Atacama Large Millimeter / submillimeter Array

ALMA

ATACAMA LARGE MILLIMETER ARRAY

Interface Control Document

Between:

HIL Simulation Environment

And:

Infrastructure

ALMA-05.13.00.00-20.00.00.00-A-ICD

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				Chen

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1 Description

1.1 Purpose

The HIL simulation environment is a distributed system that includes up to 4 antennas at the AOS, fiber optic cables inside both, the AOS TB and the OSF TB, and finally a set of racks inside HIL room located in the OSF TB. The purpose of this document is to define the interfaces of HIL at the AOS and OSF technical buildings.

1.2 Scope

This ICD describes the number, locations, physical dimensions, mounting requirements, physical constraints, access requirements, electrical power, connector requirements, and cooling requirements of HIL racks. This ICD also describes the dimensions, weight, and locations of the cable trays and other fiber management equipment installed between and within the equipment rooms.

1.3 Responsibilities

This document provides a definition of interfaces of which the HIL PM is responsible to specify, purchase, assembly, install, implement and properly document in case of changes to the current configuration. At the OSF TB the HIL system will try to reutilize existing equipment and infrastructure wherever is possible. It will reinforce the HVAC capacity if needed [RD 03], will modify the electrical panel for the Room 2-Antenna Correlator [RD 04] and install a new seismic support structure to the racks [RD 05].

The IMG is responsible for providing the OSF technical room with adequate space, electrical power, cooling, and mechanical support for the correlator equipment.

2 Related Documents and Drawings

2.1 Applicable Documents

Appl.	Document Title	ALMA Doc. Number
[AD01]	AOS Technical Building Architectural Program,	SITE-20.01.02.00-001-E-PLA
[AD02]	Standard for Plugs, Socket-outlets, and Couplers,	ALMA-80.05.00.00-004-B-STD
[AD03]	ALMA System Electrical Design Requirements,	ALMA-80.05.00.00-005- B-SPE
[AD04]	Federal Standard 209D, Clean room and Work Station Requirements, Controlled Environments (1988) (obsolete)	Non-ALMA Doc
[AD05]	ALMA Seismic Design Specifications ALMA-AOS and ALMA-OSF,	SYSE-80.10.00.00-002-B-REP
[AD06]	Norma Chilena NCH 433 Diseño sísmico de edificios	Non-ALMA Doc
[AD07]	Alcance de trabajo para sistema de incendio de HIL	ALMA-20.08.10.06-0005-A-SOW
[AD08]	Alcance de trabajo para la fabricación y montaje de la estructura metálica de soporte para los racks HIL	ALMA-20.08.08.05-0024-A-SOW

[AD09]	Alcance de Trabajo. Trabajos eléctricos sala HIL	ALMA-20.08.10.07-0028-A-SOW
[AD10]	ICD between AOS TB and Baseline Correlator	ALMA-20.01.02.00-60.00.00.00-A-ICD
[AD11]	ALMA HIL HVAC Site Commissioning Statement of Work	ALMA-20.08.10.05-0007-A-SOW

2.2 Reference Documents

Ref	Document Title	ALMA Doc. Number
[RD01]	ALMA Interface Management Plan,	ALMA-80.07.00.00.001-C-PLA
[RD02]	ALMA HIL Simulation Environment Fiber Optic Patch Panels	ALMA-20.08.00.09-0001-A-SOW
[RD03]	ALMA HIL HVAC (SOW)	ALMA-20.08.10.05-0007-A-SOW
[RD04]	ALMA HIL Simulation Environment Power and Electrical Panel	ALMA-20.08.10.07-0028-A-SOW
[RD05]	ALMA HIL Simulation Environment Room Anti-Seismic Structure Statement of Work (SOW)	ALMA-20.08.10.05-0008-A-SOW

2.3 Abbreviations and Acronyms

AC	Alternating Current
ANSI	American National Standards Institute
AOS	Array Operations Site
FO	Fiber Optics
HVAC	Heating, Ventilation, and Air Conditioning
HIL	Hardware in the Loop
HIL-PM	Hardware in the Loop Project Manager
ICD	Interface Control Document
IEC	International Electro technical Commission
LO	Local Oscillator
OSF	Operations Support Facility
RH	Relative Humidity
SOW	Statement of Work
TB	AOS Technical Building
TBD	To Be Determined
UPS	Uninterruptible Power Supply

3 Interface with the AOS TB

3.1 Interior Cable Trays

The HIL system will use the existing overhead cable trays in order to bring 4 FO patch cords between the Patch Panel Room 128 to the Computing room 130 and one FO patch cord from the LO Room 127 to the Computing room 130 as shown in Figure 1.

