



## ALMA Study Project

**PMD-365-031-A-PLA**  
**Safety Compliance Plan and Hazard**  
**Analysis for the**  
**ALMA Correlator Upgrade Project**


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# Safety Compliance Plan and Hazard Analysis for the ALMA Correlator Upgrade Project

Status: *Approved*

2017-01-25

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## Change Record

Version	Date	Affected section(s)	Reason/Initiation/Remarks
A.1	2016 Sep 12	All	Initial draft
A.2	2017-01-24	All	Change focus to upgrade development project only. Remove references to study project.
A.3	2017-01-25	Several	Add items from Saez




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## 1. GENERAL

### 1.1. Purpose and Scope

This document provides a systematic examination of the deliverables<sup>1</sup> and activities identified in the ALMA Correlator Upgrade, assessing potential risk of hazards within the proposed system, which may be present in its environment, associated with its installation, implementation, or impact to safety of ongoing operation. This plan outlines steps the NRAO Correlator Group shall take to meet Safety Compliance Requirements and address specific hazards that have been identified. It should be noted that equipment proposed to be delivered installs in existing environments where a hazard analysis has already been performed on the existing host rooms, racks, and infrastructure. This report does not retrace the content of those reports, but serves as a subsidy to them for the equipment being added. See RD-03 and RD-04 for examples where similar assessments have previously been performed. In most cases, hazards that apply to the proposed upgrades are similar to existing equipment, where safety protocols and labeling is already in place, and procedures already include mitigation against these safety risks has already been established.

Section 2 describes criteria used to rate the probability and severity of a potential hazard. Section 4.1 contains the Risk List which details the evaluation of all risk areas in relation to the correlator upgrade. The Hazard Analysis in Section 4.2 provides a thorough evaluation of critical items identified in the Risk List.

### 1.2. Applicable Documents

This section contains a list of Applicable Documents, which define the content, requirements and specifications for this document and a list of Reference Documents, which contain information related to the products and processes in this document.

**Table 1: Applicable Documents**

Reference	Document Title	ALMA Doc. Number
[AD-01]	ALMA Product Assurance Requirements	ALMA-80.11.00.00-001-D-GEN
[AD-02]	ALMA Subsystem Testing and Handover Guidelines	ALMA-80.00.00.00-008-A-PLA

<sup>1</sup> Deliverables will be listed in the project Statement of Work and are currently listed in the upgrade development proposal, PMD0485



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[AD-03]	ALMA Safety Risk Analysis Procedures	ALMA-10.08.00.00-004-A-GEN
[AD-04]	ALMA General Safety Design Specification	ALMA-10.08.00.00-003-B-SPE

### 1.3. Reference Documents

**Table 2: Reference Documents**

Reference	Document Title	ALMA Doc. Number
[RD-01]	Spectral Resolution and Bandwidth Upgrade of the ALMA Correlator - SOW	TBD
[RD-02]	ICDs Between Correlator upgrade and ALMA Site, other systems, etc.	TBD
[RD-03]	64-Antenna Correlator Hazard Analysis	ALMA-60.00.00.00-057-A-REP
[RD-04]	APP Hazard Analysis and Safety Compliance Plan	ALMA-05.11.10.01-0003-A-PLA
[RD-05]		

### 1.4. Definitions


For the purpose of this document, the following terms and definitions apply:

**Accident** – An undesired event resulting in death, injury, damage to health, damage to property or other form of loss.

**Harm** - Physical injury or damage to property or to the environment.

**Hazard** - a biological, chemical or physical agent or condition with the potential to cause a harm. Hazards can be qualified to define its origin or the nature of the expected “harm” (e.g., electric shock hazard, crushing hazard, cutting hazard, fire hazard).

**Hazard Identification** – Identification of biological, chemical, and physical agents capable of causing adverse health effects.

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**Hazard Verification** – All activities performed to demonstrate that the design meets or is capable of meeting the specified safety requirements.

**Life-cycle** - All phases of the item's life including design, research, development, test and evaluation, production, deployment (inventory), operations and support, and disposal.

**Risk** – An expression of the likelihood of injury or harm resulting from a hazard. A combination of the probability of an adverse health effect and the severity of that effect.

