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Project Orion

Spacecraft Test & Verification Facility System Requirements Document for the Kennedy Space Center Operations and Checkout Building

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FOREWORD

This document has been prepared for and is being submitted to the National Aeronautics and Space Administration (NASA) at Johnson Space Center (JSC) in Houston, Texas in accordance with Data Requirements Description (DRD) CEV-T-082, Spacecraft Test & Verification Facility System Requirements Document and Contract Number NNJ06TA25C.

Initial delivery of this document at System Design Review (SDR) primarily derived requirements from LMSSC-ORION-KSC-003 Operations and Checkout (O&C) Facility Design Criteria (FDC) Rev. 3 (ERB-07-0056 - 08 May 2007). For the Preliminary Design Review (PDR) release, updates to CEV-T-082400 are based in part by the Crew Exploration Vehicle (CEV) 606C and 606D baselines as well as changes as captured in Revision 4 of the Facility Design Criteria (ERB-08-0216 - 22 Apr 2008).

The Industrial Operations Zone (IOZ) which makes up part of the Operations and Checkout Facility at Kennedy Space Center will be operated and controlled by Lockheed Martin to perform manufacture, integration, and testing of the Orion vehicle. Renovation of the IOZ to ensure readiness to accept flight hardware, tooling, and ground support equipment is unique in that in order to meet the Flight Test Article Assembly Integration and Production schedule, commencement of the facility work precedes the final delivery of the DRD as well as the Orion Program PDR. It is inevitable that changes to the facility baseline will be required as the Program matures though PDR and CDR. These changes will continue to be captured in subsequent deliveries of this document.

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REVISION LOG

Revision	Revision Date	Page	Change Item	Approved DCR Number
000	10 July 2007	All	Initial Submittal @ SDR	N/A
001	01 November 2008	All	Final Submittal @ PDR	N/A

1 SCOPE

1.1 PURPOSE

The purpose of the Spacecraft Test & Verification System Requirements Document for the Kennedy Space Center (KSC) Operations and Checkout Building (O&C), DRD CEV-T-082400, is to define the requirements for the test and verification of facilities, facility systems, support equipment and facilities acceptance test activities for the O&C Building. The O&C Building is the primary Assembly Integration and Production (AI&P) facility for the Constellation Program's (CxP) Crew Exploration Vehicle. Ground Support Equipment (GSE) requirements and Tooling Requirements will not be captured in DRD-T-082400. GSE requirements will be captured in the GSE O&C Design Criteria Document (LM-ORN-0091) and Tooling Requirements will be captured in the O&C AI&P Tooling Interface Control Document. Where appropriate, Tooling/GSE to Facility interfaces will be captured in DRD-T-082400.

All requirements identified in the DRD have been mapped to a requirements allocation spreadsheet matrix in the Verification Section of this Document. The matrix provides an accounting of the requirements as well as their verification method necessary to ensure facility and system compliance. Subsequent O&C test plans such as DRD-T-084400 O&C Building Spacecraft Test and Verification Facility Certification Plan and the Facility Design Criteria (FDC) Test Plan will contain verification cross reference matrices that provide a trace to the requirements allocated in this matrix to provide a complete accountability for each requirement.

1.2 DEFINITION OF TERMS

1.2.1 Document Definitions

Table 1: Document Definitions

Term	Definition
Analysis	Analysis is the use of calculations or comparisons to show that a system or one of its elements satisfies its functional or design requirements. Mathematical models representing the system or element under study, using data from tests or other analyses, are often employed. Comparison of the item with others that are substantially similar or identical in design, manufacturing processes and quality control and have been tested or used to equivalent or more stringent criteria is an acceptable form of verification analysis.
Certification	The formal written act whereby a responsible official attests to the satisfactory accomplishment of specified activities and authorizes the