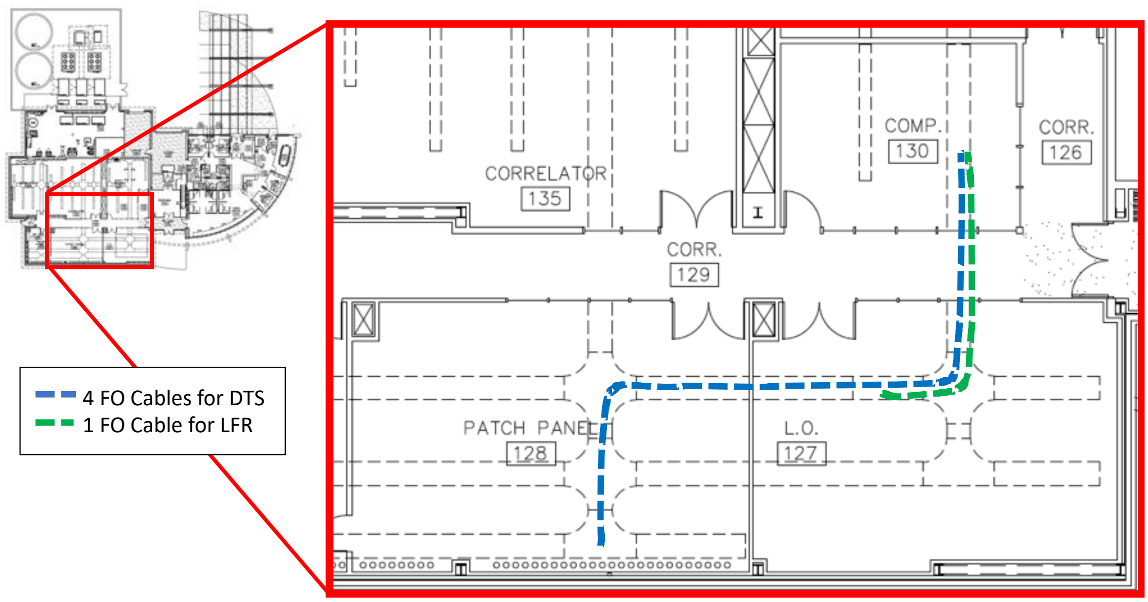

Figure 1. HIL Fiber Optic links between the Patch Panel room 128 (In blue), the Lo Room 127 (In green), and the Computing Room 130.

Occupancy of cable trays is sufficiently low so that these new cables do not interfere in any way.

4 Interface with the OSF TB

4.1 Mechanical Interfaces at the 2-Antenna Correlator room

The HIL system containing the racks and equipment will be installed at the OSF TB room 2-Antenna Correlator as shown in Figure 2 from [RD 03].

