



Title: LI Safety Requirements	Owner: Bolyard	Date: 2019-07-10
NRAO Doc. #: 020.80.00.00.00-0001-REQ-A-LI_SAFETY_REQS		Version: A



LI Safety Requirements

020.80.00.00.00-0001-REQ-A-LI_SAFETY_REQS

Status: **RELEASED**

PREPARED BY	ORGANIZATION	DATE
J. Bolyard, Environmental, Safety, & Security Manager	ES&S, Facilities & Administration, NRAO	2019-05-30

APPROVALS (Name and Signature)	ORGANIZATION	DATE
R. Selina, Project Engineer	Electronics Division, NRAO	2019-07-10
M. McKinnon, Project Director	Asst. Director, NM-Operations, NRAO	2019-07-10

RELEASED BY (Name and Signature)	ORGANIZATION	DATE
M. McKinnon, Project Director	Asst. Director, NM-Operations, NRAO	2019-07-10



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Change Record

Version	Date	Author	Affected Section(s)	Reason
1	2019-03-28	J. Bolyard	All	Initial draft
2	2019-05-30	A. Lear	All	Format and copyedit to prepare for approvals
3	2019-06-11	R. Selina	1, 2, 5	Minor edits for clarity; updated document references; updated numbering scheme to match ngVLA convention
4	2019-07-09	M. McKinnon	All	Minor edits
A	2019-07-10	A. Lear	All	Prepared document for approvals & release



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I Introduction

1.1 Purpose

This document provides the safety design requirements applicable to hardware, software, and processes/procedures through the entire ngVLA lifecycle. The document addresses the ngVLA safe design requirements through reviews and prototyping, construction, commissioning actions, operation, and ultimate decommissioning.

The essential ngVLA requirements for safety are described in a series of requirements listed in section 5. These have been proposed and adopted for the ngVLA Project as the design safety requirements (Level I). Since a single device or article may contain hazards that are in several categories, several requirements may be applicable at the same time.

The requirements define the hazards to mitigate and the results to be attained but do not specify the technical solutions for doing so. For a wide range of items, the designer may choose standards that meet the essential requirements. This allows flexibility in choosing which standards to apply in the ngVLA project. The designers must document the standards they are working to and the choice of standards shall be reviewed and approved by the Safety IPT with Systems Engineering.

The flow-down of the relevant essential requirements must be based on the hazards applicable to a given product. Therefore, designers need to carry out a Hazard Analysis to determine the essential requirements applicable to the product. This analysis must be documented and included in the technical documentation.

1.2 Scope

The scope of this document extends to all Integrated Product Teams (IPTs), all project reviews, all work practices in labs and worksites, and all subcontractors that provide documentation, procedures, or work at any ngVLA site.

This specification defines the general safety requirements for all parties involved in ngVLA design. A major part of a design to meet the essential safety requirements is the work that involves identification of hazards and the means to prevent them. A document that lists such information is called a Hazard Analysis.

1.3 Project Background

The Next Generation Very Large Array (ngVLA) is a project of the National Radio Astronomy Observatory (NRAO) to design and build an astronomical observatory that will operate at centimeter wavelengths (25 to 0.26 centimeters, corresponding to a frequency range extending from 1.2 GHz to 116 GHz). The observatory will be a synthesis radio telescope constituted of approximately 244 reflector antennas each of 18 meters diameter for the Main Array and the Long Baseline Array (LBA), plus 19 antennas each of 6 meters diameter for the Short Baseline Array (SBA). All 263 antennas will operate in a phased or interferometric mode.

LBA antenna locations will likely include New Mexico, Texas, Arizona, and northern Mexico, as well as all ten current VLBA locations.



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2 Related Documents and Drawings

2.1 Applicable Documents

The following documents are applicable to this Safety Specification to the extent specified. In the event of conflict between the documents referenced herein and the content of this Safety requirement, the latter shall take precedence.