Term	Definition
	specified hardware/software, procedures, facilities and/or personnel for program usage.
Demonstration	Demonstration is the observation of functional operation to determine compliance with requirements. Demonstration is often used to show that a proper response results from a specific stimulus or interrogation. It is also well suited to proving compliance with human factors and maintenance requirements.
Inspection	Visual examination of the item (hardware and software) and associated descriptive documentation which compares appropriate characteristics with predetermined standards to determine conformance to requirements without the use of special laboratory equipment or procedures.
Shall	Denotes an intended mandatory requirement. Shall requires a verification process. Each use of the term "shall" is subscripted numerically within each major paragraph and is listed in the Requirement / Verification Cross Reference Matrix. The Seller is required to state how the requirement of each "shall" is to be met. Note: The Seller is at liberty to propose that any individual "shall" requirement be revised to facilitate design trades. In such cases, a supporting rationale will be provided by the Seller.
Should or May	Denotes non-mandatory provisions and are used to show guidelines and to indicate a goal which must be addressed by the design but is not formally verified.
Test	Any program or procedure which is designed to obtain, verify, or provide data for the evaluation of any of the following: 1) progress in accomplishing developmental objectives, 2) the performance, operational capability and suitability of systems, subsystems, components, and equipment items, and 3) the vulnerability and lethality of systems, subsystems, components, and equipment items. A method of verifying requirements, involving the execution of system elements and analyzing test results against expected results.
Validation	Proof by examination of objective evidence, that the product accomplishes the intended purpose. Validation is performed to ensure that the product is ready for a particular use, function, or mission and may be determined by test, analysis, demonstration, or a combination of these.
Verification	Proof, by examination of objective evidence that the product complies with specifications. Verification is performed to ensure the product complies with requirements and may be determined by test, analysis, demonstration, inspection, or a combination of these.
Will	Denotes an intended mandatory and contractual requirement. It is synonymous with “shall” but does not require verification. It is used to indicate a statement of fact.

1.2.2 Facility Definitions

Table 2: Facility Definitions

Term	Definition
Command Control and Monitor System (CCMS) back end equipment	The CCMS back end equipment is the portion of the CCMS that is located in the control center.
CCMS front end equipment	The CCMS front end equipment is the portion of the CCMS that is remotely located in the integration cell.
Clean Work Area (CWA)	The CWA is defined as the high bay areas, low bay areas, and off-line processing areas maintained at a 100K working environment.
Computer Room Areas	Computer Room areas are raised floor areas having similar environmental requirements including the CCMS Control Room, Server Room, and Training Room
Facility Electrical Distribution System	All electrical equipment in a building, group of buildings, or other facility located between the upstream energy supplier (the utility) and the downstream interfaces.
Human Engineering	The area of human factors, which applies scientific knowledge to the design of items to achieve effective man-machine integration and utilization.
Industrial Operating Zone (IOZ)	The IOZ is defined as all the Lockheed Martin responsible areas within the O&C facility.
Industrial Operating Zone Basement	The area below the floor in the high and low bays. The basement area extends from the high bay east wall to the low bay west wall and from the north wall of the bays to approximately 40 feet south.
Lightning Protection System	A lightning protection system does not prevent lightning from striking; it provides a means for controlling it and preventing damage by providing a low resistance path for the discharge of lightning energy.
Off Line Processing Areas	The off line processing areas are defined as the areas to the north and south of the High and Low bay perimeter.

2 APPLICABLE DOCUMENTS

2.1 FEDERAL

2.1.1 Parent

Table 3: Parent Documents

Document ID	Title	Revision	Date
CxP 70036	Constellation Program Environmental Qualification and Acceptance Testing Requirements (CEQATR)	Rev A	05 Sep 2007
CEV-T-084400	Spacecraft Test and Verification Facility Certification Plan for the Kennedy Space Center Operations and Checkout Building	001	PDR
CEV-T-088000	CEV Imagery Plan/Imagery Deliverables Project Orion	000	29 July 2008

2.1.2 Applicable Documents

Table 4: Applicable Documents

Document ID	Title	Revision	Date
MIL-HDBK-454B	General Guidelines for Electronic Equipment	Rev B	15 April 2007
MIL-STD 1472F	Human Engineering	-	05 Dec 2003
NFPA 70	National Electric Code	-	15 Aug 2007
NFPA 101	Life Safety Code	-	18 Aug 2005
NFPA 780	Standard for the Installation of Lightning Protection Systems	-	15 Aug 2007
MIL-PRF-27401	Propellant - Pressurizing Agent Nitrogen	-	10 Jan 2008

2.1.3 Guidance Documents

Table 5: Guidance Documents

Document ID	Title	Revision	Date
AFM 91-201	Explosives Safety Manual	-	18 Oct 2001
ASME B30.2	Overhead and Gantry Cranes	-	2005
ASME/ANSI 17.1	Specification for Refurbishment of Elevators	-	2004
MIL-STD-1542B	Electromagnetic Compatibility and Grounding Requirements for Space System Facilities	Rev B	15 Nov 1991
OSHA 29 CFR 1910.179	Overhead and Gantry Cranes	-	2008
STP-72115	Cleanliness Controls for Spacecraft/Systems	-	14 Aug 2007
MIL-PRF-27407	Propellant - Pressurizing Agent Helium	-	29 Nov 2006

