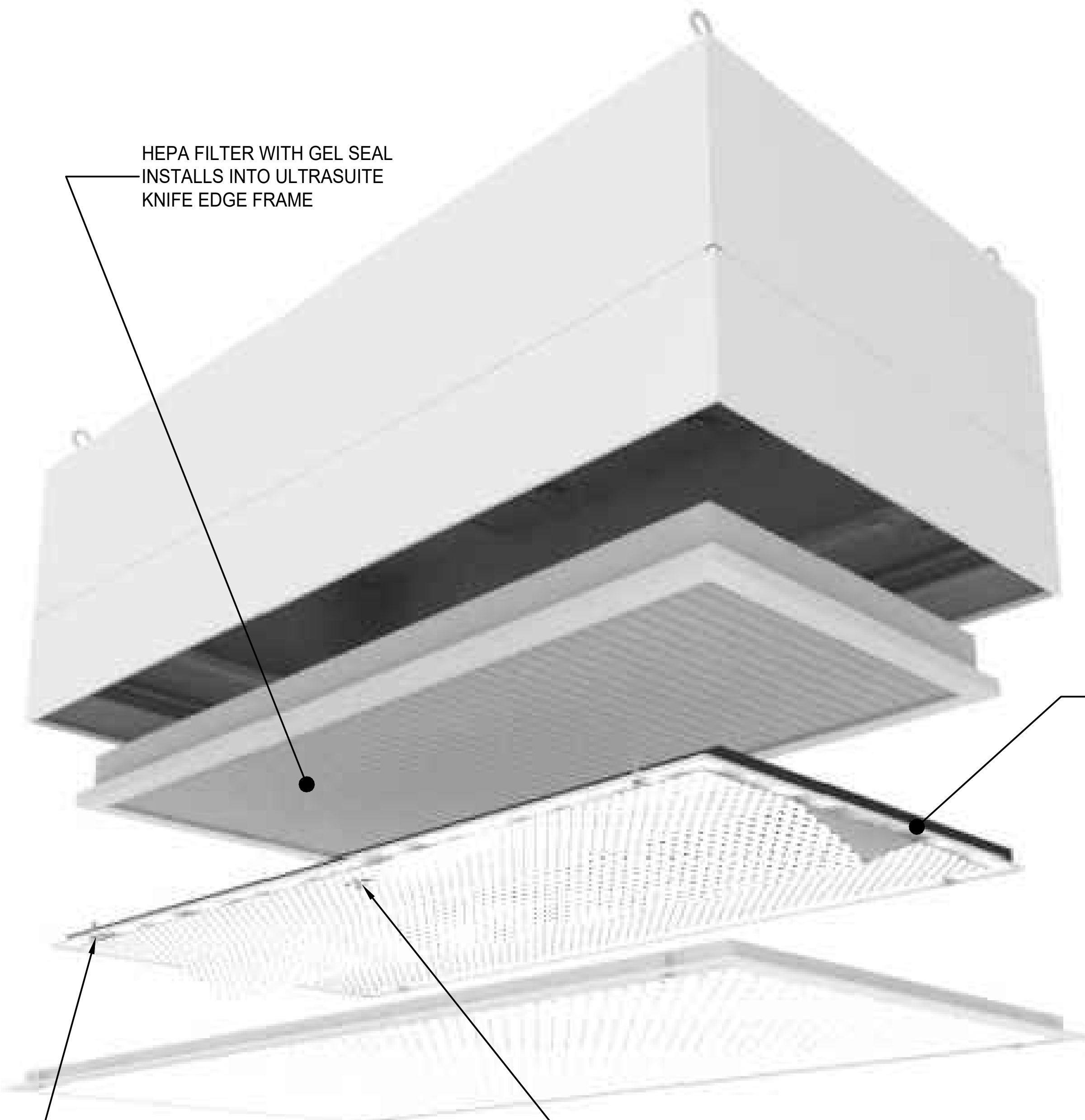
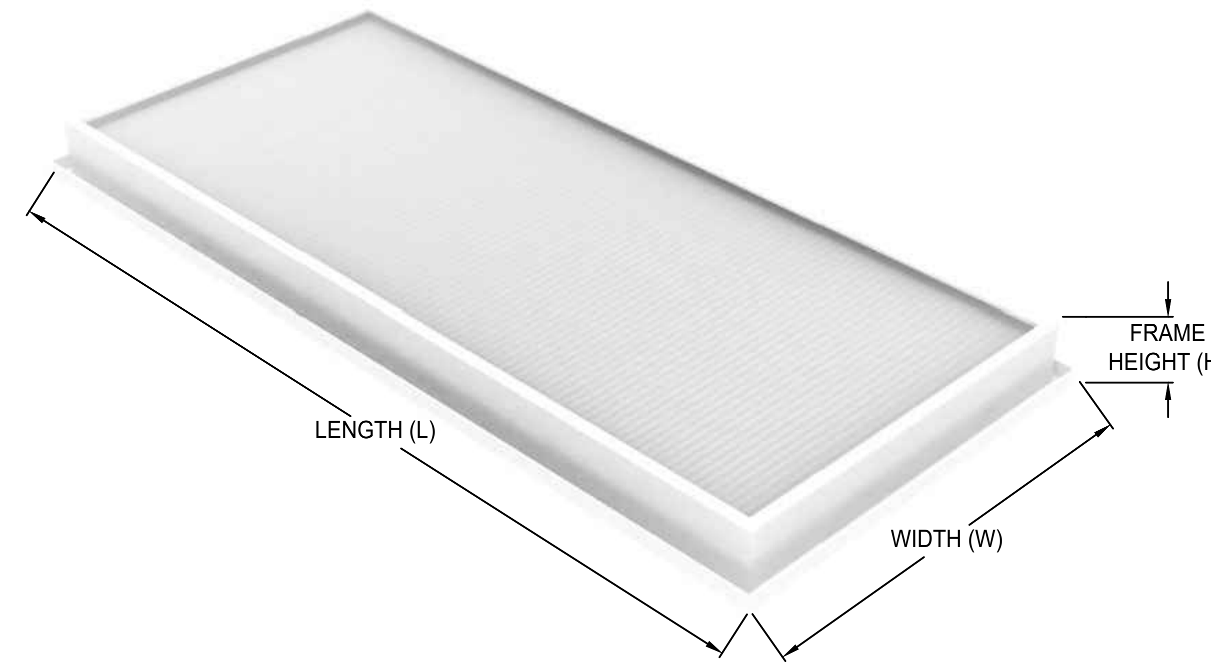
ULTRASUITE® + STRUCTURE

OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

FAAPD FACE ADJUSTABLE APERTURE PLATE DAMPER DETAILS

○ OPTIONAL ROOMSIDE HEPA FILTRATION





FILTER SIZING					
NOMINAL UNIT WIDTH	NOMINAL UNIT LENGTH	ACTUAL UNIT WIDTH	ACTUAL UNIT LENGTH	ACTUAL FILTER (W)	ACTUAL FILTER (L)
24.000	24.000	24.250	24.250	19.88	19.88
24.000	36.000	24.250	36.375	19.88	32.01
24.000	48.000	24.250	48.500	19.88	44.13

NOTES:

- FILTER PLEATS RUN PARALLEL TO THE WIDTH (W) DIMENSION
- DIMENSIONS W & L TOLERANCES +/- $\frac{1}{16}$"
- FILTERS COME WITH GEL SEAL FILLED CHANNEL
- FILTERS MUST BE ORDERED SEPARATELY UNDER THE FTR-1-X LINESTRING

FRAME DETAILS:

- MATERIAL: ANODIZED EXTRUDED ALUMINUM
- THICKNESS: $\frac{1}{16}$" (MINIMUM)
- FILTERS ARE UL 900 CLASS 1 CERTIFIED
- EFFICIENCY AND LEAK SCAN TESTED
- HEPA EFFICIENCY: 99.99% (.3 MICRON)
- MINIMUM MODULE WIDTH FOR ROOMSIDE HEPA FILTRATION IS 12"

VISIT PRICE INDUSTRIES WEBSITE FOR FILTER QUICK START GUIDE
https://www.priceindustries.com/content/uploads/assets/literature/manuals/section%20e/ftr-room-side-replaceable-filter-rsr-quick-start-guide.pdf

NOTE:
UL 1598 DOES NOT HAVE PROVISIONS FOR HEPA FILTERS MOUNTED WITHIN FIXTURE. USA COMPLIES WITH UL 1598 WITH HEPA FILTERS ORDERED SEPERATELY ON FTR-1-X LINESTRING.

price | CRITICAL ENVIRONMENTS

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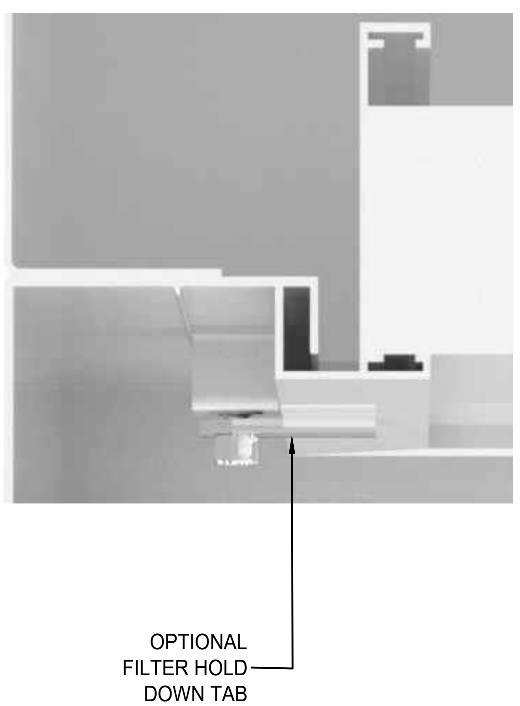
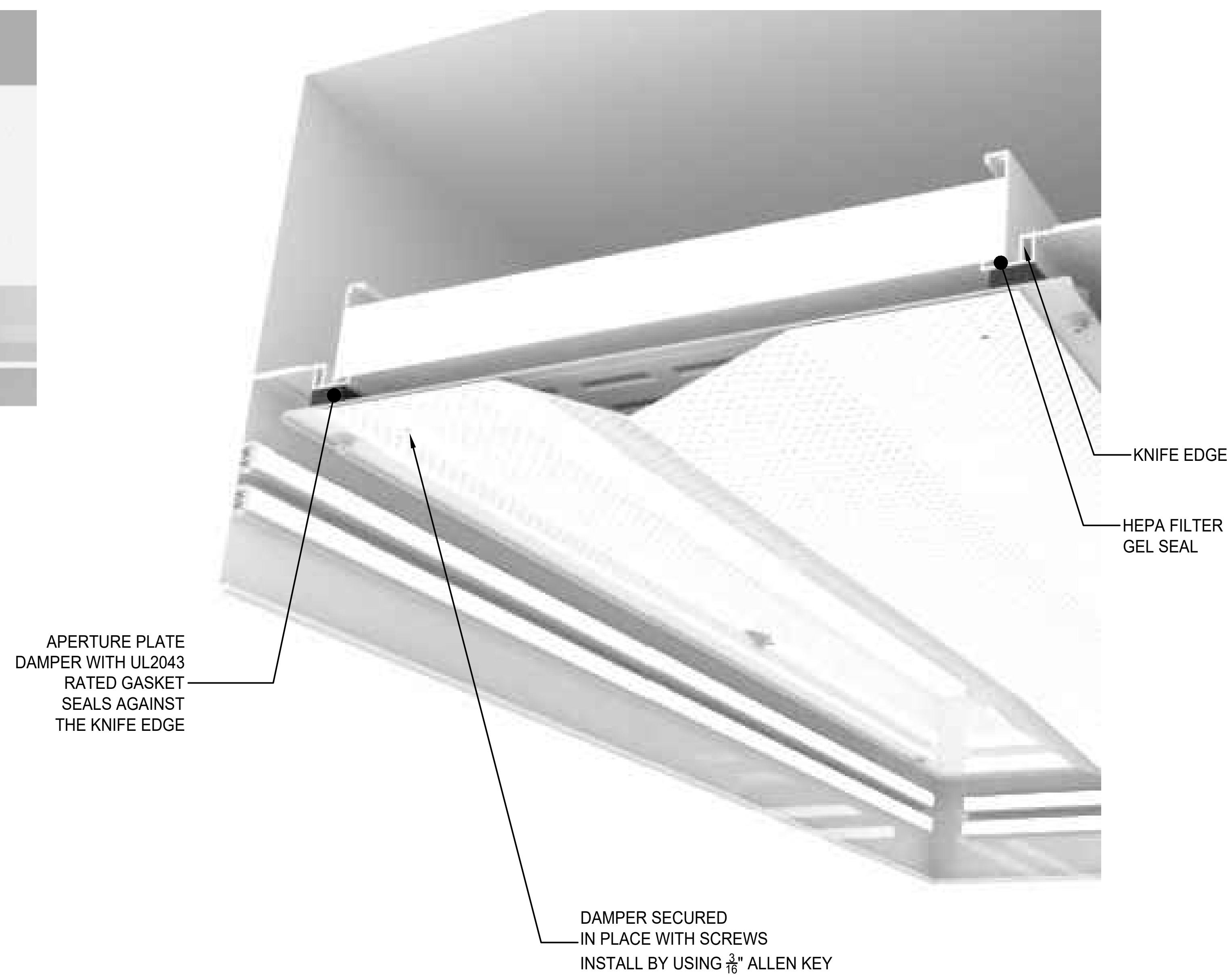
FAAPD FACE ADJUSTABLE APERTURE PLATE DAMPER DETAILS