Reference No.	Document Title	Rev/Doc. No.
AD01	ngVLA Preliminary System Requirements	020.10.15.10.00-0003-REQ
AD02	NRAO Environment, Safety, and Security Policy and Program Manual	Version D, Oct. 2016.
AD03	ngVLA Safety Risk Analysis Procedures	020.80.00.00.00-0002-PRO
AD04	ngVLA L0 Safety Requirements	020.10.15.10.00-0004-REQ

2.2 Reference Documents

The following references provide supporting context:

Reference No.	Document Title	Rev/Doc. No.
RD01	OSHA General Industry Standard	29 CFR 1910
RD02	OSHA Construction Standard	29 CFR 1926
RD03	Environmental Protection Agency Clean Air Act of 1963	33 U.S.C.: Navigable Waters
RD04	Environmental Protection Agency Clean Water Act of 1972	42 U.S.C. ch. 85, subch. I § 7401 et seq
RD05	National Fire Protection Association, Consensus Standards	NFPA

3 Safety Scope

The Safety IPT work package includes safety, physical security, ongoing environmental protection actions, sustainability, and identification of associated risks. In the context of this document, “safety” includes all the aforementioned program elements. The scope of the Safety IPT includes an assessment of the requirements for all phases of the ngVLA effort.

The Safety IPT crosses all IPT boundaries and is anticipated to be integrated into all design packages and operational procedures. Safety extends through the lifecycle of the ngVLA. The ngVLA Safety IPT will assist to ensure compliance with federal, state and local safety requirements. In addition, the effort will examine compliance with international standards, such as may be applicable in Mexico.

The ngVLA proposed project will require compliance with the AUI policies for safe planning and management of large facilities. Consequently, there must be significant collaboration with all other Integrated Product Teams (IPTs) as the requirements influence the safety support needed.



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4 Safety Across the ngVLA Lifecycle

All IPTs shall have a designated central point of contact for safety related issues and preparation of safety documentation for reviews. All personnel shall be alert to the need to identify potential safety hazards. Once identified, steps shall be taken to eliminate them, or reduce them to levels judged acceptable. The central point of contact for safety matters shall be the IPT Safety Liaison.

4.1 Design Activities

Safety assurance matters shall conform to the requirements defined in the NRAO Environment, Safety, and Security Policy and Program Manual [AD02], and with site-specific Safety directives.

Potential hazards shall be identified as a part of the normal design process and eliminated or reduced as far as possible. Safeguards shall be determined for outstanding hazards, which will reduce their possible effects to the lowest reasonable level in accordance with the ngVLA Safety Risk Analysis Procedures.

Any safety hazards that cannot be eliminated during the design process shall be reported to the Safety IPT Lead at the design review and to the ngVLA Project Office. Any progress shall be reported, including necessary proof that the relevant requirements have been satisfied.

4.2 Operations Activities

Operations activities are not addressed in this document and shall follow the NRAO ES&S Policies governing operational safety as described in the Environment, Safety, and Security Policy and Program Manual [AD02].



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5 Essential Safety Requirements for Design

The following requirements shall be fulfilled *as a minimum* to achieve acceptable levels of safety across the ngVLA project.

Requirement ID#	Requirement Name	Requirement
SAF0028	Design for all Lifecycle Phase Safety	The ngVLA shall be designed to achieve the highest level of personnel health and safety performance in all phases of the project lifecycle in accordance with standards applicable to the work.
SAF0029	Comply with ES&S Manual	All aspects of the design and construction shall comply with the ES&S Policy And Program Manual.
SAF0030	Develop Safe Procedures	Where appropriate, each IPT shall develop procedures for personnel and equipment safety throughout the design, construction, and operation phases to address working conditions and use procedures, as well as identify the design features that impact safety, environmental protection, and sustainability.
SAF0031	Follow Safe Design Priorities	The priority for safe design shall address safety of personnel, followed by safety of equipment, and then the integrity of the data.
SAF0032	Follow Mitigation Order of Precedence	The ngVLA system shall govern the hazard analysis and safety practices in an order of precedence as follows: 1) Design for Minimum Risk: The primary means for mitigating risk shall be to eliminate the hazard through design. 2) Incorporate Safety Devices: Protective devices shall be used as part of system design to reduce hazard risks to an acceptable level where possible. 3) Provide warning Devices: when neither design nor safety devices can effectively minimize a hazard risk, devices shall be used to detect the hazard condition and alert personnel of its presence. 4) Procedures and Training: Only when it is impractical to substantially eliminate or reduce the hazard, or where the condition of the hazard indicates additional emphasis, special operating procedures and training shall be used. All such procedures shall be fully documented.
SAF0033	Develop Operational Safety Plan	An operational safety plan shall be developed and implemented before the commissioning phase starts.
SAF0034	Follow Safety Design Specification	The safety system specification must be followed during the design of both individual system components and integration of system elements.



