中央研究院
天文及天文物理研究所
ACADEMIA SINICA
Institute of Astronomy and Astrophysics

GLT Antenna Cabling System for March 2017 Shipment

- Power Entry – Support Cone, Az-Wrap, LSC, RSC
- Panelboards – LSC, RSC
- Grounding – LSC, RSC
- Fiber Optics – Support Cone, Az-Wrap, LSC, RSC, Receiver Cabin
- Cable Glands -
- Elevation Wrap –
- Vertex Servo System –
- Helium Lines – and M&C
- Menerga HVAC cables – Power, M&C, Glycol Lines

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GLT Antenna Cabling System

- ASIAA is currently working with NCSIST/ICP to define the technical details of the Cabling System
- Challenges
  - Large number of cables and associated hardware
  - Distribution of responsibilities across multiple organizations, ASIAA, ICP, ARL, ESAN
  - -65 C environmental specification
  - Initial deployment in Thule
  - Redeployment from Thule to Summit Station requires partial disassembly/reassembly of the telescope
- Near term NCSIST deliverables for heavy shipment in March 2017
  - Power and Ground Subsystem
    - 480 VAC power to LSC, RSC, Receiver Cabin
    - 208 VAC “clean” power to LSC, Receiver Cabin
    - 208 VAC “dirty” power to LSC, RSC, Receiver Cabin
  - Fiber Optic Subsystem
    - Support Cone to LSC, RSC, and Receiver Cabin
    - Includes LO fiber optic cable through Az and El wraps and torque tubes
  - Signal and M&C Cabling
    - CAT5E, RG-58U between Receiver Cabin and LSC/RSC
    - Menerga M&C Cabling from LSC to Receiver Cabin and Outdoor Unit (details TBD)
    - Vertex M&C Cabling from RSC to Support Cone, LSC, Receiver Cabin, Dish, … (details TBD)

GLT Antenna Cabling System – Power Entry

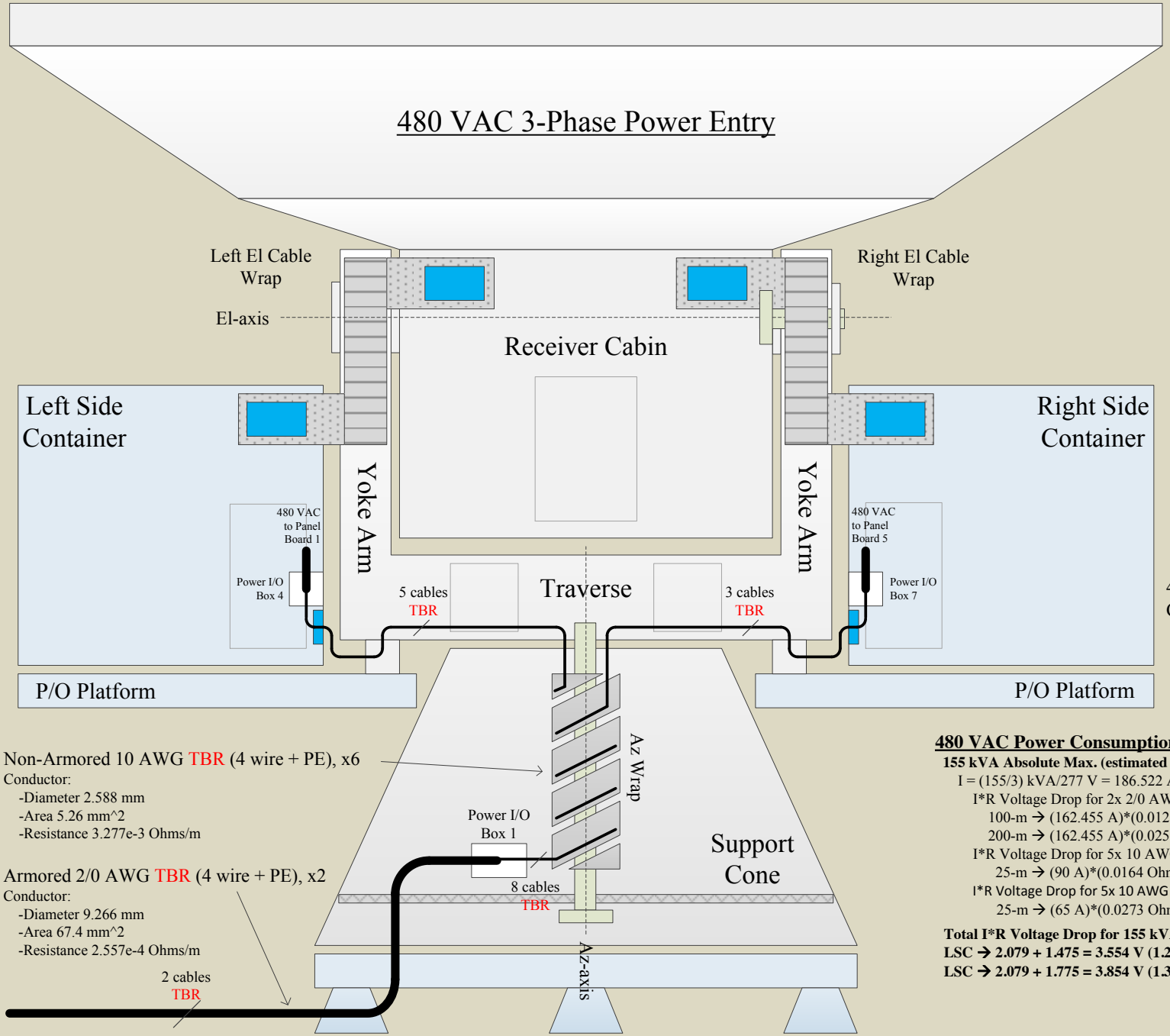
Power Entry into Support Cone, Azimuth Wrap, LSC, and RSC

- Wire gauges (and circuit breakers) shown below are based on maximum loads to support full power for each subsystem
  - ESAN HVACs in LSC and RSC
  - Menerga HVAC for Receiver Cabin
  - Deice for Primary Dish
- Nominal power consumption has been calculated to be 55 kVA (TBR) at Summit Station with all instruments active
  - Actual power consumption will likely be less
  - Theoretical absolute maximum power consumption is 195 kVA (TBR) but will never occur in practice
- 480 VAC 3-Phase Power (160 kVA abs max, 35 kVA nom TBR)
  - Non-UPS to support high transient current draw from compressors
  - Two (2) Armored 2/0-AWG (TBR) 5-wire cables from Substation to Support Cone
  - Eight (8) separate 10-AWG (TBR) 5-wire cables through Azimuth Wrap
    - Multiple smaller gauge cables required for bending movement in Azimuth Wrap
    - Five (5) (TBR) cables from Support Cone to LSC (Panelboard-1)
    - Three (3) (TBR) cables from Support Cone to RSC (Panelboard-5)

GLT Antenna Cabling System – Power Entry

- Power Entry (continued)
  - 208 VAC 3-Phase "Clean" Power (10 kVA abs max, 5 kVA nom TBR)
    - UPS at Substation (no compressors permitted on this supply)
    - One (1) Armored 1/0-AWG cable from Power Substation to Support Cone
    - Two (2) 10-AWG 5-wire cables through Azimuth Wrap
      - Two (2) cables from Support Cone to Left Side Container (Panelboard-2)
  - 208 VAC 3-Phase "Dirty" Power (25 kVA abs max, 15 kVA nom TBR)
    - UPS at Substation (no compressors permitted on this supply)
    - Two (2) Armored 1/0-AWG (TBR) 5-wire cables from Substation to Support Cone
    - Six (6) 10-AWG (TBR) 5-wire cables through Azimuth Wrap
      - Three (3) cables from Support Cone to LSC (Panelboard-1)
      - Three (3) cables from Support Cone to RSC (Panelboard-5)

480 VAC 3-Phase Power Entry



480 VAC NEC Color Code:
- Line-1 (brown)
- Line-2 (orange)
- Line-3 (yellow)
- Neutral (gray)
- Protective Earth (green)

Non-Armored 10 AWG TBR (4 wire + PE), x6
Conductor:
- -Diameter 2.588 mm
- -Area 5.26 mm^2
- -Resistance 3.277e-3 Ohms/m

Armored 2/0 AWG TBR (4 wire + PE), x2
Conductor:
- -Diameter 9.266 mm
- -Area 67.4 mm^2
- -Resistance 2.557e-4 Ohms/m

480 VAC Power Consumption:

155 kVA Absolute Max. (estimated for sizing wire gauge)

I = (155/3) kVA/277 V = 186.522 A/phase

I*R Voltage Drop for 2x 2/0 AWG:
- 100-m → (162.455 A)*(0.0128 Ohm) = 2.079 V (0.75%)
- 200-m → (162.455 A)*(0.0256 Ohm) = 4.158 V (1.50%)

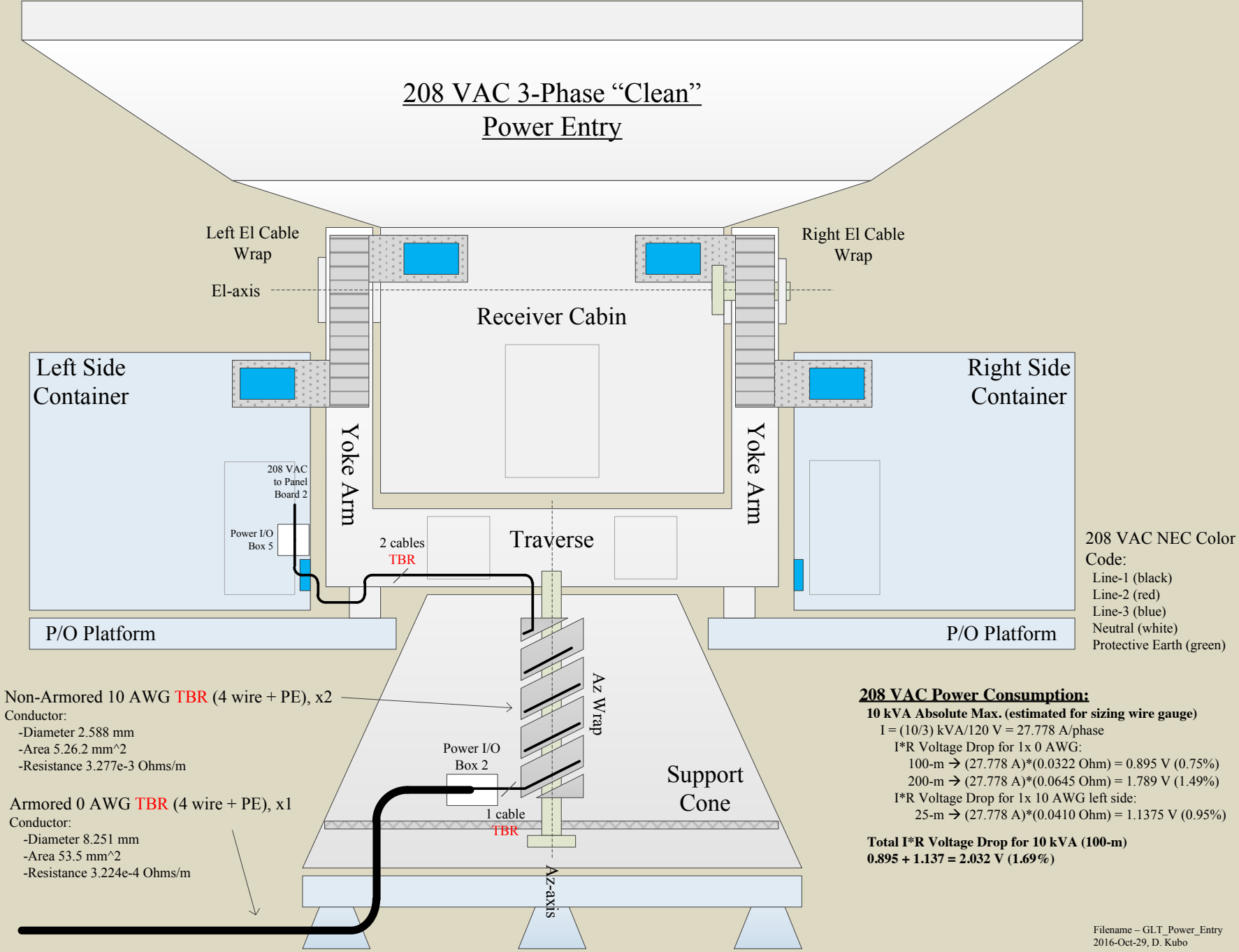
I*R Voltage Drop for 5x 10 AWG LSC:
- 25-m → (90 A)*(0.0164 Ohm) = 1.475 V (0.53%)