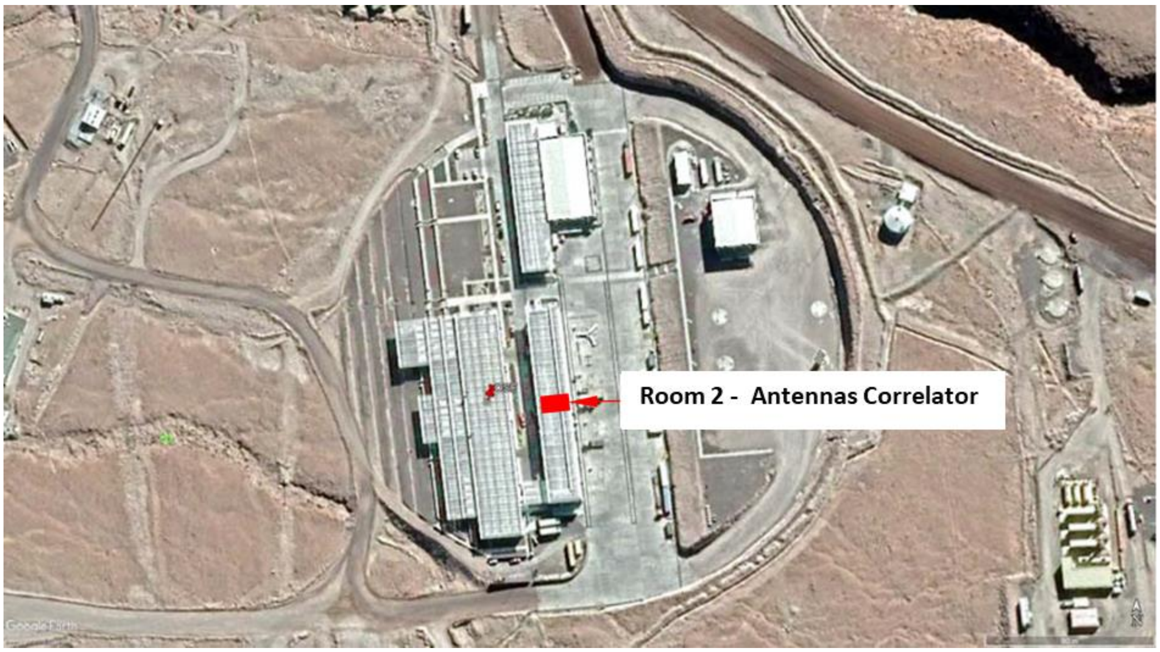

Figure 2. Location of the Room where the HIL equipment will be installed

The hardware to be housed in this room is listed in Table 1 below:

Quantity	Dimension	Height	Description
1	900 x 740 [mm]	2,000 [mm]	Station Rack
4	900 x 740 [mm]	2,000 [mm]	Correlator Racks
1	610 x 680 [mm]	2,130 [mm]	Power Supply Rack
1	800 x 1000 [mm]	1,870 [mm]	CDP Computer System Rack
1	900 x 740 [mm]	1,870 [mm]	TFINT Rack
1	1000 x 635 [mm]	2,000 [mm]	FOAD Rack
1	780 x 570 [mm]	760 [mm]	SAS/LLC Rack
1	700 x 535 [mm]	1,745 [mm]	tCLOTs Rack

Table 1. Racks in the HIL 2-Antenna Correlator Room

The ALMA-HIL correlator sub-system associated racks will be assembled as a line of contiguous racks with adjacent side panels removed and racks bolted together to allow running cables from rack to rack without going under the floor. A set of auxiliary racks will be also installed for housing Back End equipment and computing infrastructure. The minimum floor space required to house the ALMA-HIL is 39[m^2] distributed in a 4.1 [m] by 9.5 [m] configuration (Figure 3).

The ceiling height should be 3 m above the raised floor

4.1.1 Raised floors and rack's mounting

A seismically-rated steel support structure beneath the racks is required. The top of this structure shall be bolted to the bottom of the racks and the bottom of this structure shall be bolted to the concrete slab at the true floor level. The 2-antenna correlator room shall reutilize the existing raised floor leveled at 590 [mm] above the true concrete floor to accommodate for the new rack layout. The space under the raised floor shall serve as an air plenum for forced air cooling and shall permit under-floor electrical power conduits. No other cables shall be installed below the floor.

The raised floor and seismic structure shall be electrically bonded to the building's ground. The HIL PM will be responsible for the design construction and installation of the seismic structure according to [AD 05], [AD 06] and [AD 08].

4.1.2 HIL Racks location

The HIL racks shall be located as shown in Figure 3. The position of the seismic support structure with respect to the NE corner of the room in the same figure.