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Requirement ID#	Requirement Name	Requirement
SAF0035	Use Safety Design Specification for Validation	The safety system specification shall be used in validation of the integrated system elements for system validation.
SAF0036	Document Safety Compliance	Each completed element of design must document safety compliance with the safety system specifications.
SAF0037	Describe Process to Achieve Safe State	Each element must describe processes and address details to achieve safe state including potential sequencing of events.
SAF0038	Describe Additional Safety Requirements	Each element must describe any additional measures required to be utilized during validation, and describe consequences of failure to follow sequential processes.
SAF0039	Design Facilities for Safe Operational Use	The ngVLA Facilities shall be designed to safely meet its technical requirements and operational specifications at the following physical locations. The "Facility" includes the main radio antenna, service areas, utility equipment, and all other infrastructure necessary to safely execute all the operational functions and secure all ngVLA assets. The Facility design must provide the space and functional equipment to maintain all the system assets operating on the site.
SAF0040	Design Controls for Safe Operation	The control capabilities throughout the system shall include both local and remote exclusive control modes for safe operation. Note this applies to any system that has potential for motion.
SAF0041	Ensure Initial Safe State for Subsystem Power Up	Each Facility in the ngVLA Observatory shall implement a non-software-based safety system(s) in areas where injury or harm to personnel and or equipment can occur. Each subsystem when powered up shall be initialized into a known safe state without human intervention.
SAF0042	Ensure Subsystems are Standalone Safe	Each subsystem shall be responsible for maintaining its own technical health, safety, and status without any other subsystem operational.
SAF0043	Address facility security in design	The project shall affirmatively address site and facility security needs in the design in accordance with the NRAO security policy(ies).
SAF0044	Address Sustainability in Design	The project shall affirmatively address sustainability goals in the design and ongoing operations of the ngVLA project.



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5.1 General Considerations

The design of the ngVLA system and subsystems shall comply with the essential safety requirements given in this document. It should be noted that additional ngVLA specifications on electrical design, environmental conditions, and environmental protection may have been prepared for specific safety requirements adopted for the ngVLA project. Each design shall meet the requirements contained in these additional ngVLA specifications.

A risk analysis shall be done for each subsystem. See the Applicable Documents for specific documents on the Risk Analysis procedures.

Requirements on workplace and construction safety that affect the subsystem design must be in compliance with applicable OSHA safety standards, National Electric Code requirements, and applicable construction codes.

5.2 Low-Voltage Electrical Equipment

5.2.1 Introduction

These requirements seek to ensure that electrical equipment within certain voltage limits provides protection for workers and visitors. These requirements cover electrical equipment designed for use with a voltage rating of between 50V and 1000V for alternating current and between 75V and 1500V for direct current. It should be noted that these voltage ratings refer to the voltage of the electrical input or output, not to voltages that may appear inside the equipment.

5.2.2 General Conditions for all Electrical Equipment

SAF0050: The essential characteristics ensuring that electrical equipment will be used safely and in applications for which it was made shall be marked on the equipment or, if this is not possible, on an accompanying notice.

SAF0060: The designers' brand name or trademark shall be clearly printed on the electrical equipment or, where that is not possible, on the packaging.

SAF0070: The electrical equipment, together with its component parts shall be made in such a way as to ensure that it can be safely and properly assembled and connected.