I*R Voltage Drop for 5x 10 AWG LSC:
- 25-m → (65 A)*(0.0273 Ohm) = 1.775 V (0.64%)

Total I*R Voltage Drop for 155 kVA (100-m)
LSC → 2.079 + 1.475 = 3.554 V (1.28%)
LSC → 2.079 + 1.775 = 3.854 V (1.39%)

Filename – GLT_Power_Entry
2016-Oct-30, D. Kubo

208 VAC 3-Phase "Clean" Power Entry



208 VAC NEC Color Code:
- Line-1 (black)
- Line-2 (red)
- Line-3 (blue)
- Neutral (white)
- Protective Earth (green)

Non-Armored 10 AWG TBR (4 wire + PE), x2
Conductor:
- -Diameter 2.588 mm
- -Area 5.26.2 mm^2
- -Resistance 3.277e-3 Ohms/m

Armored 0 AWG TBR (4 wire + PE), x1
Conductor:
- -Diameter 8.251 mm
- -Area 53.5 mm^2
- -Resistance 3.224e-4 Ohms/m

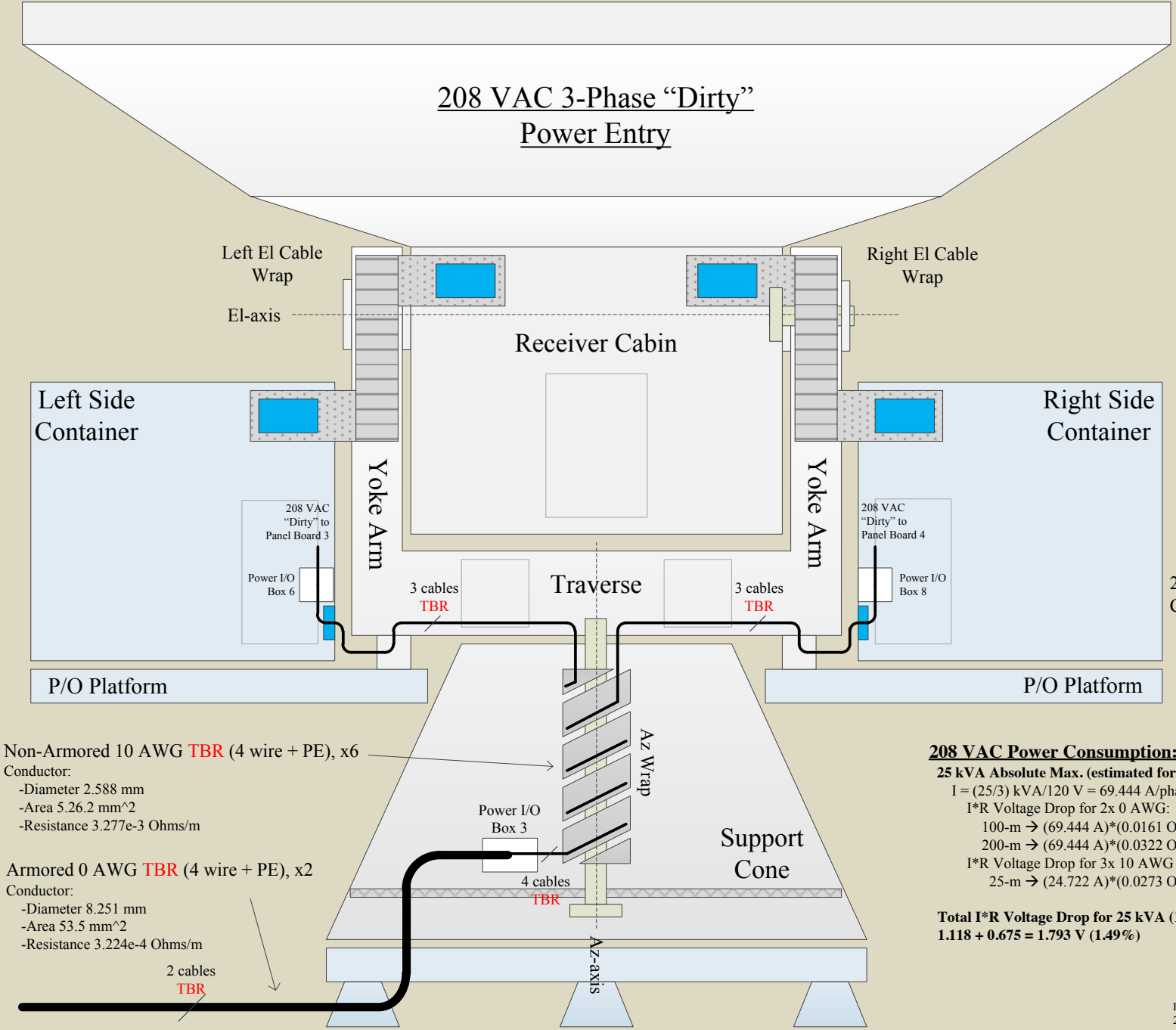
208 VAC Power Consumption:

10 kVA Absolute Max. (estimated for sizing wire gauge)
- I = (10/3) kVA/120 V = 27.778 A/phase
- I*R Voltage Drop for 1x 0 AWG:
  - 100-m → (27.778 A)*(0.0322 Ohm) = 0.895 V (0.75%)
  - 200-m → (27.778 A)*(0.0645 Ohm) = 1.789 V (1.49%)
- I*R Voltage Drop for 1x 10 AWG left side:
  - 25-m → (27.778 A)*(0.0410 Ohm) = 1.1375 V (0.95%)

Total I*R Voltage Drop for 10 kVA (100-m)
0.895 + 1.137 = 2.032 V (1.69%)

Filename – GLT_Power_Entry
2016-Oct-29, D. Kubo

208 VAC 3-Phase "Dirty" Power Entry



208 VAC NEC Color Code:
- Line-1 (black)
- Line-2 (red)
- Line-3 (blue)
- Neutral (white)
- Protective Earth (green)

208 VAC Power Consumption:

25 kVA Absolute Max. (estimated for sizing wire gauge)

I = (25/3) kVA/120 V = 69.444 A/phase

I*R Voltage Drop for 2x 0 AWG:

100-m → (69.444 A)*(0.0161 Ohm) = 1.118 V (0.93%)

200-m → (69.444 A)*(0.0322 Ohm) = 2.236 V (1.86%)

I*R Voltage Drop for 3x 10 AWG per side:

25-m → (24.722 A)*(0.0273 Ohm) = 0.675 V (0.56%)

Total I*R Voltage Drop for 25 kVA (100-m)

1.118 + 0.675 = 1.793 V (1.49%)

Filename – GLT_Power_Entry
2016-Oct-30, D. Kubo

GLT Antenna Cabling System – Power Entry

- Summary/Issues
  - Power Cables within Azimuth Wrap will undergo regular movement at low temperature (-30 C)
  - Self heating of cables (I^2*R) will help with flexing
  - Insulation must not fail!
  - NEC calls for de-rating of cables when grouped and confined together
    - This code may be waved due to the low temperature in the support cone
  - Can sixteen (16) 10-AWG cables fit within the Azimuth Wrap (along with fiber optic and M&C cables)?
    - The cables will be arranged on the outer perimeter for maximum bend radius
    - Typical 5 conductor 10-AWG cable has an OD of 0.80 inches (2.03 cm)
    - A cursory look at the wrap indicates that 16 cables may not fit
    - We will likely need to design/fabricate larger hangers

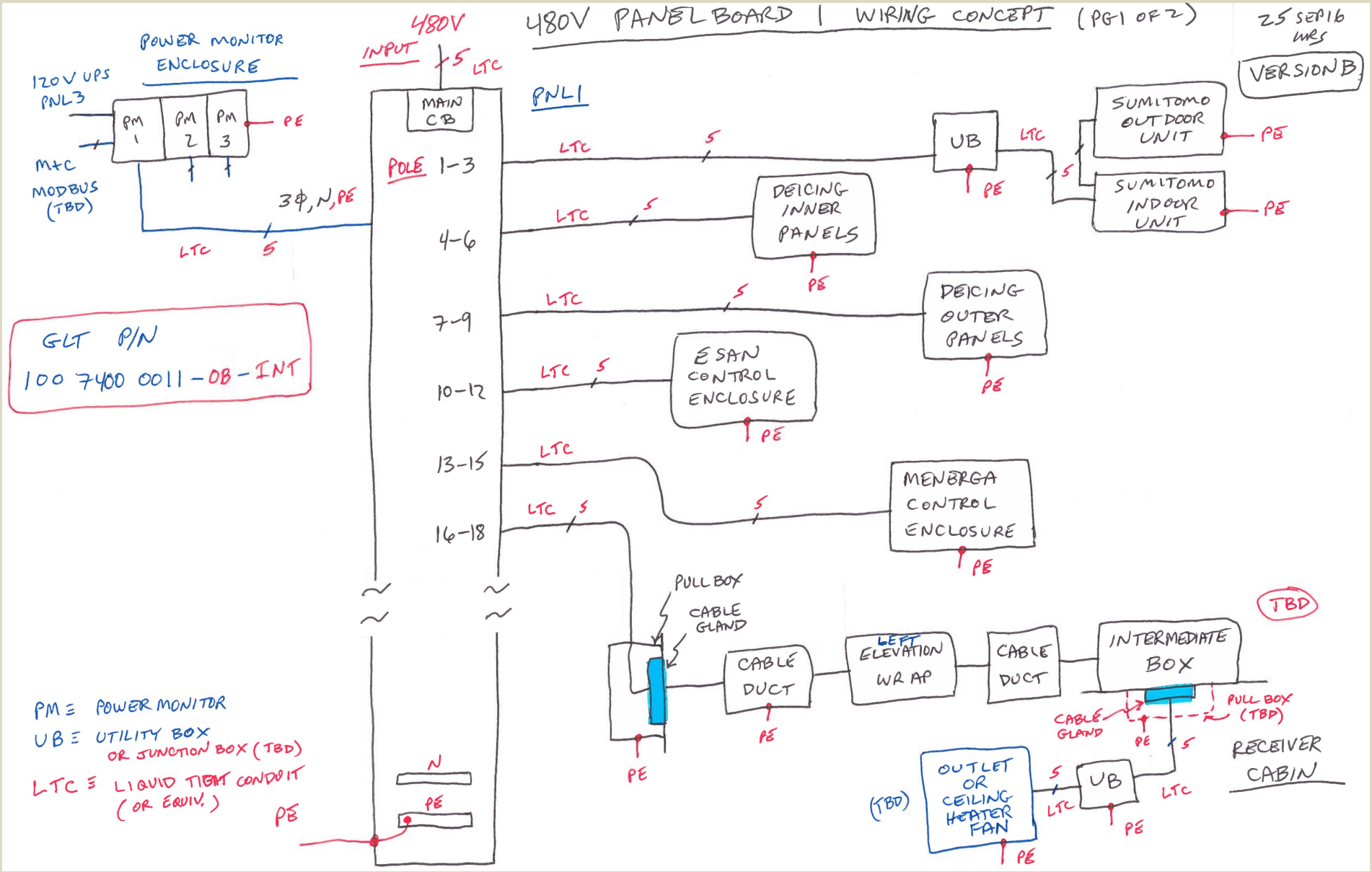
GLT Antenna Cabling System – Power Entry