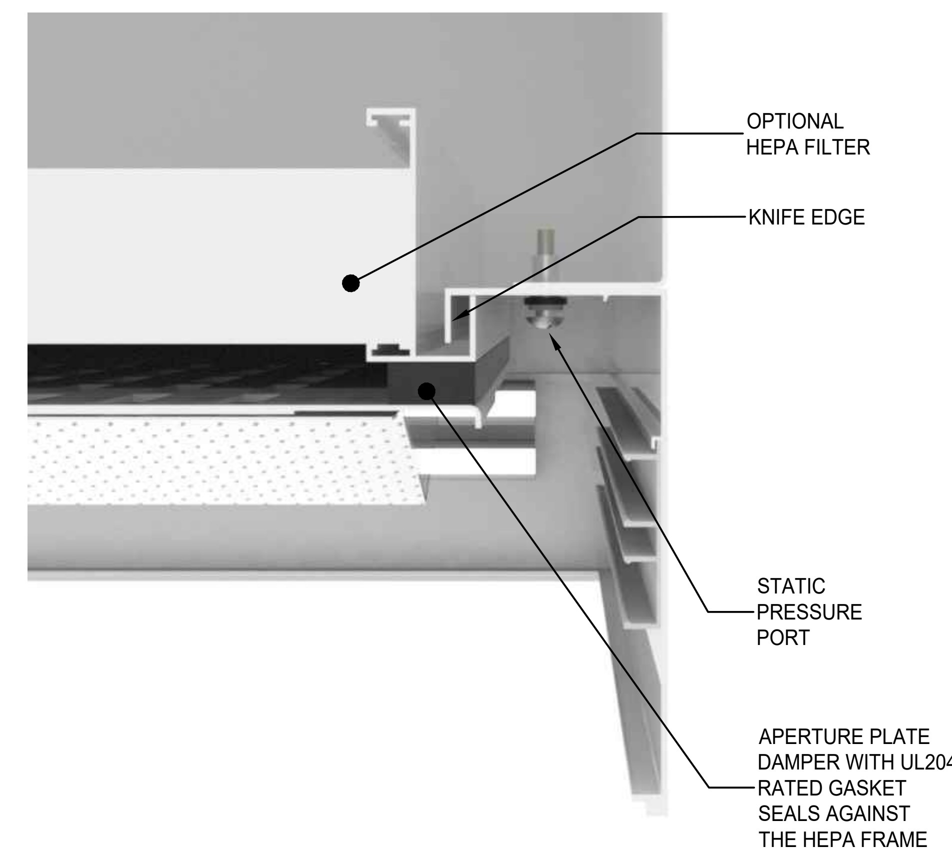
○ OPTIONAL ROOMSIDE HEPA FILTRATION

FILTER HOLD DOWN TAB DETAIL





STATIC PRESSURE PORT DETAIL



price | CRITICAL ENVIRONMENTS

Project:		
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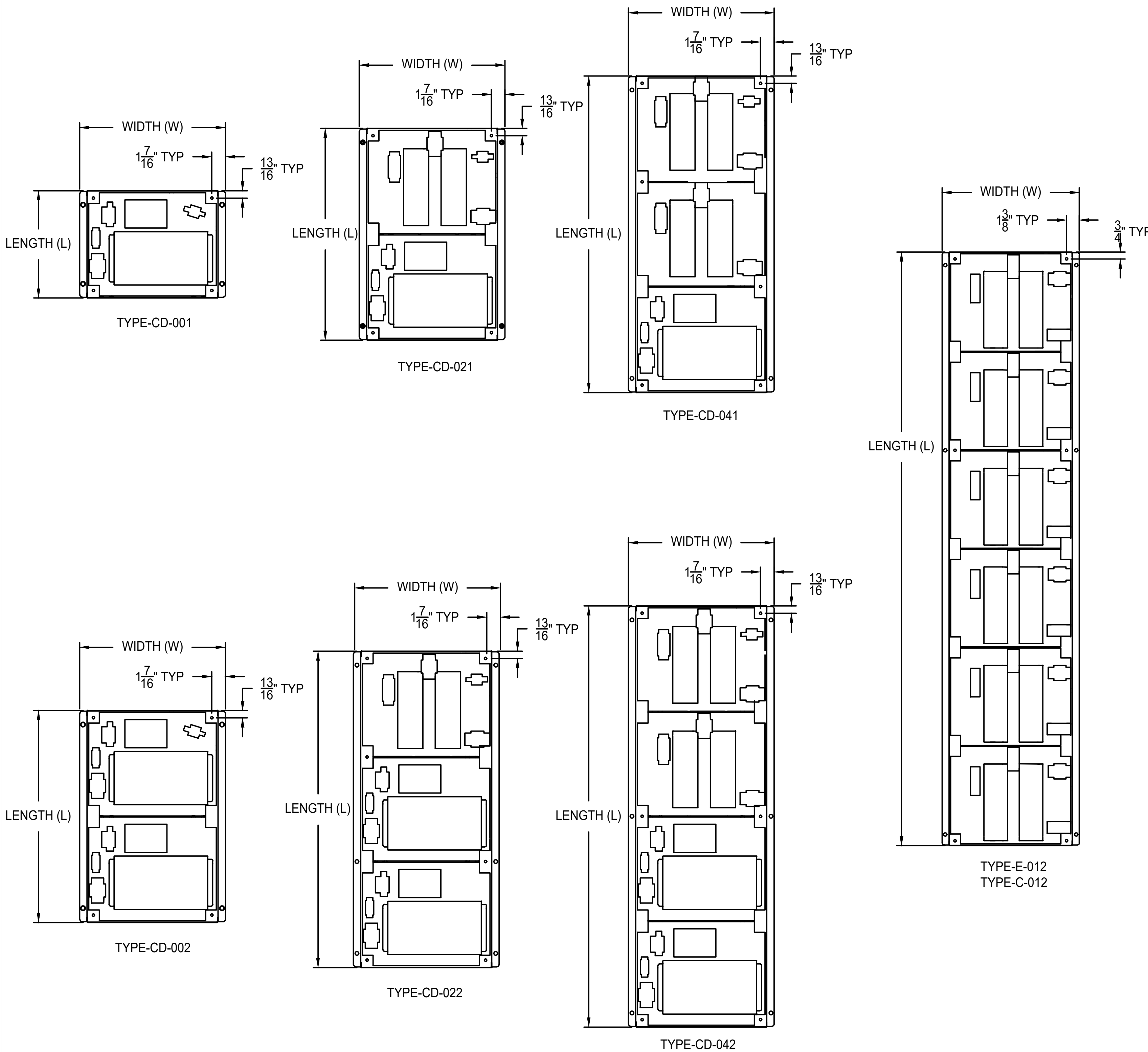
ULTRASUITE® + STRUCTURE

OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

URDC ULTRA REMOTE DRIVER CABINETS - STANDARD OFFERINGS



- ALL DRIVER CABINETS ARE ORDERED ON URDC-1-X LINESTRING.
- REMOTE DRIVER CABINETS REQUIRE SINGLE POINT HIGH VOLTAGE (120-277v~) CONNECTION (277V~ RECOMMENDED).
- ALL DIMMING SWITCHES ARE ORDERED ON UCA-1-X LINESTRING.
- 0-10V DIMMING SWITCH SHIPPED LOOSE. THE TOTAL LENGTH FOR 0-10V CONTROL SIGNAL WIRING FOR THIS CONTROL SHOULD NOT EXCEED 500'. DO NOT USE WIRE SMALLER THAN 20 AWG.
- 8A AND 16A 0-10V DIMMING SWITCHES AVAILABLE. DIMMING ZONES AND CONTROL ARE COMPLETELY CUSTOMIZABLE.
- 0-10V DIMMING SIGNAL FROM SWITCH CAN CONTROL UP TO 100 DRIVERS.
- LED DRIVER TYPE E OFFERS CONTINUOUS, FLICKER-FREE DIMMING FROM 100% TO 1% WITH 0-10 VOLTAGE DIMMER SHIPPED LOOSE OR DIMMING SIGNAL PROVIDED BY OTHERS.
- LED DRIVER TYPE C AND CD OFFERS CONTINUOUS, FLICKER-FREE DIMMING FROM 100% TO 10% WITH 0-10 VOLTAGE DIMMER SHIPPED LOOSE. OPTIONAL SOLID STATE RELAY WITH 4-32VDC RELAY SHUT OFF SIGNAL AND 0-10VDC DIMMING SIGNAL PROVIDED BY OTHERS
- 30A DISCONNECT SWITCH AVAILABLE TO PROVIDE FULL SYSTEM SHUTOFF WHEN UTILIZING 0-10V SIGNAL
- LED DRIVERS SHIP FACTORY WIRED AND INSTALLED IN REMOTE DRIVER CABINETS.
- URDC DRIVER CABINETS CAN BE WALL MOUNTED, TYPICALLY IN AN ADJACENT EQUIPMENT ROOM, OR INSTALLED ABOVE THE CEILING. DRIVER CABINETS CANNOT BE RECESSED BETWEEN WALL STUDS AS THEY REQUIRE VENTILATION.
- ULTRASUITE MODULES COME WITH FACTORY WIRED AND INSTALLED TOP MOUNTED LOW VOLTAGE TERMINAL BLOCK ENCLOSURE
- INCOMING HIGH VOLTAGE POWER AND LOW VOLTAGE CONNECTION BETWEEN ULTRASUITE MODULES AND REMOTE DRIVER CABINET ARE THE RESPONSIBILITY OF THE INSTALLER.
- MAX DISTANCE BETWEEN ULTRASUITE MODULE AND REMOTE DRIVER CABINET IS DEPENDANT ON WIRE GAUGE TO MINIMIZE VOLTAGE DROP. SEE TABLE BELOW.
- SEE ULTRASUITE INSTALLATION MANUAL AVAILABLE AT https://www.priceindustries.com/criticalenvironments/products/ultrasuite FOR RECOMMENDED REMOTE DRIVER CABINET AND ULTRASUITE SYSTEM INSTALLATION.

DRIVER CABINET	# OF MODULES	# OF DRIVERS	L	W	H	WEIGHT	AC CURRENT - TYPE E (120VAC / 277VAC)	AC CURRENT - TYPE C (120VAC / 277VAC)
TYPE E/C-001	1	1	0'-11 1/2"	1' - 3 1/2"	5"	7 lbs.	0.95A / 0.4A	1.2A / 0.50A
TYPE E/C-002		2	0'-11 1/2"	1' - 3 1/2"	5"	15 lbs.	1.9A / 0.8A	2.4A / 1.7A
TYPE E/C-003	2	3	1' - 10 9/16"	1' - 3 1/2"	5"	22 lbs.	2.95A / 1.2A	3.6A / 2.9A
TYPE E/C-004		4	1' - 10 9/16"	1' - 3 1/2"	5"	30 lbs.	3.8A / 1.6A	4.8A / 4.1A
TYPE E/C-005	3	5	2' - 9 11/16"	1' - 3 1/2"	5"	37 lbs.	4.75A / 2A	6.0A / 5.3A
TYPE E/C-006		6	2' - 9 11/16"	1' - 3 1/2"	5"	45 lbs.	5.7A / 2.4A	7.2A / 6.5A
TYPE E/C-007	4	7	3' - 8 13/16"	1' - 3 1/2"	5"	52 lbs.	6.65A / 2.8A	8.4A / 7.7A
TYPE E/C-008		8	3' - 8 13/16"	1' - 3 1/2"	5"	60 lbs.	7.6A / 3.2A	9.6A / 8.9A
TYPE E/C-009	5	9	4' - 7 15/16"	1' - 3 1/2"	5"	67 lbs.	8.55A / 3.6A	10.8A / 10.1A
TYPE E/C-010		10	4' - 7 15/16"	1' - 3 1/2"	5"	75 lbs.	9.5A / 4A	12.0A / 11.3A
TYPE E/C-011	6	11	5' - 7 1/16"	1' - 3 1/2"	5"	82 lbs.	10.45A / 4.4A	13.2A / 12.5A
TYPE E/C-012		12	5' - 7 1/16"	1' - 3 1/2"	5"	90 lbs.	11.4A / 4.8A	14.4A / 13.7A

DRIVER CABINET	# OF MODULES	# OF DRIVERS	L	W	H	WEIGHT	AC CURRENT - TYPE E (120VAC / 277VAC)
TYPE-CD-001	3	1	0'-11 1/2"	1' - 3 1/2"	5"	20 lbs.	7A / 2.9A
TYPE-CD-021	4	3	1' - 10 9/16"	1' - 3 1/2"	5"	35 lbs.	9.4A / 3.9A
TYPE-CD-041	5	5	2' - 9 11/16"	1' - 3 1/2"	5"	50 lbs.	11.8A /4.9A
TYPE-CD-002	6	2	1' - 10 9/16"	1' - 3 1/2"	5"	40 lbs.	14.0A / 5.8A
TYPE-CD-022	7	4	2' - 9 11/16"	1' - 3 1/2"	5"	55 lbs.	- / 6.8A
TYPE-CD-042	8	6	3' - 8 13/16"	1' - 3 1/2"	5"	70 lbs.	- / 7.8A

- TYPE C & CD OFFERS 100 TO 10% DIMMING
- TYPE E OFFERS 100 TO 1% DIMMING
- TYPE CD OFFERS OVER 40% SPACE SAVING FOR CABINET INSTALLATION
- TYPE C ALLOWS FOR RECESSED TYPE IC INSTALLATION
- TYPE E & CD ALLOWS FOR SURFACE, WALL OR CEILING MOUNT INSTALLATION. PASSIVE VENTILATION OF CABINET IS REQUIRED THROUGH OUTER BOX LOUVERS

price | CRITICAL ENVIRONMENTS

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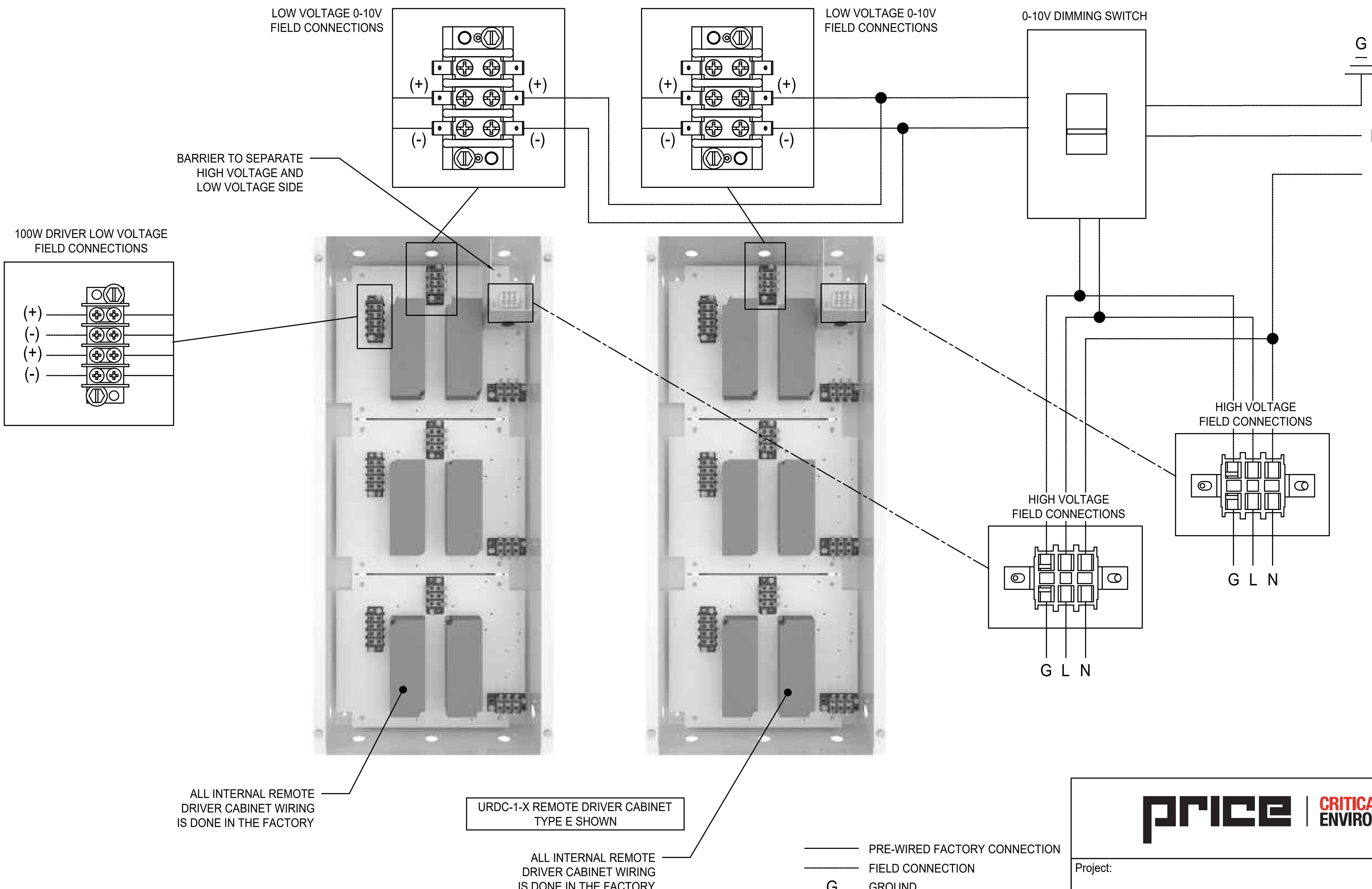
○ URDC ULTRA REMOTE DRIVER CABINETS - WIRING FOR SINGLE DIMMING ZONE (100 TO 1% DIMMING)



———	PRE-WIRED FACTORY CONNECTION
- - - -	FIELD CONNECTION
G	GROUND
N	NEUTRAL
L	LINE CONNECTION

- VISUAL WIRING DETAIL IS SHOWN FOR REFERENCE ONLY, REFERENCE INSTALLATION MANUAL FOR WIRING DIAGRAMS
- INSTALLATION WORK AND ELECTRICAL WIRING MUST BE COMPLETED BY A CERTIFIED ELECTRICIAN AND/OR QUALIFIED PERSON(S) IN ACCORDANCE WITH APPLICABLE ELECTRICAL CODES AND STANDARDS

price | CRITICAL ENVIRONMENTS

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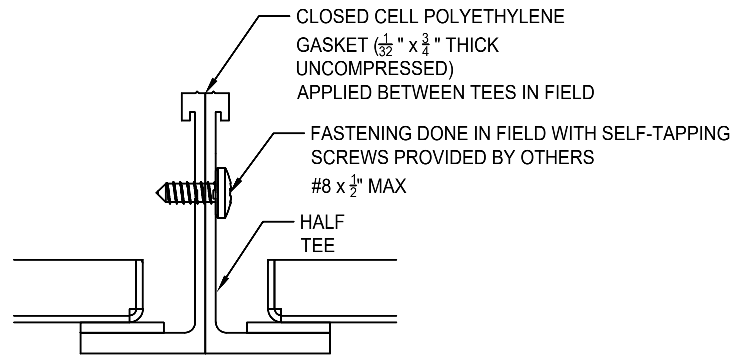
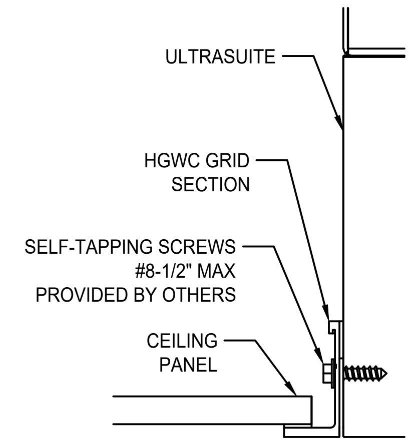
ULTRASUITE® + STRUCTURE

OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

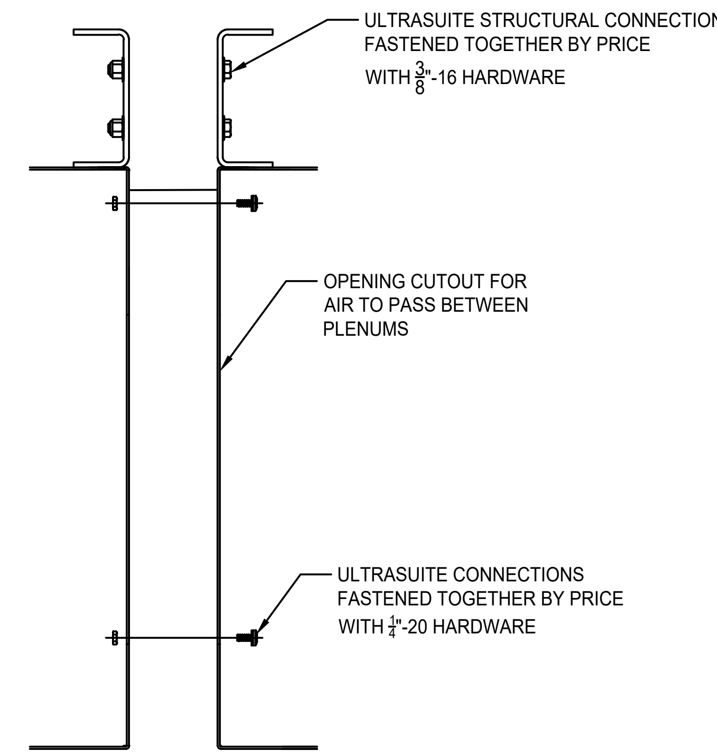
HGWC INTEGRATION DETAILS



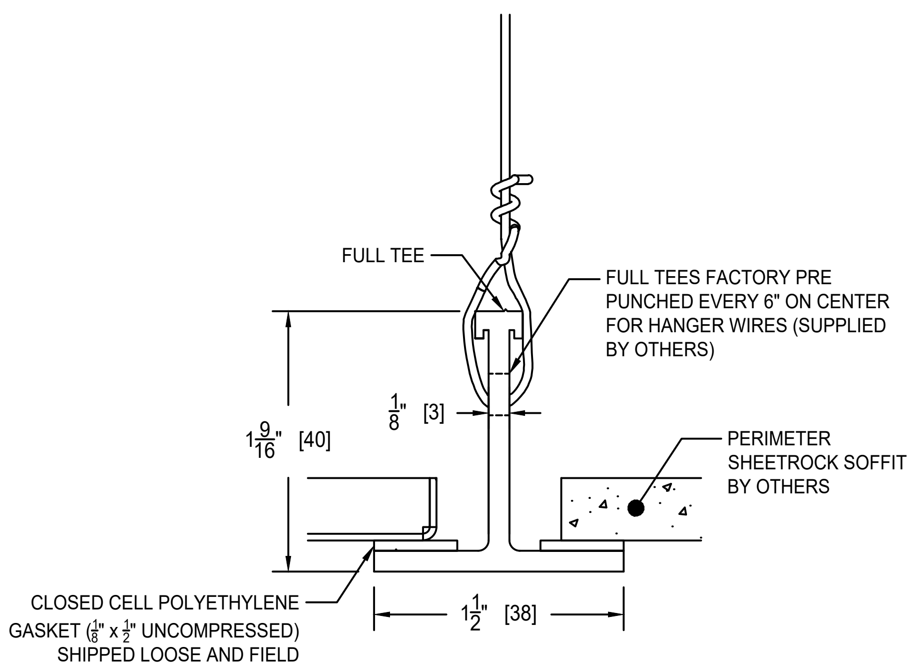
A HALF TEE FIELD JOINT



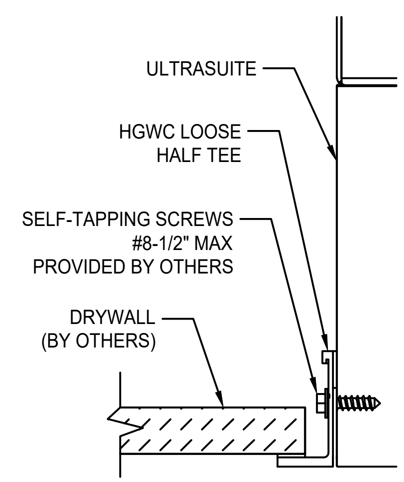
C HGWC GRID INTEGRATION



E BOLTED JOINT ASSEMBLY



B FULL TEE PERIMETER SHEETROCK SOFFIT DETAIL



D PERIMETER HALF TEE INTEGRATION

price | CRITICAL ENVIRONMENTS

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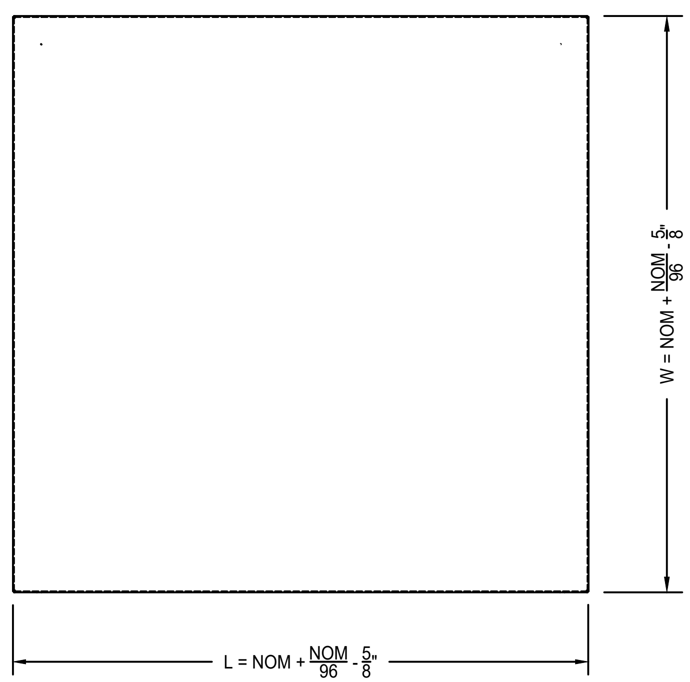
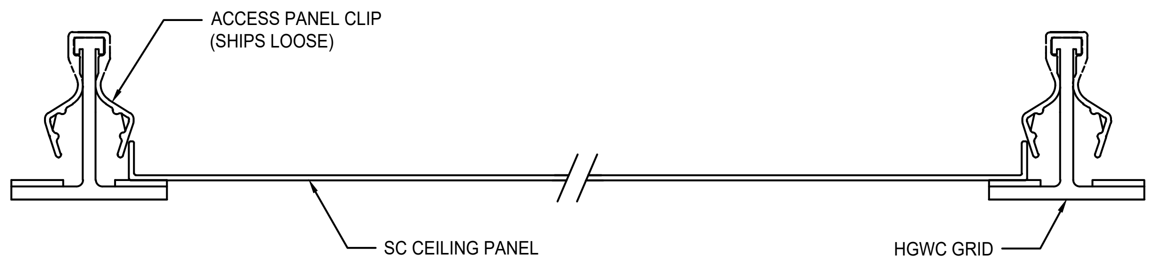
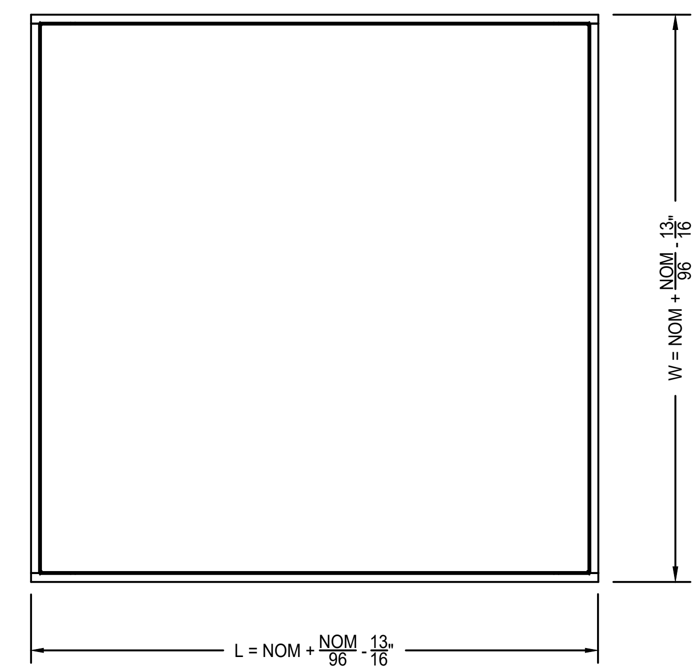
OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

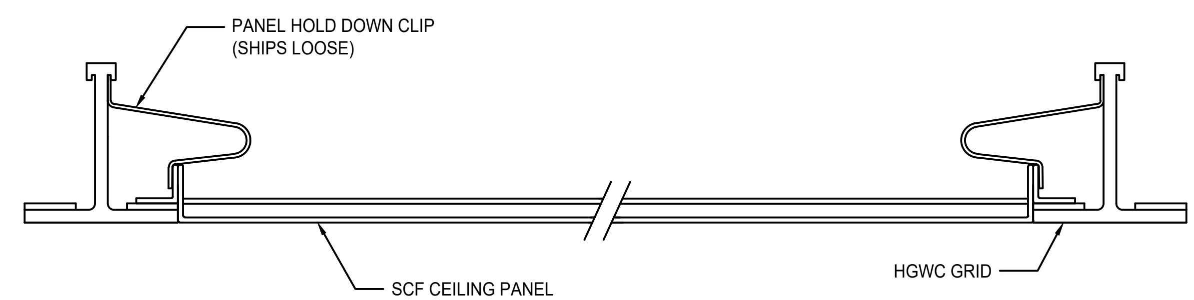
SC - SOLID CORE

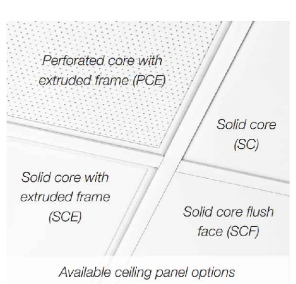




SCF - SOLID CORE WITH FLUSH MOUNT FRAME







Available ceiling panel options

PANEL MATERIAL / FINISH:

- SC PANEL - .080" ALUMINUM / B12 STANDARD WHITE
- SCF PANEL - .040" ALUMINUM / B12 STANDARD WHITE

CEILING TYPE:

- HGWC - 1 1/2" HOSPITAL GRADE WELDED CEILING SYSTEM

PRICE | CRITICAL ENVIRONMENTS

Project:

276328	Revision: 3A	05-17-2024

ULTRASUITE® + STRUCTURE

OPERATING ROOM DIFFUSER SYSTEM WITH INTEGRATED LED LIGHTING AND ALUMINUM STRUCTURAL SUPPORT

SUPPORTING CONTENT

MANUALS

ULTRASUITE MANUAL
FTR ROOM-SIDE REPLACEABLE FILTER (RSR) QUICK START GUIDE
URDC ULTRA DRIVER CABINET MANUAL
UCA ULTRA COMPONENTS AND ACCESSORIES MANUAL
HGWC HOSPITAL GRADE WELDED CEILING SYSTEM MANUAL

CATALOGUE / PERFORMANCE

USA ULTRASUITE CATALOGUE
USA ULTRASUITE PERFORMANCE
USA ULTRASUITE PERFORMANCE (METRIC)

SPECIFICATIONS

USA ULTRASUITE SPECIFICATIONS

REVIT FILES

USASA TRADITIONAL OR REVIT FILE

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USA ULTRASUITE INSTALLATION TIME LAPSE VIDEO
USA ULTRASUITE SMOKE TEST VIDEO
USA ULTRASUITE IN BAYLOR SCOTT & WHITE MEDICAL CENTER TESTIMONIAL
HEPA FILTER REPLACEMENT (USA AND UFFU) VIDEO
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price | CRITICAL ENVIRONMENTS

Project:		
276328	Revision: 3A	05-17-2024

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ULTRASUITE Project #276328

STRUCTURAL ANALYSIS AND DESIGN

REPORT 2024002-AR01

<u>Project Address</u>: 20 Crestridge Drive, Suwannee, GA 30024.

Prepared By: Peter Lacoursiere, P.Eng. | *F.A.Roberts & Associates Ltd.*

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1.0 EXECUTIVE SUMMARY

1.1. Project Overview

Ultrasuite project #276328 consists of a suspended aluminum frame and steel boom mounting structures designed to support an integrated lighting and ventilation system along with equipment booms by Stryker. The frame structural design is described on drawings *276328 Rev. 3_ Sheets 1-6* and is designed for installation in an operating room at 20 Crestridge Drive, Suwannee, GA 30024.

1.2. Design Requirements

This report presents analysis results verifying compliance with

- Georgia Building Code, based on the 2018 International Building Code (IBC) with Georgia Amendments
- ASCE 07-16 Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- ANSI/AISC 360-16 Specification for Structural Steel Buildings
- Aluminum Design Manual 2020

1.3. Analysis and Results

The frame is analyzed for load combinations comprised of calculated seismic loading, frame self-weight and design boom loads and moments as defined by the boom equipment manufacturer. This report finds the following:

- The aluminum frame members see moderate load levels for this configuration and possess ample capacity as designed.
- The load effects due to the orientation of the moments on all (4) boom mounts was tested separately and is described in Appendix A; the (3) controlling load cases were used in load combinations.
- Anchor reactions at the top of the hangers and braces are provided in Appendix B; maximum hanger and brace forces are defined in section 6.1.

The analysis of the boom mounts is described in design report 2024002-AR02, which also includes information on physical lab testing of the single boom mount.

Lab testing was conducted at defined design loads for 3 orientations, as well as at 150% of load level in bending about the weak axis (My).

2.0 PROJECT DESCRIPTION

This report is prepared to support and verify the suspended Ultrasuite Structure configuration meets the applicable design requirements. The structural configuration is shown on Figure 1 below and is described on design drawings *276328 Rev. 3_ Sheets 1-6.*

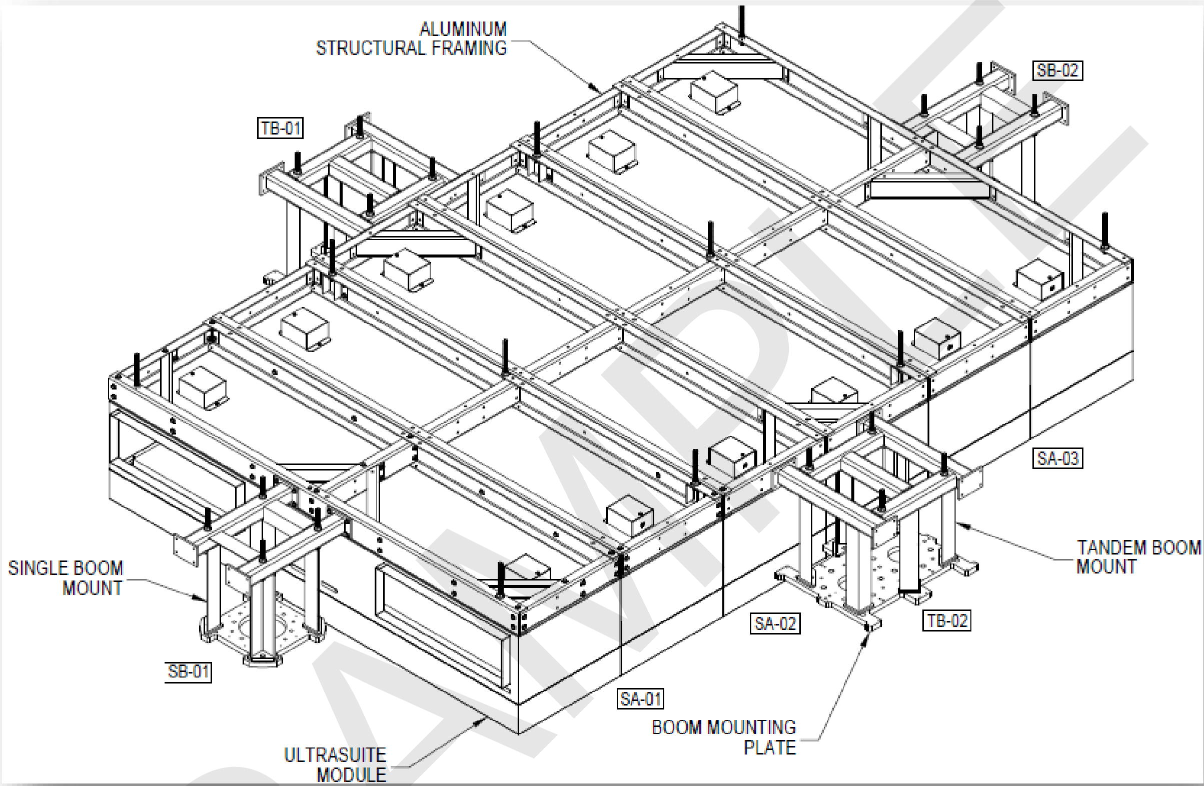


Figure 1. Ultrasuite Structure Isometric View

The Ultrasuite System consists of the following components and material grades:

- USA Modules: Formed 16 ga. boxes from CS Type B galvannealed sheet with integrated ventilation, lighting and air filters (design by others)
- HGWC Sections: ceiling panels (design by others, independently supported)
- Aluminum Structural Frame: Formed 5052-H32 aluminum alloy structural members, includes:
  - *Primary beams*: C5x2x3/16 formed channels
  - *Cross beams*: C4.5x2x3/16 formed channels, bolted through top flange and web with bolted 3/16" angle clip

  - *Corner Braces*: C4x2x3/16 formed channels
  - *Angle Clips*: L1.75x1.75x3/16 formed angles, c/w (2) 7/16"Ø bolt holes
  - *Hanger Brackets*: 3/16 formed brackets, c/w (4) 7/16"Ø bolt holes
- HSS Boom Mount: Steel weldment designed to support Stryker Plate specified loads, includes:
  - *Top beams*: HSS 3x3x1/4, ASTM A500 Gr. B or C
  - *Drop down legs*: L3x3x1/4, ASTM A36 or equivalent
  - *Plates*: 3/8" plate, ASTM A36 or equivalent

- Stryker Plate: 1" Boom Mount Plate (design by others)

- Threaded Rod Hangers: 5/8"Ø ASTM F1554 Gr. 55 or equivalent

- Bracing: Required to limit sway

NOTE: Hangers and bracing, as well as their connections to the main building framing, are to be designed by a 3rd party engineer. References to these components and sample feasibility calculations are provided in this report but final brace and hanger design is the responsibility of others.

