TOTAL PAGES : 75

ALCATEL SPACE

SPIRE-ALC-DOC-000986

HERSCHEL / PLANCK

SAFETY REQUIREMENTS for Subcontractors

Rédigé par/*Written by*	**Responsabilité /*Responsibility***	**Date**	**Signature**
P. DERENNE	Safety Responsible	31/05/02	[signature]
Vérifié par/*Verified by*			
D. STORTO	Safety Team Leader	07/06/02	[signature]
Approbation/*Approved*			
D. DEMARQUILLY	ASPI Safety and Reliability Manager	07/06/2002	[signature]
	Technical Responsible		
C. MASSE	PA Manager	10/06/2002	[signature]
J.J. JUILLET	Project Manager	10/06/02	[signature]

Entité Emettrice : Q/PY

TOTAL PAGES : 75

ALCATEL SPACE

HERSCHEL / PLANCK

SAFETY REQUIREMENTS for Subcontractors

Rédigé par/*Written by*	**Responsabilité /*Responsibility***	**Date**	**Signature**
P. DERENNE	Safety Responsible		
Vérifié par/*Verified by*			
D. STORTO	Safety Team Leader		
Approbation/*Approved*			
D. DEMARQUILLY	ASPI Safety and Reliability Manager		
	Technical Responsible		
C. MASSE	PA Manager		
J.J. JUILLET	Project Manager		

Entité Emettrice : Q/PY

ENREGISTREMENT DES EVOLUTIONS / *CHANGE RECORDS*

ISSUE	DATE	§: DESCRIPTION DES EVOLUTIONS *§: CHANGE RECORD*	REDACTEUR *AUTHOR*
01/00	03/04/2001	First Issue	P. DERENNE
02/00	12/06/2001	Changes are indicated by a right margin bar.	P. DERENNE
02/01	26/04/2002	Page 19 § 4 :Modification of the text to clarify the applicability of the CSG safety regulation paragraphs.	P. DERENNE

TABLE DES MATIÈRES / *TABLE OF CONTENTS*

1. INTRODUCTION 10
1.1 BACKGROUND 10
1.2 PURPOSE 10
1.3 DOCUMENT OBJECTIVE 10
2. DOCUMENTS 12
2.1 APPLICABLE DOCUMENTS 12
2.1.1 Generic Requirements 12
2.1.2 Launcher Agencies Documentation 12
2.1.3 Range Safety Regulations. 12
2.1.4 Other Documentation 13
2.2 REFERENCE DOCUMENTS (FOR INFORMATION ONLY) 13
3. GENERAL ASPECTS OF SAFETY REQUIREMENTS 14
3.1 GENERAL 14
3.2 SAFETY ANALYSIS LOGIC 14
3.2.1 AIM 14
3.2.2 Description of hazard (scenario) 15
3.2.3 Hazard Level 16
3.3 HAZARD REDUCTION AND CONTROL 17
3.3.1 Design for Minimum Hazard 17
3.3.1.1 Failure Tolerant Design 17
3.3.1.2 Design Criteria and Margin Requirements 17
3.3.2 Safety Devices 18
3.3.3 Warning Devices 18
3.3.4 Special Procedures 18
4. SATELLITE DESIGN SAFETY REQUIREMENTS 19
4.1 GENERAL 21
4.2 FAILURE TOLERANCE 21
4.3 CONTROL OF HAZARDOUS FUNCTIONS 21

4.3.1 Liquid Propellant Propulsion Subsystem 22
4.3.2 RF Energy Radiation Subsystems (undesired emission) 23
4.3.3 Ejectable cryostat cover 23
4.4 FAILURE PROPAGATION 23
4.5 REDUNDANCY SEPARATION 24
4.6 STRUCTURAL SUBSYSTEMS 24
4.6.1 Structural Design 24
4.6.2 Stress Corrosion 24
4.6.3 Pressure Vessels including batteries 25
4.6.3.1 Pressure vessels 25
4.6.3.2 Batteries 26
4.6.4 Pressurised Lines, Fittings and other components 27
4.6.5 Pressure Systems 28
4.6.6 Heat Pipes 28
4.7 HAZARDOUS MATERIALS 28
4.8 FLAMMABLE MATERIALS 29
4.9 PYROTECHNICS 29
4.10 RADIATION SUBSYSTEMS 30
4.11 ELECTRICAL SUBSYSTEMS 30
4.12 VERIFICATION REQUIREMENTS 31
4.13 HAZARDOUS PROCEDURES 31
4.14 FLAMMABLE ATMOSPHERES 33
4.15 OPTICAL SYSTEMS 34
4.16 CRYOGENICS 34
4.16.1 General 34
4.16.2 Cryostat 34

5. GROUND SUPPORT EQUIPMENT AND OPERATIONS SAFETY REQUIREMENTS36
5.1 DESIGN REQUIREMENTS 36
5.1.1 General 36
5.1.2 Mechanical Ground Support Equipment 36
5.1.3 Electrical Ground Support Equipment 37

5.1.4 Tanking and Cryogenics/Vacuum Ground Support Equipment........................ 37
5.1.5 Optical Ground Support Equipment 37
5.2 TEST REQUIREMENTS 38
5.2.1 Mechanical Ground Support Equipment.. 38
5.2.2 Electrical Ground Support Equipment 38
5.2.3 Tanking and Cryogenics/Vacuum Ground Support Equipment....................... 39
5.3 GROUND OPERATIONS REQUIREMENTS 39
5.3.1 Hazardous Materials.. 39
5.3.2 Hazardous procedures 39
6. SAFETY ANALYSIS 40
6.1 COMPLIANCE MATRIX 40
6.2 SAFETY ANALYSIS CONTENT 40
6.2.1 Hazard Reports 40
6.3 SAFETY ANALYSIS PROCESS...42
6.3.1 Inputs for Safety Submission Phase 0 safety review (Design Concept) 42
6.3.2 Inputs for Safety Submission Phase 1 safety review (S/S or unit level PDR or equivalent) 42
6.3.3 Inputs for Safety Submission Phase 2 safety review (S/S or unit level CDR or equivalent) 42
6.3.4 Inputs for Safety Submission Phase 3 Safety Review (Hardware delivery) 43
6.4 SATELLITE HAZARD REPORTS DATA SUBMITTAL...................................44
6.4.1 Control of hazardous functions 44
6.4.2 Structural.. 44
6.4.3 Pressure vessels... 45
6.4.4 Pressurised lines, fittings, and other components 45
6.4.5 Heat-pipes.. 45
6.4.6 Hazardous materials.. 46
6.4.7 Pyrotechnics 46
6.4.8 Non ionising radiation.. 47
6.4.9 Electrical system... 47
6.4.10 Hazardous procedures 48

6.4.11 Flammable atmospheres 48
6.4.12 Cryogenics system 49
6.5 GROUND SUPPORT EQUIPMENT HAZARD REPORT DATA SUBMITTAL 50
6.5.1 Mechanical Ground Support Equipment 50
6.5.2 Electrical Ground System Equipment 50
6.5.3 Tanking and Cryogenics/Vacuum Ground Support Equipment 51
6.5.4 Optical Ground Support Equipment 52
6.6 GROUND CRYOGENICS OPERATIONS 52

LISTE DES FIGURES / *LIST OF FIGURES*

FIGURE 3-1 STANDARD LOGIC OF A SCENARIO (WITH AN EXAMPLE)......................... 15

FIGURE 4-1 SAFETY REQUIREMENTS SUMMARY CSG SAFETY REGULATIONS............... 20

FIGURE 4.3.2-1 ALLOWED RF EXPOSURE LEVELS 23

FIGURE 6-1 HAZARD REPORT FORM.. 53

FIGURE 6-2 PAYLOAD HAZARD REPORT FORM (ANNEX) 54

LIST OF ACRONYMS

CDR	Critical Design Review
CSG	Centre Spatial Guyanais (Guyana Space Centre)
CVSE	Cryogenics/Vacuum ground Support Equipment
DC	Direct Current
EED	Electro-Explosive Device
EGSE	Electrical Ground Support Equipment
EMC	Electro Magnetic Compatibility
ESA	European Space Agency
FMECA	Failure Modes, Effects and Criticality Analysis
GMEOP	Ground Maximum Expected Operating Pressure
GSE	Ground Support Equipment
IATA	International Air Transport Association
LBB	Leak Before Burst
MAWP	Maximum Allowable Working Pressure
MDP	Maximum design pressure
MEOP	Maximum Expected Operating Pressure
MGSE	Mechanical Ground Support Equipment
MIL STD	Military Standard
NATO	North Atlantic Treaty Organisation
NCR	Non Conformance Report
NDI	Non Destructive Inspection
NPT	National Pipe Thread
OGSE	Optical Ground Support Equipment
OSHA	Occupational Safety and Health Administration
PDR	Preliminary Design Review
PSS	Procedures, Standards and Specifications
PVC	Poly Vinyl Chloride
RF	Radio Frequency

RFD	Request For Deviation
RFW	Request For Waiver
RS	Règlement de Sauvegarde (Safety Regulation)
S/S	Subsystem
SRD	Safety Requirements Document
TBD	To Be Defined
TGSE	Tanking Ground Support Equipment
TTC	Telemetry and TeleCommand
UN	United

1. INTRODUCTION

1.1 BACKGROUND

The satellite and its range ground support equipment is developed with the overall objective to be free of conditions, both in design and operations (assembly and tests at the launch site), that could produce uncontrolled safety hazards for:

- The ground Launch Vehicle personnel,
- The Launch Vehicle itself,
- Other Launch Vehicle payloads if any,
- The Ground Support Equipment,
- And the general public.