SAF0080: The electrical equipment shall be designed and manufactured such that protection against all hazards is assured, provided that the equipment is used in applications for which it was made and is adequately maintained.

5.2.3 Protection Against Hazards Arising from the Electrical Equipment

Measures of a technical nature should be prescribed in order to ensure compliance with the following:

SAF0090: Persons are adequately protected against danger of physical injury or other harm which might be caused by direct or indirect electrical contact.

SAF0100: Temperatures, arcs, or radiation that would cause a danger are not produced.

SAF0110: Persons and property are adequately protected against non-electrical dangers caused by the electrical equipment that are revealed by experience.

SAF0120: The equipment and wiring insulation must be suitable for foreseeable conditions.



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5.2.4 Protection Against External Hazards on Electrical Equipment

SAF0130: The electrical equipment must meet the expected mechanical requirements in such a way that persons and property are not endangered.

SAF0140: The electrical equipment shall be resistant to non-mechanical influences in expected environmental conditions, so that persons and property are not endangered.

SAF0150: The electrical equipment shall not endanger persons and property in foreseeable conditions of overload.

5.3 Essential Health and Safety Requirements of Machinery/Equipment

5.3.1 General Remarks

This section identifies essential safety requirements for health and safety for operators and persons near machinery/equipment. These essential requirements are applicable to all ngVLA machines and equipment.

5.3.1.1 Definitions

- **Machinery:** An assembly of linked parts or components, which may move, with the appropriate actuators, control and power circuits, etc., joined together for a specific application.
- **Danger zone:** Any zone within and/or around machinery/equipment in which an exposed person is subject to a risk to his health or safety.
- **Exposed person:** Any person wholly or partially in a danger zone.
- **Operator:** The person or persons given the task of installing, operating, adjusting, maintaining, cleaning, repairing, or transporting machinery/equipment.

5.3.1.2 Principles of Safety Integration

SAF0160: Machinery/equipment must be constructed and fitted for its function, and able to be adjusted and maintained without putting persons at risk when operations are carried out under the conditions foreseen by the designer. The measures taken must eliminate risk of accident throughout the foreseeable lifetime of the machinery/equipment, including the phases of assembly and dismantling, even where risks of accident arise from foreseeable abnormal situations.

SAF0170: In selecting the most appropriate methods, the designer must apply the following principles, in the order given:

- Eliminate or reduce risks as far as possible (inherently safe machinery/equipment design and construction)
- Take the necessary protection measures in relation to risks that cannot be eliminated
- Inform users of the residual risks due to any shortcomings of the protection measures adopted, indicate whether any particular training is required and specify any need to provide personal protection equipment

SAF0180: When designing and constructing machinery/equipment, and when drafting the instructions, the designer must envisage not only the normal use of the machinery/equipment but also uses which could reasonably be expected. The machinery/equipment must be designed to prevent abnormal use if such use would engender a risk. In other cases, the instructions must draw the user's attention to ways in which the machinery/equipment should not be used.

SAF0190: Under the intended conditions of use, the discomfort, fatigue, and psychological stress faced by the operator must be reduced to the minimum possible taking ergonomic principles into account.



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SAF0200: When designing and constructing machinery/equipment, the designer must take account of the constraints to which the operator is subject as a result of the necessary or foreseeable use of personal protection equipment (such as footwear, gloves, etc.).

SAF0210: Machinery/equipment must be supplied with all the essential special equipment and accessories to enable it to be adjusted, maintained and used without risk.

5.3.1.3 *Material and Products*

SAF0220: The materials used to construct machinery/equipment or products used and created during its use must not endanger exposed persons' safety or health. For example, where fluids are used, machinery/equipment must be designed and constructed for use without risks due to filling, use, recovery, or draining.

5.3.1.4 *Lighting*

SAF0230: The design must permit integral lighting suitable for the operations concerned where its lack is likely to cause a risk despite ambient lighting of normal intensity. The designer must ensure that there is no area of shadow likely to cause nuisance, that there is no irritating dazzle, and that there are no dangerous stroboscopic effects due to the lighting provided. Internal parts requiring frequent inspection, adjustment, and maintenance must be provided with appropriate lighting.