The current project #276328 is described on Price drawings 276328-1-6 Rev. 3_ and is a nominal 8'x12' array of Ultrasuite mechanical modules, as well as (2) tandem boom mounts and (2) single boom mounts.

This suspended frame will be installed at: *20 Crestridge Drive, Suwannee, GA 30024*

Figure 2 shows the standard components of the *Ultrasuite + Structure* system, not including the boom mounted equipment that is suspended from the Stryker Mount Plate.

The structural frame and hanger/brace configuration is shown as a plan view in Figure 3.

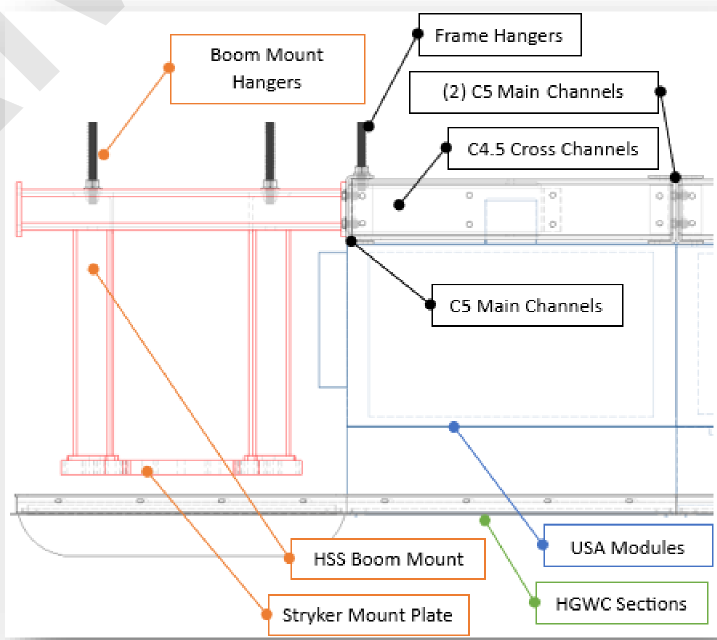


Figure 2. Ultrasuite Frame Components

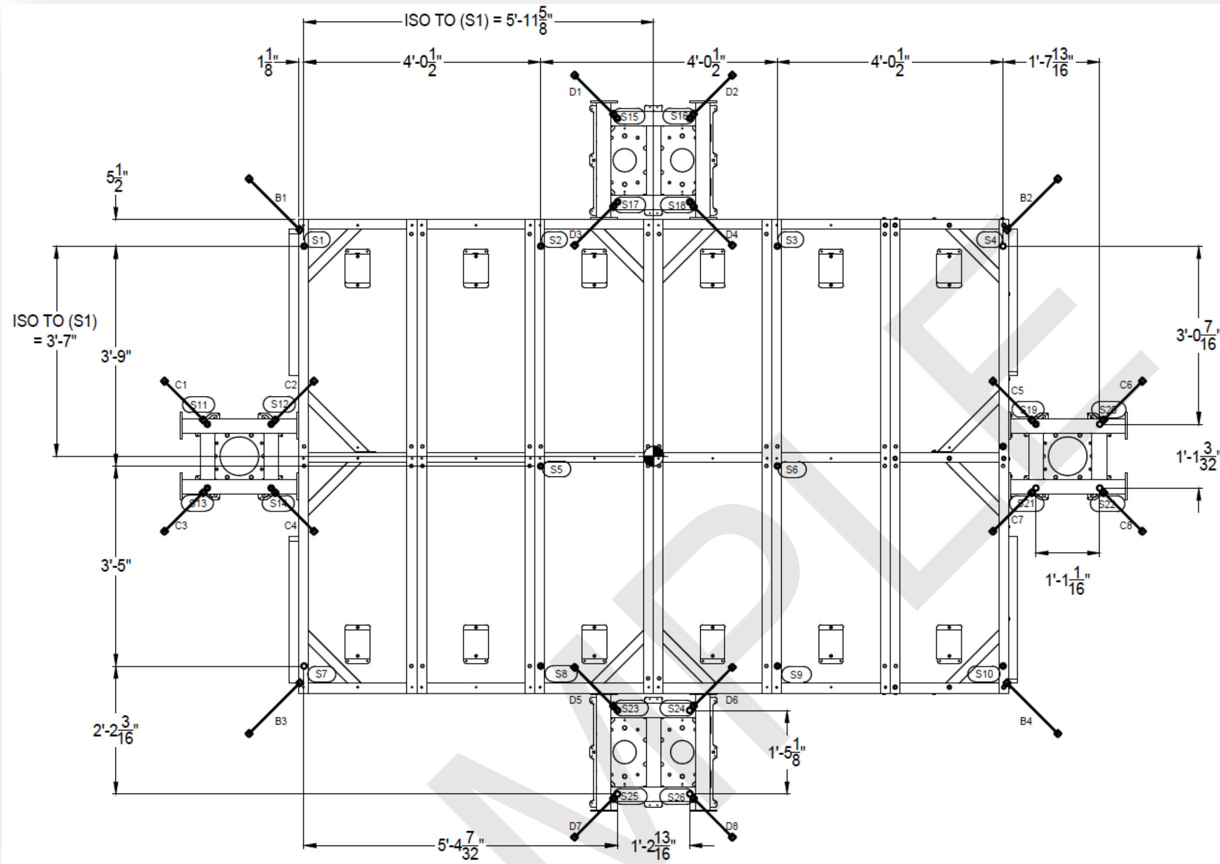


Figure 3. Ultrasuite Structure Layout

3.0 REFERENCE DOCUMENTS

Project #276328, designed for installation in Suwannee, Georgia, is analyzed for compliance with the requirements of the following building codes:

- Georgia Building Code, based on the 2018 International Building Code (IBC) with Georgia Amendments
- ASCE 07-16 Minimum Design Loads and Associated Criteria for Buildings and Other Structures
- ANSI/AISC 360-16 Specification for Structural Steel Buildings
- Aluminum Design Manual 2020

4.0 STRUCTURAL DESIGN REQUIREMENTS

4.1. Design Overview

The structural design of the Ultrasuite project is focused on the design of the aluminum frame, where the HSS equipment boom mounts are previously designed and tested.

4.2. Design Loading

We have defined the following load cases:

4.2.1. Dead Load (D). The estimated weight of the system is 1,593 lbs, not including the HGWC and panels which are separately supported.

4.2.2. Seismic Load. *ATC Hazards by Location Tool*, provides the following seismic parameters at the projects address (coordinates 34.0269541, -84.033122699):

Risk Category: IV I_p:1.5   *Site class: D - Default* S_s:*0.197* S_1:*0.087* S_{ds}:*0.21*

Using a_p:*1.0* R_p:*1.5*   (ASCE 7-16 Table 13.6-1 "Other mech. and elec. comp...")

Calculate the horizontal and vertical seismic accelerations per ASCE 07-16 as shown below:

Risk Category: **IV** $I_p := 1.5$ Site Class: **D - Default** (assumed)

$S_S := 0.197$ $S_1 := 0.087$ $S_{DS} := 0.21$ $S_{D1} := 0.139$

$h := 120\ ft$ $z := 90\ ft$ (NOTE: h, z values chosen arbitrarily)

$a_p := 1.0$ $R_p := 1.5$ (ASCE 7-16 Table 13.6-1 *"Other mechanical...components..."*)

Lateral Shear: $$F_{ph} := \frac{0.4 \cdot a_p \cdot S_{DS} \cdot \left(1 + 2\,\frac{z}{h}\right)}{\left(\frac{R_p}{I_p}\right)} = 0.210\ (Wp)$$ (ASCE 7-16 Eq. 13.3-1)

$F_{ph\_MAX} := 1.6 \cdot S_{DS} \cdot I_p = 0.504$ (Wp)   (ASCE 7-16 Eq. 13.3-2)

$F_{p\_MIN} := 0.3 \cdot S_{DS} \cdot I_p = 0.095$ (Wp)   (ASCE 7-16 Eq. 13.3-3)

Then, use *Fp_min=0.210 Wp*

Vertical Shear: $F_{p\_v} := 0.2 \cdot S_{DS} = 0.042$ (ASCE 7-16 cl.13.3.1.2)

Use *0.042 Wp for concurrent vertical seismic loads*

We define the following seismic basic load cases, acting on boom mount weights and modelled dead load weights plus the weight of HGWC and panels (120 lbs):

Load Case Eh-x : 0.210 lateral acceleration in the -x direction
Load Case Ehy : 0.210 lateral acceleration in the +y direction
Load Case Ev : 0.042 downwards vertical acceleration in the -z direction
Load Case -Ev : 0.042 vertical acceleration in the +z direction

4.2.3. Live Load. We define the live load on this structural system as the boom mount design equipment loads required by Stryker:

- Single Boom Mount: P_b=1,100 lbf, M_b=5,650 ft*lbf
- Tandem Boom Mount: P_b=2,200 lbf, M_b=11,300 ft*lbf

The orientation of the design moment is not fixed and may vary at each of the (4) boom mounts in this configuration.

The combined effects of the boom mounts on the frame have been evaluated for various orientations and are compared in Appendix A. Three of these scenarios have been selected as controlling live load cases and are included in load combinations:

- L_mx: All boom mount moments are applied in the +Mx direction
- L_my: All boom mount moments are applied in the +My direction
- L_m*: Single boom mounts in +Mx, tandem mounts in +My direction (L_m*4)

4.2.4. Load Combinations

The following ASD controlling load combinations per ASCE 07-16 structural code are used for our verification of the structural design:

LC 1: D
LC 3a: D + L_mx
LC 3b: D + L_my
LC 3c: D + L_m*
LC 8a: D + 0.7Ev + 0.7Ehy
LC 8b: D + 0.7Ev + 0.7Eh-x
LC 9a: D + 0.525Ev + 0.525Ehy + 0.75L_mx
LC 9b: D + 0.525Ev + 0.525Eh-x + 0.75L_my
LC 9c: D + 0.525Ev + 0.525Ehy + 0.75L_m*
LC 10a: 0.6D - 0.7Ev + 0.7Ehy
LC 10b: 0.6D - 0.7Ev + 0.7Eh-x

Additionally, we define load combinations with overstrength factors as follows:
LC 8'a (w/ overstrength): D + 0.7Ev + 2.0*0.7Ehy
LC 8'b (w/ overstrength): D + 0.7Ev + 2.0*0.7Eh-x
LC 9'a (w/ overstrength): D + 0.525Ev + 2.0*0.525Ehy + 0.75L_mx
LC 9'b (w/ overstrength): D + 0.525Ev + 2.0*0.525Eh-x + 0.75L_my
LC 9'c (w/ overstrength): D + 0.525Ev + 2.0*0.525Ehy + 0.75L_m*
LC 10'a (w/ overstrength): 0.6D - 0.7Ev + 2.0*0.7Ehy
LC 10'b (w/ overstrength): 0.6D - 0.7Ev + 2.0*0.7Eh-x

5.0 FRAME FEA ANALYSIS

5.1. Finite Element Modeling

5.1.1. Modeling

The cold formed aluminum suspended structural frame is modelled as a wireframe (beam) model based on design drawings.

5.1.2. Analysis Type

The analyses were performed using a static stress approach with linear-elastic material models using Autodesk Simulation Mechanical 2018 with material properties for 5052-H32 aluminum alloys or mild carbon steel for the HSS boom mounts. Equipment boom mounting plates and the USA mechanical boxes were modelled with plate meshes.

5.1.3. Loads and Boundary Conditions

The hangers and braces are modelled with pinned constraints at the nominal anchorage point, approximately 24” above the structural frame.

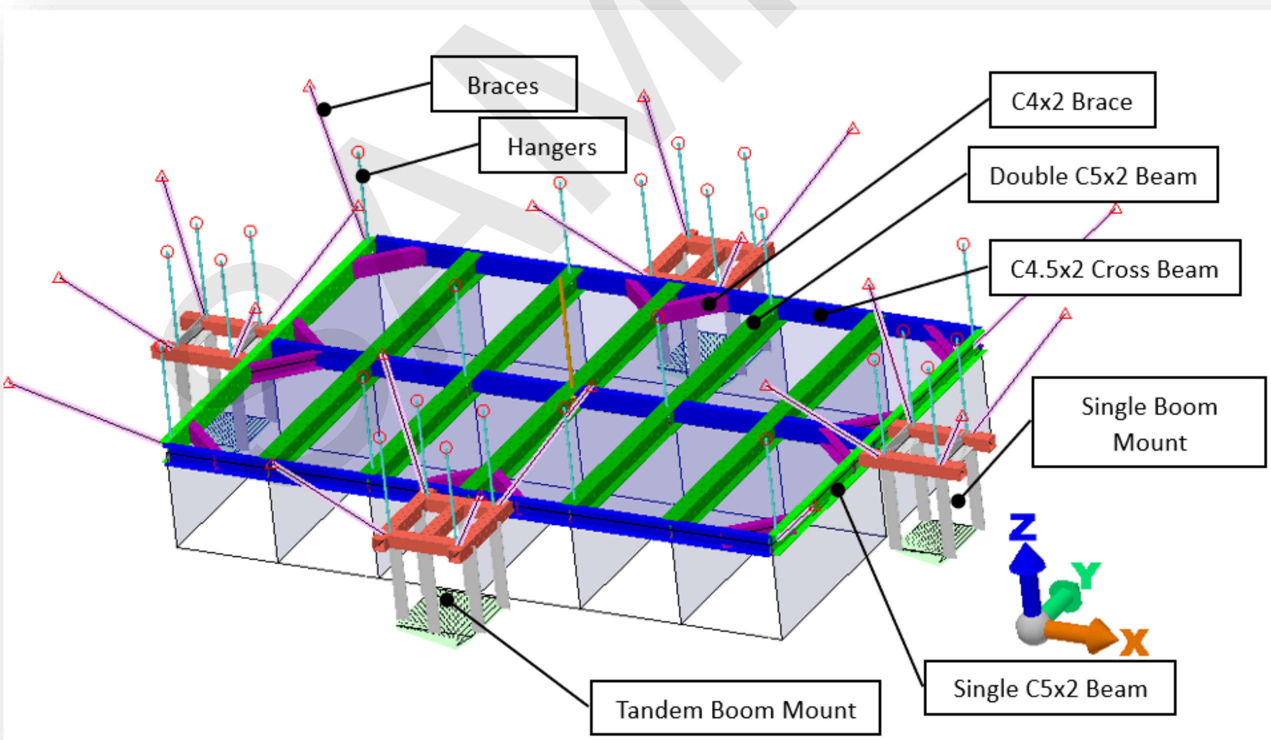


Figure 4. Ultrasuite wireframe FEA model

5.2. Finite Element Results

The defined ASD load combinations result in the following member stresses.

ASD Load Comb.	PEAK COMBINED STRESS (von Mises) psi				
	C5x2x3/16 Main Beam	C4.5x2x3/16 Cross Beam	C4x2x3/16 Brace	HSS 3x3x1/4 Boom Mount	*L3x3x1/4
LC1	69	56	23	90	98
LC3a	1,829	2,194	448	4,631	6,675
LC3b	1,494	6,067	880	6,259	11,473
LC3c	2,891	6,668	1,114	6,279	11,414
LC8a	249	221	129	341	1,383
LC8b	229	325	80	424	1,414
LC9a	1,495	1,705	366	3,685	6,019
LC9b	1,024	4,625	636	4,943	9,640
LC9c	2,292	4,875	802	4,932	9,573
LC10a	241	211	125	321	1,306
LC10b	193	318	75	397	1,336
Max. Stress	2,891	6,668	1,114	6,279	11,473
Allowable Strength (Fy/Ω for Ω=1.67)	13,800	13,800	13,800	27,600	21,600
Material Grade	5052-H32	5052-H32	5052-H32	ASTM A500 Gr. B	ASTM A36
Yield Strength	23,000	23,000	23,000	46,000	36,000

Stresses in aluminum structural members consist primarily of bending stresses, with minimal axial stresses induced by hanger braces.

The hanger and brace reactions for ASD load cases with overstrength factors can be found in Appendix B.

6.0 SUPPLEMENTARY CALCULATIONS

6.1. Hangers and Braces

The anchorage to the building structure and design of the suspension components are to be designed by others. In order to verify the design of the suspended frame, a nominal design for braces and hangers was evaluated and provides a basis for the minimum level of support required. Hanger and brace reactions found in Appendix B are summarized below:

MAXIMUM AXIAL FORCES [LBF]		
HANGERS	TENSION	COMPRESSION
S1,S4,S5,S6,S7,S10	450	300
S2,S3,S8,S9	1,100	850
S11-S14	2,550	2,050
S15-S18	4,150	3,150
S19-S22	2,550	2,050
S23-S26	4,150	3,150
BRACES	TENSION	COMPRESSION
B1-B4	400	400
C1-C8	350	250
D1-D8	600	400

For 5/8" grade 55 threaded rods, verify allowable compressive forces for lengths of 24", 16" and 12".