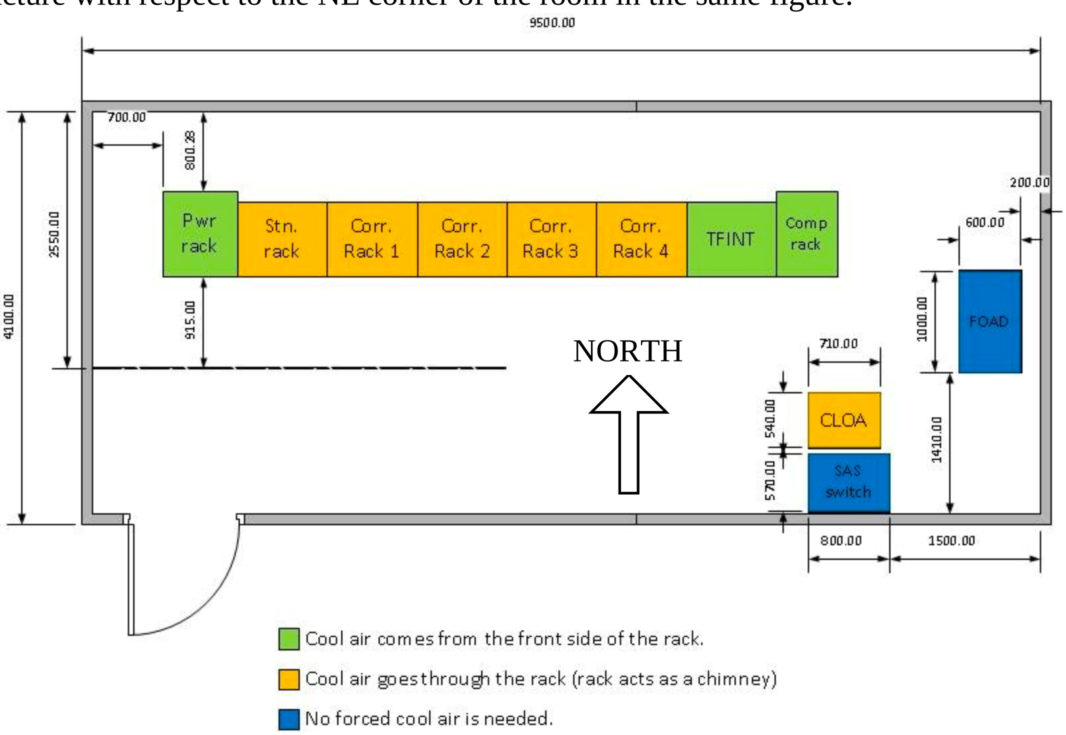

Figure 3. Location of the HIL rack relative to the NE corner of the 2-Antenna Correlator Room

4.1.3 Fiber routing

The fiber optic links between the computing rooms at the OSF and the 2-Antenna correlator Room, where the HIL equipment will be installed, is shown in Figure 4:

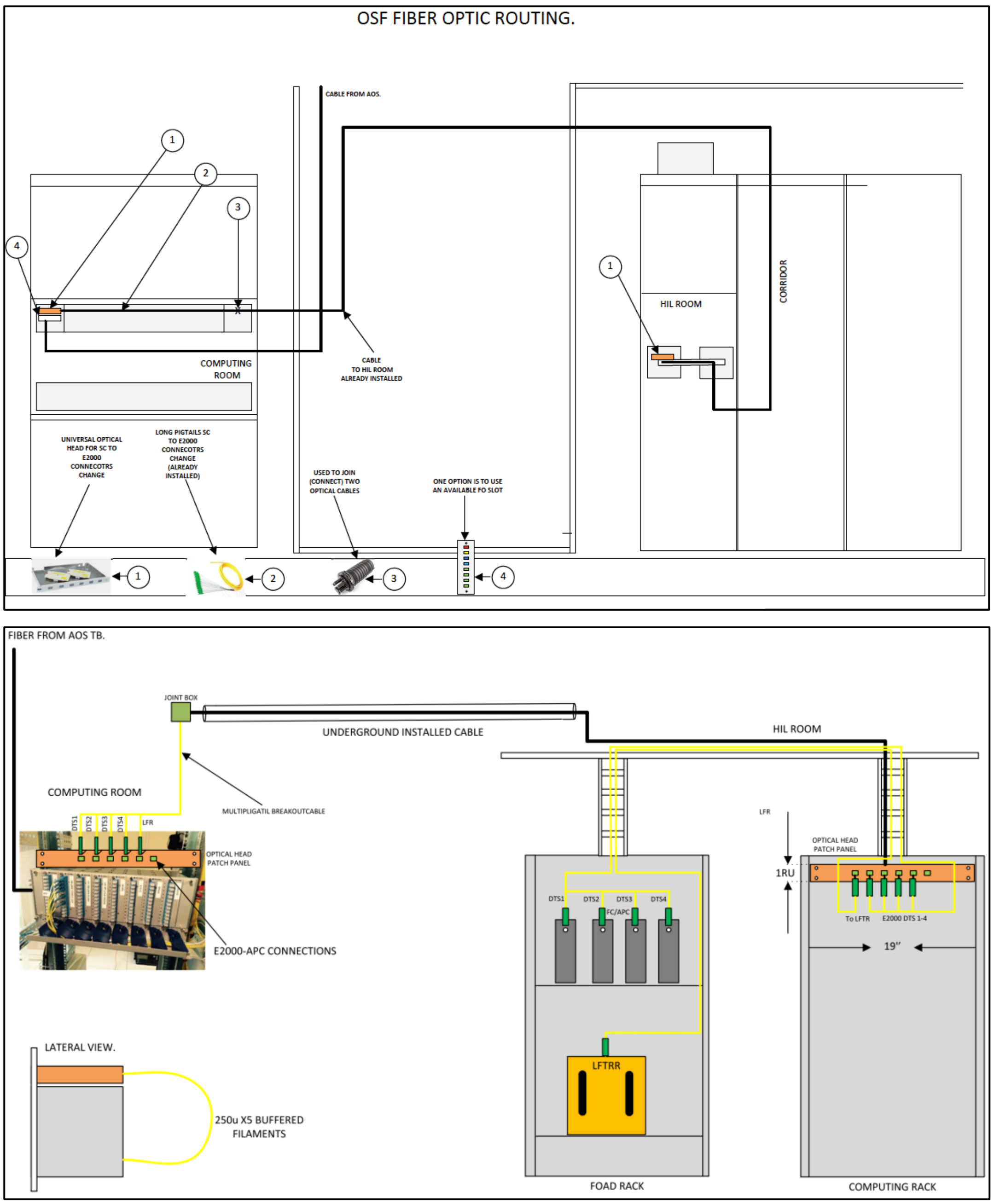

Figure 4. HIL fiber routing across the OSF TB

4.2 Electrical Interface

The details of the electrical interface are described in [AD 09]. The basis for the interfaces is also referenced from [AD 10].

The power factor is estimated to be at least 0.9 as it is also described in [AD 10].

4.2.1 Electrical Connectors

Power outlets shall be provided under the floor near the base of each rack [AD 09]. This shall be achieved with circuit breaker panels on the walls and conduits running under the floor to junction boxes near the rack footprints. Each rack shall be equipped with a flexible cord that connects to a power outlet. Both the cords and power outlets shall be provided by the HIL PM. The plugs and outlets shall conform to [AD 02].

Figure 5 shows the position of the power outlets in the HIL room.