5.3.1.5 *Design of Machinery/Equipment to Facilitate its Handling*

SAF0240: Machinery/equipment or each component part thereof must be capable of being handled safely, or be packaged or designed so that it can be stored safely and without damage (e.g., adequate stability, special supports, etc.).

SAF0250: Where the weight, size, or shape of machinery/equipment or its various component parts prevents them from being moved by hand, the machinery/equipment or each component part must

- Be fitted with attachments for lifting gear, or
- Be designed so that it can be fitted with such attachments (e.g., threaded holes), or
- Be shaped in such a way that standard lifting gear can easily be attached.

SAF0260: Where machinery/equipment or one of its component parts is to be moved by hand, it must either be easily movable or be equipped for picking up (e.g., hand-grips, etc.) and moving in complete safety.

SAF0270: Special arrangements must be made for the handling of tools and/or machinery/equipment parts, even if lightweight, which could be dangerous (shape, material, etc.).

5.3.2 *Protection Against Mechanical Hazards*

5.3.2.1 *Stability*

SAF0470: Machinery/equipment, components, and fittings must be so designed and constructed that they are stable enough, under the foreseen operating conditions, for use without risk of overturning, falling or unexpected movement. If the shape of the machinery/equipment itself or its intended installation does not offer sufficient stability, appropriate means of anchorage must be incorporated and indicated in the instructions.

5.3.2.2 *Risk of Breakup During Operation*

SAF0480: The various parts of machinery/equipment and their linkages must be able to withstand the stresses to which they are subject when used as foreseen by the designer.



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SAF0490: The durability of the materials used must be adequate for the nature of the work place foreseen by the designer, in particular as regards the phenomena of fatigue, ageing, corrosion, and abrasion.

SAF0500: The designer must indicate in the instructions the type and frequency of inspection and maintenance required for safety reasons. Where appropriate, indicate the parts subject to wear and the criteria for replacement.

SAF0520: Both rigid and flexible pipes carrying fluids and/or gases, particularly those under high pressure, must be able to withstand the foreseen internal and external stresses and must be firmly attached and/or protected against all manner of external stresses and strains. Precautions must be taken to ensure that no risk is posed by a rupture.

5.3.2.3 Risks Due to Falling or Ejected Objects

SAF0530: Precautions must be taken to prevent risks from falling or ejected objects.

5.3.2.4 Risks Due to Surfaces, Edges, or Angles

SAF0540: As far as their purpose allows, accessible parts of the machinery/equipment must have no sharp edges, no sharp angles, and no rough surfaces likely to cause injury.

5.3.2.5 Prevention of Risks Related to Moving Parts

SAF0570: Moving parts of machinery/equipment must be laid out to avoid hazards or fixed with guards or protective devices to prevent all risk of contact that could lead to accidents.

SAF0580: Necessary steps must be taken to prevent accidental blockage of moving parts involved in the work. In cases where a blockage may occur, specific protection devices or tools, the instruction handbook and possibly a sign on the machinery/equipment should be provided by the designer to enable the equipment to be safely unblocked.

5.3.2.6 Choice of Protection Against Risks Related to Moving Parts

SAF0590: Guards or protection devices to protect against moving parts must be selected on the basis of the type of risk. The following guidelines must be used to help make the choice.

SAF0600: Guards designed to protect exposed persons against the risks associated with moving transmission parts (such as pulleys, belts, gears, shafts, etc.) must be either fixed, or removable. Removable guards should be used where frequent access is foreseen.

SAF0610: Guards or protection devices designed to protect exposed persons against the risks associated with moving parts contributing to the work (such as cutting tools, moving parts of presses, cylinders, parts in the process of being machined, etc.) must be, where possible, fixed guards. Otherwise use movable guards or protection devices such as sensing devices (e.g., non-material barriers, sensor mats), remote-hold protection devices (e.g., two-hand controls), or protection devices intended automatically to prevent all or part of the operator's body from encroaching on the danger zone.