2.2 LOCKHEED MARTIN

Table 6: Lockheed Martin Reference Documents

Document ID	Title	Revision	Date
CPS 565	Workplace Security – Maintaining a Safe and Respectful Workplace Free From Threats and Violence	Rev 3	14 Jan 2008
CPS 569	Security	Rev 3	18 Aug 2005
LMSSC-ORION-KSC-003	O&C Facility Design Criteria	Rev 3	08 May 2007
LMSSC-ORION-KSC-008	Operations and Checkout Building, Facilities Concept of Operations	Rev Basic	28 Mar 2008
1.3.3-T1-ESH-12.0-S	Overhead Cranes	Rev 0	27 Nov 2007
2.3.5-T2-SysSec-1.0-P	System Security Engineering	Rev 0	25 May 2005
2.3.6-T1-ProdProt-1.0-G	Packaging, Handling, Storage and Transportation Guidebook	Rev 0	19 Dec 2006
2.3.8.1-T1-Test-1.1-G	Test Engineering Guidebook	Rev 2	25 Sept 2007
2.3.8-T1-Test-2.0-D	Video Monitoring of Critical Operations (Directive)	Rev 0	12 July 2005

Document ID	Title	Revision	Date
2.3.8.1-T1-Test-7.0-P	FFMEA for Ground Processing Equipment	Rev 3	28 Nov 2006
2.4-T1-Ops-1.1-P	Foreign Object Elimination (FOE) Process	Rev 0	24 Apr 2005

2.3 NASA

Table 7: NASA Reference Documents

Document ID	Title	Revision	Date
KNPR-8500.1	Kennedy Space Center Environmental Requirements	Rev A	05 Nov 2005
KNPR-8715.3	Kennedy Space Center Practices Procedural Requirements	Rev B	04 Apr 2007
KSC-C-123H	Specification for Cleanliness of Fluid Systems	Rev H	25 Sep 1995
KSC-DE-512-SM	Facility, System and Equipment General Design Requirements	Rev K	30 Sep 2004
KSC-STD-E-0012E	Standard for Facility Grounding and Lightning Protection	Rev. E	01 Aug 2001
NASA-STD-5005B	Ground Support Equipment	Rev B	15 Sep 2003
NASA-STD-8719.9	Standard for Lifting Devices and Equipment	-	
NASA-STD-8719.11	Safety Standard for Fire Protection	Change 3	6 Apr 2006

2.4 United Space Alliance (USA)

None Applicable

2.5 OTHER PUBLICATIONS

Table 8: Other Documents

Document ID	Title	Revision	Date
CMAA 70	Crane Manufacturer's Association of America, Specification Number 70-2000	-	2004
IESNA HB-9-2000	Illumination Engineering Society of North America, Lighting Handbook	9th Edition	01 Dec 2000

3 O&C FACILITY REQUIREMENTS

3.1 O&C FACILITY OVERVIEW

3.1.1 FACILITY DESCRIPTION

3.1.1.1 Facility Purpose

The Kennedy Space Center IOZ purpose is to support the Assembly, Integration, and Production of the CEV spacecraft. Crew Module (CM), Service Module (SM), and Spacecraft Adapter (SA) structures as well as all other necessary components to construct the CEV spacecraft will be received by the facility. Following receipt and acceptance of the components and subsystems will be assembled, integrated and tested in series of dedicated CM and SM Processing Stations. To leverage process commonality CM and SM modules will be processed side by side as individual spacecraft prior to being integrated and tested as a CEV CM/SM stack. The fully integrated and tested CEV stack will then be accepted by the customer and leave the O&C to be integrated with the Crew Launch Vehicle (CLV) and readied for flight.

3.1.1.2 Facility Design/Layout

The O&C was initially completed in 1964 for the Apollo program and has continuously provided support to NASA manned space flight (MSF) programs to the present day. The portion of the O&C that will be utilized for the AI&P of the CEV Spacecraft is called the Industrial Operating Zone (IOZ). The IOZ is an area defined in the CEV/Orion Contract, NNJ06TA25C, Attachment J-12, Appendix 1 and is located within the O&C Checkout building for Lockheed Martin manufacturing operations. The IOZ consists of over 87,000 square feet of floor space and consists of the Clean Work Area (CWA) comprising the low bay, high bay, and off-line processing areas such as tool cribs and laboratories. The CWA is an ISO Class 8.5 with capability to ISO Class 8 when required. Other areas of the IOZ include the Command Control and Monitor System (CCMS) Control Room, office areas, and basement area. Figure 1 contains a high level overview of the IOZ areas in the O&C. A more detailed floor plan is provided in the O&C West and East layouts as shown in Figures 2 and 3 respectively. Specific information about the rooms as well as a detailed description of the purpose of each room is provided in the Room/Area Description, Section 3.2.1.