Minor diameter: $d := 0.517\ in$ $\quad F_y := 55\ ksi$ $\quad E := 29000\ ksi$

Area: $A_{rod} := \frac{\pi \cdot d^2}{4} = 0.210\ in^2$ $\quad$ Radius of Gyration: $r := \frac{d}{4} = 0.129\ in$

For: $L := 24\ in$ $\quad 4.71 \cdot \sqrt{\frac{E}{F_y}} = 108.153$ $\quad K := 1.0$ $\quad \frac{K \cdot L}{r} = 185.687$ >108.15

Then: $F_e := \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L}{r}\right)^2} = 8301.114\ psi$ $\quad F_{cr} := 0.877 \cdot F_e = 7280.077\ psi$

$\Omega := 1.67$ $\quad \Omega P_n := \frac{F_{cr} \cdot A_{rod}}{\Omega} = 915.146\ lbf$ >850 lbf ∴ OK

For: $L := 16\ in$ $\quad K := 1.0$ $\quad \frac{K \cdot L}{r} = 123.791$ >108.15

Then: $F_e := \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L}{r}\right)^2} = 18677.506\ psi$ $\quad F_{cr} := 0.877 \cdot F_e = 16380.173\ psi$

$\Omega P_n := \frac{F_{cr} \cdot A_{rod}}{\Omega} = 2059.079\ lbf$ >2,050 lbf ∴ OK

For: $L := 12\ in$ $\quad K := 1.0$ $\quad \frac{K \cdot L}{r} = 92.843$ <108.15

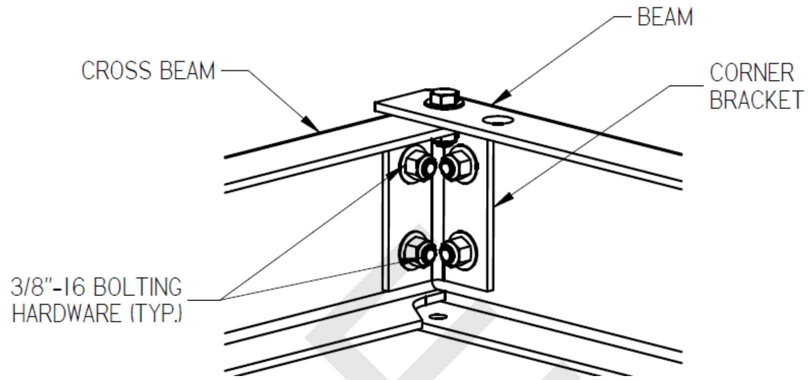
Then: $F_e := \frac{\pi^2 \cdot E}{\left(\frac{K \cdot L}{r}\right)^2} = 33204.455\ psi$ $\quad F_{cr} := \left(0.658^{\frac{F_y}{F_e}}\right) F_y = 27496.112\ psi$

$\Omega P_n := \frac{F_{cr} \cdot A_{rod}}{\Omega} = 3456.414\ lbf$ >3,150 lbf ∴ OK

Then, hangers S1-S10 may have unbraced lengths of up to L=24", and all other hangers may have unbraced lengths of up to L=12" or 16". If the installation hanger length exceed this value, the threaded rods must be suitable stiffened to achieve the design compressive capacity.

6.2. Cross Beam Bolted Connections

The cross beam bolted connection consists of (3) 3/8” bolts – (2) bolts connecting the cross beam and main beams via an angle corner bracket and (1) bolt through the top flanges. The peak reaction (LC3c) in the FEA model is as follows.



T= -292lbf   Vz= -690.0lbf   Vy= 117.2lbf
Mz= 604.3 lbf*in   My= 2151.2 lbf*in

Check the 3-bolt connection for shear and bending. The bending moment will cause the top flange bolt to engage in shear, and pivot from the lower bolt. The distance between these bolts is 3.25in. Then, we can calculate the peak bolt shear as:

$$P := -292\ lbf \quad V_z := -690\ lbf \quad V_y := 117.2\ lbf \quad M_y := 2151.2\ lbf \cdot in \quad M_z := 604.3\ lbf \cdot in$$

$$x_b := 3.25\ in \quad n := 3 \quad V_{bolt} := \frac{\sqrt{P^2 + V_z^2}}{n} + \frac{M_y}{x_b} = 911.7\ lbf$$

By observation, the 3/8-16 grade 5 bolts have ample capacity for calculated loads. Check the bearing shear strength in the connected plies of 3/16” thick 5052-H32 aluminum per Aluminum Design Manual section J3.7:

$$D := 0.375\ in \quad d_e := 1\ in \quad t := 0.188\ in \quad F_u := 31000\ psi \quad \Omega := 1.95$$

$$R_n := min\left(d_e \cdot t \cdot F_u, 2 \cdot D \cdot t \cdot F_u\right) = 4371.000\ lbf \qquad R_{n\_\Omega} := \frac{R_n}{\Omega} = 2241.54\ lbf$$

>>V_bolt ∴ OK

6.3. Brace Bolted Connections

Similar to section 6.2, the brace bolted connection consists of (2) 3/8” bolts connecting the brace to the cross beam and main beams via a bent flange and a bolt through the top flanges (at cross brace only). The peak reaction (LC3c) in the FEA model is as follows.

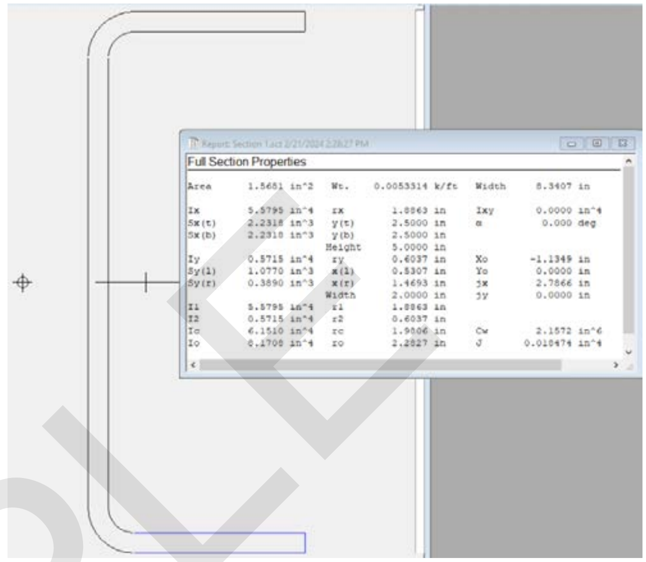
T= 74.1 lbf   Vz= 39.7 lbf   Vy= 1.0 lbf   Mz= 1.9 lbf*in   My= 405.1 lbf*in

Then, we can calculate the peak bolt shear as:

$$P := 74.1\ lbf \quad V_z := 39.7\ lbf \quad V_y := 1.0\ lbf \quad M_y := 405.1\ lbf \cdot in \quad M_z := 1.9\ lbf \cdot in$$

$$x_b := 2.0\ in \quad n := 2 \quad V_{bolt} := \frac{\sqrt{P^2 + V_z^2}}{n} + \frac{M_y}{x_b} = 244.6\ lbf$$

6.4. Beam Lateral-Torsional Buckling



The C5x2 primary beams are laterally braced at max 4 ft o/c, and as open structural shapes are required to be checked for lateral torsional buckling in flexure per the *Aluminum Design Manual* section F4.2.1.

$L_b := 48\ in \quad C_b := 1.0 \quad \Omega_b := 1.65 \quad E := 10100\ ksi \quad d := 5\ in$

$I_y := 0.5715\ in^4 \quad S_x := 2.2318\ in^3 \quad J := 0.018474\ in^4 \quad C_W := 2.1572\ in^6$

$$r_{ye} := \sqrt{\frac{\sqrt{I_y}}{S_x} \cdot \sqrt{C_W + 0.038 \cdot J \cdot L_b^2}} = 0.811\ in \qquad (F4.2.1b)$$

$F_{ty} := 23\ ksi \quad F_{cy} := 0.9\ F_{ty} = 20.7\ ksi \quad \kappa := 1.0\ ksi \quad \lambda := \frac{L_b}{r_{ye} \cdot \sqrt{C_b}} = 59.17$

$$B_c := F_{cy} \cdot \left(1 + \left(\frac{F_{cy}}{1000\ \kappa}\right)^{\frac{1}{2}}\right) = 23678.2\ psi \qquad D_c := \frac{B_c}{20} \cdot \left(\frac{6\ B_c}{E}\right)^{\frac{1}{2}} = 140.4\ psi$$

$$C_c := \frac{2\ B_c}{3\ D_c} = 112.42 \qquad \frac{L_b}{r_{ye} \cdot \sqrt{C_b}} = 59.17$$

<Cc ∴ use limit state of inelastic buckling

Then, since we are lower than the slenderness limit S2, use the limit state of inelastic buckling:

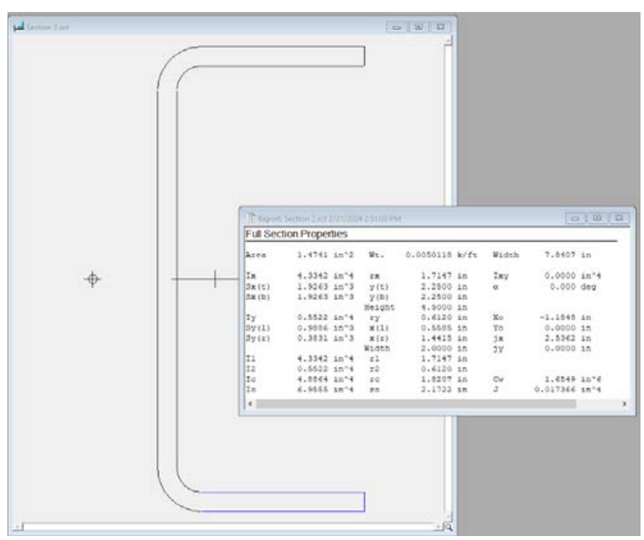
$$M_{np} := 1.5 \cdot S_c \cdot F_{cy} = 69297.4\ lbf \cdot in$$

$$M_{nmb} := M_{np} \cdot \left(1 - \frac{\lambda}{C_c}\right) + \frac{\pi^2 \cdot E \cdot \lambda \cdot S_c}{C_c^{\ 3}} = 42089.6\ lbf \cdot in$$

$$M_{nmb\Omega} := \frac{M_{nmb}}{\Omega} = 21584.4\ lbf \cdot in$$

From the FEA model, the C5x2 beams see a peak bending moment of **3,112 lbf*in** for load case LC3c, well within the allowable capacity.

6.5. Cross Beam Lateral-Torsional Buckling



The C4.5x2 cross beams are unbraced and span a max of 2 ft o/c, and are also required to be checked for lateral torsional buckling in flexure per the *Aluminum Design Manual* section F4.2.1. Then:

$L_b := 24\ in \quad C_b := 1.0 \quad \Omega_b := 1.65 \quad E := 10100\ ksi \quad d := 4.5\ in$

$I_y := 0.5522\ in^4 \quad S_x := 1.9263\ in^3 \quad J := 0.017366\ in^4 \quad C_W := 1.6549\ in^6$

$$r_{ye} := \sqrt{\frac{\sqrt{I_y}}{S_x} \cdot \sqrt{C_W + 0.038 \cdot J \cdot L_b^2}} = 0.742\ in \qquad (F4.2.1b)$$

$F_{ty} := 23\ ksi \quad F_{cy} := 0.9\ F_{ty} = 20.7\ ksi \quad \kappa := 1.0\ ksi \quad \lambda := \frac{L_b}{r_{ye} \cdot \sqrt{C_b}} = 32.35$

$$B_c := F_{cy} \cdot \left(1 + \left(\frac{F_{cy}}{1000\ \kappa}\right)^{\frac{1}{2}}\right) = 23678.2\ psi \qquad D_c := \frac{B_c}{20} \cdot \left(\frac{6\ B_c}{E}\right)^{\frac{1}{2}} = 140.4\ psi$$

$$C_c := \frac{2\ B_c}{3\ D_c} = 112.42 \qquad \frac{L_b}{r_{ye} \cdot \sqrt{C_b}} = 32.35$$

<Cc ∴ use limit state of inelastic buckling

Then, for the limit state of inelastic buckling:

$$M_{np} := 1.5 \cdot S_c \cdot F_{cy} = 69297.4\ lbf \cdot in$$

$$M_{nmb} := M_{np} \cdot \left(1 - \frac{\lambda}{C_c}\right) + \frac{\pi^2 \cdot E \cdot \lambda \cdot S_c}{C_c^{\ 3}} = 54420.8\ lbf \cdot in$$

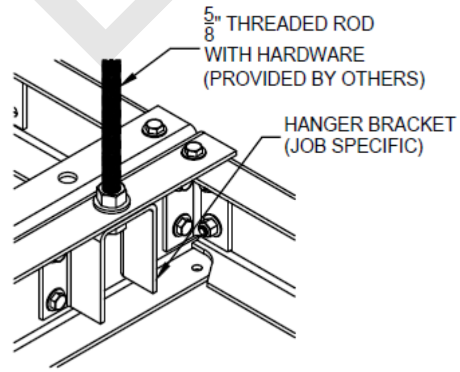
$$M_{nmb\Omega} := \frac{M_{nmb}}{\Omega} = 27908.1\ lbf \cdot in$$

From the FEA model, the C4.5x2 cross beams see a peak bending moment of **8,325.6 lbf*in** for load case LC3b, well within the allowable capacity.

6.6. Flange Bending at Hangers

The C5x2 primary beams are suspended with threaded rods with hanger positions denoted S1-S10. C4.5x2 cross beams located near hanger locations to brace the primary beams.

At hanger locations near boom mounts, the boom mount design moment induces higher hanger forces, and the hanger forces exceed the flange bending capacity of the cold formed beams. At these locations, formed reinforcing brackets are incorporated to connect the flange and web and reduce the flange bending stresses. The reinforcing brackets are placed within beam the upper flange, and are connected to the 5/8" hanger, and bolted to the beam web with (4) 3/8" bolts.



HANGER BRACKET (ISO VIEW)

A solid model was created to reproduce and test (4) condition at the hanger locations:

> **Model 1**. C5x2 with cross-beam, without reinforcing bracket, 450lbf in tension
> **Model 2**. C5x2 with cross-beam, without reinforcing bracket, 300lbf in compression
> **Model 3**. C5x2 with cross-beam, with reinforcing bracket, 1,100 lbf in tension
> **Model 4**. C5x2 with cross-beam, with reinforcing bracket, 850 lbf in compression

Figure 5 below shows the setup (Model 3):

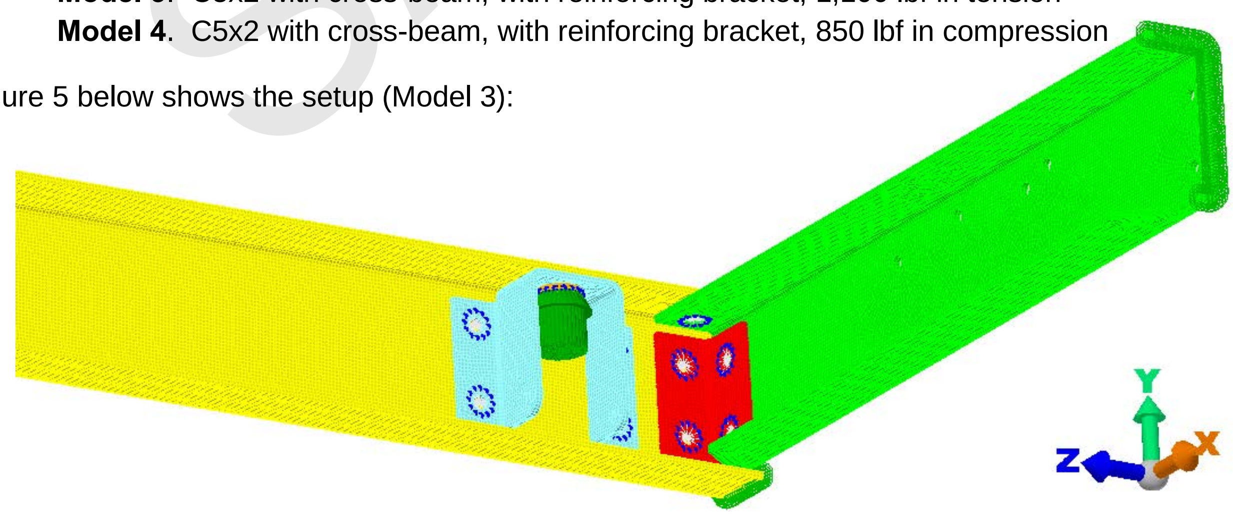


Figure 5. Model 3 setup (C5x2 beam with reinforcement, 1,100 lbf tension)