1.2 PURPOSE

The purpose of this document is to define the safety requirements applicable to all Subcontractors.

In this document the term "Subcontractor" applies to all Contractors, Co-contractors, Subcontractors and lower third Subcontractors involved in the project.

This Safety Requirements document is mainly applicable to HERSCHEL / PLANCK satellites.

This Safety Requirements document is only applicable for unmanned missions.

1.3 DOCUMENT OBJECTIVE

The objective of the safety program is to identify and either eliminate or control the hazards associated with the satellite system and its Ground Support Equipment as defined in the applicable safety documents.

The prime contractor is responsible for performing the Safety program, and will be supported by the Subcontractors as specified in this specification and by the appropriate statement of work.

In case of conflict between this document and an applicable document or the Range Safety regulations, any discrepancy shall be notified to the attention of the Prime for clarification and resolution.

In this document, remarks and clarifications, which are not requirements, are in italic.

2. DOCUMENTS

2.1 APPLICABLE DOCUMENTS

2.1.1 Generic Requirements

Left intentionally blank.

2.1.2 Launcher Agencies Documentation.

- ARIANE 5 User's Manual
  No Reference Issue 3 dated March 2000

2.1.3 Range Safety Regulations.

- CSG Safety Regulations General Rules Volume 1
  CSG-RS-10A-CN Edition 5 Rev. 1 dated March 1999
- CSG Safety Regulations Specific Rules Ground Installations Volume 2 Part 1
  CSG-RS-21A-CN Edition 5 dated Dec. 1997
  Except paragraphs 3.3.1.g; 3.3.5.1; 4.2; 4.3; 4.4; 4.6.5 and 4.6.8 *(1)*
- CSG Safety Regulations Specific Rules Spacecraft Volume 2 Part 2
  CSG-RS-22A-CN Edition 5 Rev. 1 dated March 1999
  Except paragraphs 3.2.2.1; 3.2.2.3 and 3.2.2.4 *(1)*

(1) these requirements are included in the present document.

2.1.4 *Other Documentation*

- Electro-Explosive Subsystems Safety Requirements and Tests Methods for Space Systems

  MIL-STD-1576 dated 31 July 1984
- Design Criteria for Controlling Stress Corrosion Cracking

  MSFC-SPEC-522-B Notice 01 March 1988
- Material Selection for Controlling Stress Corrosion Cracking *(2)*

  ESA PSS-01-736 Issue 1

  ECSS Q70 36 A dated Jan. 1998
- ESA Fracture Control Requirements *(2)*

  ESA PSS-01-401 Issue 2

  ECSS E 30 01 A dated April 1999
- Standard General Requirements for Safe Design and Operation of Pressurized Missile and Space Systems

  MIL-STD-1522 A Notice 3 dated 04/09/92
- IATA Dangerous Goods Regulations

2.2 REFERENCE DOCUMENTS (FOR INFORMATION ONLY)

- System Safety Requirements for ESA Space Systems

  ESA PSS-01-40 Issue 2 dated September 1988
- Space Product Assurance - Safety

  ECSS Q40A dated April 1996
- Hazard Analysis Requirements and Methods

  ESA PSS-01-403
- Flammability, Odor, and Offgassing Requirements and Test Procedures for Materials in Environments That Support Combustion

  NHB 8060.1 C
- Space Transportation System Payload Ground Safety Handbook

  KHB 1700.7 Revision B September 92

(2) both are usable, subcontractor may use the more adapted to their subsystem.

3. GENERAL ASPECTS OF SAFETY REQUIREMENTS

3.1 GENERAL

Safety requirements are derived from ARIANE 4 and 5 User's manuals and CSG Safety Regulation.

When necessary or required, specific safety requirements have been specified. Compliance with requirements and criteria shall be verified by safety analytical process and documented in "Payload Hazard Reports" (see figures 6-1 and 6-2).

R.3.1-1: Those safety requirements have been established at system level and shall be applied for all Safety subsystems as structural, materials, ... It is the Subcontractor's responsibility to transmit these safety requirements in their entirety or only relevant requirements to lower tier Subcontractors.

NOTE: *A "safety subsystem" shall be defined as the set of subsystems, equipment, components that presents common hazard in term of "form of energy" (e.g., electrical subsystem covers all electrical boxes and harnesses of the satellite); and not as the "physical subsystems" of the satellite.*

R.3.1-2: The user shall be aware that above regulations (stated in 2.1) reference other documents that further detail requirements for spacecraft design and operations. In addition policy letters issued by the controlling organisations supplements launch bases safety requirements. Policy letters change, clarify, or add to existing regulations between formal revisions and have the same applicability as the regulation.

3.2 SAFETY ANALYSIS LOGIC

3.2.1 AIM

The aim of the safety analysis is to provide a method for the systematic identification, evaluation and classification of the characteristics of a system that leading to a threat to system safety.

R.3.2-1: The system has to be examined in order to identify these safety hazards so they can be removed or controlled and so that undesirable scenarios can be eliminated or made less probable. The logic involved in the tracking of hazards will be presented in detail.

R.3.2-2: The safety analysis shall be performed for Ground Operations and for Flight Operations up to the separation from the launcher.

3.2.2 Description of hazard (scenario)

Each path leading from dangers in a system via hazard causes to a consequence represents a scenario (or hazard description). The individual sequential elements of a scenario are defined using the standard logic described in the example shown in Figure 3.1.

The presence and/or generation of		The presence and/or generation of
HAZARDS	level 1	**high pressure, toxicity**
in the		in the
SYSTEM DESIGN or OPERATION	level 2	**propulsion tanks**
are manifested in		are manifested in
HAZARDOUS CONDITIONS	level 3	**toxic liquids under high-pressure in a tank**
which dependent upon the occurrence of		which dependent upon the occurrence of
INITIATOR EVENTS	level 4	**stress corrosion cracking of tank material**
can cause		can cause
UNDESIRABLE EVENTS	level 5	**tank bursting with release of toxic liquids**
that combined with		that combined with
EXPOSURE SITUATIONS	level 5	**personnel**
result in		result in
CONSEQUENCES	level 6	**loss of life due to inhalation of toxic gas**

FIGURE 3-1 STANDARD LOGIC OF A SCENARIO (WITH AN EXAMPLE)

3.2.3 Hazard Level

R.3.2-3: According to the severity of the consequence the hazard shall be categorised as follows:

CATASTROPHIC HAZARD:

May cause:

- Loss of life, life threatening or permanently disabling injury or occupational illness.

CRITICAL (SEVERE / MAJOR / SERIOUS) HAZARD:

May cause:

- Temporarily disabling, but not life threatening injury, or temporary occupational illness;
- Loss of, or major damage to, flight systems, major flight system elements, or ground facilities;
- Use of emergency procedures;
- Loss of, or major damage to, public or private property; or
- Long term detrimental environmental effects.

SIGNIFICANT (MARGINAL) HAZARD:

May Cause:

- Minor non disabling injury or occupational illness
- Minor damage to other hardware
- Minor damage to public or private property or
- Temporary detrimental environmental effects.

NEGLIGIBLE (INSIGNIFICANT) HAZARD:

Will not result in any of the above.

Note: Several definitions are used by Agencies or Launch Authorities. Definitions used for expendable vehicles are quite similar.

3.3 HAZARD REDUCTION AND CONTROL

R.3.3-1: The identified hazards shall be eliminated or controlled to assure compliance with each applicable technical requirement. As far as possible the prevention of failures caused by human errors shall be performed by design.

R.3.3-2: Action for reducing hazards shall be conducted in the following order of precedence (from paragraph 3.3.1 to 3.3.4):

3.3.1 Design for Minimum Hazard

The major goal throughout the design phase shall be to ensure inherent safety through the selection of appropriate design features. Damage control, containment, and isolation of potential hazards shall be included in design considerations.

3.3.1.1 Failure Tolerant Design

Where possible an applicable number of credible failures and / or operator errors shall be tolerated by the design for hazardous functions depending on hazard level.

Criteria of the Single Failure and Double Failure:

- No failure (single failure or human error) shall present a critical risk
- No combination of two failures (failure and / or human error) shall present a catastrophic risk.

These criteria are applicable for hazards resulting from

- Loss of function
- Inadvertent occurrence of function.