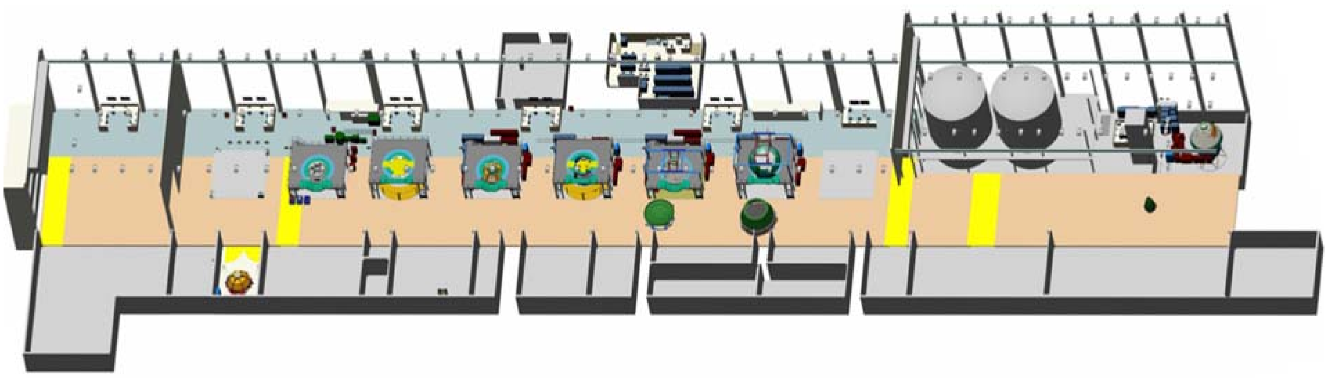

Figure 1: O&C Layout

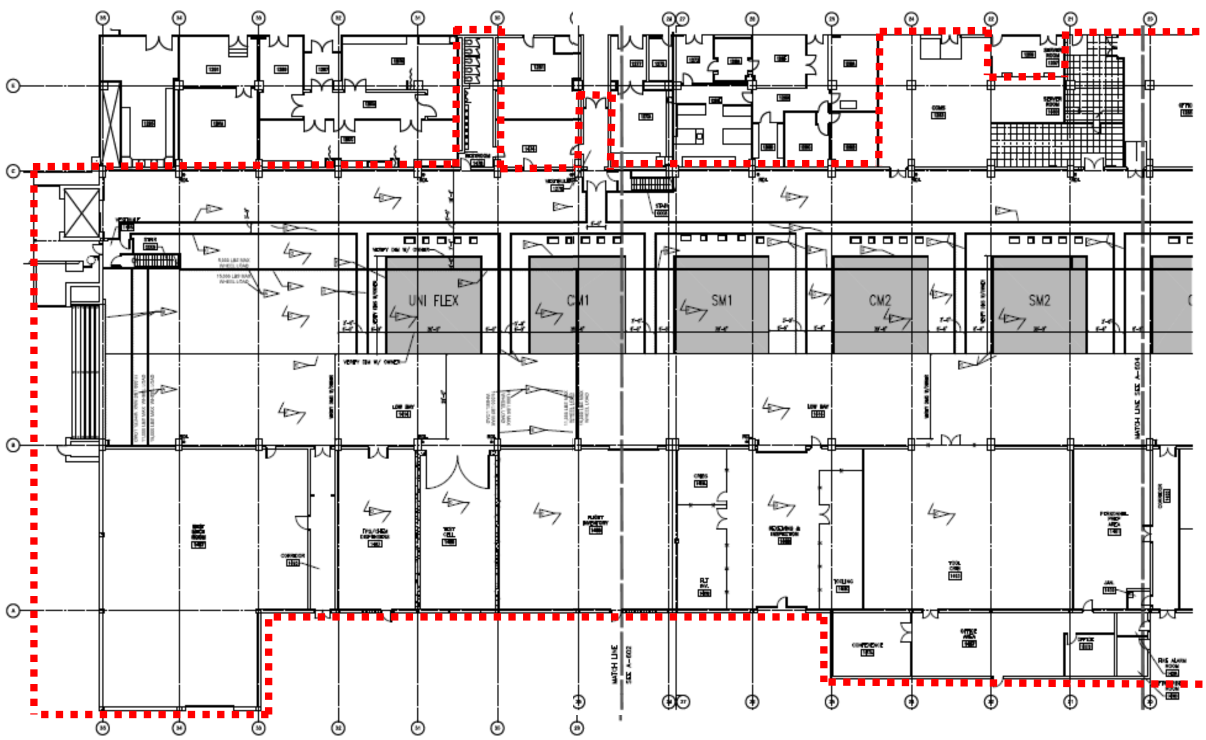

Figure 2: O&C West Layout

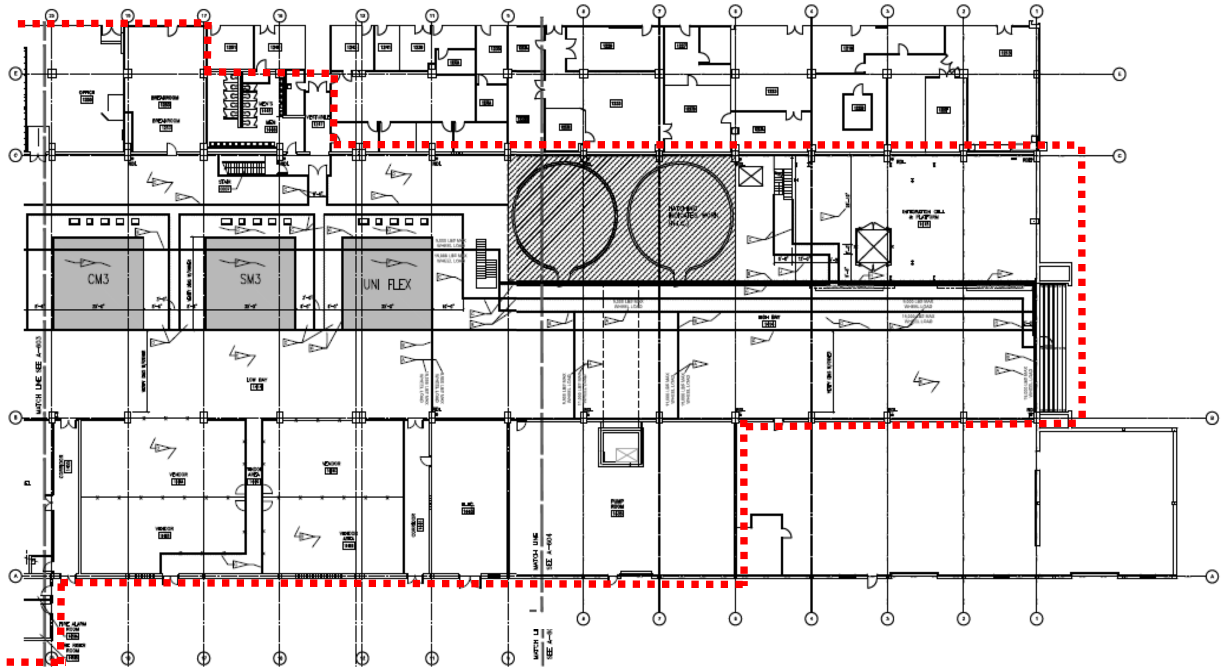

Figure 3: O&C East Layout

3.1.2 ROOM/AREA DESCRIPTIONS

These sections describe the purpose and a functional description of each work, maintenance, and facility service area. Table 10 provides a locator reference that includes room number, room name, and a room function.

Table 9: Room Area Description Matrix

Room No.	Room Name	Function
0100	Lower Integration Cell	Vehicle processing
0108	East Basement	Storage
0108	West Basement	Storage
1253	Break Room	LM and Touch Labor Break
1255	CCMS Control Room	CCMS/EGSE Control Center
1263	Training Room	Online Training
1287	Office Area	Lockheed Martin Office Area
1400	High/Low Bay	Vehicle processing
1415	Integration Cell	Vehicle Erection and Processing