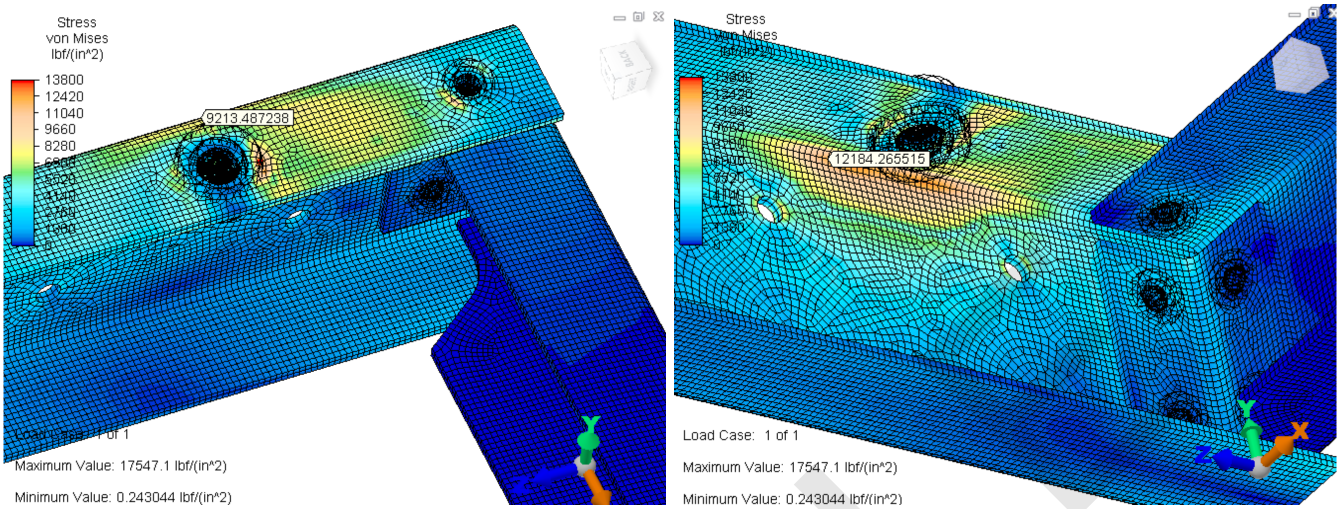


Figure 6. Model 1 FEA Results (C5x2 beam; no reinforcement; 450 lbf tension) von Mises stress

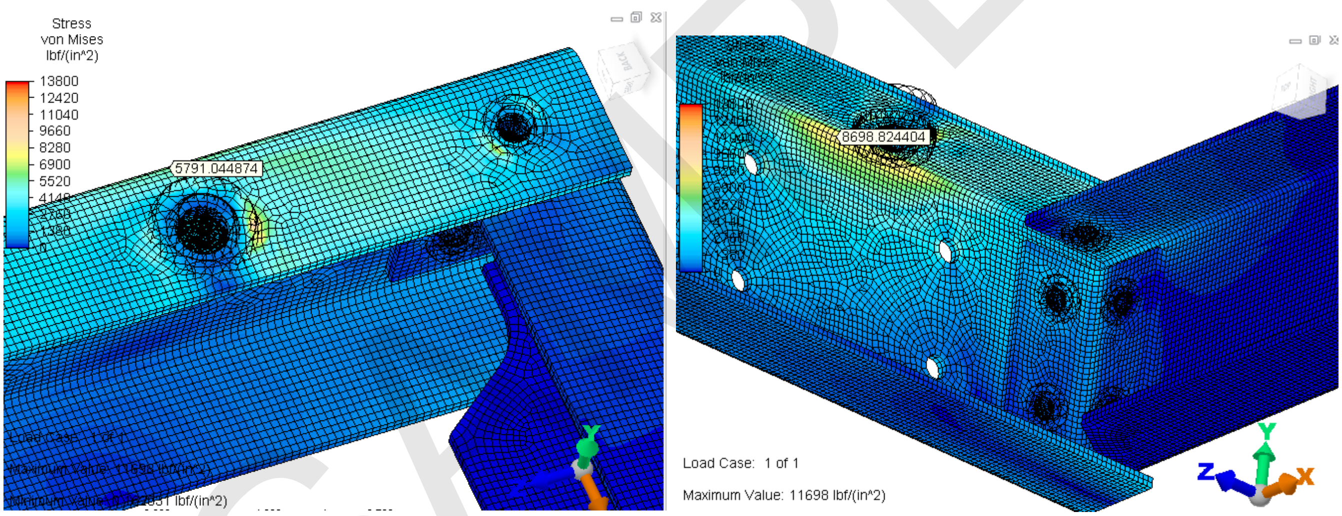


Figure 7. Model 2 FEA Results (C5x2 beam; no reinforcement; 300 lbf compression) von Mises stress

As can be seen in Figures 6 and 7, the flange bending von Mises stresses are less than the allowable stresses of 13,800 psi in the unreinforced condition, for hanger forces of +450lbf/-300 lbf.

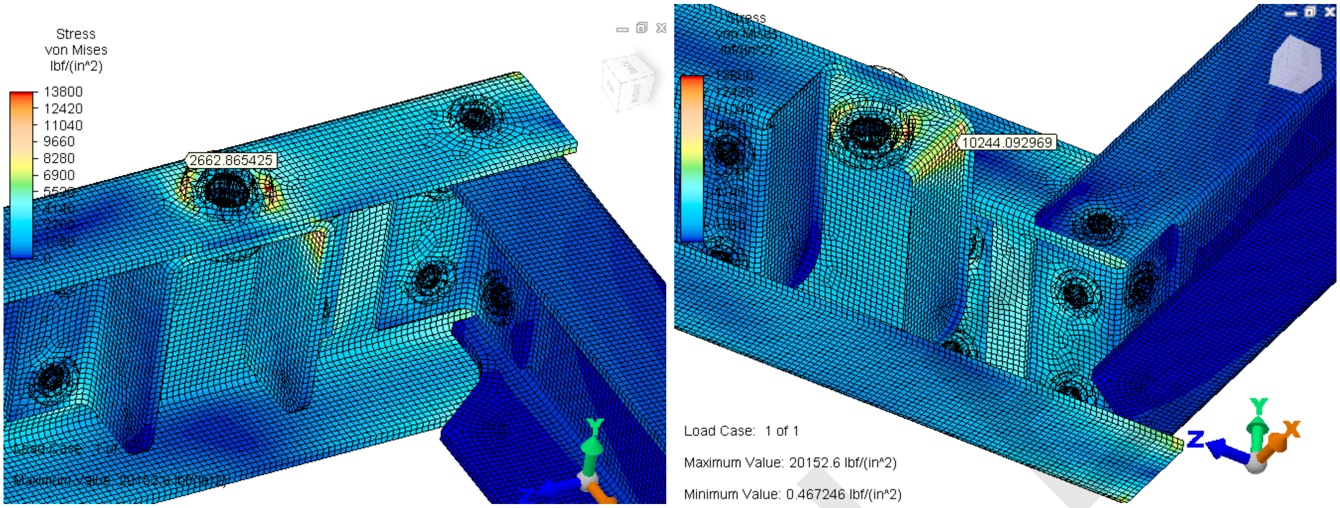


__Figure 8__. Model 3 FEA Results (C5x2 beam; with reinforcement; 1,100 lbf tension) von Mises stress

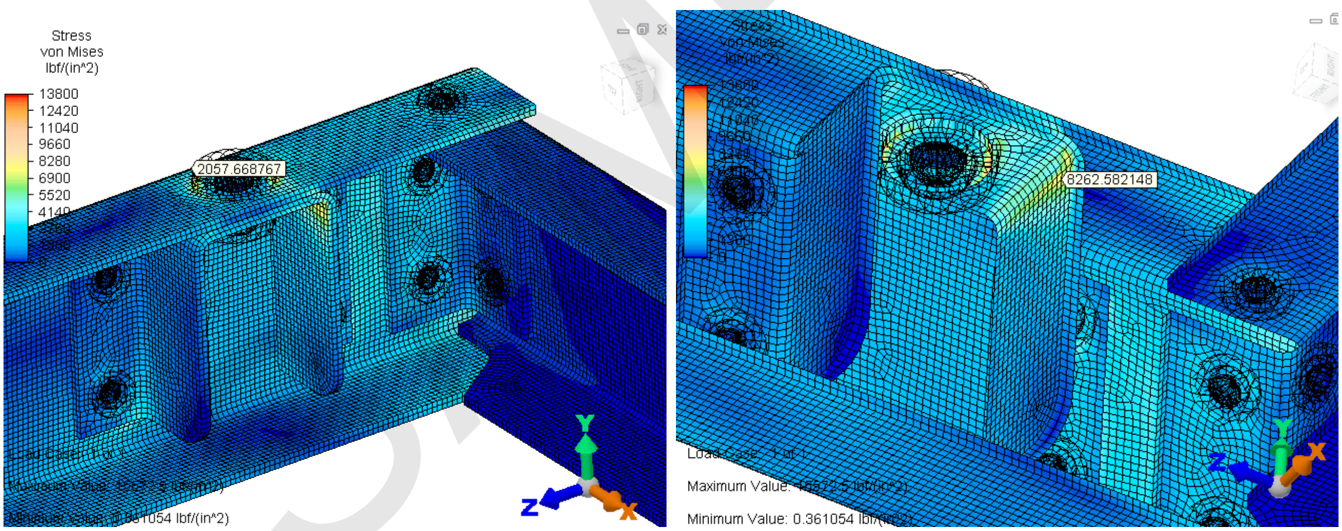


__Figure 9__. Model 4 FEA Results (C5x2 beam; no reinforcement; 850 lbf compression) von Mises stress

As can be seen in Figures 8 and 9, the von Mises stresses are lower than the allowable stresses of 13,800 psi in the unreinforced condition, for hanger forces of +1,100 lbf/-850 lbf.

APPENDIX A | BOOM MOUNT LIVE LOAD CASES

This section compares the structural system effects of varying boom orientations on all 4 booms. The controlling 3 configurations were selected for use in the structural load combinations.

NOTES:

- Single Boom Mounts have a nodal mass of 1,100 lbf applied at the tip of a rigid lever arm.
- Tandem boom mounts have a nodal mass of 2,200 lbf applied at the tip of a rigid lever arm.
- The modeled rigid lever arms are 61.64 inches long to produce the design moment and are oriented to produce the moments as tabulated below.

Load Case	Single Mnt.1	Single Mnt.2	Tandem Mnt.1	Tandem Mnt.2	C4.5x2 Worst Stress [psi]	C5x2 Worst Stress [psi]	Displacement [in]
D+L_mx	Mx+	Mx+	Mx+	Mx+	1809	1351	0.034
D+L_my	My+	My+	My+	My+	4253	1198	0.038
D+L_m*1	Mx+	Mx-	My+	My-	4194	1346	0.038
D+L_m*2	My+	My-	Mx-	Mx+	1695	1053	0.029
D+L_m*3	My-	My+	Mx+	Mx-	1972	1184	0.027
D+L_m*4	Mx+	Mx+	My+	My+	4246	1382	0.036
D+L_m*5	Mx+	Mx+	Mx-	Mx-	1826	1372	0.029

Related combined stresses are recorded for the C4.5x2x3/16 cross beams and C5x2x3/16 primary beams (spanning the width of the frame). As can be seen, there is a minimal variation in stress levels beyond what is captured in the “D+Lmx” and “D+Lmy” load cases. The third controlling case (L_m*) will be L_m*4. Refer to Figures 11-17 for a graphic representation of these load cases.

The displacement values shown in the above table only includes the peak displacement for frame members and the boom mount.

The following figures show the combined stresses of these beam elements and a visualized model with an artificially high displacement factor to aid in visualization of the structural motion.

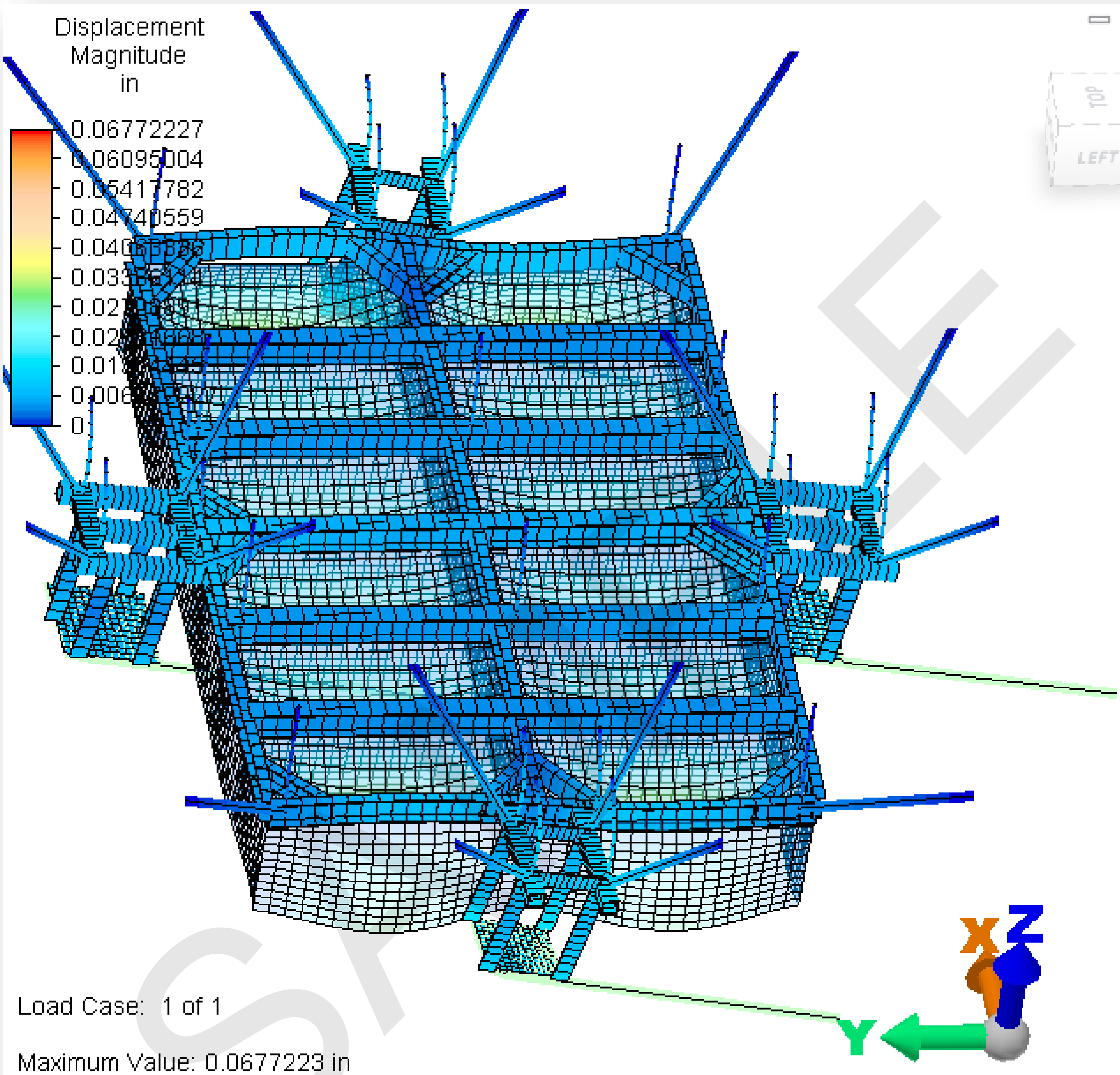
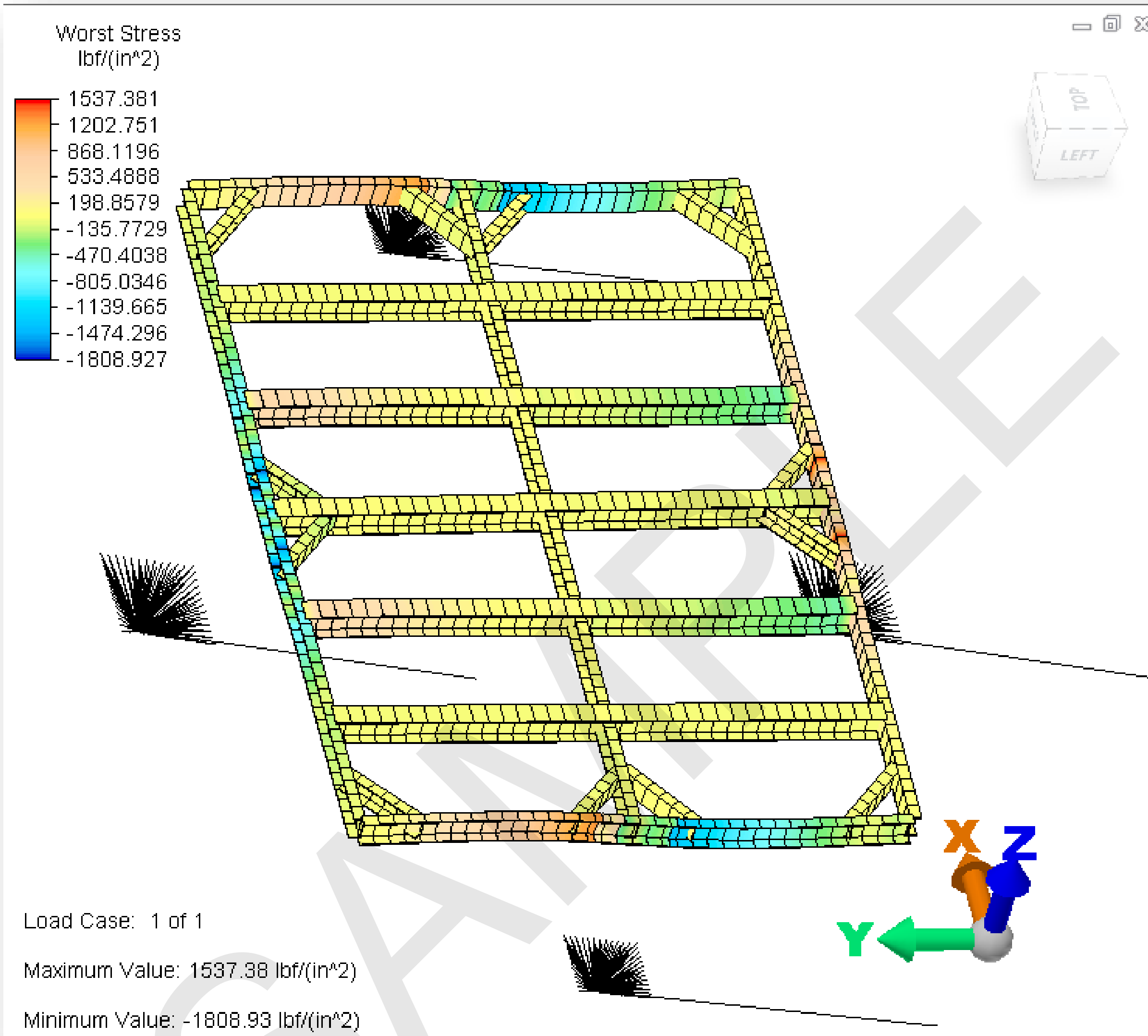