These criteria are applicable both for the design, achievement and operation of the system.

3.3.1.2 Design Criteria and Margin Requirements

For hazards arising from structural failure of mechanical components that cannot have redundant backup, such as primary structures, mechanisms, pressure vessels, or from fire or toxicity, it will be necessary to establish design criteria and margin requirements that preclude their occurrence. Those requirements and criteria are stipulated in Chapter 4.

3.3.2 Safety Devices

Hazards, which cannot be eliminated through design selection, shall be reduced and made controllable through the use of automatic safety devices as part of the system, subsystem, or equipment.

3.3.3 Warning Devices

When it is not practical to preclude the existence or occurrence of known hazards by design or to use automatic safety devices, devices shall be employed for the timely detection of the condition and the generation of an adequate warning signal, coupled with emergency controls or corrective action, for operating personnel to safe or shut down the affected subsystem. Warning signals and their application shall be designed to minimise the probability of wrong signals or of improper personnel reaction to the signal.

3.3.4 Special Procedures

Where it is not possible to reduce the magnitude of an existing or potential hazard through design or the use of safety and warning devices, special procedures shall be developed to counter hazardous conditions for enhancement of personnel safety (e.g. Propulsion subsystem servicing procedures, RF test procedure (chains, labels, ... to define a safe area, ...).

4. SATELLITE DESIGN SAFETY REQUIREMENTS

R.4-1: The satellite design shall be reviewed in light of the compliance with the safety requirements.

Non compliance shall be identified and submitted to the Prime for approval.

The figure 4-1 here after, lists the CSG Safety regulations paragraphs concerning safety requirements, for both design and operations. The applicability is given here, in §2.1.3.

SAFETY SUBSYSTEM	CSG SAFETY REGULATIONS CSG-RS-22A-CN Spacecraft	CSG-RS-21A-CN Ground Installations
MGSE	4.2.2.5	4.6.8
PROCEDURES	4.2 4.4	4.2
NON-IONIZING RADIATIONS and GSE	4.2.2.5	4.6.4 4.6.5
HAZARDOUS MATERIALS and GSE	4.2.2.5 4.5	4.4 4.6.2
MECHANICAL / ELECTROMECHANICAL	3.2.2.5	3.3.6
PRESSURE SYSTEMS (GSE HARDWARE)	N/A	3.3.3 4.4 4.6.2
PRESSURE SYSTEMS (FLIGHT HARDWARE)	3.2.2.3 3.3.1 4.2.1 4.2.2.2 4.2.2.3 4.5	4.4
ORDNANCE SYSTEMS and GSE	3.2.2.4 3.3.2 3.3.4 4.2.2.4 4.5	4.5
ELECTRICAL SYSTEMS and GSE	3.2.2.1 3.2.2.2 3.2.2.6 3.3.4 4.2.2.1 4.2.2.5	3.3.1 3.3.5.1 4.3
COMPUTING SYSTEMS AND SOFTWARE		

FIGURE 4-1 SAFETY REQUIREMENTS SUMMARY
CSG SAFETY REGULATIONS

4.1 GENERAL

R.4.1-1: Requirements apply under worst case natural and induced environments.

4.2 FAILURE TOLERANCE

R.4.2-1: An applicable number of credible failures and/or operator errors shall be tolerated by the design for hazardous functions depending on hazard level and shall be approved by ALCATEL.

4.3 CONTROL OF HAZARDOUS FUNCTIONS

***NOTE**: The below requirements apply in their entirety only when the hazardous function is under the responsibility of one subsystem. In the other cases the distribution of the inhibits and monitors is made at system level.*

- System control of functions resulting in critical hazards:
  - **R.4.3-1:** Two independent inhibits
  - **R.4.3-2:** At least one inhibit shall be monitored
  - **R.4.3-3:** Return to a safe condition shall be implemented.
- System control of functions resulting in catastrophic hazards :
  - **R.4.3-4:** Three independent inhibits
  - **R.4.3-5:** Monitor of at least two of three inhibits
  - **R.4.3-6:** Specific monitoring and safing requirements for identified catastrophic hazards based on planned operations
  - **R.4.3-7:** Return to a safe condition shall be implemented.

    (Basic approach is to design to two failure tolerance and maintain knowledge through real or near real-time monitoring of single failure tolerance).
- **R.4.3-8:** A power failure in the circuits of an interruption device (inhibit) must not cause it to change state. That means the inhibit must remain in the safe state.
- Computer controlled inhibits:
  - **R.4.3-9:** The method to control at least one of the inhibits must be independent of the computer system.

- **R.4.3-10:** For a catastrophic hazard the independence of the remaining two controls (i.e. performed by the computer system) shall be adequately demonstrated.
- **R.4.3-11:** This requirement (R.4.3-10) is applicable for unmanned launchers during ground operations up to satellite separation from the launcher.

- **R.4.3-12:** Implementation of an automatic sequence (time tag generation...) shall not violate the fault tolerance principle (paragraph 4.3, requirements R.4.3-1 and R.4.3-4). In particular the inhibits commands independence shall be respected.

  Design of such automatism shall be notified to the Prime Safety Manager for approval before implementation.

4.3.1 Liquid Propellant Propulsion Subsystem

- **R.4.3-13:** Minimum of three mechanically independent flow control devices (inhibits) in series are required for catastrophic hazards; and minimum of two for critical hazards.
- **R.4.3-14:** Flow control devices shall be used to isolate tanks from distribution system
- **R.4.3-15:** Opening of any flow control device shall not result in adiabatic detonation, which is a catastrophic hazard (only for monopropellant systems using hydrazine).
- **R.4.3-16:** Devices must prevent propellant expulsion through thrust chambers
- **R.4.3-17:** The internal and external leakage rate of valves shall be specified (case by case analysis)
- **R.4.3-18:** Electrical controls, monitoring and safing requirements shall be function of planned operations
- **R.4.3-19:** Flow control devices which isolate the propellant tanks from the remainder of the distribution system (i.e. which are inhibits) shall not be opened on ground.
- **R.4.3-20:** Components commands that are capable of heating propellant sufficiently to create a catastrophic hazard (e.g. heaters, valve coils, ...) shall be two failures tolerant for heating the propellant.
- **R.4.3-21:** When propellant may be entrapped upstream valve shall be equipped with a back pressure relief capability.
- **R.4.3-22:** If that valve is closed on ground, entrapping propellant in a closed portion of tubing, this back pressure relief capability shall be failure tolerant with regards to the no opening failure case. If not the valve shall be redounded in parallel.

- **R.4.3-23:** All hazardous pressure systems shall be properly grounded and bonded to the spacecraft metallic structure.
- **R.4.3-24:** The subsystem shall be designed so that depressurisation and full off-loading is possible with the satellite in the launch position.

4.3.2 RF Energy Radiation Subsystems (undesired emission)

- **R.4.3-25:** No inhibit is required for exposure level lower than those specified in the figure 4.3.2-1.
- **R.4.3-26:** Three independent inhibits to radiation are required if exposure level is greater than those specified in the figure 4.3.2-1.

  No command monitoring is required for those inhibits.

Frequency (MHz)	Density of equivalent power flat wave (W/m²)
10 – 400	10
400 – 2000	Frequency / 40
2000 – 150000	50
150000 - 300000	3.334×10^{-4} x Frequency

FIGURE 4.3.2-1 ALLOWED RF EXPOSURE LEVELS

4.3.3 Ejectable cryostat cover

R.4.3-27: At least two independent inhibits to function;

R.4.3-28: At least one inhibit shall be monitored;

R.4.3-29: Designed to preclude inadvertent mechanical operation in induced environments.

R.4.2.30: Ground safety mechanical restrain shall be implemented (remove before flight protection).

4.4 FAILURE PROPAGATION

R.4.4-1: All safety controls will be designed with the intent of precluding failure propagation from one to another control in series.

R.4.4-2: Design shall also minimise propagation of failures from other subsystems to the environment outside the subsystems.

4.5 REDUNDANCY SEPARATION

R.4.5-1: Safety critical redundant subsystems shall be arranged so that propagation of failure from main to redundant or vice versa is minimised.

4.6 STRUCTURAL SUBSYSTEMS

4.6.1 Structural Design

R.4.6-1: Ultimate factors of safety required by the launcher user's manuals shall be taken into account in design of the satellite structure.

Satellite lifting points:

- **R.4.6-2:** They must be capable of accepting an additional mass of 400 kg (ARIANE 5 requirement) + MGSE if any.
  The lifted mass = the filled satellite mass + 400 Kg + MGSE if any. The design limit load (used for calculation) = (lifted mass x handling acceleration) x safety factor.
- **R.4.6-3:** They shall be designed with an ultimate safety factor greater than 2
- **R.4.6-4:** and the lifting points shall be designed so that the lost of one point will not result in the dropping of the spacecraft. Induced chock shall be taken into account in the non single failure point analysis.
- **R.4.6-5:** Flight hardware lifting points shall be acceptance load tested to 100 % of rated load (i.e. the maximum mass to be lifted at the range, including the additional mass, please refer to R.4.6-2) as an integral part of structural load testing.