Room No.	Room Name	Function
1443	Electrical Room	Electrical Switch Gear
1445	Corridor	Hallway
1449	Vendor Area	Subcontractor Areas
1455	Corridor	Hallway
1456	Personnel Preparation Area	Change Out Room
1460	Server Room	LMI and Servers
1461	TPS/Chemical Dispensing	Chemical Storage, Mixing and Dispensing
1463	Tool Crib	Store and Distribute Tools
1465	Conference Room	Lockheed Martin Office Area
1465	Office Area	Lockheed Martin Office Area
1465	Office Area	Lockheed Martin Office Area
1469	Receive and Inspecting Area	Receive and Inspection of Flight Hardware
1480	Flight Inventory	Flight Hardware Storage
1486	Proof Test Cell	Spacecraft Proof and Pressure Test
1492	Airlock	Receive and Inspection of Flight Hardware
1495	Corridor	Hallway
1495	Mechanical Room	West Mechanical Equipment Room

3.1.2.1 Low Bay

The Low Bay, Room 1400, is part of the CWA and runs from the West end of the IOZ column # 35 to the east end of the altitude chambers column # 10 approximately 475 ft. long with a ceiling height approximately 70 ft. Eight Processing Stations along the center of the low-bay support Orion AI&P Operations. Stations are similarly sized and have common utility suite interfaces. Utility suites provide gases, chilled water, vents, electrical power, and network connections and will be discussed in detail in the Functional Capabilities section of this document. Two types of processing stations are utilized in the Low bay, Assembly Stations and Flex Stations. The Airlock Area comprises the remainder of the Low Bay Area. IOZ access to the west side of the Low Bay will be through an existing roll up door. Replacement of the doors will not be performed as part of the facility refurbishment.

3.1.2.1.1 Assembly Station 1

Station 1 consists of Crew Module and Service Module areas and is primarily dedicated to welding operations of fluid and gas systems such as ECLSS and propulsion. High pressure tanks, valves, and manifolds will be installed to primary and secondary structure and the associated tubing will be then be routed and prepared for orbital arc welding. To facilitate efficient operations, non destructive evaluation (NDE) of welds will be performed in-line with welding operations. Although the primary task in Station 1 is welding, where practical, wire harnesses, secondary structure, and Operational Flight Instrumentation (OFI) and Developmental Flight Instrumentation (DFI) may also be installed in Station 1.

3.1.2.1.2 Assembly Station 2

Crew and Service Modules with installed Subsystems (i.e. propellant, Environmental Control and Life Support System (ECLSS), etc.) that have satisfactorily completed NDE and final proof pressure testing will be moved to Station 2 where the remainder of harnesses and cabling will be installed and tested. Cold plates, avionics boxes, remaining ECLSS and OFI/DFI will be installed in Station 2. Crew modules in Station 2 will also have crew interfaces, Reaction Control System (RCS) and command systems installed. Station 2 will be supported by the CCMS and CM initial power on activities will commence. Testing in Station 2 will primarily be at the subsystem level.

3.1.2.1.3 Assembly Station 3

Station 3 is where the final buildup of the individual CM and SM will occur. System level functional checkouts and Mission Tests on the CM and SM will occur in Station 3. Station 3 is the first place that the CM and SM will be electrically soft mated for integrated CEV checkout. CM forward bay components and panels will be installed and closed out. Hatches, windows, and the docking hatch will be installed as well as crew seats and lockers. Finally the CM heat shield will be integrated and installed.

The SM operation in Station 3 will consist of installation of all remaining OFI/DFI and main engine installation, alignment and checkout. Remaining system functional checkouts will be completed and Multilayer Insulation (MLI) and Passive Thermal Control System (PTCS) installations will be completed. Upon completion of the integrated electrical soft mate tests the CM will move to the integration cell for stacking and the SM will be moved to the flex cell for radiator installation and then follow the CM to the integration cell.

3.1.2.1.4 Flex Stations

Flex Stations are located on each end of the assembly stations in the O&C low bay. Flex Station 1, located in the westernmost end of the processing stations, is primarily utilized as an overflow station for Station 1 welding operations and as an inspection/holding area for CM refurbishment. Flex Station 2 is located at the easternmost end of the processing stations and is used for overflow operations. Flex stations are not base-lined to have large tooling stands therefore they provide complete access to the spacecraft. Utility suite configuration in the Flex Stations is identical to all other Processing Stations and provides Gaseous Nitrogen (GN2) and Gaseous Helium (GHe), chilled water, vents, vacuum, electrical, power, phone, and network connections. Flex Station operations are limited since neither flex station has a CCMS capability and cannot support any vehicle testing that requires CCMS support. Figure 4 provides a detailed view of the Western O&C showing Assembly Stations, Flex Stations, and the Airlock Area.