Figure 10. *Ultrasuite Frame Displacement (DL+L_mx)*



*<u>**Figure 11**</u>. Ultrasuite Aluminum Frame Stresses (DL+L_mx)*

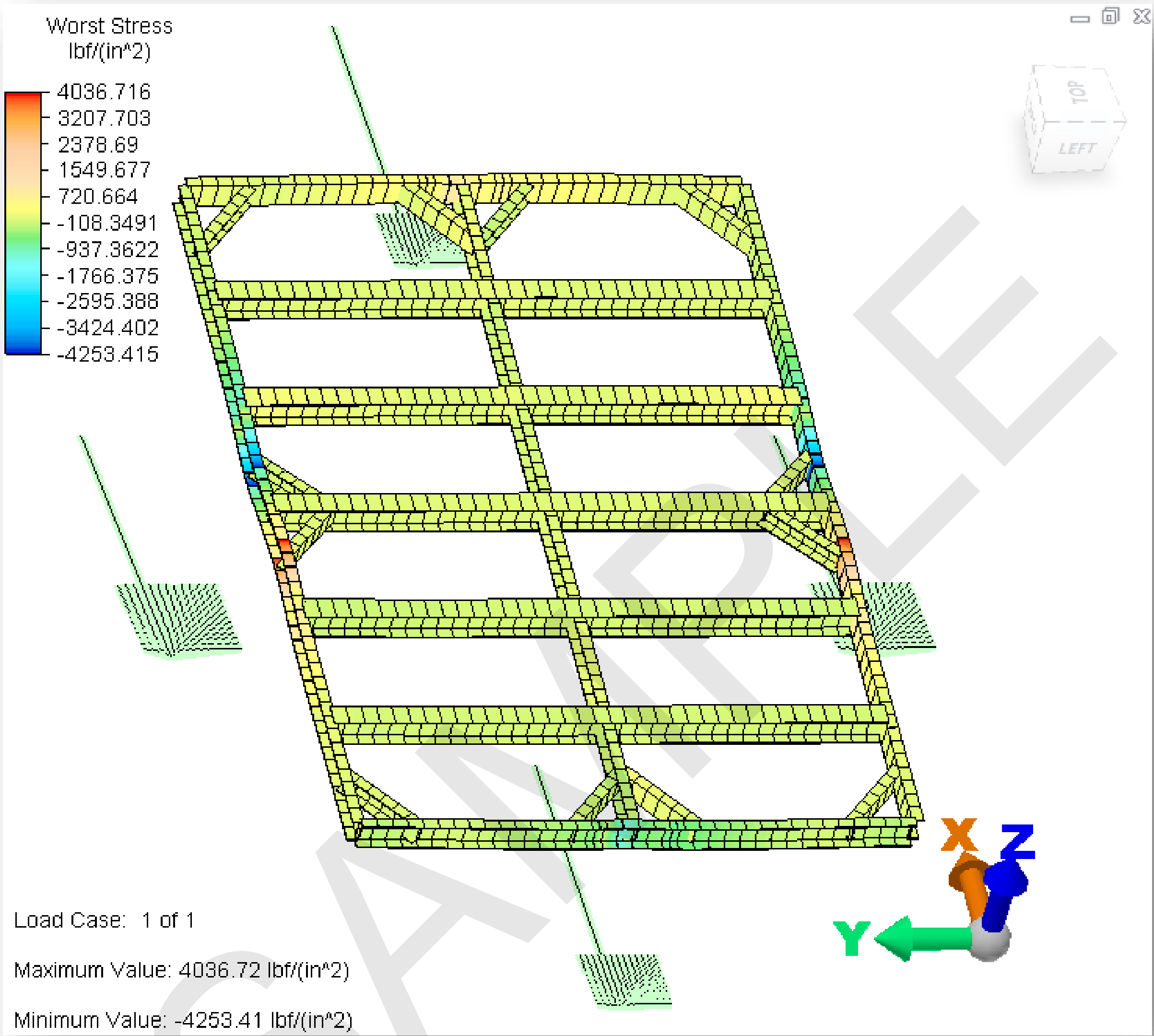


Figure 12. Ultrasuite Aluminum Frame Stresses (DL+L_my)