4.6.2 Stress Corrosion

R.4.6-6: For safety critical parts such as pressure vessels, lifting points... metallic materials must comply with the Table 1 of the ESA PSS-01-736 or ECSS Q70 36 or MSFC SPEC.5.22.B.

4.6.3 Pressure Vessels including batteries

4.6.3.1 Pressure vessels

- **R.4.6-7:** The tanks shall be compliant with:
  - The MIL-STD-1522 A, Approach A (i.e. burst safety factor equal to 1.5 or greater) requirements,
- **R.4.6-8:** If the qualification burst test has not been performed to actual bursting, the requested safety factor shall be increased up by 10 %. Obviously, this increased factor shall also apply for the qualification burst pressure test.
- **R.4.6-9:** Deleted.
- **R.4.6-10:** A detailed status of compliance with regards to the MIL-STD-1522 A, Approach A requirements must be provided.
- **R.4.6-11:** Fluid compatibility data for manufacturing, cleaning, tests (including dye penetrant) and operations must be provided.
- **R.4.6-12:** Analyses concerning pressure variation on propellant tanks versus temperature (tank filled and temperature lower than 40°C) shall be performed (Ground concern only).
- **R.4.6-13:** Vessels, which are designed to MIL-STD-1522A, Approach A and exhibit a brittle fracture or hazardous leak before burst failure mode, shall maintain a minimum safety factor of 2:1 (design burst to range pressure) during transport or ground handling operations at the range. For Hydrazine system the tank safety factor shall be 2:1 minimum.
- **R.4.6-14:** Safe operating limits shall be established for each pressure vessel based on the appropriate analysis and testing used in its design and qualification. The desired information shall include, but not be limited to, such data as operational cycles limits (number, duration, ...), temperature limits, operational, testing and cleaning fluids. Those data shall also be provided in the logbook, which must accompany the vessel and trace all events (number of cycles, fluids used, ...)

4.6.3.2 Batteries

Requirements applicable to all type of battery chemistries:

- **R.4.6-15:** Battery / cell case shall be designed to a minimum of 3:1 ultimate safety factor with respect to worst case pressure build up for normal operations.
- **R.4.6-16:** Batteries that have chemically limited pressure (such as Nickel Hydrogen chemistries) and whose battery/cell case can be designed to withstand worst case pressure build up in abnormal conditions such as direct short circuit and extreme temperatures, can reduce the safety factor to 2:1 ultimate.
- **R.4.6-17:** Sealed batteries shall have pressure relief capability unless the battery case is designed to a safety factor of at least 3:1 based on worst case internal pressure. Pressure relief devices shall be set to operate at a maximum of 1.5 times the operating pressure and sized so that the resulting maximum stress of the case does not exceed the yield strength of the case material.
- **R.4.6-18:** A burst test shall be performed on a cell to demonstrate the ultimate safety factor.
- **R.4.6-19:** A proof test at 1.5 x MEOP shall be performed on each cell. If a pressure relief capability is provided the test pressure shall be 1.25 x MEOP. The proof test is not usually required for Nickel Cadmium cells.

Lithium Battery additional requirements:

In addition, the following tests shall be performed prior to the use or storage of lithium batteries at the Ranges:

- **R.4.6-20:** Lithium battery constant current discharge and reversal test
- **R.4.6-21:** Lithium battery short circuit test
- **R.4.6-22:** Lithium battery drop Test

Nickel hydrogen battery additional requirements:

- **R.4.6-23:** An "external short circuit" test shall be performed on Nickel Hydrogen battery and/or cell case to prove they can withstand worst case pressure build up in abnormal conditions (such as direct short circuit and extreme temperature).
- **R.4.6-24:** Nickel Hydrogen battery and/or cells that are proven by test to withstand worst case pressure build up in abnormal conditions (such as direct short circuit and extreme temperature that can be experienced) are not required to have pressure relief capability.

- **R.4.6-25:** Following test shall be performed on two cells for each manufacturing lot:
  - On one cell: a cycling test at the maximum operating pressure for a number of cycles equal to 4 times those performed throughout the ground service life and a burst test to the actual burst pressure.
  - On the other cell: a burst test to the actual burst pressure.

4.6.4 Pressurised Lines, Fittings and other components

- **R.4.6-26:** Fittings and lines shall have an ultimate factor of safety greater than or equal to:
  - 4 for diameter lower than 1.5 inch
  - 3 for diameter greater than or equal to 1.5 inch.
- **R.4.6-27:** Other components (e.g. valves, filters, regulators, sensors, etc.), except pressure transducer used in chemical propulsion systems, and their internal parts (e.g. bellows, diaphragms, etc.) which are exposed to system pressure shall have an ultimate safety greater than or equal to 2.5.
- **R.4.6-28:** Pressure transducer used with hazardous fluid (such as hydrazine or hypergolic propellants) shall have an ultimate safety factor greater than or equal to 4.
- **R.4.6-29:** All hazardous pressure system components other than pressure vessels shall be designed for safe endurance against hazardous failure modes for not less than 400 % of total number of expected pre launch cycles.
- **R.4.6-30:** Screwed joints shall not be used in pressure and propellant system piping and tubing. Screwed joints which are not of the "National Pipe Thread" (NPT) type may be used for connecting thruster valves.
- **R.4.6-31:** The design and configuration of the fill and drain valves, the ground half couplings, the leak test caps and the by pass tubes shall be sufficient to avoid cross connection:
  - Between two or more incompatible media,
  - Between two or more pressurised sections with incompatible safety factors (e.g. between low and high pressure sections)
  - Between fill and vent outputs of a propellant tank.

4.6.5 Pressure Systems

- **R.4.6-32:** All pressure systems shall be proof tested at 1.5 GMEOP (1.25 GMEOP, for the tank section, if the tank burst safety factor is 1.5). For welded systems, exceptions require specific Prime System Safety approval.
- **R.4.6-33:** All pressure systems shall be leak tested at the launch site GMEOP at the range prior to its normal use.
- **R.4.6-34:** At the launch site, prior to any propellant loading or pressurisation, Graphite Epoxy Composite Over wrapped Pressure Vessels shall be pressure tested to 1.1 times ground maximum expected operating pressure during 10 min. minimum.

NOTE 1: Reader shall be aware that pressure relief capability shall be taken into account for the GMEOP identification.

NOTE 2: For hydrazine systems, due to the presence of pressure relief capability proof test and range leak test implementation shall be carefully taken into account in the design.

NOTE 3: GMEOP here refers to the Ground Maximum Expected Operating Pressure that personnel are exposed to (during integration tests, system tests and range operations).

4.6.6 Heat Pipes

- **R.4.6-35:** Heat-pipes shall have an ultimate factor of safety greater than or equal to 4.
- **R.4.6-36:** Fluid compatibility data for manufacturing, cleaning, tests (including dye penetrant) and operations must be provided.

4.7 HAZARDOUS MATERIALS

- **R.4.7-1:** Hazardous materials shall not be used, released or ejected.

Please find hereafter a non exhaustive list of hazardous materials:

Barium, Beryllium, Cadmium, Mercury, Carboxy Nitroso Rubber, Polyvinyl Chloride (PVC), Silicone, Zinc...

- **R.4.7-2:** Material Safety Data Sheets must be provided (Propulsion, Batteries, Heat pipes, ...).

- **R.4.7-3:** The same basic information are required by the CSG and must be provided.

- Materials used in hazardous fluid systems including batteries and heat-pipes:
  - **R.4.7-4:** Materials shall be compatible with identified fluids at the MEOP and maximum temperature.
  - **R.4.7-5:** The compatibility is required for all components wet on ground or to be nominally wet in orbit (i.e. inadvertently wet on ground).
  - **R.4.7-6:** For components leak failures tolerant such as fill and drain valves, ... the compatibility is also required for portions which are wet after barriers failure.
  - **R.4.7-7:** Fluid compatibility versus material data must be provided.
  - **R.4.7-8:** The consequence of large quantity of helium released (including cryostat failure) shall be analysed.

4.8 FLAMMABLE MATERIALS

Good practices are required as far as possible:

- *Minimise usage of flammable materials*
- *Separate flammable materials to prevent flame propagation*
- *Separate flammable materials from ignition sources to maximum extent practicable.*

NOTES: *(1) Materials that meet NHB 8060.1C (tests n° 1) to be considered as non flammable*

(2) JSC 02861, JSC 09604 and JSC 11123 provide test data, material selection lists, and guidelines.

4.9 PYROTECHNICS

The system requirements state pyrotechnics must not be implemented. In case of use the next requirements are applicable.