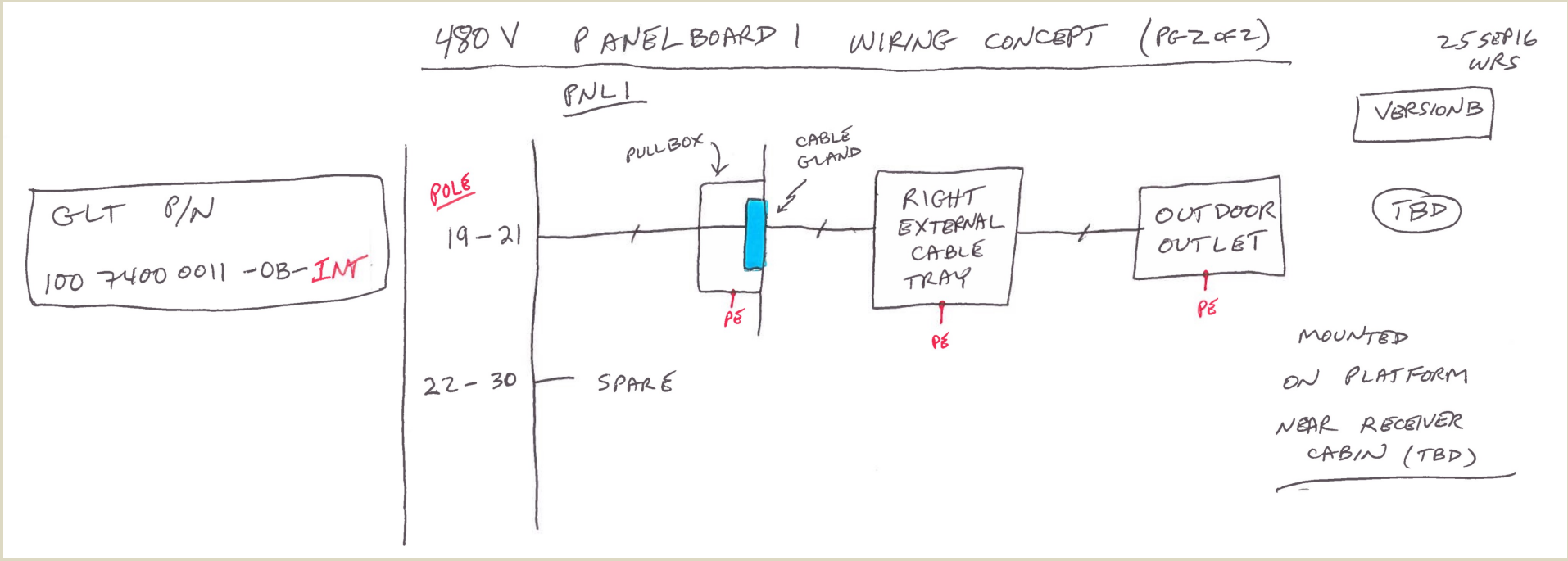
- Summary/Issues (continued)
  - Can sixteen (16) 10-AWG cables exit the Support Cone through the two holes in the traverse?
    - Each opening is 14.5-cm in diameter
    - 10 cables exit the left traverse hole to the LSC
    - 6 cables exit the right traverse hole to the RSC
    - 10 cables arranged in an ellipse can fit within 8.5 x 6.0 cm area so we are probably OK
  - ID and order low temperature power cables soon!
  - Not shown but associated to the 8 Power I/O boxes are Surge Protection Devices for each phase

GLT Antenna Cabling System – Panelboard-1

Panelboard Name: PNL1
Assembly GLT P/N: TBD
Voltage (V): 480
Main Breaker Size (A): 225
Input Wire Gauge (AWG): 2/0
Location: Left Side Container

								Branch	Branch	Cable
		Maximum	Number	Pole				Circuit	Wire	Temperature
Circuit	Name	Load	Phases	Numbers	L1	L2	L3	Breaker	Gauge	Rating
		(kVA)			(A)	(A)	(A)	(A)	(AWG)	
1	Sumitomo Helium Compressor	11.5	3	1, 2, 3	13.8	13.8	13.8	20	12	RT
2	Deicing Power Enclosure - Inner Panels	10	3	4, 5, 6	12.0	12.0	12.0	20	12	RT
3	Deicing Power Enclosure - Outer Panels	10	3	7, 8, 9	12.0	12.0	12.0	20	12	RT
4	ESAN HVAC Control Enclosure	22	3	10, 11, 12	26.5	26.5	26.5	40	8	RT
5	Menerga HVAC Control Enclosure	34	3	13, 14, 15	40.9	40.9	40.9	60	6	RT
6	Receiver Cabin 480 V Outlet	5	3	16, 17, 18	6.0	6.0	6.0	20	12	LT
7	Outdoor Outlet (Near Receiver Cabin)	5	3	19, 20, 21	6.0	6.0	6.0	20	12	LT
	Spares			22-30						
	Total =	98		Total =	117	117	117			

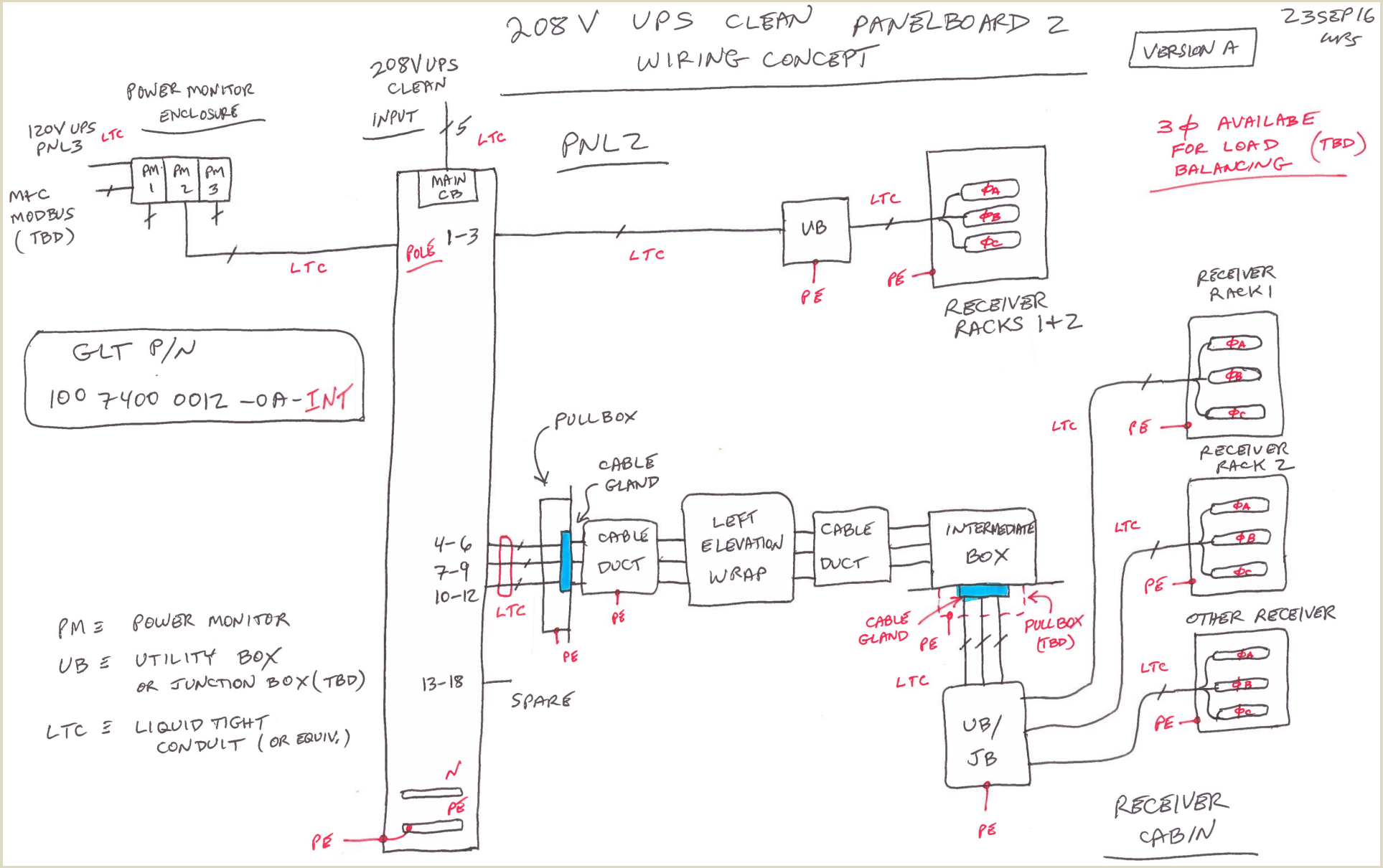

480V PANEL BOARD 1 WIRING CONCEPT (PG1 OF 2)
25 SEP16 MRS
VERSION B
480V INPUT
5
LTC
MAIN CB
PNL1
POWER MONITOR ENCLOSURE
120V UPS PNL3
PM 1
PM 2
PM 3
PE
M+C MODBUS (TBD)
3Φ,N,PE
LTC
5
POLE 1-3
4-6
7-9
10-12
13-15
16-18
UB
SUMITOMO OUTDOOR UNIT
SUMITOMO INDOOR UNIT
DEICING INNER PANELS
DEICING OUTER PANELS
ESAN CONTROL ENCLOSURE
MENERGA CONTROL ENCLOSURE
GLT P/N
100 7400 0011-0B-INT
PULL BOX
CABLE GLAND
CABLE DUCT
LEFT ELEVATION WRAP
INTERMEDIATE BOX
TBD
PULL BOX (TBD)
RECEIVER CABIN
OUTLET OR CEILING HEATER FAN
N
PM ≡ POWER MONITOR
UB ≡ UTILITY BOX OR JUNCTION BOX (TBD)
LTC ≡ LIQUID TIGHT CONDUIT (OR EQUIV.)