SAF0620: When moving parts directly involved in the process cannot be made completely or partially inaccessible during operation owing to operations requiring nearby operator intervention, where technically possible such parts must be fitted with fixed guards preventing access to the parts that are not used in the work, or adjustable guards restricting access to the sections of the moving parts that are strictly for the work.



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5.3.3 Required Characteristics of Guards and Protection Devices

5.3.3.1 General Requirements

SAF0630: Guards and protection devices must

- Be of robust construction,
- Not give rise to any additional risk,
- Not be easy to bypass or render non-operational,
- Be located at an adequate distance from the danger zone,
- Cause minimum obstruction to the view of the production process, and
- Enable essential work to be carried out on installation and/or replacement of tools and also for maintenance by restricting access only to the area where the work has to be done, if possible without the guard or protection device having to be dismantled.

5.3.3.2 Special Requirements for Guards

SAF0640: Fixed guards must be securely held in place and fixed by systems that can be opened only with tools. Where possible, guards must be unable to remain in place without their attachment fixings.

SAF0650: Movable guards must, as far as possible, remain fixed to the machinery/equipment when open, and have an interlocking device to prevent moving parts starting up when the parts can be accessed and to give a stop command whenever they are no longer closed.

5.3.3.3 Adjustable Guards Restricting Access

SAF0670: Adjustable guards restricting access to those areas of the moving parts strictly necessary for the work must be adjustable manually or automatically according to the type of work involved, and be readily adjustable without the use of tools.

5.3.4 Protection Against Other Hazards

5.3.4.1 Electrical Supply

SAF0690: Where machinery/equipment has an electricity supply, it must be designed, constructed and equipped so that all hazards of an electrical nature are or can be prevented.

SAF0700: The specific requirements relating to electrical equipment designed for use within certain voltage limits applies to machinery/equipment that is subject to those limits.

5.3.4.2 Static Electricity

SAF0710: Machinery/equipment must be designed and constructed to prevent or limit the build-up of potentially dangerous electrostatic charges and/or be fitted with a discharging system.

5.3.4.3 Energy Supply Other than Electricity

SAF0720: Where machinery/equipment is powered by energy other than electricity (e.g., hydraulic, pneumatic or thermal energy, etc.), it must be so designed, constructed, and equipped to avoid all potential hazards associated with these types of energy.

5.3.4.4 Errors of Fitting

SAF0730: Errors likely to be made when fitting or refitting certain parts that could be a source of risk must be made impossible by the design of such parts or by information given on the parts themselves and/or the housings. The same information must be given on moving parts and/or their housings where the direction of movement must be known to avoid a risk.



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SAF0740: Where a faulty connection can be the source of risk, incorrect fluid connections, including electrical conductors, must be made impossible by the design or, failing this, by information given on the pipes, cables, etc. and/or connector blocks.

5.3.4.5 *Extreme Temperatures*

SAF0750: Steps must be taken to eliminate any risk of injury caused by contact with or proximity to machinery/equipment parts or materials at high or very low temperatures.

SAF0760: Assess the risk of hot or very cold material being ejected. Where this risk exists, the necessary steps must be taken to prevent it or, if this is not technically possible, to render it non-dangerous.

5.3.4.6 *Fire*

SAF0770: Machinery/equipment must be designed and constructed to avoid all risk of fire or overheating posed by the machinery/equipment itself or by gases, liquids, dust, vapors or other substances produced or used by the machinery/equipment.

5.3.4.7 *Explosion*

SAF0780: Machinery/equipment must be designed and constructed to avoid any risk of explosion posed by the machinery/equipment itself or by gases, liquids, dust, vapors or other substances produced or used by the machinery/equipment.

SAF0790: The same precautions must be taken if the designer foresees use of the machinery/equipment in a potentially explosive atmosphere. Electrical equipment forming part of the machinery/equipment must conform, as far as the risk from explosion is concerned, to the provision of the specific requirements in force.

5.3.4.8 *Noise*

SAF0800: Machinery/equipment must be designed and constructed such that risks resulting from the emission of airborne noise are reduced to the lowest level taking account of technical progress and the availability of means of reducing noise, in particular at the source.