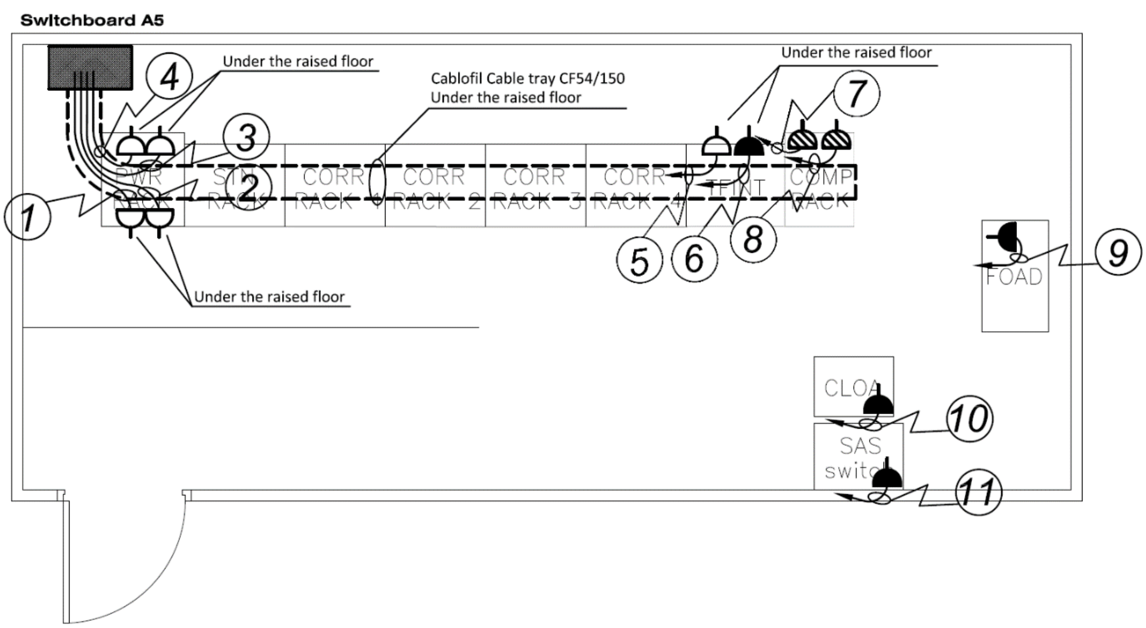

Figure 5. HIL 2-Antenna Correlator Room, position of power outlets

A total of five IEC 60309 5-contact socket-outlets (such as International Configurations, Inc. catalog number 888-1239) will be required. Each socket-outlet provides 3 phase power. Four of these distribute the three-phase power to the ALMA-HIL correlator power supply rectifier rack, and the other will distribute the three-phase power to TFINT.

Four Schuko type socket-outlet (CEE-el Publication 7 - standard sheet IV and VII) will be required. Each socket-outlet provides single-phase 'normal power' (i.e., non-UPS). These distribute the single-phase 'normal power' to the TFINT, FOAD, CLOA and SAS in accordance with Table 2.

Two IEC 60309 3-contact socket-outlets will be required. Each socket-outlet provides single-phase power. These distribute the single-phase power to the Comp Rack.

All socket-outlets will be selected according to the standards provided in [AD 02]. The socket-outlets for the Power Rack and TFINT will be placed under the computer floor.

Figure 6 below shows the one-line electrical diagram for the HIL equipment.