**Protective Measure** - means used to reduce risk. Protective measures include risk reduction by inherently safe design, protective devices, personal protective equipment, information for use and installation, and training.

**Safety** - freedom from unacceptable risk

## 1.5. Responsibilities

### NRAO Correlator Group


- Review the design and implementation concept for safety issues and risk
- Identify and document hazards
- Complete the Preliminary Hazard Analysis.
- Outline the plan for safety compliance and risk mitigation
- Provide safety certifications on COTS components

### ALMA JAO

- Review Hazard Analysis, Safety Compliance Plan, and COTS certifications
- Advise on proposed strategy for safety compliance and risk mitigation
- Identify gaps in plan due to specifics of local environment or safety protocols
- Feedback is expected within 3 months from the start of the project

## 2. RISK ESTIMATION PROCESS

This section details the criteria used to evaluate the severity of potential hazards, the likelihood or probability of their occurrence, and the type or category of exposure.

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## 2.1. Hazard Severity Ratings

The following table details the severity levels used to rate the magnitude of consequence related to each identified risk, should it occur. These ratings are used to evaluate the risks in the Risk List and the Hazard Analysis.

**Table 3: Hazard Severity Ratings**


Category	Severity Description	Mishap Definition
1	Catastrophic	Death and/or the instrument is more than 4 weeks out of operation or it cannot be recovered at a reasonable cost.
2	Critical	Severe injury, severe occupational illness, and/or the instrument can be repaired, but support from the supplier/industry is necessary and/or the instrument is up to 4 weeks out of operation.
3	Marginal	Minor injury, minor occupational illness, and/or the instrument can be repaired by ALMA staff, and/or the instrument is up to one week out of operation.
4	Negligible	Less than minor injuries, less than minor occupational illness, and/or the instrument is less than one day out of operation.

## 2.2. Hazard Probability Levels

The probability that a hazard will occur during the total lifetime of an instrument is defined using the following criteria. The ratings are used in the Risk List and the Hazard Analysis.

**Table 4: Hazard Probability Levels**

Level	Probability Description	Definition
A	Frequent	Likely to occur more than once per year
B	Probable	Will occur 6 to 10 times during the whole lifetime
C	Occasional	Will occur 2 to 5 times during the total lifetime
D	Remote	Unlikely but possible to occur once during the total lifetime
E	Improbable	So unlikely that an occurrence can be assumed not to be experienced.

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### 2.3. Risk Acceptance Criteria/Rejection Criteria

The following figure prioritizes hazards for use in defining corrective actions.


**Table 5: Risk Acceptance Criteria**

Frequency of Occurrence	Hazard Categories				Accept/Reject Criteria
	Catastrophic	Critical	Marginal	Negligible	
Frequent	1A	2A	3A	4A	Unacceptable
Probable	1B	2B	3B	4B	Undesirable, ESO & AUI/NRAO decision required.
Occasional	1C	2C	3C	4C	Acceptable with ESO & AUI/NRAO review.
Remote	1D	2D	3D	4D	Acceptable without ESO & AUI/NRAO review.
Improbable	1E	2E	3E	4E	Acceptable without ESO & AUI/NRAO review.

### 2.4. Hazard Exposure Categorization

The following list defines the categories of estimated exposure for a potential risk and the scope of effect should the risk occur. These categories are used to evaluate risks in the Risk List.

- O** - Occupational exposure, i.e. hazard has potential impact only for workers in immediate area.
- F** - Could impact workers in the facility but not likely to impact the outside environment.
- E** - Hazard that could have environmental consequences, e.g. a solvent spilled in large enough quantities to cause environmental pollution outside the facility.
- P** - Hazard that could have consequences to the off-site public.

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### 3. SYSTEM DESCRIPTION

#### 3.1. Correlator Upgrade Sub-system Components

This section lists the components of the Sub-system upgrade and locations where they are installed.