5.3.4.9 *Vibration*

SAF0810: Machinery/equipment must be designed and constructed such that risks resulting from vibrations produced by the machinery/equipment are reduced to the lowest level, taking account the availability of means of reducing vibration, in particular at the source.

5.3.4.10 *Radiation*

SAF0820: Machinery/equipment must be designed and constructed such that any emission of radiation is limited to the extent necessary for its operation and that the effects on exposed persons are non-existent or reduced to non-dangerous proportions.

5.3.4.11 *Laser Equipment*

SAF0840: Where laser equipment is used, the following provisions should be taken into account:

- Laser equipment on machinery/equipment must be designed and constructed so as to prevent any accidental radiation.
- Laser equipment on machinery/equipment must be protected so that effective radiation, radiation produced by reflection or diffusion and secondary radiation do not damage health.
- Optical equipment for the observation or adjustment of laser equipment on machinery/equipment must be such that no health risk is created by the laser.



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5.3.4.12 Emissions of Dust, Gases, etc.

SAF0850: Machinery/equipment must be so designed, constructed and/or equipped such that risks due to gases, liquids, dust, vapors, and other waste materials which it produces can be avoided, contained and/or evacuated.

SAF0860: Where machinery/equipment is not enclosed during normal operation, the devices for containment and/or evacuation must be situated as close as possible to the source emission.

5.3.4.13 Risk of Being Trapped in a Machine

SAF0870: Machinery/equipment must be designed, constructed or fitted with a means of preventing an exposed person from being enclosed within it or, if that is impossible, with a means of summoning help.

5.3.4.14 Risk of Slipping, Tripping, or Falling

SAF0880: Parts of the machinery/equipment where persons are liable to move about or stand must be designed and constructed to prevent persons from slipping, tripping, or falling on or off these parts.

5.3.5 Maintenance

5.3.5.1 Machinery/Equipment Maintenance

SAF0890: Adjustment, lubrication and maintenance must be located outside danger zones. It must be possible to carry out adjustment, maintenance, repair, cleaning and servicing operations while machinery/equipment is at a standstill. If the above conditions cannot be satisfied for technical reasons, these operations must be possible without risk.

5.3.5.2 Access to Operating Position and Servicing Points

SAF0920: The designer must provide means of access (stairs, ladders, catwalks, etc.) to allow safe access to all areas used for production, adjustment, and maintenance operations.

5.3.5.3 Isolation of Energy Sources

SAF0930: All machinery/equipment must be fitted with means to isolate it from all energy sources. Such isolators must be clearly identified. They must be capable of being locked if reconnection could endanger exposed persons. In the case of machinery/equipment supplied with electricity through a plug capable of being plugged into a circuit, separation of the plug is sufficient. The isolator must be capable of being locked also where an operator is unable, from any of the points to which she or he has access, to check that the energy is still cut off.

SAF0940: After the energy is cut off, it must be possible to dissipate normally any energy remaining or stored in the circuits of the machinery/equipment without risk to exposed persons.

As an exception to the above requirements, certain circuits may remain connected to their energy sources in order, for example, to hold parts, protect information, light interiors, etc. In this case, special steps must be taken to ensure operator safety.

5.3.5.4 Cleaning of Internal Parts

SAF0960: The machinery/equipment must be designed and constructed in such a way that it is possible to clean internal parts which have contained dangerous substances or preparations without entering them; any necessary unblocking must also be possible from the outside. If it is absolutely impossible to avoid entering the machinery/equipment, the designer must take steps during its construction to allow cleaning to take place with the minimum of danger.



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5.3.6 Indicators

5.3.6.1 Information Devices

SAF0970: The information needed to control machinery/equipment must be unambiguous and easily understood. It must not be excessive to the extent of overloading the operator.

SAF0980: Where the health and safety of exposed persons may be endangered by a fault in the operation of unsupervised machinery/equipment, the machinery/equipment must be equipped to give an appropriate acoustic or light signal as a warning.