480 V PANELBOARD 1 WIRING CONCEPT (PG 2 OF 2)
25 SEP 16 WRS
VERSION B
PNL1
GLT P/N
100 7400 0011 -0B-INT
POLE
19 - 21
22 - 30
SPARE
PULLBOX
CABLE GLAND
PE
RIGHT EXTERNAL CABLE TRAY
PE
OUTDOOR OUTLET
PE
TBD
MOUNTED ON PLATFORM NEAR RECEIVER CABIN (TBD)

GLT Antenna Cabling System – Panelboard-2

Panelboard Name: PNL2
Assembly GLT P/N: TBD
Voltage (V): 208 UPS Clean
Main Breaker Size (A): 125
Input Wire Gauge (AWG): 6
Location: Left Side Container

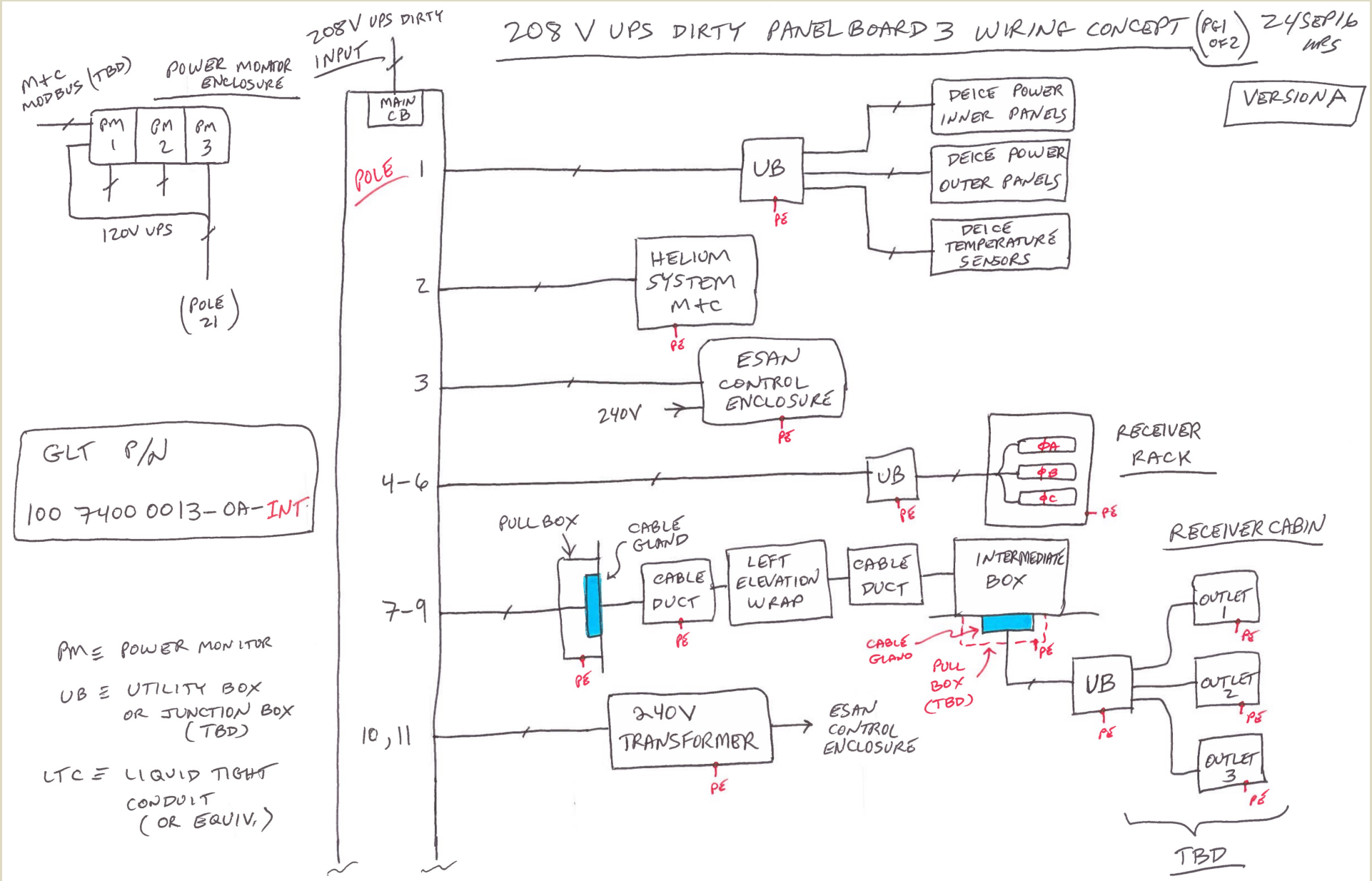
Circuit	Name	Maximum Load (kVA)	Number Phases	Pole Numbers	L1 (A)	L2 (A)	L3 (A)	Branch Circuit Breaker (A)	Branch Wire Gauge (AWG)	Cable Temperature Rating
1	Container Receiver Rack - Phase A (TBD)	0.3	1	1	2.5			20	12	RT
2	Container Receiver Rack - Phase B (TBD)	0.3	1	2		2.5		20	12	RT
3	Container Receiver Rack - Phase C (TBD)	0.3	1	3			2.5	20	12	RT
4	Receiver Rack 1 Phase A	0.6	1	4	5.0			20	12	LT
5	Receiver Rack 1 Phase B	0.6	1	5		5.0		20	12	LT
6	Receiver Rack 1 Phase C	0.6	1	6			5.0	20	12	LT
7	Receiver Rack 2 Phase A	0.6	1	7	5.0			20	12	LT
8	Receiver Rack 2 Phase B	0.6	1	8		5.0		20	12	LT
9	Receiver Rack 2 Phase C	0.6	1	9			5.0	20	12	LT
10	Other Receiver Phase A	0.3	1	10	2.5			20	12	LT
11	Other Receiver Phase B	0.3	1	11		2.5		20	12	LT
12	Other Receiver Phase C	0.3	1	12			2.5	20	12	LT
	Spares			13-18						
	Total =	**5**		**Total =**	**15**	**15**	**15**			

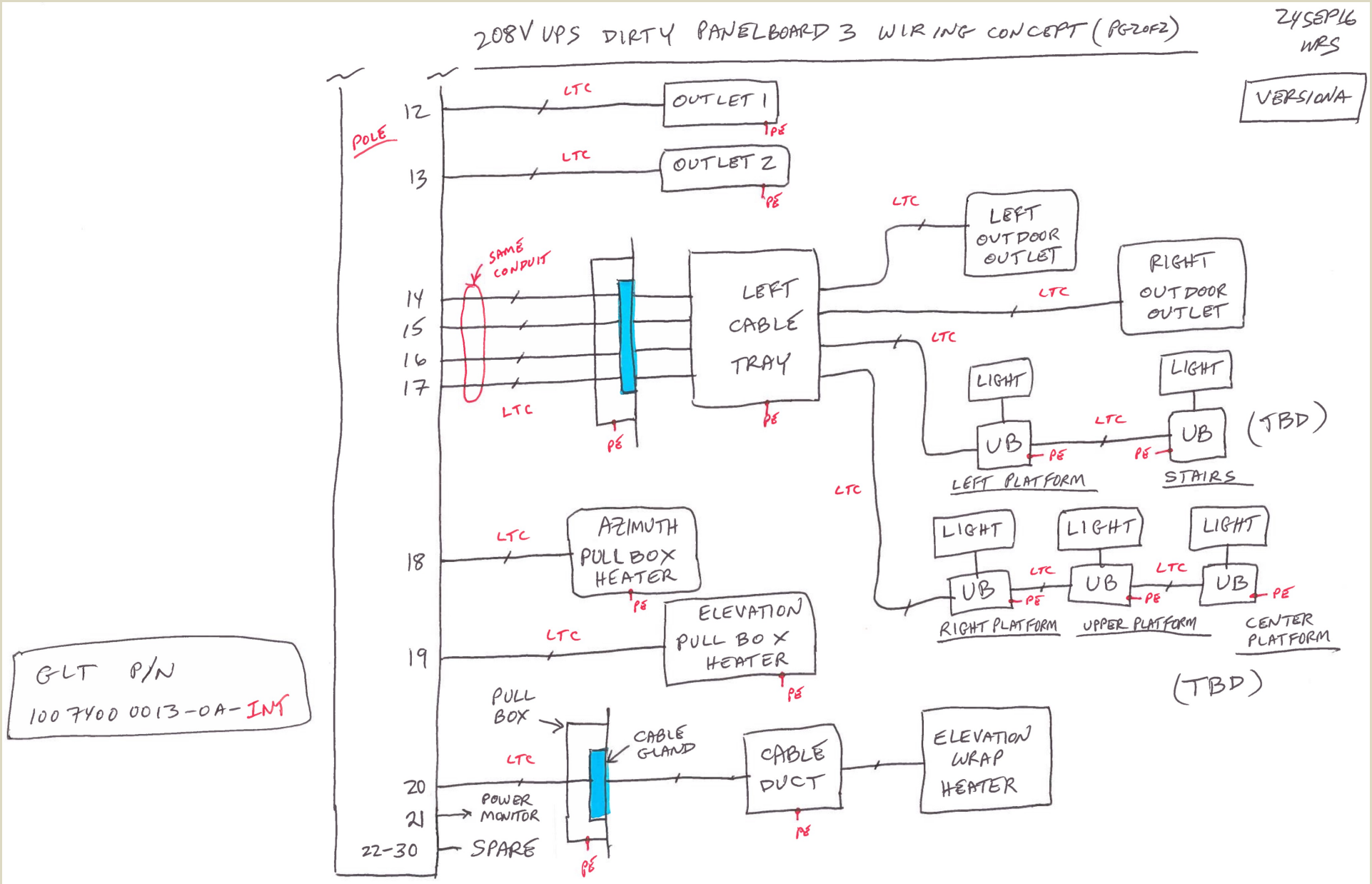

208V UPS CLEAN PANELBOARD 2
WIRING CONCEPT
VERSION A
23SEP16
CWS
3φ AVAILABE FOR LOAD BALANCING (TBD)
POWER MONITOR ENCLOSURE
120V UPS PNL3
LTC
PM 1
PM 2
PM 3
M+C MODBUS (TBD)
208V UPS CLEAN INPUT
MAIN CB
POLE 1-3
PNL2
LTC
UB
PE
RECEIVER RACKS 1+2
ΦA
ΦB
ΦC
GLT P/N
100 7400 0012 -0A-INT
PULLBOX
CABLE GLAND
4-6
7-9
10-12
CABLE DUCT
LEFT ELEVATION WRAP
INTERMEDIATE BOX
13-18
SPARE
N
PE
RECEIVER RACK 1
RECEIVER RACK 2
OTHER RECEIVER
UB/ JB
RECEIVER CABIN
PM ≡ POWER MONITOR
UB ≡ UTILITY BOX OR JUNCTION BOX (TBD)
LTC ≡ LIQUID TIGHT CONDUIT (OR EQUIV.)