- **R.4.9-1:** All pyrotechnical subsystems and devices shall meet Launch Agencies (refer to paragraph 2.1.3) and MIL-STD-1576 chapters 5.1 to 5.11 and 5.13 requirements, in particular:
  - **R.4.9-2:** Electroexplosive devices shall be of 1A / 1W / 5mn no fire type.
  - **R.4.9-3:** Electroexplosive devices shall be capable of withstanding a 25 kV discharge (pin to pin mode with a 5 kilo-ohms resistor in series and pin to case mode without a series resistor) from a 500 pF capacitor.

  - **R.4.9-4:** Safe and arm plugs in accordance with Launch Agencies safety regulations shall be implemented (short circuits, grounding, colours and streamers).
  - **R.4.9-5:** The firing circuit shielding will be designed to limit RF power at each EED (produced by Range and vehicle transmitter) to a level at least 20 dB below the pin to pin DC no fire power of the EED and to have a positive margin with regard to the RF no fire power of the EED.
- **R.4.9-6:** Easy access for plugs installation or removal through the fairing shall be ensured.
- **R.4.9-7:** Arm connectors (i.e. Flight connectors) shall be electrically connected after satellite installation on the launcher and electrical interfaces verification completed. Exceptions require specific Launch Site Safety Office approval.
- **R.4.9-8:** Hazard classification of ordnance items must be provided.

4.10 RADIATION SUBSYSTEMS

(Electrical S/S, TTC and Payload S/S, intentional emission)

Non ionising radiation:

- **R.4.10-1:** Subsystems shall not emit electromagnetic radiation (including x-rays) that presents a hazard (not applicable for TTC and Payload subsystems, except for x-rays).
- **R.4.10-2:** RF hazard area (exposure level greater than those specified in the figure 4.3.2-1) shall be identified, posted and controlled to prevent unnecessary personnel exposure (applicable for TTC and Payload subsystems during tests, ...).

4.11 ELECTRICAL SUBSYSTEMS

- **R.4.11-1:** Double insulation shall be implemented for all the unprotected circuits (harness including umbilical wires and electrical boxes circuits) directly connected to the main power bus, the batteries and the battery pyrotechnic bus until the first protection.
- **R.4.11-2:** This double insulation shall be verifiable after equipment integration.
- **R.4.11-3:** Electrical power distribution shall be designed (i.e. protected) so that faults internal to subsystem:
  - Do not damage launcher circuits
  - Do not create ignition sources for satellite material.

- **R.4.11-4:** Electrical lines between satellite subsystems and EGSE shall be protected by a fuse or a current limiter located either in the satellite or in the EGSE. Otherwise a double insulation on lines located inside the satellite and the EGSE is required. The protection shall be close to the power. *(Refer to paragraph 5.1.3 for EGSE requirements).*
- **R.4.11-5:** The relation between wire sizes, wire current capacities, wire maximum temperature (satellite power lines) and the ultimate trip limit current value of the protection device (fuse or current limiter) located upstream (in EGSE or satellite circuits) must be stated (on ground safety concern only, no derating required) *(Refer to paragraph 5.1.3 for EGSE requirements).*
- **R.4.11-6:** Heater temperature must be studied in case of failed "ON" heater (during the ground phase, risk of heating pressure vessels containing hazardous or cryogenic fluids).

4.12 VERIFICATION REQUIREMENTS

- **R.4.12-1:** Safety aspects (control provisions, design criteria, ...) of hazardous subsystem equipment shall be satisfactorily verified.
- **R.4.12-2:** Test, analysis and inspection are common and valid techniques for verification of design features used to control hazards.
- **R.4.12-3:** Safety verification methods shall be documented in time for Safety Reviews.
- **R.4.12-4:** At the final Safety review, results of verification shall be adequately documented with documentation references and summary of results provided.

4.13 HAZARDOUS PROCEDURES

R.4.13-1: Operating procedures shall be prepared for assembly, tests and operations.

R.4.13-2: Operating procedures shall be prepared to safely off-load hazardous satellite propellants (fuel and oxidizer) at any point after pressurisation or loading, including the ability to offload at the launch pad without demating of the spacecraft from the launch vehicle.

Basically, human error applicability fields are:

- *Payload integration and tests*
- *Platform integration and tests*
- *Satellite integration and test (including Launch Pad)*

- *Launch and flight operations (from lift-off till satellite separation from launcher).*

R.4.13-3: All the procedures shall be reviewed and when a hazard is identified, the procedures must be classified as "Hazardous procedure".

R.4.13-4: That analysis is to be performed for every facility.

R.4.13-5: Concerning the launch base, in addition to the classification (hazardous or not), the content of the hazardous procedures is reviewed by the launch agency safety services.

Typical items that are to be checked in procedures are:

- *Cover page properly marked as hazardous*
- *Identification of operating area*
- *Specific hazard involved*
- *List of support elements / facilities required*
- *List of tools, equipment, and clothing required*
- *Identification of major and local hazardous control areas*
- *Applicable safety rules and regulations*
- *Safety controls (if applicable)*
- *Essential personnel list for controlled area*
- *Essential personnel list and location*
- *Warning / Note located prior and following hazardous sequence*
- *Identification of hazardous steps*
- *Control area properly identified*
- *Procedural step to clear non essential personnel*
- *Procedural step requesting Quality Assurance or Safety concurrence to proceed with hazardous steps*
- *Procedural step requesting Quality Assurance or Safety concurrence to open a control area*
- *Identification of inhibits and verification step to verify that inhibits are in place*
- *Adequate Emergency / Contingency steps*
- *Identification of necessary operations to return to a safe configuration.*
- *etc.*

R.4.13-6: It is mandatory that technical operating procedures be approved by safety Sub-contractor departments.

R.4.13-7: Procedures shall be verified to demonstrate control of the hazard (including human errors).

4.14 FLAMMABLE ATMOSPHERES

R.4.14-1: During ground operations normal subsystem functions shall not cause ignition of a flammable atmosphere, which may result from leakage of fluids.

This flammable atmosphere may exist from satellite filling with propellants up to the end of life!

Possible ignition sources may be divided in two categories:

- *Electrical discharges including sparks caused by short circuits, relays contacts, …*
- *Hot surfaces*

Control of ignition sources:

- Electrical discharges:
  - **R.4.14-2:** Relays and other similar ignition sources must be sealed.
  - **R.4.14-3:** All parts which can generate electrostatic discharge shall be grounded.
  - **R.4.14-4:** Current through umbilical connectors during lift-off must be lower than:
    - 10 mA and voltage lower than 50 V (ARIANE 4)
    - 100 mA and voltage lower than 85 V and maximum power limitation of 2 W (ARIANE 5)
  - **R.4.14-5:** No sparks «generator» shall be allowed during and after filling activities.
- Hot surfaces:
  - **R.4.14-6:** Any exposed surfaces including heaters that have temperatures of greater than 180°C must be identified (ground operations).

R.4.14-7: The satellite must be OFF during filling activities.

All remaining powered lines (battery power lines, battery cells voltage monitoring lines, …) upstream switching device shall respect the double insulation requirement including electrical boxes input circuits up to the switching device.

R.4.14-8: The satellite shall be rapidly and safely (i.e. without creating ignition of flammable atmosphere) switched OFF on request in case of flammable fluid leakage.

If it is not possible all remaining powered lines shall respect the double insulation requirement including electrical boxes input circuits.

4.15 OPTICAL SYSTEMS

R.4.15-1: Care shall be exercised when designing those systems, to protect eyesight against emissions which are hazardous due to their intensity, or outside of the visible spectrum (infrared or ultraviolet).

4.16 CRYOGENICS

4.16.1 General

System elements associated with the safe containment, delivery and control of cryogenic and that require special design and procedural considerations include pumps, storage vessels, transfer lines seals, vent valves, relief valves, quick disconnect and insulation. Important design considerations include materials compatibility, dimensional contraction, impact sensitivity, condensation accumulation, cleanliness requirements, purge procedures, disposal constraints and chilldown techniques.

The potential hazards affecting the design and operations of cryogenics systems are:

- Personnel exposure to extreme cold gases.
- Low temperature environment effects on mechanisms and structural materials.
- High pressure potential arising from confinement of liquids and gases.

4.16.2 Cryostat

R.4.16-1: According to the CSG safety regulations the cryostat is not to be considered as a pressure vessel if the internal pressure remains lower than 4 bar.

The following safety aspects shall be taken into account:

- **R.4.16-2:** definition of pressures:
  * Maximum Expected Operating Pressure: MEOP
  * Maximum Allowable Working Pressure: MAWP

  have to be clearly specified.
- **R.4.16-3:** Required Safety factors:
  Helium tank and vacuum vessel:
  * Proof factor greater than 1.5
  * Burst factor greater than 2.