- **Equipment to be installed or replaced in the Correlator room at the AOS**
  - Correlator Cards
    - Will remove and replace 1 for every 4 currently in system (128 total cards installed)
  - Correlator Interface Cards
    - Will replace all of these 1 for 1 (512 total).
  - Station Interface Cards
    - Will replace all of these 1 for 1 (128 total).
  - Station Cards
    - Will replace all of these 1 for 1 (256 total)
  - Final Adder Cards
    - Will replace all of these 1 for every 1 (8 cards total).
  - DRX and TFB Cards
    - All DRX and TFB cards will be removed (768 cards total)
    - These will be replaced by DRX/TFB cards (256 total)
  - LVDS Cables
    - Will disconnect and tie off approximately 256 of these
    - Will add approximately 256 of these

#### 3.2. List of Hazard Sources for Correlator Upgrade Activities

This section itemizes general sources of hazards that will be reviewed and addressed, as they are applicable to the Correlator upgrade and its operating environment.

##### 3.2.1. Environmental

- Precipitation (rain, snow, hail,...)
- Lightning
- Humidity
- Temperature
- Altitude (air pressure)
- UV light
- Wind
- Earthquake

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- Acceleration / movement
- Shock during transportation
- Electric power fluctuation
- Electric power interruption
- Electric shock
- Software
- Hardware
- Operator

### **3.2.2. System (Hazardous components)**

- Fire/Flammability
- Overheat/high temperature
- Mechanical
- Electric shock
- Software
- Hardware
- Operator

## **4. RISK ASSESSMENT**

### **4.1. Correlator Upgrade Hazard List**

The Hazard List identifies the primary hazards and accident scenarios associated with the specific (sub)system being designed, describes the risk and estimates the probability of occurrence of a harmful event. The estimation of the risk considers the frequency and duration of the exposure of persons to the hazard, probability of occurrence of a hazardous event, the technical and human possibilities to avoid or limit the harm (e.g. emergency stop equipment, reduced speed enabling device, awareness of risks) and severity of harm. In many cases these elements cannot be exactly determined, but can only be estimated.

Where risk has been identified, the following measures are necessary to prevent injury.

- Assess Design Measures - Determine if measures are appropriate to level of risk. First, eliminate hazards by design, manage remaining risks, notify and train users on remaining risk.
- Verify Compatibility of Design Measures - Ensure that design features and measures will not defeat other measures or modes of operations.



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**Table 6: Detailed Hazard List**

Potential Hazard	Severity	Probability	Scope	Comments
<b>MECHANICAL HAZARDS (parts or workpieces)</b>				
a) shape	N/A			
b) relative location	N/A			
c) mass and stability (potential energy of elements which may move under the effect of gravity)	N/A			
d) mass and velocity (kinetic energy of elements in controlled or uncontrolled motion)	N/A			
e) inadequacy of mechanical strength	N/A			
f) elastic elements (springs)	N/A			
g) liquids and gases under pressure	N/A			
h) the effect of vacuum	N/A			
Crushing hazard	2	E	O	Applicable only if a rack is detached from support structure , not anticipated during implementation
Shearing hazard	N/A			
cutting or severing hazard	4	E	O	Some risk is involved with handling modules and other system hardware.
entanglement hazard	N/A			.
drawing- in or trapping hazard	N/A			
impact hazard	N/A			
Stabbing	N/A			
friction or abrasion hazard	N/A			
high pressure fluid injection or ejection hazard	N/A			
<b>ELECTRICAL HAZARD</b>				



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Potential Hazard	Severity	Probability	Scope	Comments
low voltage/high current	3	D	O	Shorting equipment rails could cause equipment damage and possible burns. Correlator Room is under controlled access. Power supplies are fused and circuit breakers are present in the UPS. Site personnel are trained.
exposed 115 V, 230 V	N/A			
approach to live parts under high voltage	N/A			
high power	N/A			
stored energy/capacitors	N/A			
stored energy/inductors	N/A			
electrostatic discharge including lightning	3	D	F	There is a potential for equipment damage from a person to electronics if a wrist strap is not properly worn. Maintenance protocols require ESD protection devices be used while servicing. Operational location and servicing to be conducted in a humidity controlled environment. Lightning suppression is not the responsibility of the Design Team doing the upgrade.
Battery	N/A			
contact of persons with live parts (direct contact)	N/A			