GLT Antenna Cabling System – Panelboard-3

Panelboard Name: PNL3
Assembly GLT P/N: TBD
Voltage (V): 208 UPS Dirty
Main Breaker Size (A): 125
Input Wire Gauge (AWG): 1/0
Location: Left Side Container

Circuit	Name	Maximum Load (kVA)	Number Phases	Pole Numbers	L1 (A)	L2 (A)	L3 (A)	Branch Circuit Breaker (A)	Branch Wire Gauge (AWG)	Cable Temperature Rating
1	Deicing Power & Temperature Enclosures	0.5	1	1	4.2			20	12	RT
2	Helium System M&C	0.1	1	2		0.8		20	12	RT
3	ESAN Control Enclosure	1	1	3			8.3	20	12	RT
4	Container Receiver Rack - Phase A	0.3	1	4	2.5			20	12	RT
5	Container Receiver Rack - Phase B	0.3	1	5		2.5		20	12	RT
6	Container Receiver Rack - Phase C	0.3	1	6			2.5	20	12	RT
7	Receiver Cabin Outlet - Phase A	1	1	7	8.3			20	12	LT
8	Receiver Cabin Outlet - Phase B	1	1	8		8.3		20	12	LT
9	Receiver Cabin Outlet - Phase C	1	1	9			8.3	20	12	LT
10	208 to 240 V Transformer (ESAN)	0.6	2	10, 11	2.9	2.9		20	12	RT
11	Side Container Indoor Outlet 1	1	1	12			8.3	20	12	RT
12	Side Container Indoor Outlet 2	1	1	13	8.3			20	12	RT
13	Left Container Outdoor Outlet	1	1	14		8.3		20	12	LT
14	Right Container Outdoor Outlet	1	1	15			8.3	20	12	LT
15	Left Platform & Stairs Outdoor Lights	0.3	1	16	2.5			20	12	LT
16	Right, Upper, Center Platform Outdoor Lights	0.3	1	17		2.5		20	12	LT
17	Azimuth Wrap Pull Box Heater	0.5	1	18			4.2	20	12	RT
18	Elevation Wrap Pull Box Heater	0.5	1	19	4.2			20	12	RT
19	Elevation Wrap Internal Heaters	0.5	1	20		4.2		20	12	LT
20	Panelboard Power Monitors 1-3	0.1	1	21			0.8	20	12	RT
	Spares			22-30						
	Total =	**12**		**Total =**	**33**	**30**	**41**			

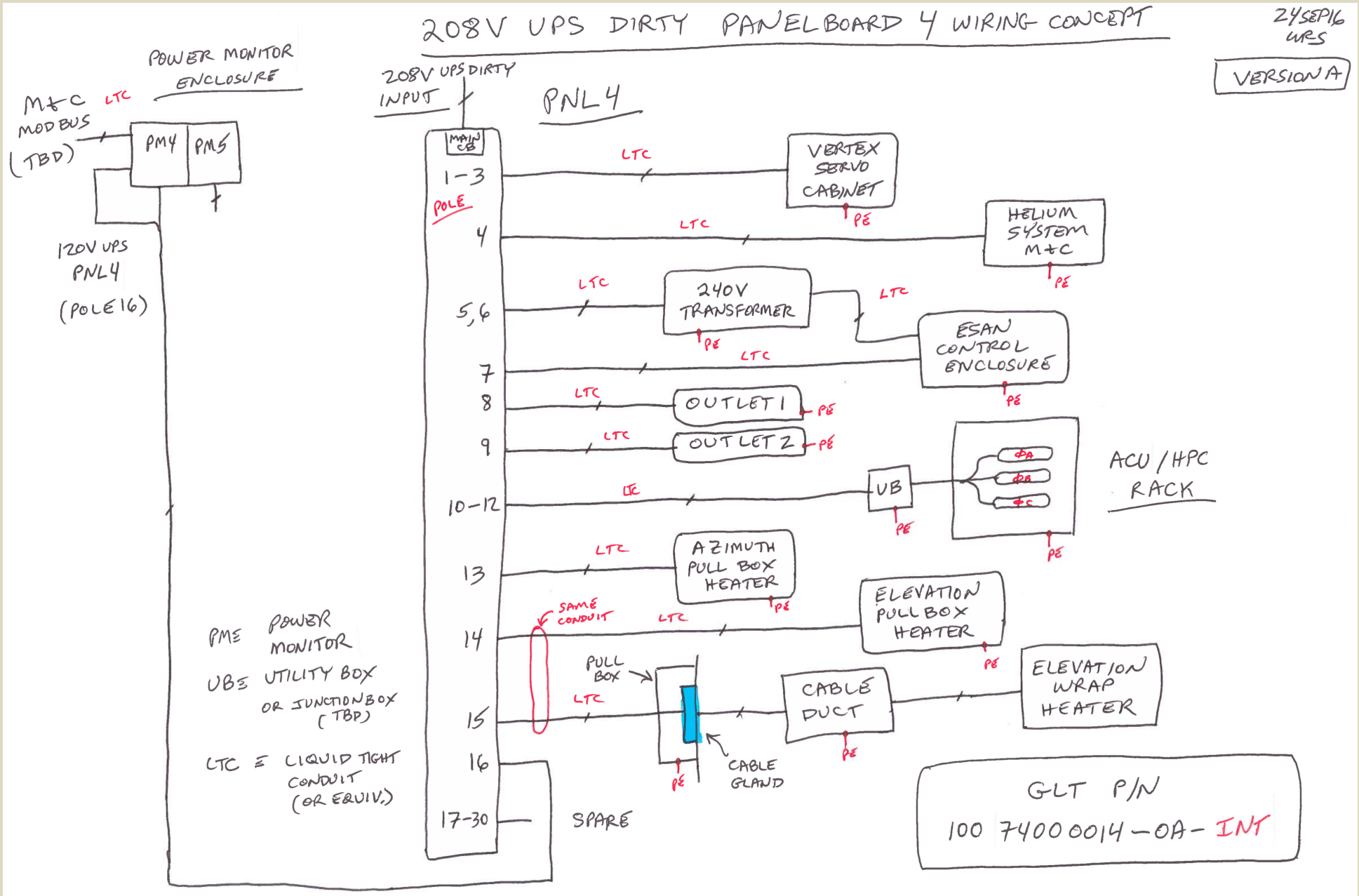

208 V UPS DIRTY PANELBOARD 3 WIRING CONCEPT (PG1 OF 2)
24SEP16 MRS
VERSION A
208V UPS DIRTY INPUT
M+C MODBUS (TBD)
POWER MONITOR ENCLOSURE
PM 1
PM 2
PM 3
120V UPS
(POLE 21)
MAIN CB
POLE 1
2
3
4-6
7-9
10, 11
UB
DEICE POWER INNER PANELS
DEICE POWER OUTER PANELS
DEICE TEMPERATURE SENSORS
HELIUM SYSTEM M+C
ESAN CONTROL ENCLOSURE
240V
GLT P/N
100 7400 0013-0A-INT
RECEIVER RACK
ΦA
ΦB
ΦC
PULL BOX
CABLE GLAND
CABLE DUCT
LEFT ELEVATION WRAP
INTERMEDIATE BOX
RECEIVER CABIN
OUTLET 1
OUTLET 2
OUTLET 3
240V TRANSFORMER
ESAN CONTROL ENCLOSURE
PE
TBD
PM ≡ POWER MONITOR
UB ≡ UTILITY BOX OR JUNCTION BOX (TBD)
LTC ≡ LIQUID TIGHT CONDUIT (OR EQUIV.)


208V UPS DIRTY PANELBOARD 3 WIRING CONCEPT (PG2OF2)
24SEP16 WRS
VERSIONA
POLE
12
13
14
15
16
17
18
19
20
21
22-30
LTC
PE
OUTLET 1
OUTLET 2
SAME CONDUIT
LEFT CABLE TRAY
LEFT OUTDOOR OUTLET
RIGHT OUTDOOR OUTLET
LIGHT
UB
LEFT PLATFORM
STAIRS
(TBD)
RIGHT PLATFORM
UPPER PLATFORM
CENTER PLATFORM
AZIMUTH PULL BOX HEATER
ELEVATION PULL BOX HEATER
PULL BOX
CABLE GLAND
CABLE DUCT
ELEVATION WRAP HEATER
POWER MONITOR
SPARE
GLT P/N
100 7400 0013-0A-INT

GLT Antenna Cabling System – Panelboard-4

Panelboard Name: PNL4
Assembly GLT P/N: TBD
Voltage (V): 208 Dirty
Main Breaker Size (A): 125
Input Wire Gauge (AWG): 1/0
Location: Right Side Container

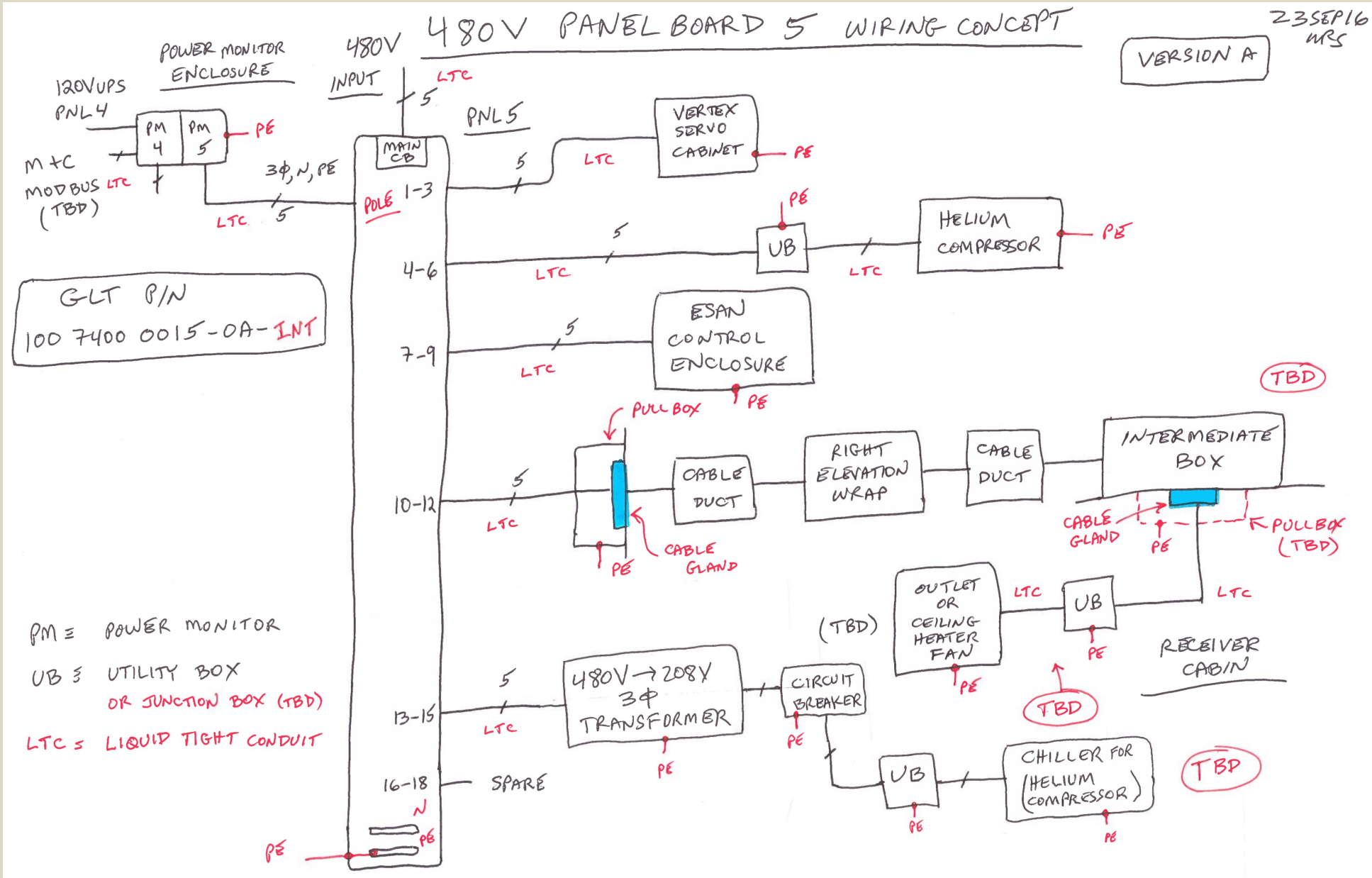
								Branch	Branch	Cable
		Maximum	Number	Pole				Circuit	Wire	Temperature
Circuit	Name	Load	Phases	Numbers	L1	L2	L3	Breaker	Gauge	Rating
		(kVA)			(A)	(A)	(A)	(A)	(AWG)	
1	Vertex Servo Cabinet	6	1	1, 2, 3	16.7	16.7	16.7	30	10	RT
2	Helium System M&C	0.1	1	4	0.8			20	12	RT
3	208 to 240 V Transformer (ESAN)	0.6	2	5, 6		2.9	2.9	20	12	RT
4	ESAN Control Enclosure	1	1	7	8.3			20	12	RT
5	Side Container Indoor Outlet 1	0.3	1	8		2.5		20	12	RT
6	Side Container Indoor Outlet 2	0.3	1	9			2.5	20	12	RT
7	Container ACU/HPC Rack - Phase A	0.3	1	10	2.5			20	12	RT
8	Container ACU/HPC Rack - Phase B	1	1	11		8.3		20	12	RT
9	Container ACU/HPC Rack - Phase C	1	1	12			8.3	20	12	RT
10	Azimuth Wrap Pull Box Heater	0.5	1	13	4.2			20	12	RT
11	Elevation Wrap Pull Box Heater	0.5		14		4.2		20	12	LT
12	Elevation Wrap Internal Heaters	0.5	1	15			4.2	20	12	LT
13	Panelboard Power Monitors 4-5	0.1	1	16	0.8			20	12	RT
	Spares			17-30						
	Total =	**12**		**Total =**	**33**	**35**	**35**			