  Tubing: 4

  Other components:
  * Proof factor greater than 1.5
  * Burst factor greater than 2.5..
- **R.4.16-4:** Helium leakage (vacuum vessel)
  * 2 pressure relief devices (safety valve, burst disc, ...) shall be implemented on each helium tank, external vacuum vessels and on each closed volume (nominal or after failure);
  * Potential valves blockage shall be carefully analysed;
  * Possibility of helium flow to pass through rupture disc and/or safety valves shall be studied;
  * Premature ejection of the cryostat cover to be examined;
  * Release of large quantity of helium not in open air (i.e. within closed integration and test facilities) shall be addressed in the safety analyses (cryostat failure case);
  * Temperature monitoring (safety aspect of ground operations) to be addressed;
  * Compliance with IATA regulations shall be demonstrated.

NOTE: for cryo/vacuum ground support equipment refer to paragraph 5.

5. GROUND SUPPORT EQUIPMENT AND OPERATIONS SAFETY REQUIREMENTS

R.5-1: Ground equipment to be used and operations to be performed on the launch site must be compliant with the Ranges regulations.

CSG Safety regulations paragraphs are listed in Figure 4-1.

In particular, the following points shall be taken into account. This chapter focuses on some specific points whereas general requirements are addressed in the Range specifications.

5.1 DESIGN REQUIREMENTS

5.1.1 General

R.5.1-1: Ground Support Equipment shall be designed avoiding sharp corners and edges

R.5.1-2: Possibility of grounding every piece of equipment shall exist.

R.5.1-3: GSE and in particular EGSE shall remain stable under any maximum combination of applicable design loads.

The maximum stand to tilt coefficient shall be 1.2 for stationary items and 1.3 for slow moving items.

5.1.2 Mechanical Ground Support Equipment

(e.g. lifting beam, slings, shackles, eyebolts, etc.)

- **R.5.1-4:** Lifting Equipment shall be designed with the following safety factors:
  - Ultimate = 6.0
  - Yield = 3.0
- **R.5.1-5:** Maximum safe working loads shall be posted on all lifting and hoisting equipment and fixtures.
- **R.5.1-6:** Lifting devices used for encapsulation process at the range shall be designed to accept an additional mass of minimum 400 Kg (refer to paragraph 4.6.1).
- **R.5.1-7:** Load bearing, hooks, shackles, eyebolts and welds constituting a single point of failure have to be identified.
  Critical welds shall be eliminated where possible, and if elimination is not possible they shall be inspected for cracks.

- **R.5.1-8:** Slings which have components that are normally disassembled shall be either marked, coded, or tethered to assure proper assembly of verified hardware.
- **R.5.1-9:** Use of synthetic ropes shall be avoided. If use of such ropes if needed they shall be inspected prior each utilisation and shall have a safety factor of 10.
- **R.5.1-10:** Aircraft transport containers shall fulfil IATA/ULD Standard Specification 80/2.
- **R.5.1-11:** MGSE pressure systems shall have an ultimate safety factor of 4 and shall be proof pressure tested at 1.5 MDP.

5.1.3 Electrical Ground Support Equipment

- **R.5.1-12:** Inhibition of orders activating hazardous functions shall be implemented.
- **R.5.1-13:** EGSE electrical lines between EGSE and satellite subsystems shall be protected by a fuse or a current limiter located in the EGSE. Otherwise a double insulation on EGSE lines is required *(Refer to paragraph 4.11 for satellite requirements).*
- **R.5.1-14:** The relation between wire sizes, wire capacities, wire maximum temperature (EGSE power wires and wires between EGSE and satellite) and the ultimate trip limit current value of the protection device (fuse or current limiter) located upstream must be stated.
- **R.5.1-15:** All electrical GSE (including electrical parts of TGSE, MGSE, OGSE, ...) used in hazardous (explosive) atmosphere locations (a location is hazardous when propellants, MMH for example, are present, in the satellite or in a container for example) shall meet the applicable Range Safety regulations.

5.1.4 Tanking and Cryogenics/Vacuum Ground Support Equipment

- **R.5.1-16:** The TGSE/CVSE shall comply with applicable Range Safety regulations. The use of HBK.1700.7 B is recommended.

5.1.5 Optical Ground Support Equipment

- **R.5.1-17:** The OGSE including lasers, ... shall comply with applicable Range Safety regulations.

5.2 TEST REQUIREMENTS

5.2.1 Mechanical Ground Support Equipment

R.5.2-1: Tests of lifting and hoisting equipment shall be performed at twice the maximum allowable load (Initial test, plus within one year before use at the launch range).

R.5.2-2: Tests of handling equipment shall be performed at twice the maximum allowable load prior to first operational use.

R.5.2-3: CANCELLED

R.5.2-4: Lifting, hoisting and handling equipment shall be inspected every year by an approved organisation.

R.5.2-5: Inspection for cracks (dye penetrant, X rays, ...) shall be performed on parts that are single points of failure and on critical welds (safety aspects only).
Critical welds: welds which are considered as single failure point.

R.5.2-6: Results of inspection shall be provided.

5.2.2 Electrical Ground Support Equipment

R.5.2-7: Verification of hazardous orders inhibition shall be performed.

R.5.2-8: Certificate of conformity for electrical equipment used in flammable atmosphere (EEx certificate) shall be provided.

R.5.2-9: Certificate of conformity for interconnecting of electrical equipment used in flammable atmosphere (EEx certificate) shall be obtained by an approved organism and provided.

5.2.3 Tanking and Cryogenics/Vacuum Ground Support Equipment

R.5.2-10: They shall be annually proof tested and also after dismounting, reparation, modification...

R.5.2-11: They shall be always validated at the range (including leak tests at MEOP, relief valves set-up, …) prior to use.

R.5.2-12: CANCELLED

5.3 GROUND OPERATIONS REQUIREMENTS

5.3.1 Hazardous Materials

R.5.3-1: Material Safety Data Sheets must be provided for all chemicals brought inside the range.

R.5.3-2: The same basic information are required by the CSG and must be provided.

5.3.2 Hazardous procedures

R.5.3-3: Hazardous procedures shall be validated before first use.

6. SAFETY ANALYSIS

The primary objective of the safety analysis process is to obtain safety concurrence with the safety assurance process conducted by the Customer.

This includes:

- ***a.*** *An analysis to identify potential hazards, and an identification of the possible hazard causes.*
- ***b.*** *An identification of how to control hazard causes.*
- ***c.*** *An identification of verification methods used to assure the effectiveness of the hazard controls.*
- ***d.*** *A status on these verification methods to trace them to successful completion (positive feedback that all safety verification have been completed).*

6.1 COMPLIANCE MATRIX

R.6.1-1: The Safety Requirements Compliance Matrix provided at the end of this document shall be filled in by the System Level Technical Responsible or by each subcontractor if this document is set applicable to subcontractors.

6.2 SAFETY ANALYSIS CONTENT

R.6.2-1: The safety analysis shall include:

- A safety oriented description of equipment or subsystem being studied,
- A list of RFW / RFD / NCR having safety impacts,
- A list of safety open points,
- Hazard reports.

R.6.2-2: All changes having safety impacts shall be clearly identified in the analysis (bar in the right-hand margin next to the change is recommended).

6.2.1 Hazard Reports

The safety analytical process may use various methods (FMECA, FAULT-TREES, CAUSE-CONSEQUENCE DIAGRAM, etc.).

R.6.2-3: One hazard report for each unique hazard identified shall be implemented.

R.6.2-4: There is no mandatory method but, at the end of the analysis, the following point must be documented in hazard reports:

a. Description of hazard

Hazards can be found in Hardware / Software systems, the man-machine relationship, or both.

b. Hazard causes

The identified causes for the risk situation and the unsafe act or condition listed under the hazard description.

c. Hazard controls

Identify the design features, safety devices, warning devices, and / or special procedures that will eliminate, reduce, safe, or counter the hazards resulting from each hazard cause.

d. Safety verification methods

Identify the methods used to assure the effectiveness of the hazard controls and the methods used to assure that safety requirements are met.

e. Status of verification (including reference of document)

Indicate the status of each safety verification.

R.6.2-5: If the hazard causes (and the associated controls) are not under the Subcontractor control, they have to be documented in the safety analyses for being taken into account at a system level.

For convenience, use of Figures 6-1 and 6-2 forms is recommended.

R.6.2-6: Hazard reports shall stand alone and data required to understand the safety analysis shall be attached to the report (diagrams, sequence of events, etc.).

R.6.2-7: When reference is made to a document describing design, hazard controls, testing, etc. a copy of the appropriate section shall be included.

6.3 SAFETY ANALYSIS PROCESS

R.6.3-1: Safety activities shall be initiated by the prime early in the design phase. Consequently Subcontractors safety analyses shall be required at the beginning of the design phase and shall be kept current throughout the development phases.

R.6.3-2: Safety documentation is to be provided for flight and ground equipment.

R.6.3-3: Safety documentation shall be provided, by each subcontractor, for each main step in the development (Design concept, PDR, CDR, Hardware delivery).