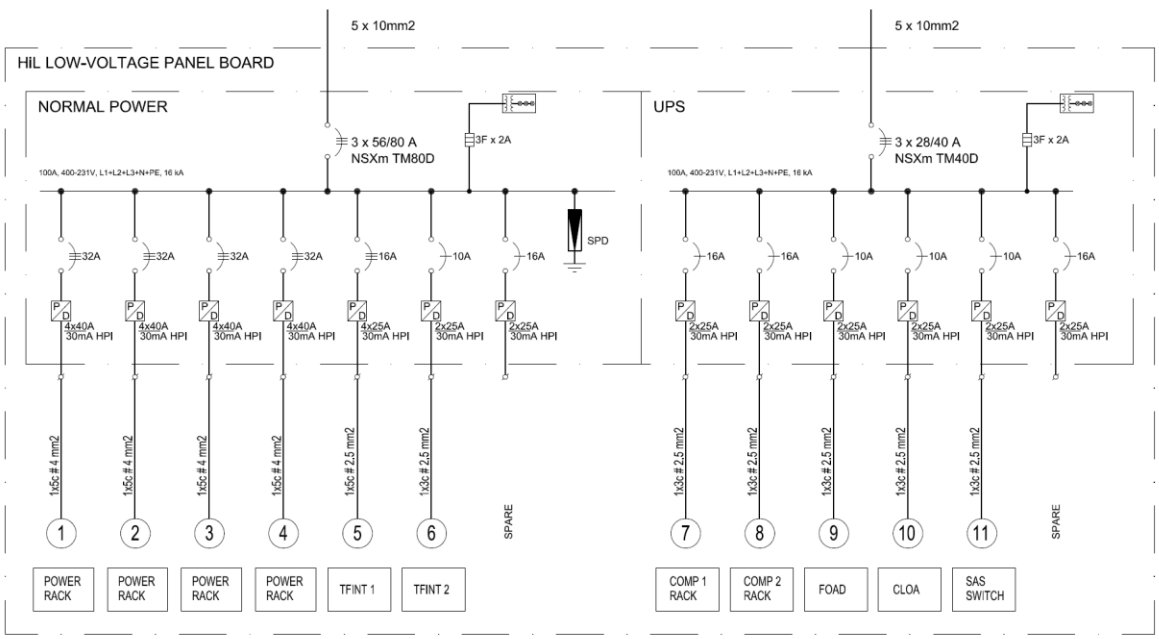

Figure 6. One-line electrical diagram for HIL equipment in the room

4.2.2 UPS requirements

UPS power shall be provided to the HIL racks in 2-Antenna Correlator Room so that the equipment listed in Table 2 is protected. It is estimated the HIL racks will require 3KVA of UPS power.

Rack name	Type of outlet	Qty	Connected to the UPS
Power Rack	3-phase, 32[A]	4	NO
Comp Rack	Single Phase, 16[A]	2	YES
TFINT	3-phase, 32[A]	1	NO
TFINT	single phase, 10[A]	1	NO
FOAD	single phase, 10[A]	1	YES
CLOA	single phase, 10[A]	1	YES
SAS	single phase, 10[A]	1	YES

Table 2. List of HIL equipment requiring (or not) UPS

4.2.3 Grounding

There shall be a copper grounding bus for the HIL equipment racks. This bus shall be installed below the raised floor near the rack footprints. The bus shall be bonded to the building ground counterpoise. The bus shall have a minimum cross section of 125 mm^2 and be large enough to allow one ground connection for each rack. The bus and the ground connections for each rack will be purchased and installed the by the HIL PM.

The grounding shall comply with [AD 03].

4.2.4 Cable Trays

Cable trays for the power cables shall be provided underneath the raised floor.

4.3 Air Conditioning

The HIL racks in the 2-Antenna Correlator room are powered and require cooling. The heat dissipation is about 20.4 kw. For these racks, temperature-controlled air shall be forced up from the bottom to exit through chimneys at the top. Required air flow is estimated at 3.586 [m^3/s] and a back pressure of 535 [mm Hg] cooling shall be provided by the HVAC through an under-floor plenum so that the maximum temperature of the air exiting the racks is safe for the equipment and electronics and no hotter than 30 C. The room temperature shall be controlled within +/- 2 C. The HVAC system will consider existing equipment, but will be subject to improvements if needed [AD 11].

To control static electricity buildup, the relative humidity shall be maintained within a range of 30% to 50%.

The air shall be filtered so airborne dust concentrations are maintained at ISO class 8 (Fed. Std. 209D class 100 000) or better.

It is mandatory to interconnect the HVAC dampers with the control system for the fire protection [AD 07] to be installed in the room.

4.4 Safety

Access to the room will remain restricted and the current RFID card reading system will be maintained.

Ear plug protection dispenser shall be placed inside the room in order to prevent damage to ears in case the inert gas of the fire protection is suddenly activated.

4.4.1 Fire Protection

Fire retardant materials and components (such as cables) shall be used throughout the HIL equipment as practicable.
The 2-antenna correlator room fire protection system shall be renewed, designed and funded by the HIL PM according to [AD 07]. Motorized dumpers in the HVAC units as well as interconnection to the fire protection system is mandatory [AD 07].

5 HIL Project Management responsibilities/agreements

- HIL PM shall evaluate need to improve or expand the need to further capacity for the HVAC system in the 2-antenna correlator room.
- HIL PM shall design, install, commission and fund the expansion of the HVAC system for the 2-Antenna Correlator Room.
- HIL PM shall provide new as-built drawings of the existing HVAC system and any modification that may be applied.
- HIL PM shall design, fabricate, install and fund the rack’s metallic support structure into the 2-antenna correlator room.
- HIL PM defines the computer floor height above concrete “true floor” slab is 590 [mm].
- HIL PM shall arrange for the computer floor finished height to match the height of the structure.
- HIL PM specifies the steel structures top surface level tolerance to be level within +1.6 mm (1/16 inch) in any 3.05 meter (10 foot) distance. This is true for both directions of the top of the structures.
- HIL PM shall provide as-built drawings of the final 2-antenna correlator room layout.