208V UPS DIRTY PANELBOARD 4 WIRING CONCEPT
24SEP16 URS
VERSION A
POWER MONITOR ENCLOSURE
M&C MODBUS (TBD)
LTC
PM4
PM5
120V UPS PNL4 (POLE 16)
208V UPS DIRTY INPUT
PNL4
MAIN CB
POLE
1-3
4
5,6
7
8
9
10-12
13
14
15
16
17-30
SPARE
VERTEX SERVO CABINET
HELIUM SYSTEM M&C
240V TRANSFORMER
ESAN CONTROL ENCLOSURE
OUTLET 1
OUTLET 2
UB
ACU / HPC RACK
AZIMUTH PULL BOX HEATER
ELEVATION PULL BOX HEATER
SAME CONDUIT
PULL BOX
CABLE DUCT
ELEVATION WRAP HEATER
CABLE GLAND
PE
PME POWER MONITOR
UBE UTILITY BOX OR JUNCTION BOX (TBD)
LTC = LIQUID TIGHT CONDUIT (OR EQUIV.)
GLT P/N
100 74000014-0A-INT

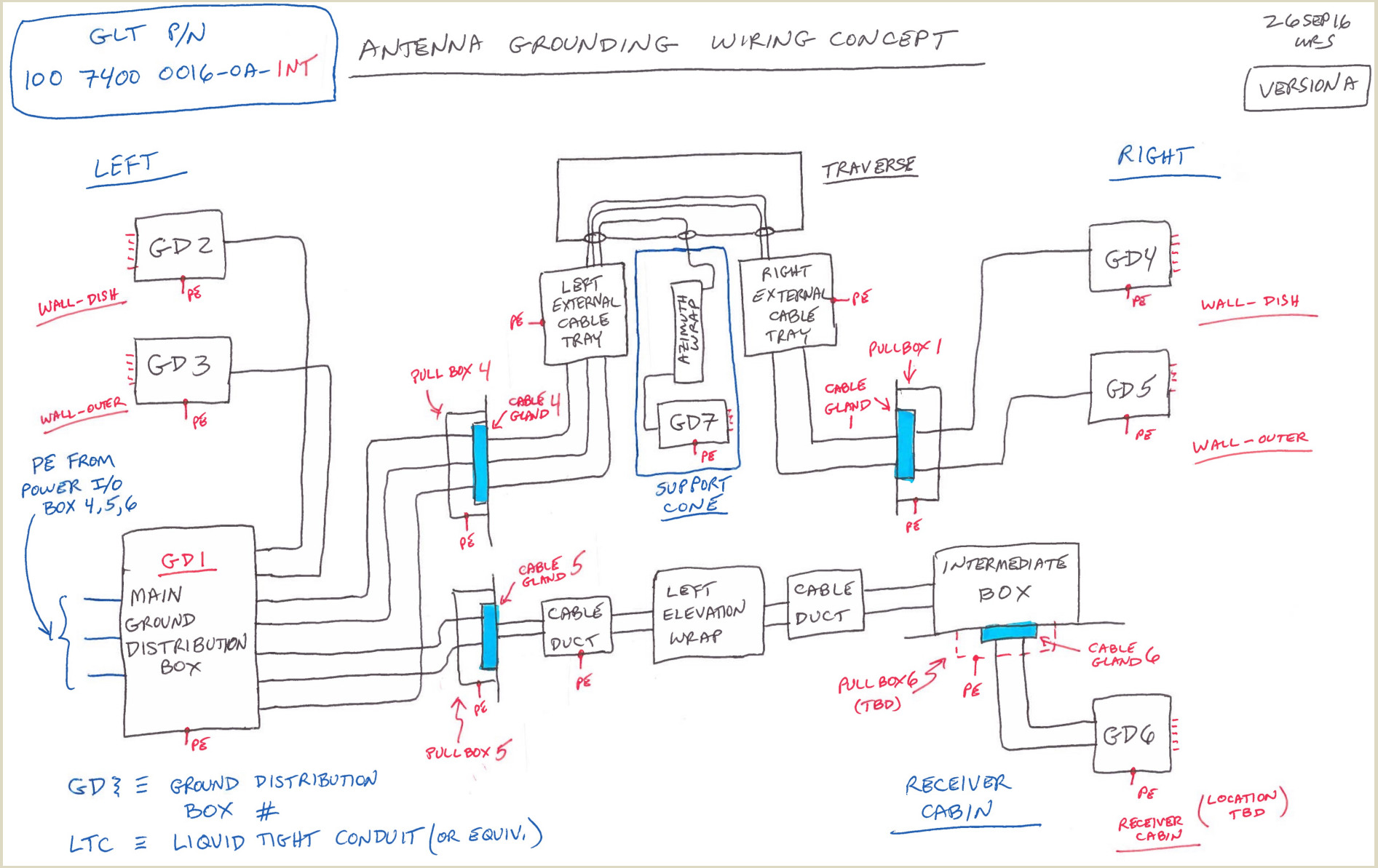
GLT Antenna Cabling System – Panelboard-5

Panelboard Name: PNL5
Assembly GLT P/N: TBD
Voltage (V): 480
Main Breaker Size (A): 225
Input Wire Gauge (AWG): 2/0
Location: Right Side Container

Circuit	Name	Maximum Load (kVA)	Number Phases	Pole Numbers	L1 (A)	L2 (A)	L3 (A)	Branch Circuit Breaker (A)	Branch Wire Gauge (AWG)	Cable Temperature Rating
1	Vertex Servo Cabinet	20	3	1, 2, 3	24.1	24.1	24.1	40	8	RT
2	Helium Compressor	10.5	3	4, 5, 6	12.6	12.6	12.6	20	12	RT
3	ESAN HVAC Control Enclosure	22	3	7, 8, 9	26.5	26.5	26.5	40	8	RT
4	Receiver Cabin 480 V Outlet	5	3	10, 11, 12	6.0	6.0	6.0	20	12	LT
5	480 V to 208 V Transformer (Chiller)	10	3	13, 14, 15	12.0	12.0	12.0	20	12	RT
	Spares			16-18						
	Total =	**68**		**Total =**	**81**	**81**	**81**			

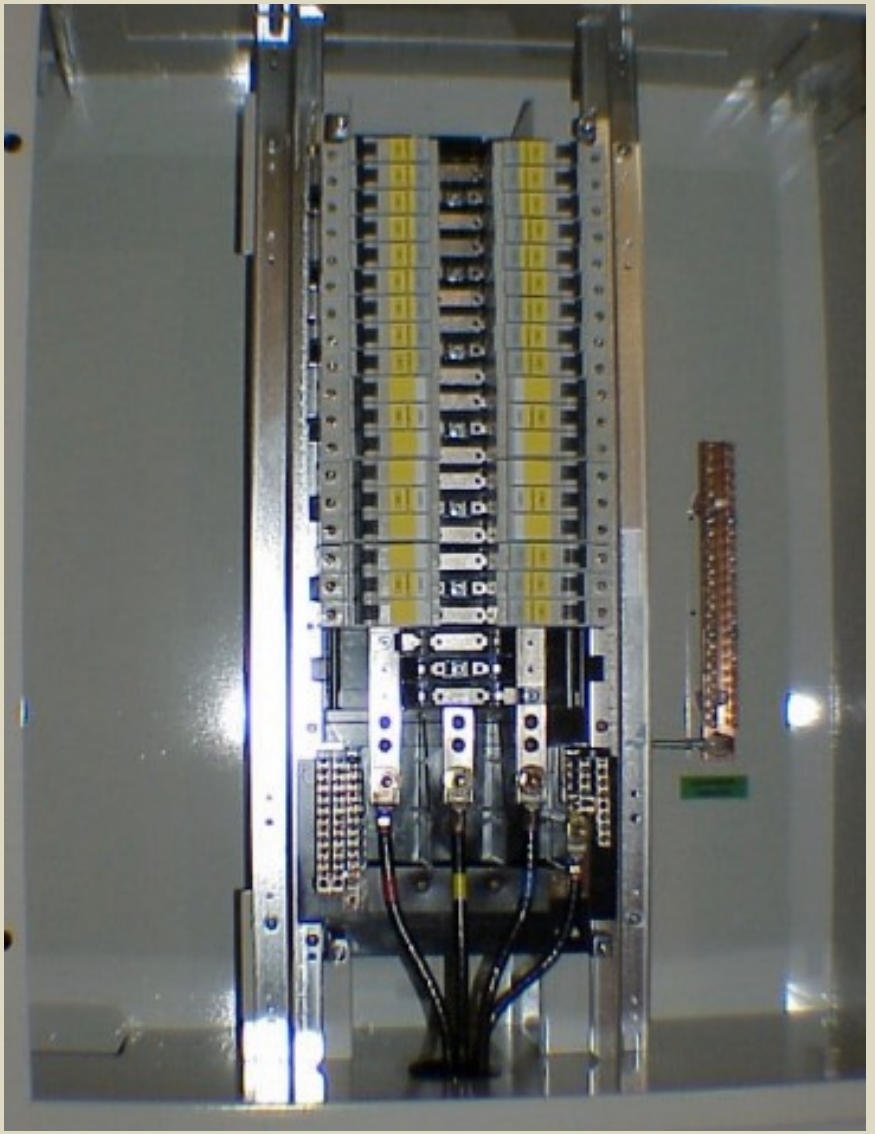

480V PANEL BOARD 5 WIRING CONCEPT
23SEP16 MRS
VERSION A
POWER MONITOR ENCLOSURE
120VUPS PNL4
PM 4
PM 5
PE
M+C MODBUS (TBD)
LTC
3φ, N, PE
480V INPUT
MAIN CB
PNL5
POLE 1-3
4-6
7-9
10-12
13-15
16-18
SPARE
N
PE
VERTEX SERVO CABINET
UB
HELIUM COMPRESSOR
ESAN CONTROL ENCLOSURE
PULL BOX
CABLE GLAND
CABLE DUCT
RIGHT ELEVATION WRAP
INTERMEDIATE BOX
PULLBOX (TBD)
TBD
OUTLET OR CEILING HEATER FAN
(TBD)
RECEIVER CABIN
480V→208V 3φ TRANSFORMER
CIRCUIT BREAKER
CHILLER FOR (HELIUM COMPRESSOR)
GLT P/N
100 7400 0015-0A-INT
PM ≡ POWER MONITOR
UB ≡ UTILITY BOX OR JUNCTION BOX (TBD)
LTC ≡ LIQUID TIGHT CONDUIT