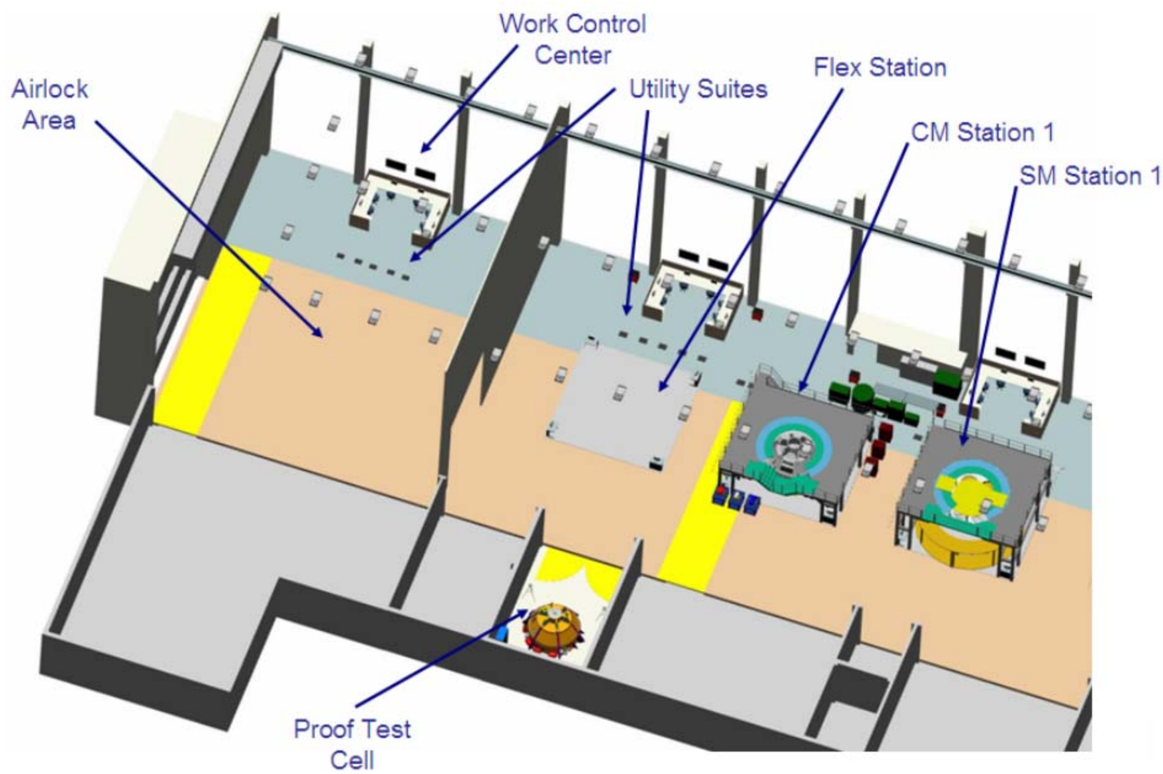

Figure 4: Detailed View of Western IOZ

3.1.2.1.5 Airlock Area

The Airlock Area, Room 1492, is located on the West end of the Low Bay. The Airlock Area is walled off from the remainder of the Low Bay from the ceiling to the floor. The design of the airlock will include removable panels to allow a pass through for the low bay crane. The primary purpose of the Airlock Area is to provide an isolated area for receiving, inspecting and off-loading large spacecraft structures such as CM structure, SM structure, heat shields and fairings. Cleaning and inspecting of previously flown Crew Modules will take place within the Airlock Area. All International Traffic in Arms Regulations (ITAR) controlled items and any components that may be re-useable will be removed. The components not re-useable will then be disposed of in the appropriate manner. Following airlock processing the reused CM will enter the production assembly line at the appropriate station based on rework requirements. The wall separating the Airlock from the remainder of the Low bay will be equipped with personnel doors as well as a door for flight hardware transport to and from the Low Bay. Although it is physically separated from the Low Bay the Airlock Area will maintain the CWA environment.

3.1.2.2 High Bay

The High Bay Area, Room 1400, runs from the East end doors of the IOZ to the west end of the altitude chambers Column #1 through #9 approximately 157 feet in length with the ceiling 94 ft. high. The primary work areas within the high bay are the integration cell and the altitude chambers. IOZ access to the east side of the High Bay will be through an existing roll up door. Replacement of the doors will not be performed as part of the facility refurbishment.