5.3.6.2 Warning Devices

SAF0990: Where machinery/equipment is equipped with warning devices (such as signals, etc.), these must be unambiguous and easily perceived. The operator must have facilities to check the operation of such warning devices at all times.

SAFI000: The specific requirements concerning colors and safety signals must be complied with.

5.3.6.3 Warning of Residual Risks

SAFI010: Where risks remain despite all the measures adopted or in the case of potential risks which are not evident (e.g., electrical cabinets, radioactive sources, bleeding of a hydraulic circuit, hazard in an unseen area, etc.), the designer must provide warnings. Such warnings should preferably use readily understandable pictograms.

5.3.6.4 Marking

SAFI020: All machinery/equipment must be marked legibly and indelibly with the following minimum particulars:

- Name and address of the designer
- Designation of series or type
- Serial number, if any
- The year of construction
- Electric power data

SAFI030: Where the machinery/equipment is intended for use in a potentially explosive atmosphere, this must be indicated on the machinery/equipment.

SAFI040: Machinery/equipment must also bear full information relevant to its type and essential to its safe use (e.g., maximum speed of certain rotating parts, maximum diameter of tools to be fitted, mass, etc.).

SAFI050: Where a machine part must be handled during use with lifting equipment, its mass must be indicated legibly, indelibly, and unambiguously. Interchangeable equipment must bear the same information.

5.3.6.5 Instructions

SAFI060: All machinery/equipment must be accompanied by instructions including at least the following:

- A repeat of the information with which the machinery/equipment is marked, except the serial number, with any appropriate additional information to facilitate maintenance (e.g., addresses of the importer, repairers, etc.)
- Foreseen use of the machinery/equipment
- Workstation(s) likely to be occupied by operators
- Instructions for safe service, use, handling, assembly, dismantling, adjustment, maintenance, along with training instructions



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Instructions should draw attention to ways in which the machinery/equipment should not be used.

SAFI080: The instructions must contain the drawings and diagrams necessary for putting into service, maintenance, inspection, checking of correct operation and, where appropriate, repair of the machinery/equipment and all useful instructions in particular with regard to safety.

SAFI090: Any literature describing the machinery/equipment must not contradict the instructions as regards safety aspects. The technical documentation describing the machinery/equipment must give information regarding the airborne noise emissions and, in the case of hand-held and/or hand-guided machinery/equipment, information regarding vibration.

SAFI100: Where necessary, the instructions must give the requirements relating to installation and assembly for reducing noise or vibration (e.g., use of dampers, type and mass of foundation block, etc.).

SAFI110: The instructions must give the information concerning airborne noise emissions by the machinery/equipment, either the actual value or a value established on the basis of measurements made on identical machinery/equipment.

SAFI120: If the designer foresees that the machinery/equipment will be used in a potentially explosive atmosphere, the instructions must give all the necessary information.

SAFI130: In the case of machinery/equipment that may also be intended for use by non-professional operators, the wording and layout of the instructions for use, while respecting the other essential requirements mentioned above, must take into account the level of general education and acumen that can reasonably be expected from such operators.

5.4 Additional Requirements

SAFI150: Requirements on workplace and construction safety that have an influence on the design must be followed according to OSHA Construction standards.

SAFI160: The designer of a product or subsystem shall identify which requirements apply. If no requirements are available that cover the scope of the product or subsystem, it must be determined what other legislation is needed to ensure a safe design.

SAFI170: In the case of buildings and the like, other norms and standards apply that do not fall under the scope of this document.



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6 Appendix

6.1 Abbreviations and Acronyms

Acronym	Description
AD	Applicable Document
CDR	Critical Design Review
ES&S	Environmental Safety and Security
ICD	Interface Control Document
IPT	Integrated Product Team
LBA	ngVLA Long Baseline Array
ngVLA	Next Generation VLA
OSHA	Occupational Safety and Health Administration
RD	Reference Document
RFI	Radio Frequency Interference
SBA	ngVLA Short Baseline Array
TBD	To Be Determined
VLA	Jansky Very Large Array
VLBA	Very Long Baseline Array