GLT Antenna Cabling System – Grounding



GLT Antenna Cabling System – Panelboards

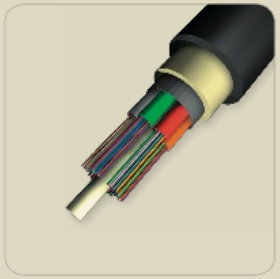
- Summary/Issues
  - ESAN Side Containers
    - Need to settle on the physical arrangement of the hardware within the containers
  - ID and order room temperature power cables
    - Refer to panelboard schedule
  - ID and order low temperature cables
    - Refer to panelboard schedule
  - ID and order Panelboards (x5)
    - Circuit breakers
  - ID and order Surge Protection Devices
    - Maybe located within I/O Boxes
  - ID and order Power Monitors and Enclosures
  - ID and order Ground Distribution Boxes
    - Main
    - GD1 – GD7



For illustration only (not actual panel board)

GLT Antenna Cabling System – Fiber Optics

- Fiber Optic Cable Entry into Support Cone, Azimuth Wrap, LSC, and RSC
  - Have identified low temperature fiber optic cable from AFL, -60 C option
    - Operation -60 to +70 C
    - Cable is non-armored, plan to route from Control Container to Telescope within protective conduit
  - Cables to Support Cone
    - 12-fiber cable
      - 6-fiber cable through Az-wrap to LSC
      - 6-fiber cable through Az-wrap to RSC
    - 24-fiber cable
      - 24-fiber cable to Receiver Cabin
      - 1-fiber cable through Az & El Torque Tubes



Extreme Low Temp LSZH Double Jacket I/O Loose Tube (LA Series)

The LA-Series is specially designed for applications that demand reliable performance in harsh environment installations. The cable construction incorporates a variety of packaging technologies that allow the product to operate in extremely low temperatures, mechanically abusive installations and highly caustic and acidic environments. The key to the reliable, ultra-high performance is the specially designed cable core and the dual layer jacketing system.

The cable core is constructed using materials and engineered geometry that optimizes the isolation of the optical fibers from the stresses and strains imparted on the cable and commonly realized in extreme environments. The outer jacketing is designed to further protect the ruggedized core assembly with a multiplying system made up of a double-ply, low smoke zero halogen (LSZH) flame resistant jacketing system that integrates a strong layer of aramid yarn between the inner and outer sheaths.

Applications

Network Connectivity for:

- Oil and Gas fields
- Low Temperature Environments
- Refineries
- Mining
- Mass Transit

Features

- Fiber Range 12-144
- OFNG-LS Listed, CSA-FT4
- IEEE Flame Test
- ICEA S-104-696
- CSA 22.2 No. 230 and 232
- Increase tensile load rating
- Chemical Resistance testing per ASTM D412
- 2X Crush Resistance compared to standard fiber optic cables
- 2X Cold Impact Resistance compared to standard fiber optic cables
- Self-supporting capability (contract factory for system design support)

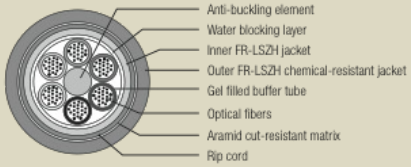
Temperature Range

	FIBER COUNT	
	12-72 FIBERS, 6-POSITION CORE	12-144 FIBERS, 8- AND 12-POSITION CORES
Operating	-55°C to +70°C	-60°C to +70°C
Storage	-60°C to +70°C	-60°C to +70°C
Installation	-30°C to +50°C	-30°C to +70°C

Mechanical

PARAMETER	VALUE
Crush	440N/CM
Cold Impact	8.8 N*m
Tensile	
Installation	1,000 lbs (4,450N)
Operational	400 lbs (1,780N)

Cable Components



Extreme Low Temp LSZH Double Jacket I/O Loose Tube (LA Series)

Fiber Specifications

FIBER TYPE	MAXIMUM ATTENUATION (DB/KM)				OVERFILL LAUNCH MIN. BANDWIDTH (MHZ•KM)		GIGABIT ETHERNET MIN. LINK DISTANCE (METERS)	
	850 NM	1300 NM	1310 NM	1550 NM	850 NM	1300 NM	850 NM	1300 NM
(6) 62.5/125 GIGA-Link™ 300	3.5	1.2	N/A	N/A	200	600	300	550
(5) 50/125 GIGA-Link™ 600	2.9	0.9	N/A	N/A	500	500	600	600
(L) 50/125 Laser-Link™ 300	2.9	0.9	N/A	N/A	1500	500	900	550
(9) Single-mode	N/A	N/A	0.35	0.25	N/A	N/A	N/A	5000
(Q) Non-zero Dispersion-shifted Single-mode	N/A	N/A	N/A	0.25	N/A	N/A	N/A	N/A
(K) AFL G.657.A1 Single-mode	N/A	N/A	0.35	0.25	N/A	N/A	N/A	5000

Gigabit Ethernet Minimum Link Distances are based on "bandwidth"/modal dispersion constraints.
Actual link distances may be constrained by attenuation, depending on specific loss budget.

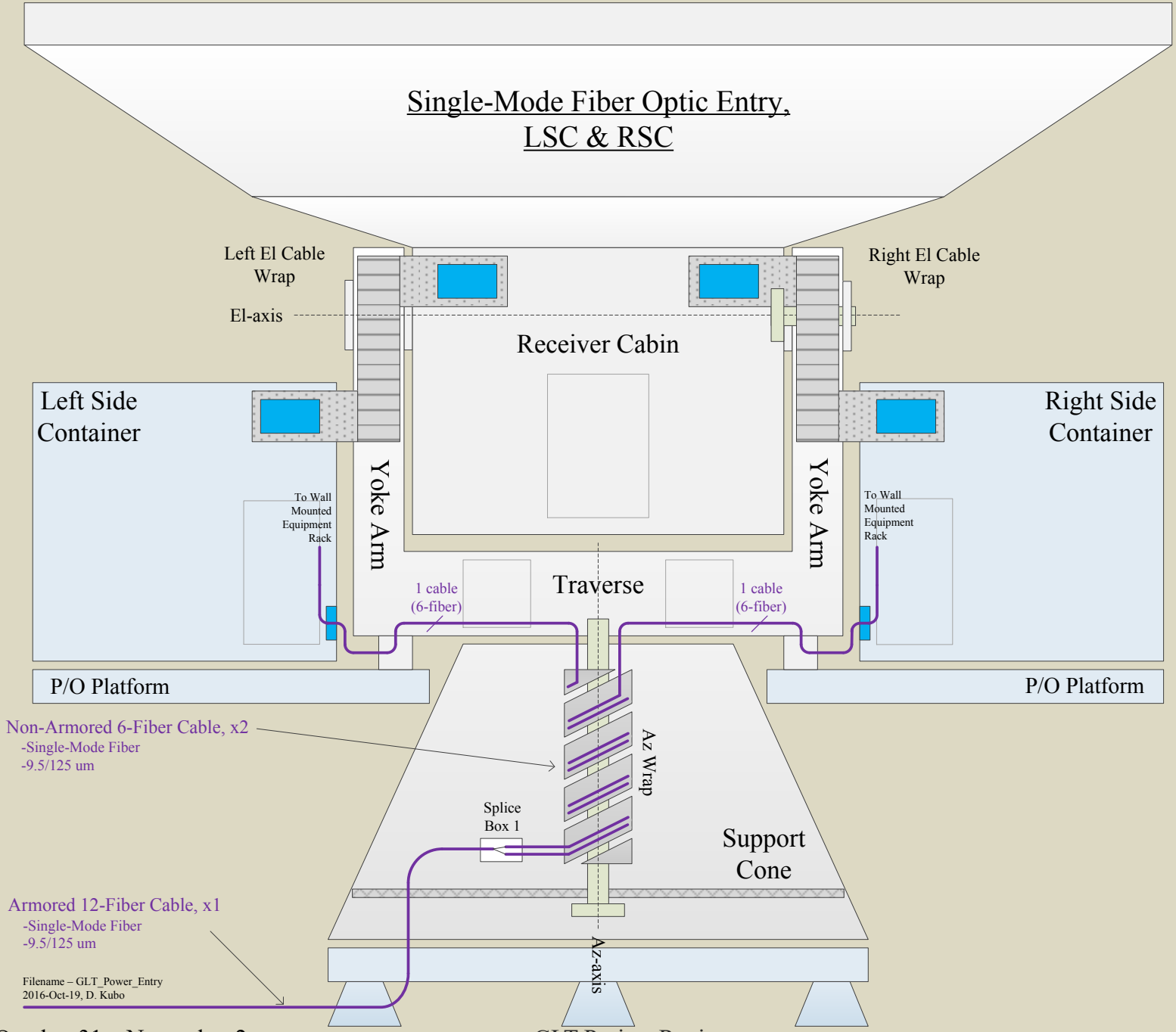
Ordering Information

6-POSITION, -50°C OPTION	FIBER COUNT	NOMINAL DIAMETER		NOMINAL WEIGHT		MAXIMUM TENSILE LOAD LBS (N)		MINIMUM BEND RADIUS INCHES (CM)	
		INCHES	MM	LBS/1,000 FT	KG/KM	INSTALLATION	OPERATION	INSTALLATION	OPERATION
LA012✶C6111N1	12	0.606	15.4	154	229	1000 (4,450)	400 (1,780)	13 (31)	6 (16)
LA024✶C6111N1	24	0.606	15.4	154	229	1000 (4,450)	400 (1,780)	13 (31)	6 (16)
LA048✶C6111N1	48	0.606	15.4	153	227	1000 (4,450)	400 (1,780)	13 (31)	6 (16)
LA072✶C6111N1	72	0.606	15.4	152	225	1000 (4,450)	400 (1,780)	13 (31)	6 (16)