Basically the safety documentation shall contain:

6.3.1 Inputs for Safety Submission Phase 0 safety review (Design Concept)

R.6.3-4: Data Requirements:

- Conceptual description of the safety critical subsystem and its operation
- Applicable safety requirements
- Hazard reports to document and scope the specific hazards identified
- Caution and device list if equipment needs special procedures

6.3.2 Inputs for Safety Submission Phase 1 safety review (S/S or unit level PDR or equivalent)

R.6.3-5: Data Requirements (update as required):

- Description (including schematics and/or block diagram) of safety-critical subsystem, GSE and its operation.
- Applicable safety requirements

Hazard reports, one for each hazard identified including GSE as a result of the safety analysis, including appropriate support data

6.3.3 Inputs for Safety Submission Phase 2 safety review (S/S or unit level CDR or equivalent)

R.6.3-6: Data Requirements (update as required):

- A status of all actions items assigned during Phase 1

- Overview of subsystem with special emphasis on design changes since P.D.R. (or equivalent)
- Description (including schematics and/or block diagram) of safety critical subsystem, GSE and its operation
- Updated and additional (if necessary) hazard reports.
- Qualification tests reports of safety-critical subsystems or piece of equipment

  The phase 2 hazard reports shall be prepared by updating the hazard reports submitted for phase 1 to reflect the completed subsystem design.
- Updated assessment of applicable requirements.
- Safety related failures or accidents

6.3.4 Inputs for Safety Submission Phase 3 Safety Review (Hardware delivery)

R.6.3-7: Data Requirements (safety compliance data package) (Update as required):

- The status of all actions items assigned during phase 2
- Description (including schematics and/or block diagrams) of safety-critical subsystem, GSE and its operation
- Hazard reports completed
- Summary of safety-related failures or accidents
- A list of RFW/RFD, NCR having safety impacts
- Open safety items list
- Pressure vessel log books
- A list of procedures for operations on the launch site
- Procedures for hazardous operations, including those for a return to a safe condition and emergency procedures in the event of an incident
- GSE (MGSE, TGSE) proof tests.
- Acceptance tests reports of safety-critical subsystems or piece of equipment

For pressure vessels, the following data shall be included in the safety analysis (summary of the logbooks with):

- Maximum operating pressure
- Proof pressure
- Burst pressure
- Number of cycles above threshold

- Number of cycles above the maximum operating pressure
- Design cycle limit
- Maximum level to which vessel was pressurised
- Date of proof test.

The actual logbook must accompany the pressure vessels.

6.4 SATELLITE HAZARD REPORTS DATA SUBMITTAL

R.6.4-1: As minimum following data shall be incorporated into hazard analyses or hazard reports.

These data shall be provided by all subcontractors (including the prime if applicable) performing a safety analysis.

6.4.1 Control of hazardous functions

- Schematic diagram presented in a clear and easily readable form.
- Identification of hardware and electrical inhibits.
- Fault tree if necessary.
- Analysis about inhibits independence.
- Identification of monitoring circuits and analysis to prove independence from inhibits circuits (in order not to compromise the safety of the inhibits).
- Procedures reference.

6.4.2 Structural

- Sketch of the satellite hoisting points
- Analysis about:
  - Fail safe design of the hoisting points, or/and
  - Safety factor of the hoisting points
  - lifting points single failure point analysis
  - Safety factor of the structure for vertical to horizontal tilting and transportation in horizontal configuration
  - Metallic material choice versus stress corrosion cracking

– Qualification and acceptance plans and test results

6.4.3 *Pressure vessels*

- Status of compliance with the MIL-STD-1522A, Approach A
- Metallic material choice versus stress corrosion
- Qualification and acceptance plans and test results
- Analysis showing pressure variation versus temperature on ground
- LBB demonstration test result for vessels having a non hazardous leak before burst failure mode
- Material compatibility data as required in paragraph 6.4.6 including over wrap
- Provide for pressure vessels the same data as requested in the paragraph 6.4.4
- Safe operating limits
- Log books

6.4.4 *Pressurised lines, fittings, and other components*

Identify for each component:

- Maximum Allowable Working Pressure
- Maximum Expected Operating Pressure or Maximum Design Pressure
- External and internal leak rates
- Burst safety factor and qualification test reports
- Material compatibility data as required in paragraph 6.4.6
- Cross sectional drawing showing seats, input and output ports, flow sense, barriers against fluids, ...
- Materials used including soft goods
- Manufacturer's name, model number, part number, ...
- Proof safety factor and acceptance test reports for proof and leak tests
- Fluids used during manufacturing, tests and operations
- type of connections

6.4.5 *Heat-pipes*

- Material compatibility data as required in paragraph 6.4.6.
- Burst safety factor and qualification test reports including burst and cycling tests.
- Acceptance test reports for proof and leak tests.

6.4.6 Hazardous materials

- Fluid compatibility versus material data for materials used in hazardous fluid systems such as propulsion, batteries, heat-pipes, Fluids list shall include manufacturing, cleaning, and test (including dye penetrant) fluids.
- Listing and quantities of all hazardous materials, liquids and gases (including inert gases) used in the flight system or during the ground operations at the range.
- Provide OSHA-20 forms for all of those chemicals.

6.4.7 Pyrotechnics

- Compliance status with the MIL-STD-1576
- Qualification and acceptance test results for EED in particular to prove:
  - 1A/1W/5mn no fire
  - 25 kV/500 pF requirement
- Sketch showing physical location of EED
- IATA classification for EED
- UN/NATO classification for EED
- Manufacturer reference and part number
- EED and boosters drawings and cross sectional sketches
- Chemical composition and characteristics, net explosive weight
- Description of functions initiated by the pyrotechnic devices
- Drawings showing safe and arm plugs location
- Mechanical and electrical drawings of safe and arm plugs
- Firing, control and monitor circuits schematics
- Sequence of events which leads to ordnance activation
- Analysis about independence of commands, controls and monitor circuits
- Analysis about EMC/RF protection against EED premature firing including:

   - 360° optical coverage, particularly at connectors levels
   - Type of shields used
   - RF susceptibility analysis to demonstrate 20 dB attenuation.
- ...

6.4.8 Non ionising radiation

Analysis of RF hazards:

- Exposure level versus distance ⇒ hazardous areas identification
- Transmitter peak power
- Type and size of antennas
- Antenna gain and illumination
- Operating frequency
- Polarisation of transmitter waves
- Description of inhibits and other safety features which prevent inadvertent exposures
- ...

6.4.9 Electrical system

- Description of power sources (batteries, ...)
- Cell chemistry and physical construction
- Cell vent parameters
- Toxic chemical emission of cells and evaluation of hazard
- Physical and electrical integration of cells to form the battery
- Description of safety devices
- Case design including vent operation and cell and battery case housing yield point
- A description of all Range operations including packing, transportation, and storage, activation installation, check out, charging, usage, removal and disposal of battery. And identification of the hazards associated with each operations identified above and the safety controls that shall be in effect.
- Manufacturing, qualification and acceptance testing results that are considered safety critical

- Battery size and weight
- A description of the EGSE used for check out of battery at the range.
- Lithium battery test results.
- Schematic showing power distribution, protection devices, circuits and lines needing double insulation
- Comprehensive analysis about double insulation implementation and testing
- Analysis showing for power lines the relation between wire size, wire current capacity, wire temperature and the ultimate trip limit current of the protection device located upstream
- Analysis about temperature increase effects in case of failed heater "ON" in pressurised components such as propulsion, battery, ...

6.4.10 Hazardous procedures

- Provide the list of procedures in which hazard procedures are identified. That list shall be approved by your safety manager.
- Provide hazardous procedures approved by your safety manager.

6.4.11 Flammable atmospheres

- Electrical discharges:
  - List of all relays and similar ignition sources (thermostats, motor, ...)
  - Analysis showing protections against sparking hazard (sealed parts, containment, ...)
  - Analysis showing grounding implementation (design, test) of parts which can generate electrostatic discharges
  - Analysis about current and voltage through umbilical connectors at lift-off.
  - Analysis of the filling operations configuration with regard to flammable atmosphere hazards
  - Analysis of the post filling operations configuration with regard to flammable atmosphere hazards

- Hot surfaces:
  - Analysis identifying all surfaces (heaters, ...) that have temperature of greater than 180°C

– Analysis showing inhibits and protections implementation.

6.4.12 Cryogenics system

Identify for each component:

- Maximum Allowable Working Pressure
- Maximum Expected Operating Pressure or Maximum Design Pressure
- External and internal leak rates
- Burst safety factor and qualification test reports
- Material compatibility data as required in paragraph 6.4.6
- Cross sectional drawing showing seats, input and output ports, flow sense, barriers against fluids, ...
- Materials used including soft goods
- Manufacturer's name, model number, part number, ...
- Proof safety factor and acceptance test reports for proof and leak tests
- Fluids used during manufacturing, tests and operations
- type of connections

6.5 GROUND SUPPORT EQUIPMENT HAZARD REPORT DATA SUBMITTAL

R.6.5-1: As minimum following data shall be provided for GSE used on launch site.