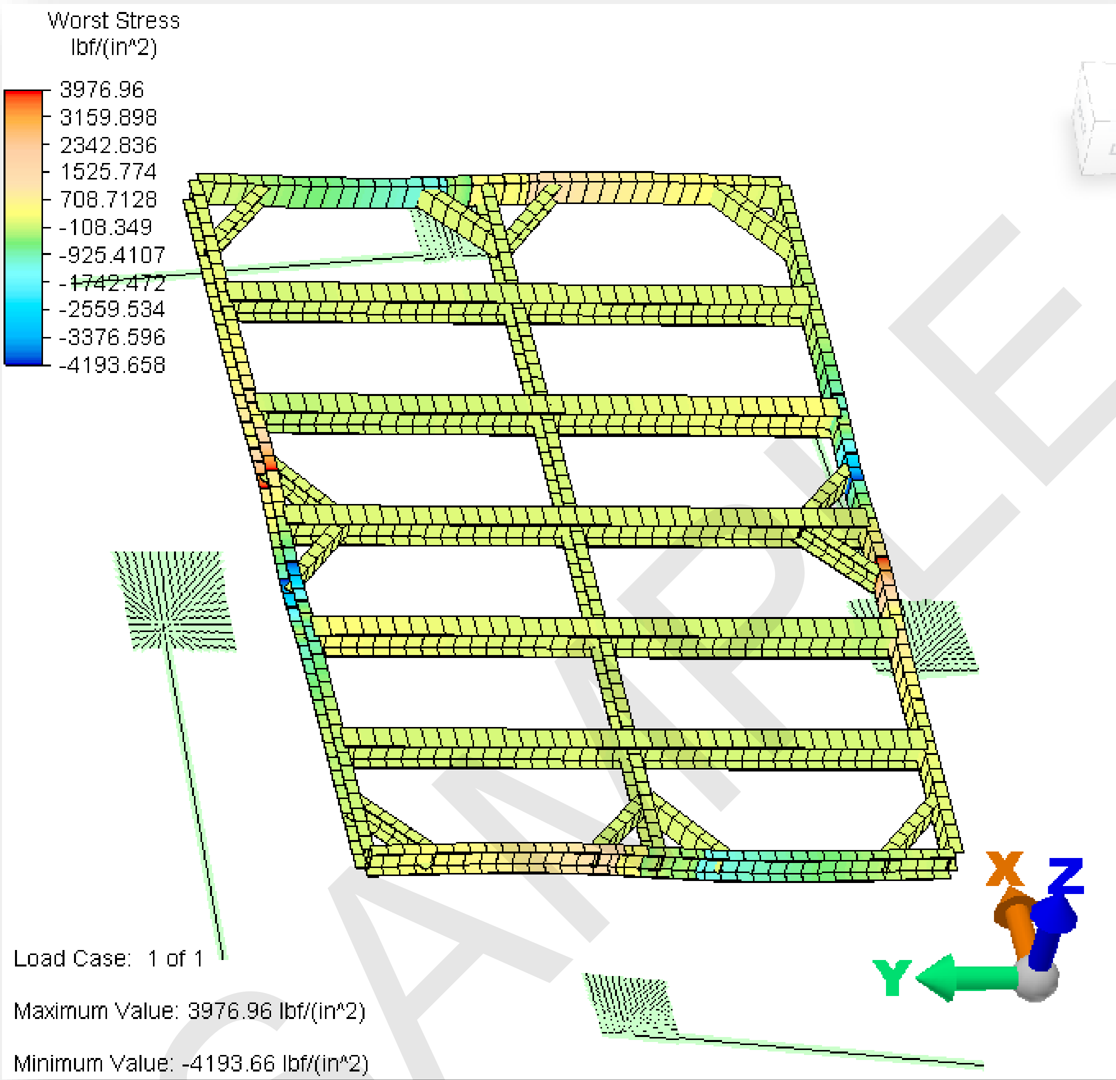


***Figure 13**. Ultrasuite Aluminum Frame Stresses (DL+L_m*1)*

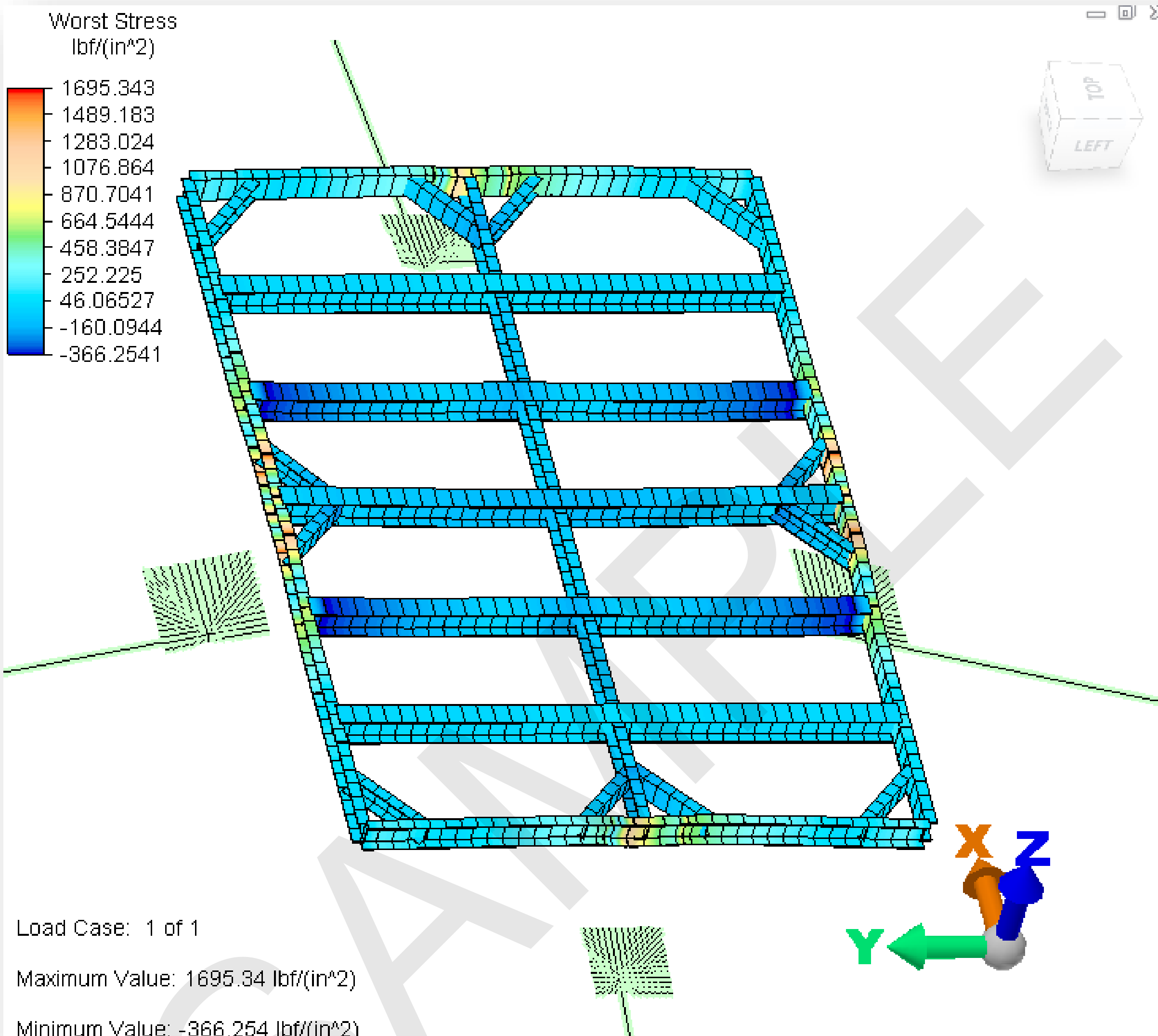


Figure 14*. Ultrasuite Aluminum Frame Stresses (DL+L_m*2)*

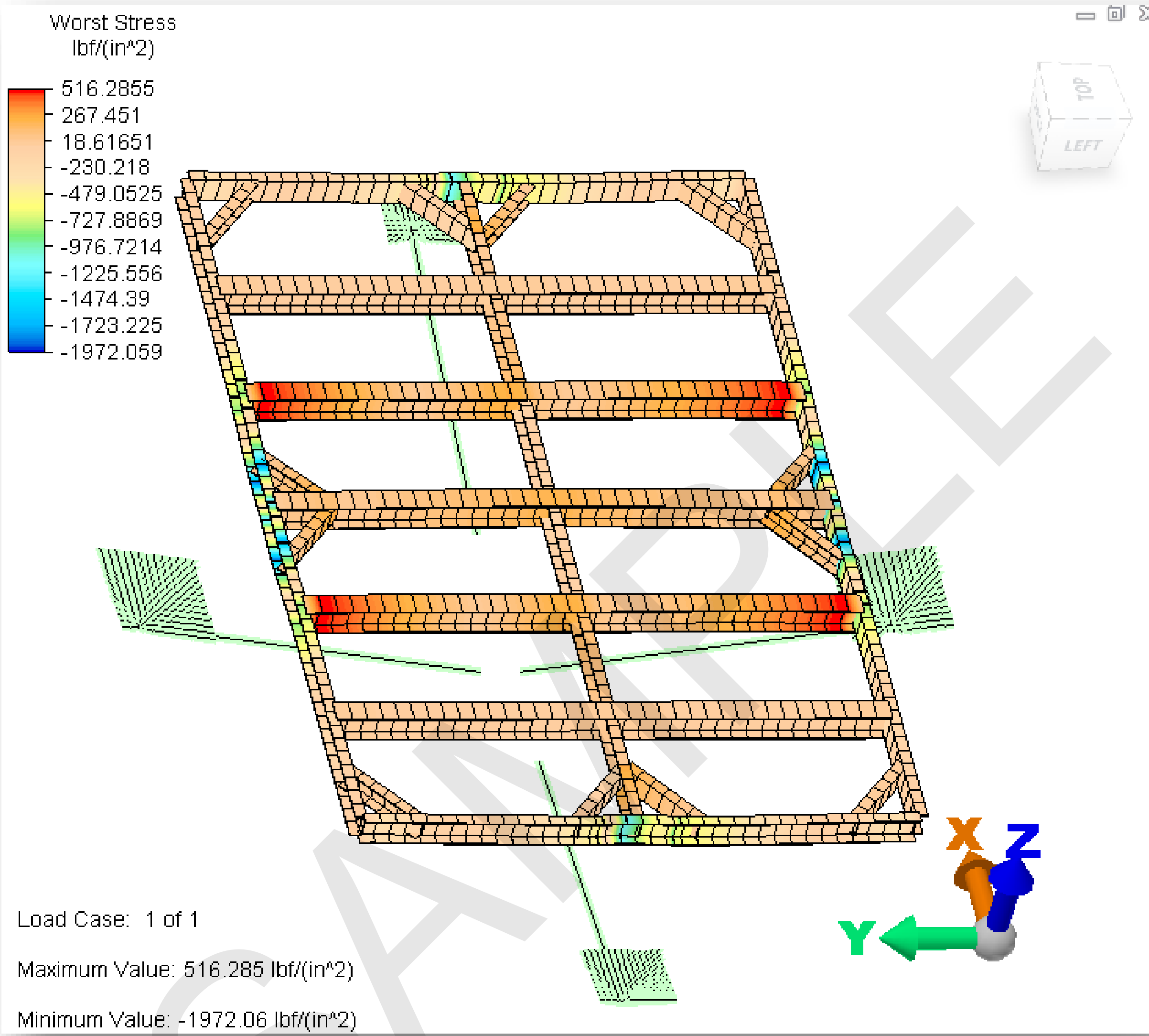


*Figure 15. Ultrasuite Aluminum Frame Stresses (DL+L_m*3)*

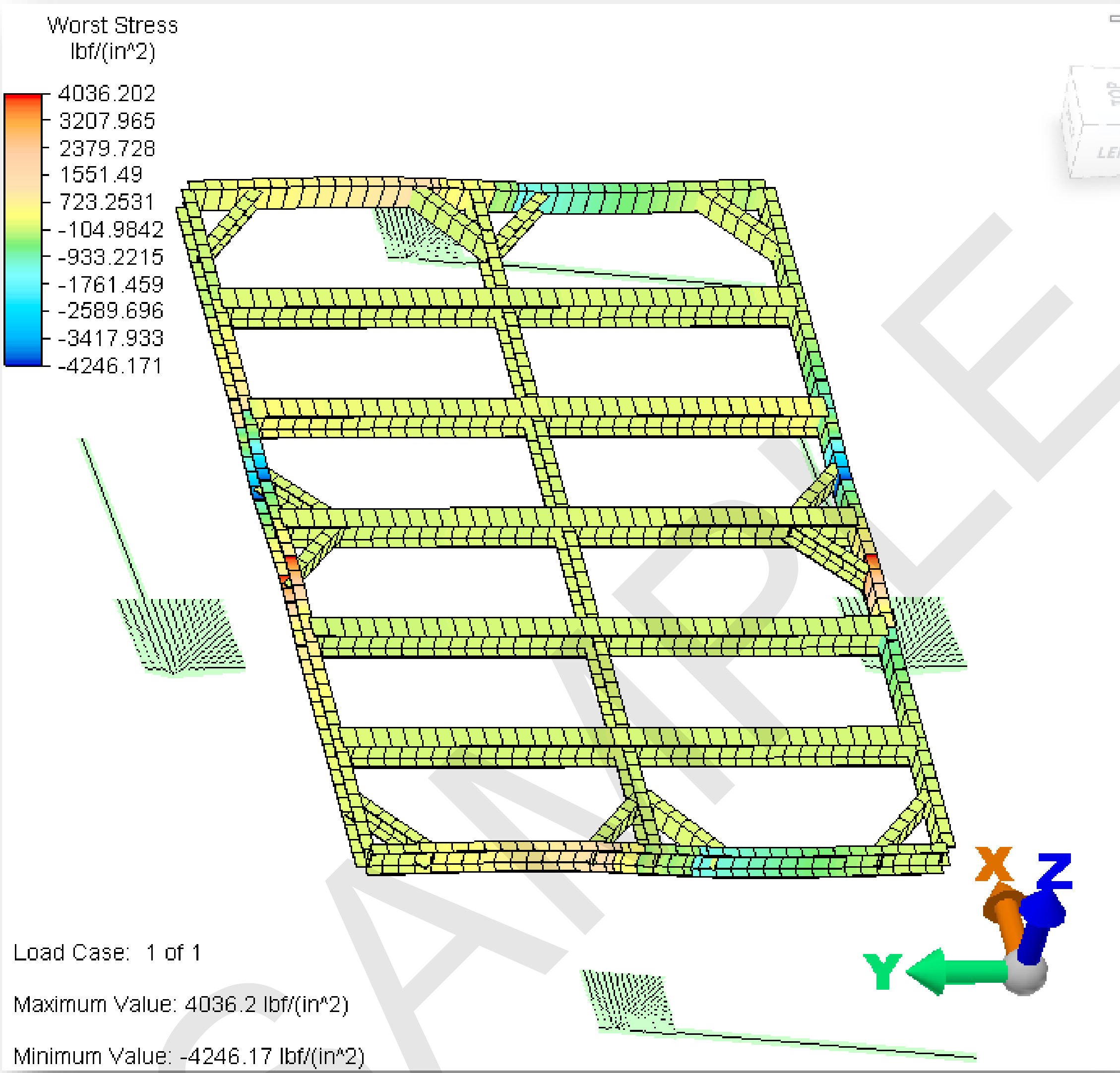


Figure 16*. Ultrasuite Aluminum Frame Stresses (DL+L_m*4)*

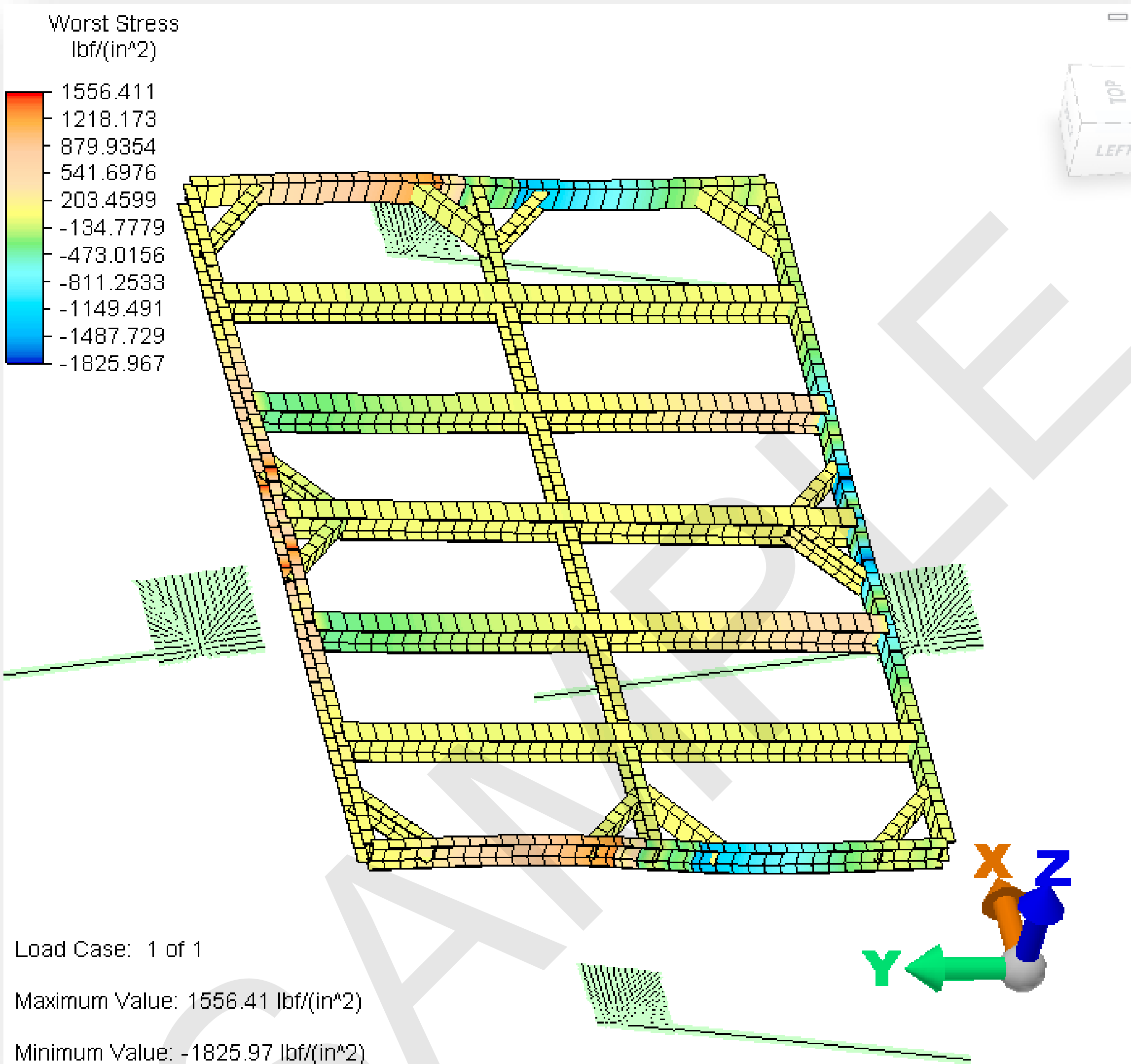


***Figure 17**. Ultrasuite Aluminum Frame Stresses (DL+L_m*5)*

APPENDIX B | HANGER/BRACE REACTIONS

Load Comb.	HANGER REACTIONS (Axial Load*) lbf									
	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10
LC1	51.2	79.6	79.6	51.2	118.4	118.4	51.3	72.5	72.5	51.3
LC3a	-195.7	1,092.1	1,092.1	-195.7	158.9	158.9	337.8	-818.1	-818.1	337.8
LC3b	312.0	-109.7	395.0	-169.7	354.3	-43.5	312.2	-131.2	397.9	-169.7
LC3c	-280.0	-217.0	521.9	29.7	94.8	215.7	112.8	-242.1	489.4	422.6
LC8'a	103.9	160.1	160.1	103.9	123.8	123.8	4.4	1.9	1.9	4.4
LC8'b	153.4	66.5	103.0	-45.1	145.7	101.4	153.5	57.7	97.0	-45.0
LC9'a	-94.4	899.4	899.4	-94.4	152.9	152.9	231.0	-648.4	-648.4	231.0
LC9'b	323.5	-72.2	333.8	-186.7	315.8	-15.8	323.6	-91.4	334.9	-186.7
LC9'c	-157.7	-82.5	471.7	74.6	104.7	195.5	62.2	-216.4	332.2	294.6
LC10'a	77.6	118.0	118.0	77.6	66.1	66.1	-22.0	-36.8	-36.8	-22.0
LC10'b	127.0	24.3	60.9	-71.4	88.0	43.7	127.1	19.0	58.3	-71.4
Minimum	-280.0	-217.0	60.9	-195.7	66.1	-43.5	-22.0	-818.1	-818.1	-186.7
Maximum	323.5	1,092.1	1,092.1	103.9	354.3	215.7	337.8	72.5	489.4	422.6

*Hangers are modelled vertically with 24” length; +/- values indicate tension/compression respectively

Load Comb.	HANGER REACTIONS (Axial Load*) lbf									
	S11	S12	S13	S14	S15	S16	S17	S18	S19	S20
LC1	15.8	64.3	15.8	64.3	40.2	40.2	69.1	69.1	64.3	15.8
LC3a	-1,891.3	-1,724.5	2,395.4	2,231.7	-3,103.2	-3,103.2	3,306.5	3,306.5	-1,724.5	-1,891.3
LC3b	-2,036.8	2,050.4	-2,036.8	2,050.4	-2,959.9	3,967.2	-2,626.1	3,507.1	-1,542.9	2,540.7
LC3c	-1,901.6	-1,704.0	2,342.8	2,211.4	-2,963.7	3,941.4	-2,606.7	3,511.1	-1,703.9	-1,838.9
LC8'a	-145.7	-85.5	191.9	229.5	-220.9	-220.9	298.0	298.0	-85.5	-145.7
LC8'b	-154.5	212.9	-154.5	212.9	-245.8	355.7	-184.5	349.1	-68.8	200.7
LC9'a	-1,535.7	-1,389.6	1,932.5	1,813.7	-2,513.2	-2,513.2	2,668.8	2,668.8	-1,389.6	-1,535.7
LC9'b	-1,651.4	1,665.3	-1,651.4	1,665.3	-2,424.4	3,222.1	-2,142.5	2,857.7	-1,240.9	2,048.2
LC9'c	-1,543.3	-1,374.3	1,893.1	1,798.6	-2,408.6	2,770.3	-1,766.1	2,822.3	-1,374.2	-1,496.3
LC10'a	-166.6	-126.7	170.9	188.3	-266.5	-266.5	243.9	243.9	-126.7	-166.6
LC10'b	-175.5	171.7	-175.5	171.7	-291.4	310.2	-238.6	295.0	-110.0	179.8
Minimum	-2,036.8	-1,724.5	-2,036.8	64.3	-3,103.2	-3,103.2	-2,626.1	69.1	-1,724.5	-1,891.3
Maximum	15.8	2,050.4	2,395.4	2,231.7	40.2	3,967.2	3,306.5	3,511.1	64.3	2,540.7

*Hangers are modelled vertically with 24” length; +/- values indicate tension/compression respectively

Load Comb.	HANGER REACTIONS (Axial Load*) lbf					
	S21	S22	S23	S24	S25	S26
LC1	64.3	15.8	69.3	69.3	40.1	40.1
LC3a	2,231.7	2,395.4	-2,425.9	-2,425.9	4,110.4	4,110.4
LC3b	-1,542.9	2,540.7	-2,625.4	3,507.1	-2,959.8	3,966.8
LC3c	2,211.5	2,405.5	-2,629.8	3,488.2	-2,934.4	3,970.9
LC8'a	229.5	191.9	-133.2	-133.2	330.8	330.8
LC8'b	-68.8	200.7	-184.3	349.3	-245.9	355.6
LC9'a	1,813.7	1,932.5	-1,954.0	-1,954.0	3,310.8	3,310.8
LC9'b	-1,240.9	2,048.2	-2,141.9	2,857.7	-2,424.3	3,221.8
LC9'c	1,798.7	1,940.1	-2,106.9	2,481.6	-1,972.8	3,206.2
LC10'a	188.3	170.9	-187.4	-187.4	285.2	285.2
LC10'b	-110.0	179.8	-238.5	295.1	-291.4	310.1
Minimum	-1,542.9	15.8	-2,629.8	-2,425.9	-2,959.8	40.1
Maximum	2,231.7	2,540.7	69.3	3,507.1	4,110.4	4,110.4

*Hangers are modelled vertically with 24" length; +/- values indicate tension/compression respectively

Load Comb.	BRACE REACTIONS (Axial Load*) lbf									
	B1	B2	B3	B4	C1	C2	C3	C4	C5	C6
LC1	7.5	7.5	7.4	7.4	8.7	16.6	8.7	16.5	16.6	8.7
LC3a	267.2	267.2	-246.0	-246.0	15.7	40.5	146.4	121.8	40.5	15.7
LC3b	386.3	-365.1	386.3	-365.1	-42.2	46.6	-42.3	46.5	115.9	204.3
LC3c	345.9	-107.2	128.4	-324.7	51.8	-76.7	251.9	75.2	87.3	-89.8
LC8'a	-114.1	-114.1	129.8	129.8	-177.5	-165.2	199.6	203.2	-165.2	-177.5
LC8'b	-126.3	142.1	-126.4	142.1	-211.4	230.3	-211.4	230.3	-192.3	233.5
LC9'a	111.1	111.1	-90.9	-90.9	-125.7	-101.8	255.2	235.5	-101.8	-125.7
LC9'b	191.3	-170.9	191.2	-171.0	-194.6	199.4	-194.7	199.3	-65.6	324.1
LC9'c	170.1	-169.7	190.0	-149.8	-98.6	-189.7	334.3	200.5	-66.7	-204.8
LC10'a	-117.9	-117.9	126.0	126.0	-185.7	-176.8	191.4	191.7	-176.8	-185.7
LC10'b	-130.2	138.3	-130.2	138.3	-219.7	218.8	-219.7	218.8	-203.8	225.3
Minimum	-130.2	-365.1	-246.0	-365.1	-219.7	-189.7	-219.7	16.5	-203.8	-204.8
Maximum	386.3	267.2	386.3	142.1	51.8	230.3	334.3	235.5	115.9	324.1

*Braces are modelled at a 45 degree angle to a horizontal plane; brace forces will vary with the angle of installation; +/- values indicate tension/compression

Load Comb.	BRACE REACTIONS (Axial Load*) lbf									
	C7	C8	D1	D2	D3	D4	D5	D6	D7	D8
LC1	16.5	8.7	14.3	14.3	20.3	20.3	20.3	20.3	14.4	14.4
LC3a	121.8	146.4	-60.7	-60.7	127.2	127.2	163.7	163.7	378.1	378.1
LC3b	115.9	204.4	-37.9	355.2	-15.2	306.3	-15.3	306.3	-37.9	355.4
LC3c	239.1	110.2	-40.4	402.2	-78.0	321.4	-30.3	369.1	-84.8	357.8
LC8'a	203.2	199.6	-367.0	-367.0	392.1	392.1	-342.7	-342.7	405.1	405.1
LC8'b	-192.3	233.5	-327.4	365.4	-307.7	357.1	-307.7	357.1	-327.4	365.5
LC9'a	235.5	255.2	-328.0	-328.0	379.3	379.3	-144.4	-144.4	580.2	580.2
LC9'b	-65.6	324.1	-281.1	533.3	-252.3	487.4	-252.4	487.4	-281.2	533.5
LC9'c	323.5	228.0	-312.8	19.2	225.4	524.9	-289.9	9.6	233.0	565.0
LC10'a	191.7	191.4	-382.1	-382.1	375.3	375.3	-359.6	-359.6	390.0	390.0
LC10'b	-203.8	225.3	-342.5	350.4	-324.5	340.3	-324.6	340.3	-342.5	350.4
Minimum	-203.8	8.7	-382.1	-382.1	-324.5	20.3	-359.6	-359.6	-342.5	14.4
Maximum	323.5	324.1	14.3	533.3	392.1	524.9	163.7	487.4	580.2	580.2

*Braces are modelled at a 45 degree angle to a horizontal plane; brace forces will vary with the angle of installation; +/- values indicate tension/compression