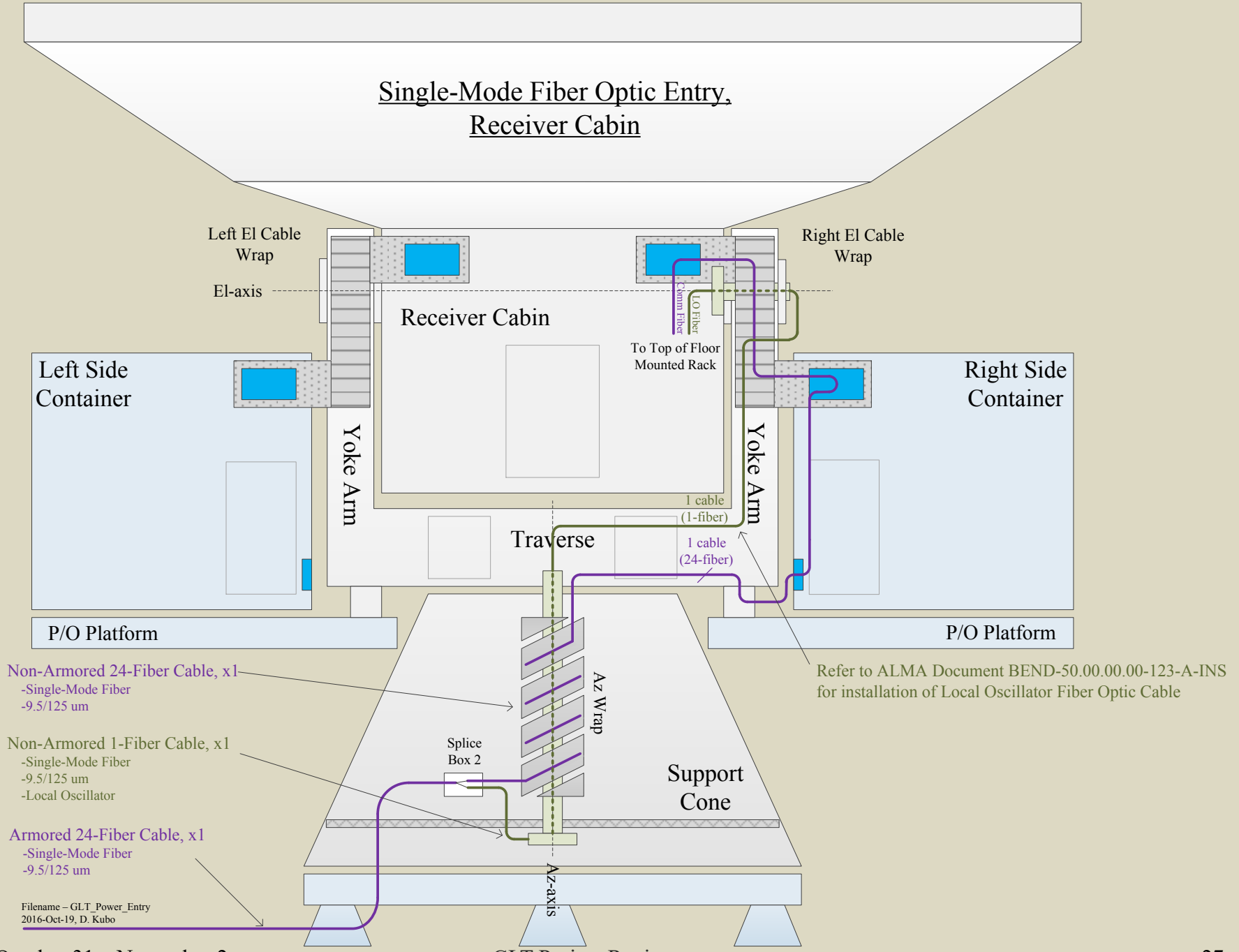
8-POSITION AND 12-POSITION, -60°C OPTION	FIBER COUNT	NOMINAL DIAMETER		NOMINAL WEIGHT		MAXIMUM TENSILE LOAD LBS (N)		MINIMUM BEND RADIUS INCHES (CM)	
		INCHES	MM	LBS/1,000 FT	KG/KM	INSTALLATION	OPERATION	INSTALLATION	OPERATION
LA012✶C8111N1	12	0.673	17.1	184	273	1000 (4,450)	400 (1,780)	14 (35)	7 (18)
LA024✶C8111N1	24	0.673	17.1	184	273	1000 (4,450)	400 (1,780)	14 (35)	7 (18)
LA048✶C8111N1	48	0.673	17.1	184	273	1000 (4,450)	400 (1,780)	14 (35)	7 (18)
LA072✶C8111N1	72	0.673	17.1	184	273	1000 (4,450)	400 (1,780)	14 (35)	7 (18)
LA096✶C8111N1	96	0.673	17.1	184	273	1000 (4,450)	400 (1,780)	14 (35)	7 (18)
LA144✶CC111NI	144	0.823	20.9	250	371	1000 (4,450)	400 (1,780)	17 (42)	9 (21)

✶ Fiber Types – Replace asterisk (✶) in AFL number with number in the Fiber Specifications table above.

Single-Mode Fiber Optic Entry, LSC & RSC



Single-Mode Fiber Optic Entry, Receiver Cabin

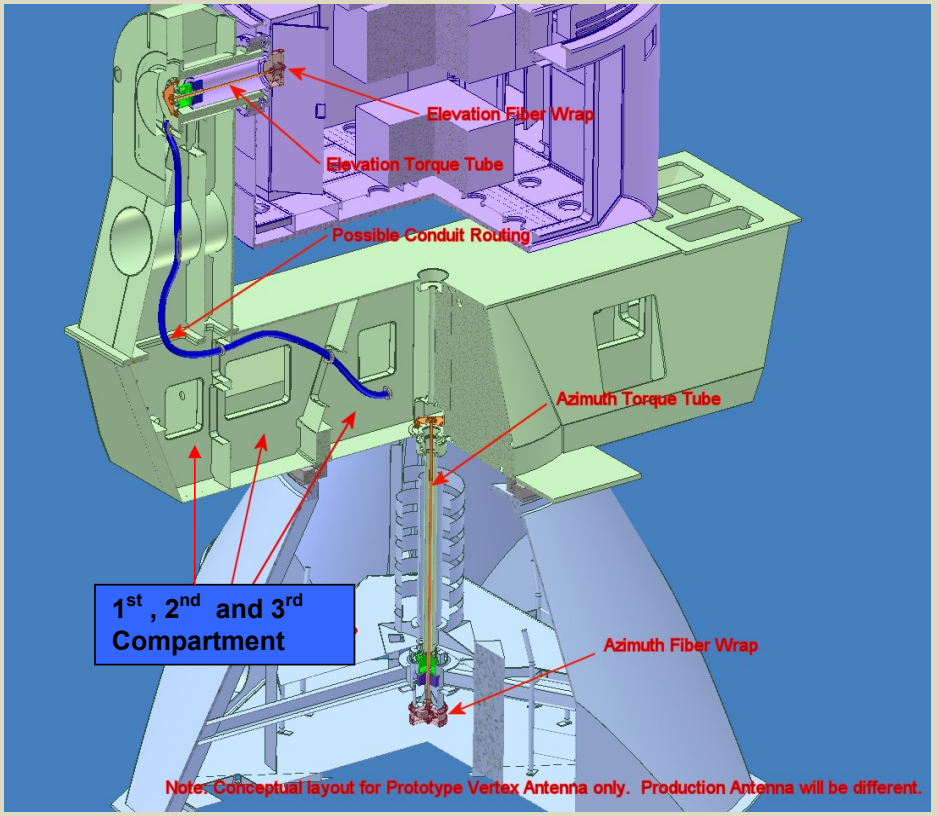


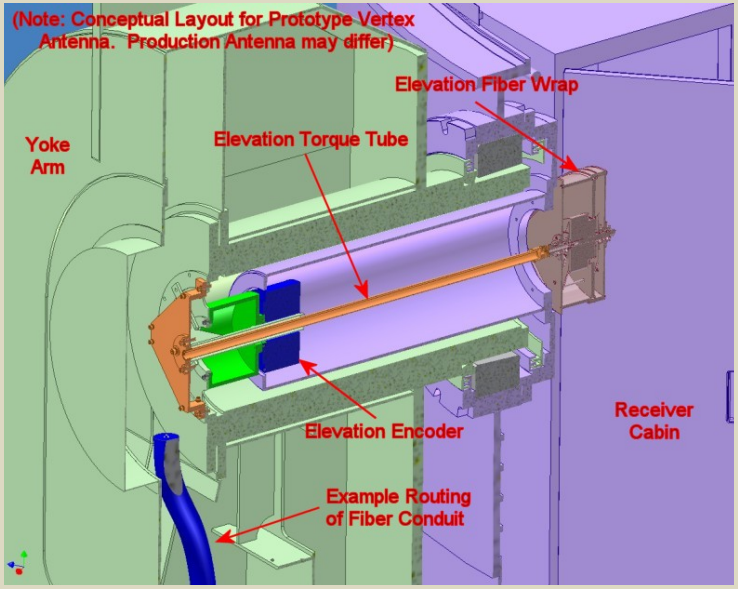
GLT Antenna Cabling System – Fiber Optics

- Summary/Issues
  - Two protected fiber optic cables will enter the Support Cone
    - 12-fiber armored cable
      - 6-fiber cable through Az-wrap to LSC
      - 6-fiber cable through Az-wrap to RSC
    - 24-fiber armored cable
      - 24-fiber cable to Receiver Cabin
      - 1-fiber cable through Az & El Torque Tubes
  - AFL fiber optic cable is specified as follows:
    - Storage -60 to +70 C
    - Operation -60 to +70 C
    - Installation -30 to +70 C
    - This limited installation temperature implies that movement at or below -30 C is not good for the cable
  - Self heating of the power cables (I^2*R) may keep the fiber cables above -30 C
    - We should probably monitor the temperature of the wrap

GLT Antenna Cabling System – Fiber Optics

- Summary/Issues (continued)
  - Custom Azimuth and Elevation FOW for LO fiber optic cable
    - Currently don't know the status of these two devices
    - It is our understanding that the FOWs are not specified to operate at -30 C
    - It may be easiest to heat the Fiber Wraps rather than performing analysis and test to operate at low temperature





GLT Antenna Cabling System – Other

- Cable Glands
  - Left and Right Side Containers (ESAN, NCSIST, ASIAA)
    - Upper Cable Glands (interfaces to Elevation Wrap)
    - Lower Glands (traverse cables, outdoor outlet)
  - Receiver Cabin (NCSIST, ASIAA)
    - Left and Right Cable Glands (interfaces to Elevation Wrap)
- Elevation Wraps
  - Custom Elevation Wraps – Shi-Hsiang Lo
    - LSC to Receiver Cabin
      - 208 VAC Clean
      - 480 VAC
      - Helium Lines
      - Menerga HVAC cables
      - Deice Cable (LSC to Dish)
      - RG-58U
      - CAT5E
      - …

GLT Antenna Cabling System – Other

- Elevation Wraps
  - Custom Elevation Wraps (continued)
    - RSC to Receiver Cabin
      - Vertex Servo Cables (200+)
      - Helium Lines
      - Hexapod Limit Switch (RSC to dish)
      - RG58U
      - CAT5E
      - …

GLT Antenna Cabling System

References:

[1] Power Distribution from Az-Wrap to Panel Boards
http://gltdatabase.asiaa.sinica.edu.tw/glt/gltDocs/10074000010-0B-INT_480%20V-208%20V-208%20V%20Power%20Distribution%20Cone-AZ%20Wrap-Container%20Wiring%20Concept%20-%20Version%20B.pdf

[2] Panel Board 1, 480 VAC, LSC
http://gltdatabase.asiaa.sinica.edu.tw/glt/gltDocs/10074000011-0B-INT_480%20V%20Panelboard%201%20Wiring%20Concept%20-%20Version%20B.pdf

[3] Panel Board 2, 208 VAC Clean, LSC
http://gltdatabase.asiaa.sinica.edu.tw/glt/gltDocs/10074000012-0A-INT_208%20V%20UPS%20Clean%20Panelboard%202%20Wiring%20Concept%20-%20Version%20A.pdf

[4] Panel Board 3, 208 VAC Dirty, LSC
http://gltdatabase.asiaa.sinica.edu.tw/glt/gltDocs/10074000013-0A-INT_208%20V%20UPS%20Dirty%20Panelboard%203%20Wiring%20Concept%20-%20Version%20A.pdf

[5] Panel Board 4, 208 VAC Dirty, RSC
http://gltdatabase.asiaa.sinica.edu.tw/glt/gltDocs/10074000014-0A-INT_208%20V%20UPS%20Dirty%20Panelboard%204%20Wiring%20Concept%20-%20Version%20A.pdf

[6] Panel Board 5, 480 VAC, RSC
http://gltdatabase.asiaa.sinica.edu.tw/glt/gltDocs/10074000015-0A-INT_480%20V%20Panelboard%205%20Wiring%20Concept%20-%20Version%20A.pdf

[7] GLT Antenna Power Budget Estimate
http://gltdatabase.asiaa.sinica.edu.tw/glt/gltDocs/10074000501-0B-DSN_GLT_Panelboard_Configuration_RevB.xlsx

[8] Electronics System Block Diagram
http://gltdatabase.asiaa.sinica.edu.tw/glt/gltDocs/10002000000-0C-BLK_Electronics_System_Block_2016oct12.pdf