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Potential Hazard	Severity	Probability	Scope	Comments
contact of persons with parts which have become live under faulty conditions (indirect contact)	N/A			
thermal radiation or other phenomena such as the projection of molten particles and chemical effects from short circuits, overloads, etc.	N/A			
<b>THERMAL HAZARDS</b>				
radiation of heat sources (high temperature equipment)	N/A			
battery bank and UPS equipment	N/A			
flames or explosions	N/A			
<b>HAZARDS GENERATED BY NOISE resulting in:</b>				
hearing loss (deafness), other physiological disorders (e.g. loss of balance, loss of awareness)	N/A			
interference with speech communication, acoustic signals	N/A			
<b>HAZARDS GENERATED BY VIBRATION</b>				
use of hand-held machines resulting in a variety of neurological and vascular disorders	N/A			
whole body vibration, particularly when combines with poor postures	N/A			
<b>HAZARDS GENERATED BY RADIATION</b>				
X and gamma rays	N/A			
Optica and IR	2	E	O	Optical fibers terminated in the correlator are driven by lasers which may have potential to cause eye damage. An upgraded laser system will be designed, by an independent group, for the correlator upgrade. Once the design is complete, the hazard needs to be re-analyzed.



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Potential Hazard	Severity	Probability	Scope	Comments
low frequency, radio frequency radiation, micro waves	4	E	O	RF sources are present at 125 MHz but are below any harmful level, i.e., no more than 50 milli-watts
intense light sources	N/A			
radiation check sources	N/A			
<b>HAZARDS GENERATED BY MATERIALS AND SUBSTANCES (and their constituent elements)</b>				
hazards from contact with or inhalation of harmful fluids, gases, mists, fumes, and dusts	N/A			
fire and explosion hazard	N/A			
biological and microbiological (viral and bacterial) hazards (i.e., water)	N/A			
<b>HAZARDS GENERATED BY NEGLECTING ERGONOMIC PRINCIPLES IN DESIGN as, e.g. hazards from:</b>				
unhealthy postures or excessive effort	N/A			
inadequate consideration of hand-arm or foot-leg anatomy	N/A			
neglected use of personal protection equipment	N/A			
inadequate local lighting	N/A			
mental overload and underload, stress and strain	N/A			
human error, human behavior	N/A			
inadequate design or location of visual display units	N/A			
repetitive motion	N/A			
<b>UNEXPECTED START-UP, UNEXPECTED OVERRUN/OVERSPEED (or any similar malfunction) from:</b>				
failure/disorder of the control system	N/A			
restoration of energy supply after an interruption	N/A			
external influences (gravity, wind, etc.)	N/A			
errors in the software	N/A			
errors made by the operator (due to mismatch of machinery with human characteristics and abilities)	N/A			
systems redundancy and diversity	N/A			
interlocks	N/A			
<b>OPERATING, TEST, MAINTENANCE AND EMERGENCY PROCEDURES</b>				
human factors considerations	N/A			



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Potential Hazard	Severity	Probability	Scope	Comments
adequacy and effectiveness of instruction, training	4	D	O	Only trained and authorized persons will be allowed to perform maintenance on the correlator
user error, including failure to activate	N/A			
effect of factors such as equipment layout, ergonomics and lighting	N/A			
crash safety, egress, rescue and survival	N/A			
variation in the speed of tools	N/A			
impossibility of stopping in the best possible condition	N/A			
<b>MECHANICAL HAZARDS AND HAZARDOUS EVENTS</b>				
loading/unloading (i.e., load falls, collisions, machine tipping)	3	D	O	At delivery and setup; items over 25Kg should only be handled by persons trained with proper operation of material handling equipment
emergency response/spill clean-up	N/A			
packaging hazardous materials	N/A			
bad road conditions (e.g., icy)	N/A			
uncontrolled amplitude of movements	N/A			
inadequate holding devices/accessories	N/A			
insufficient mechanical strength of parts	N/A			
inadequate design of pulleys, drums	N/A			
inadequate selection of technical equipment and accessories and their inadequate integration	N/A			
abnormal conditions of assembly/testing/use/maintenance	N/A			
<b>MOTION HAZARDS</b>				
falling of person from person carrier	N/A			
moving vehicles, carts, forklifts	4	E	F	Forklift and operator will be supplied by ALMA Logistics during delivery. Installation related only.
material grinding, cutting, drilling	N/A			