These data shall be provided by all subcontractors (including the prime if applicable) performing a safety analysis.

6.5.1 Mechanical Ground Support Equipment

- Sketch of MGSE (in A4 or A3 size) with identification of critical welds and single points of failure
- Safety factor versus Maximum Safe Working Load and dimensioning calculation notes
- Maximum Safe Working Load
- Identification of parts needed to be disassembled
- Proof test factor
- Acceptance test reports including NDI of critical welds
- Materials of construction (mainly those involved in the load path).
- Compliance with IATA/ULD Standard Specification 80/2 for aircraft transport containers.
- Ultimate safety factors of pressurised items and systems.
- Proof test report of pressurised systems.

6.5.2 Electrical Ground System Equipment

- Safety analysis on inhibition of orders activating hazardous functions
- Schematic showing power distribution, protection devices, circuits and lines needing double insulation
- Comprehensive analysis about double insulation implementation and testing
- Analysis showing for power lines the relation between wire size, wire current capacity, wire temperature and the ultimate trip limit current of the protection device located upstream.
- Certificate of conformance for use in explosive atmosphere for electrical equipment.

6.5.3 *Tanking and Cryogenics/Vacuum Ground Support Equipment*

- Hazard analysis on TGSE/CVSE and related operations
- TGSE/CVSE description and its operating modes including:
  - TGSE/CVSE schematic diagram showing the MEOP in the different portions
  - MAWP and MEOP of all pressure system elements
  - Safety factors of all pressure system elements
  - Actual burst safety factor if available
  - Proof pressure value for each system element
  - Materials used in fabrication of each element including soft goods
  - Cycle limits if fatigue is a factor in the system
  - Temperature limit of each element
  - Manufacturer's name, model number, part number of each component
  - Safety data for vessels
  - Sketch/drawing/cutaway of each element
  - Failure mode of each component
  - Material compatibility
  - NDI and welding procedure certification
  - Certification data for vessels designed to comply with an official standard
  - Relief valve pressure settings and flow rates
  - System fluids and maximum expected temperatures
  - Pressure range of all gages
  - Pressure setting of all pressure regulators
  - Vessels capacity and relevant vessel data
  - Tubing diameter and wall thickness
  - Flow paths
  - …
- TGSE/CVSE structural analysis including:
  - Stresses evaluation
  - Operational cycles life

- Test and operating procedures
- Log books

6.5.4 Optical Ground Support Equipment

- Safety analysis identifying hazards and protections related to:
  - Dangerous light radiation such as lasers:
  - Temperature extreme
  - Shatterable materials
  - High voltage
  - X-rays

6.6 GROUND CRYOGENICS OPERATIONS

R.6.6-1: Hazard causes from cryogenics operations shall be identified and hazard controls implemented.
The identification shall be performed accordingly to the method developed in the note CA/SO/ISO 246/90 dated 13 April 1990.

<table>
<tr><td colspan="2">HAZARD REPORT</td><td colspan="2">N°:</td></tr>
<tr><td colspan="2">SATELLITE:</td><td colspan="2">SAFETY
PHASE:</td></tr>
<tr><td>SUBSYSTEM:</td><td>HAZARD GROUP:</td><td colspan="2">DATE:</td></tr>
<tr><td colspan="4">HAZARD TITLE:</td></tr>
<tr><td colspan="2" rowspan="3">APPLICABLE SAFETY REQUIREMENTS:</td><td colspan="2">HAZARD CATEGORY:</td></tr>
<tr><td></td><td>CATASTROPHIC</td></tr>
<tr><td></td><td>CRITICAL</td></tr>
<tr><td colspan="4">DESCRIPTION OF HAZARD:</td></tr>
<tr><td colspan="4">HAZARD CAUSES:</td></tr>
<tr><td colspan="4">HAZARD CONTROLS:</td></tr>
<tr><td colspan="4">SAFETY VERIFICATION METHODS:</td></tr>
<tr><td colspan="4">STATUS OF VERIFICATION:</td></tr>
<tr><td colspan="4">TECHNICAL AGREEMENT:
SUBSYSTEM NAME SIGNATURE DATE</td></tr>
</table>

FIGURE 6-1 HAZARD REPORT FORM

ANNEX TO	**HAZARD TITLE:**	
HAZARD CAUSE:		
HAZARD CONTROLS:	**SAFETY VERIFICATION METHODS:**	**VERIFICATION STATUS:**

FIGURE 6-2 PAYLOAD HAZARD REPORT FORM (ANNEX)

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.3.1-1												
R.3.1-2												
R.3.2-1												
R.3.2-2												
R.3.2-3												
R.3.3-1												
R.3.3-2												
R.4.-1												
R.4.1-1												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.2-1												
R.4.3-1												
R.4.3-2												
R.4.3-3												
R.4.3-4												
R.4.3-5												
R.4.3-6												
R.4.3-7												
R.4.3-8												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.3-9												
R.4.3-10												
R.4.3-11												
R.4.3-12												
R.4.3-13												
R.4.3-14												
R.4.3-15												
R.4.3-16												
R.4.3-17												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.3-18												
R.4.3-19												
R.4.3-20												
R.4.3-21												
R.4.3-22												
R.4.3-23												
R.4.3-24												
R.4.3-25		X										
R.4.3-26												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.3-27												
R.4.3-28												
R.4.3-29												
R.4.3-30												
R.4.4-1												
R.4.4-2												
R.4.5-1												
R.4.6-1												
R.4.6-2												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.6-3												
R.4.6-4												
R.4.6-5												
R.4.6-6												
R.4.6-7												
R.4.6-8												
R.4.6-9												
R.4.6-10												
R.4.6-11												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.6-12												
R.4.6-13												
R.4.6-14												
R.4.6-15												
R.4.6-16												
R.4.6-17												
R.4.6-18												
R.4.6-19												
R.4.6-20												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.6-21												
R.4.6-22		X										
R.4.6-23		X										
R.4.6-24												
R.4.6-25												
R.4.6-26		X										
R.4.6-27												
R.4.6-28												
R.4.6-29												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.6-30												
R.4.6-31												
R.4.6-32												
R.4.6-33												
R.4.6-34												
R.4.6-35												
R.4.6-36												
R.4.7-1												
R.4.7-2												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.7-3												
R.4.7-4												
R.4.7-5												
R.4.7-6												
R.4.7-7												
R.4.7-8												
R.4.9-1												
R.4.9-2												
R.4.9-3												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.9-4												
R.4.9-5												
R.4.9-6												
R.4.9-7												
R.4.9-8												
R.4.10-1												
R.4.10-2												
R.4.11-1												
R.4.11-2												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.11-3												
R.4.11-4												
R.4.11-5												
R.4.11-6												
R.4.12-1												
R.4.12-2												
R.4.12-3												
R.4.12-4												
R.4.13-1												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.13-2												
R.4.13-3												
R.4.13-4												
R.4.13-5												
R.4.13-6												
R.4.13-7												
R.4.14-1												
R.4.14-2												
R.4.14-3												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.14-4												
R.4.14-5												
R.4.14-6												
R.4.14-7												
R.4.14-8												
R.4.15-1												
R.4.16-1												
R.4.16-2												
R.4.16-3												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.4.16-4												
R.5-1												
R.5.1-1												
R.5.1-2												
R.5.1-3												
R.5.1-4												
R.5.1-5												
R.5.1-6												
R.5.1-7												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.5.1-8												
R.5.1-9												
R.5.1-10												
R.5.1-11												
R.5.1-12												
R.5.1-13												
R.5.1-14												
R.5.1-15												
R.5.1-16												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.5.1-17												
R.5.2-1												
R.5.2-2												
R.5.2-3												CANCELLED
R.5.2-4												
R.5.2-5												
R.5.2-6												
R.5.2-7												
R.5.2-8												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.5.2-9												
R.5.2-10												
R.5.2-11												
R.5.2.12												CANCELLED
R.5.3-1												
R.5.3-2												
R.5.3-3												
R.6.1-1												
R.6.2-1												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.6.2-2												
R.6.2-3												
R.6.2-4												
R.6.2-5												
R.6.2-6												
R.6.2-7												
R.6.3-1												
R.6.3-2												
R.6.3-3												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

REQUIREMENT	COMPLIANCE STATUS						PLANNED COMPLIANCE DEMONSTRATION					
	Appli-cability		COMPLIANCE				TYPE OF DEMONSTRATION				DOCUMENT REFERENCE, PARAGRAPH	COMMENTS
	A	N/A	C	PC	NC	O	RD	An	S	T		
R.6.3-4												
R.6.3-5												
R.6.3-6												
R.6.3-7												
R.6.4-1												
R.6.5-1												
R.6.6-1												

A : Applicable
N/A : Non applicable

*add comments

C : Compliant
PC : Partially compliant *
NC : Non compliant *
O : Open for clarification

RD : Review of Design
An : Analysis
S : Similarity
T : Test

FIN DE DOCUMENT
END OF DOCUMENT