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Potential Hazard	Severity	Probability	Scope	Comments
work with roads and grounds equipment	N/A			
powered platforms	N/A			
Over speed of person carrier	N/A			
<b>CHEMICAL HAZARDS</b>				
acids, solvents, toxic agents and hazardous liquids	N/A			
heavy metals such as lead	N/A			
chemical reactions	N/A			
toxicity in smoke or fumes	N/A			
welding fumes	N/A			
carbon monoxide	N/A			
carcinogens	N/A			
chemical exposure	N/A			
<b>PERSONNEL HAZARDS/ HAZARDS GENERATED BY NEGLECTING ERGONOMIC PRINCIPLES</b>				
vacuum tanks	N/A			
pinch hazards	N/A			
confined spaces /insufficient means for evacuation/emergency exit	N/A			
restricted movement of persons	N/A			
lifting/carrying heavy objects	3	C	O	Some items may be > 25 kilograms. Two persons will be required to replace or handle these items and they shall bear caution labels regarding their weight.
working at heights	N/A			
slips, trips & falls	N/A			
hazards requiring PPE	3	C	O	See additional entry in this section. Safety shoes shall be worn and site safety protocols observed where PPE is needed.
inadequate seating	N/A			
inadequate lighting	N/A			
insufficient visibility	N/A			
inadequate location of manual controls	N/A			



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lack or inadequacy of visual or acoustic warning means	N/A			
<b>CONSTRUCTION HAZARDS</b>				
heavy equipment	N/A			
possibility of hitting utilities	N/A			
scaffolding	N/A			
ladder	N/A			
compressed gas	N/A			
earth moving equipment	N/A			
<b>MATERIAL HANDLING HAZARDS</b>				
ejected objects	N/A			
cranes & hoists	N/A			
fork lift operation	N/A			Some: addressed in Motion Hazards section above
chemical spills	N/A			
falling objects	N/A			
hazardous tools, equipment and machinery	N/A			
storage/handling of toxic materials	N/A			
<b>ENVIRONMENTAL HAZARDS</b>				
hazardous waste	N/A			
surface water discharges	N/A			
endangered species issues	N/A			
archeological requirements	N/A			
regulated chemical wastes	N/A			
groundwater protection	N/A			
ozone depleting substances	N/A			
sewer discharges	N/A			
drinking water quality	N/A			
<b>FIRE HAZARDS</b>				



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Potential Hazard	Severity	Probability	Scope	Comments
electrical	1	E	F	Unavoidable use of electrical components and materials is expected. Circuit protection is provided in design where needed for safety. ALMA site operations is responsible for fire protection.
flammable substances, solid, liquid or gaseous	N/A			
welding	N/A			
spark producing tools near combustibles	N/A			
spontaneous combustion	N/A			
storage of combustibles	N/A			
mobile structures (port-a-kamps)	N/A			
transportation (rail, vehicle, fueling)	N/A			
boiler, furnace, heating systems and appliances	N/A			
stationary combustion engines	N/A			
cigarette smoking	N/A			
<b>OXYGEN DEFICIENCY HAZARDS</b>				
cryogenic spills	N/A			
cryogenic gas or liquid leak	N/A			
chemical spills	N/A			
leak of supplied gases	N/A			
<b>HAZARDOUS COMPONENTS</b>				
explosives	N/A			
asphyxiates, toxic or corrosive substances	N/A			
hazardous construction materials	N/A			
pressure systems	N/A			
hydraulic machinery	N/A			
other energy sources including motion	N/A			
hazardous surfaces	N/A			
<b>FACTORS DUE TO OPERATING DOMAIN, OR THAT THE SYSTEM MAY ADD TO THE OPERATING DOMAIN</b>				
drop	N/A			
shock and vibration, including seismic	N/A			
extreme pressures and climatic conditions	N/A			




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Potential Hazard	Severity	Probability	Scope	Comments
noise	N/A			
exposure to toxic or corrosive substances	N/A			
<b>ADEQUACY OF SAFETY RELATED EQUIPMENT, SAFEGUARDS AND FAILURE CONTAINMENT MEASURES</b>				
relief valves	N/A			
energy containment vessels	N/A			
electrical protection	N/A			
toxic substance control	N/A			
electrical, air and hydraulic supplies	N/A			
personal protective equipment	N/A			
ventilation	3	C	F	Oxygen need at AOS during installation and checkout—ALMA Site operations is responsible for providing this.
noise or radiation barriers	N/A			
alarms and warnings	N/A			

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#### 4.1.1. Conclusions and Recommendations:

This section provides recommendations to address the risks identified in the Hazard List that require review and acceptance of the identified hazard and its controls solutions.

Risk	Recommendations
crushing hazard (2EO)	This risk is addressed by compliance with the Zone 4 seismic requirements for rack installation. There is no known reason in the implementation plan to detach any racks. Caution regarding disturbance to rack installation will be written into the implementation plan where appropriate.
cutting or severing hazard (4EO)	This is best addressed by administrative controls and training in conjunction with adherence to Site and Project Safety Policy. The frequency of this occurring is minimal.
low voltage/high current (3DO)	This hazard is addressed by providing barriers where contact with conductors is possible, through education, by fuse limits on available power, by short circuit protection in power supplies, and through training.
electrostatic discharge/lightning hazard (3DF)	Electrostatic discharge is managed by the humidification system and by educating maintenance personnel in the use of discharge prevention methods, primarily wrist straps. Lightning hazard is the responsibility of the site IPT.
low frequency, radio frequency radiation, microwaves (4EO)	Power levels are well below potentially harmful levels.
operating/test/maint/emerg effectiveness of training (4DO)	Only trained and authorized persons will be allowed to perform maintenance on the correlator
loading/unloading hazard (3DO)	This is addressed in the shipping and installation plans. The hazard will be minimized by utilizing contractors for rack installation and including references to safety documents in related documents.
moving vehicles, carts, forklifts (4EF)	Personnel provided by AIV should be adequately trained.
lifting /carrying heavy objects (3CO)	This is best addressed by administrative controls and training, in conjunction with adherence to Site and Project Safety Policy. The frequency of this hazard is minimal.
Hazards requiring PPE (3CO)	Related to item above, Safety shoes and gloves shall be used when handling items that are .25Kg or exhibit sharp or rough edges.

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electrical fire hazard (1EF)	Electrical components, cables, and COTs equipment shall be either CE or UL rated. Custom designs shall not expose electrical terminals and shall provide over current fault protection to guard against electrical shorts.
ventilation system (3CF)	Sufficient oxygen must be provided for personnel safety, primarily during installation and checkout. This is an ALMA operations responsibility, but should be included in the installation plan and requested as a resource during installation. Room oxygenation is limited and shared between rooms at the AOS, so must be scheduled.

**Table 7. Summary of risks and recommendations**


#### **4.2. Correlator Upgrade Hazard Analysis Process**

The Hazard Analysis (HA) identifies safety critical areas, evaluates hazards, and identifies the design criteria to be used.

##### Hazard Analysis Considerations

The output of the Hazard Analysis (HA) is a detailed list of hazards associated with the design. The HA will consider the following for identification and evaluation of hazards as a minimum:

- a. Hazardous components (e.g. electrical systems, cooling fluids, toxic substances, hazardous construction materials, pressure systems, lasers, and other energy sources).
- b. Safety related interface considerations among various elements of the design, e.g. material compatibility, inadvertent activation, fire initiation and propagation. Design criteria to control safety-critical software commands and responses (e.g. inadvertent command, failure to command, untimely command or responses, or designated undesired events) shall be identified and appropriate action taken to incorporate them in the software and related hardware specifications.
- c. Environmental constraints including transport, handling and operating environments, (e.g. drop, shock, vibration, extreme temperatures, noise, exposure to toxic substances, health hazards, fire, electrostatic discharge, lightning, electromagnetic environmental effects, and pressure).

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- d. Operating, testing, maintenance and emergency procedures (e.g. human error analysis, tasks, and requirements; factors such as equipment layout, lighting requirements, potential exposures to toxic materials, effects of noise or radiation on human performance, and environmental conditions).
- e. Facilities, support equipment (e.g. provisions for storage, assembly, checkout, proof-testing of hazardous designs/assemblies which may include toxic, flammable, corrosive or cryogenic fluids; electrical power sources) and training (e.g. training and certification pertaining to safety operations and maintenance).
- f. Safety related equipment, safeguards, and possible alternative approaches (e.g. interlocks, system redundancy, fail-safe design considerations, personal protective equipment, ventilation, and access barriers).



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**Table 8: Hazard Analysis Table**

Number	Hazard Source	Cause Factors	Effects/Severity	Severity	Occurrence Probability	Risk Index	Means for Prevention	ACTIONS/REMARKS
1	crushing	rack falling due to earthquake or mishandling	personnel injury; equipment damage.	2	E	O	Racks are adequately secured to support	There is no plan to disturb the rack infrastructure, in the event it becomes necessary, implementation plan will reference site safety protocols
2	cutting or severing hazard	Risk to fingers and toes while handling equipment	personnel injury; equipment damage.	4	E	O	Use of PPE and material handling equipment	
3	low voltage/high current	shorting supply rails	minor/moderate equipment damage; possible burns	3	D	O	lockouts, barriers, education	
4	electrostatic discharge including lightning	Environmental conditions	personnel injury; equipment damage.	3	C	F	humidification, education, lightning suppression	
5	low frequency, radio frequency radiation, micro waves	RF sources are present at 5, 10, 125 Mhz and also	possible equipment malfunction due to	4	E	O	Terminate all unused outputs. No risk of	



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Number	Hazard Source	Cause Factors	Effects/Severity	Severity	Occurrence Probability	Risk Index	Means for Prevention	ACTIONS/REMARKS
		at 4 & 10 Ghz. All are below harmful levels (no more than 50 milliwatts).	unterminated outputs				personal injury.	
7	loading/unloading (i.e., load falls, collisions, machine tipping)	improper material handling	personnel injury; equipment damage.	3	D	O	Use of proper equipment and techniques	
8	moving vehicles, carts, forklifts	untrained personnel, misuse of equip	personnel injury; equipment damage.	4	E	F	Forklift and operator supplied by ALMA.Log during delivery.	
9	lifting/carrying heavy objects	improper technique and equipment	personnel injury; equipment damage.	3	C	O	Use of proper equipment and techniques	
10	Hazards requiring PPE	Related to item directly above	personnel injury	3	C	O	Use of proper equipment and techniques	Safety shoes and gloves are recommended
11	electrical fire hazard	inadequate design, improper installation, carelessness	catastrophic damage to equipment or personnel	1	E	F	Specify CE & UL rating for COTS, design for circuit protection, installation to codes,	



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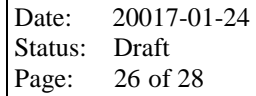
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Number	Hazard Source	Cause Factors	Effects/Severity	Severity	Occurrence Probability	Risk Index	Means for Prevention	ACTIONS/REMARKS
							education	
12	ventilation	diminished oxygen levels at AOS	minor personnel injury	3	C	F	Plan for room oxygenation, monitor O2 blood levels, carry personal O2	
13	Exposure to inert gas used in fire suppression system	Activation of the fire suppression system	minor personnel injury	2	E	O	Training, limiting access to the correlator room to trained personnel and disabling the fire protection system while someone is working in the correlator room. A visual and audible warning system is installed which provides sufficient time for staff to	



Number	Hazard Source	Cause Factors	Effects/Severity	Severity	Occurrence Probability	Risk Index	Means for Prevention	ACTIONS/REMARKS
							evacuate. A means of deactivating the system is provided.	

[illegible]



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## 5. SUMMARY

- No conditions are identified as Unacceptable.
- A few conditions are identified as Undesirable which can all be mitigated through implementation and installation of work packages.
- Items highlighted in yellow and blue shall be reviewed by APP Engineers and management to ensure all of these items are mitigated to the satisfaction of JAO.



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