3.1.2.2.1 Integration Cell

The Vehicle Integration Cell, Room 1415, is located in the North East corner of the High Bay just north of the High Bay doors. The floor is common with the basement floor 12 feet below facility floor level. The primary function of the Integration Cell is the assembly, integration and test of the CEV stack. Fully integrated and tested CM and SM/SA spacecraft subassemblies will be moved from their associated Processing Station 3 to the High Bay. The overhead crane will perform the stacking operation by lowering the SM/SA onto tooling previously placed on the basement floor. The CM will then be lowered onto the SM/SA and all electrical and mechanical interfaces will be made to complete the CEV stack mating operation.

3.1.2.2.2 Altitude Chambers

Two Apollo era Altitude Chambers are located on the northwest side of the High Bay. The West Chamber remains in "Active" status with a certified capability of 1×10^{-4} Torr. The East Chamber has been "Abandoned in Place". Use of vacuum chambers is in the Orion baseline however no firm plans currently exist for the Apollo Altitude Chambers.

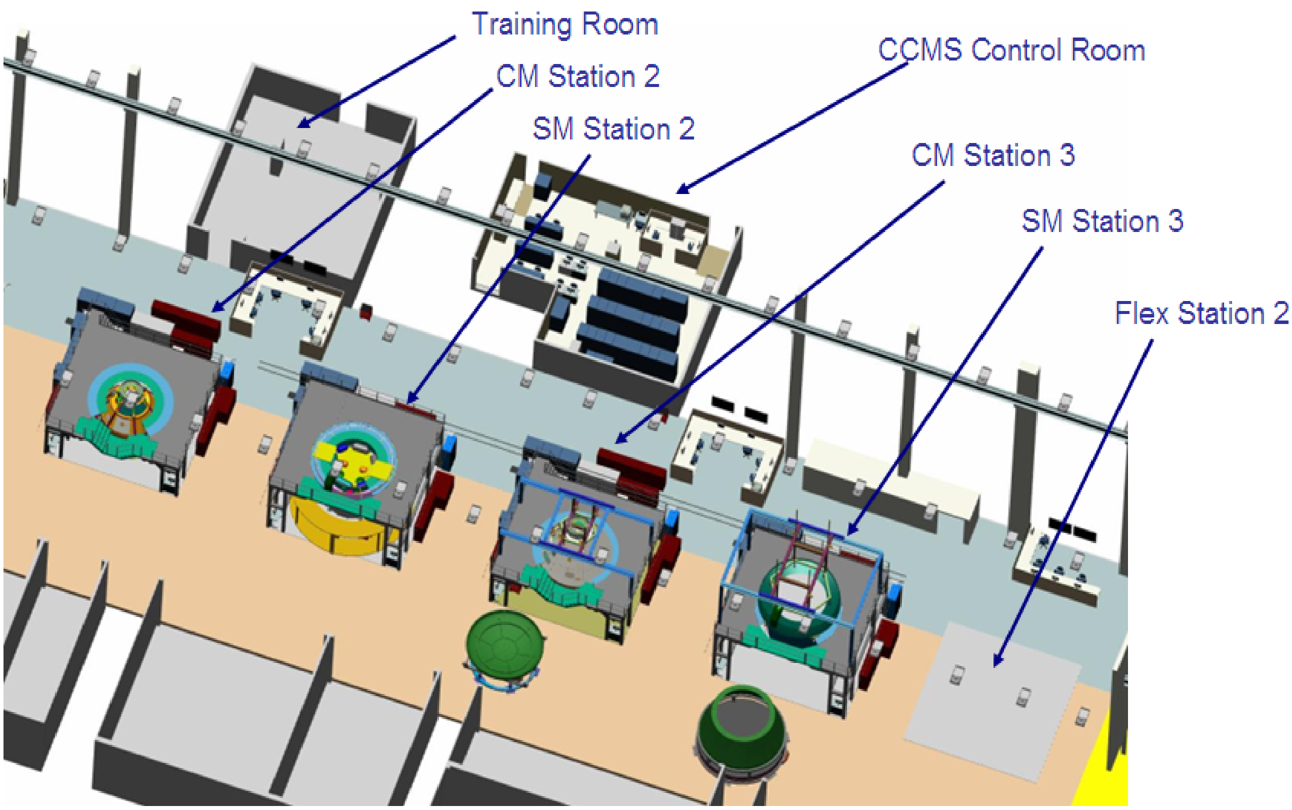

Figure 5: Detailed View of IOZ Center

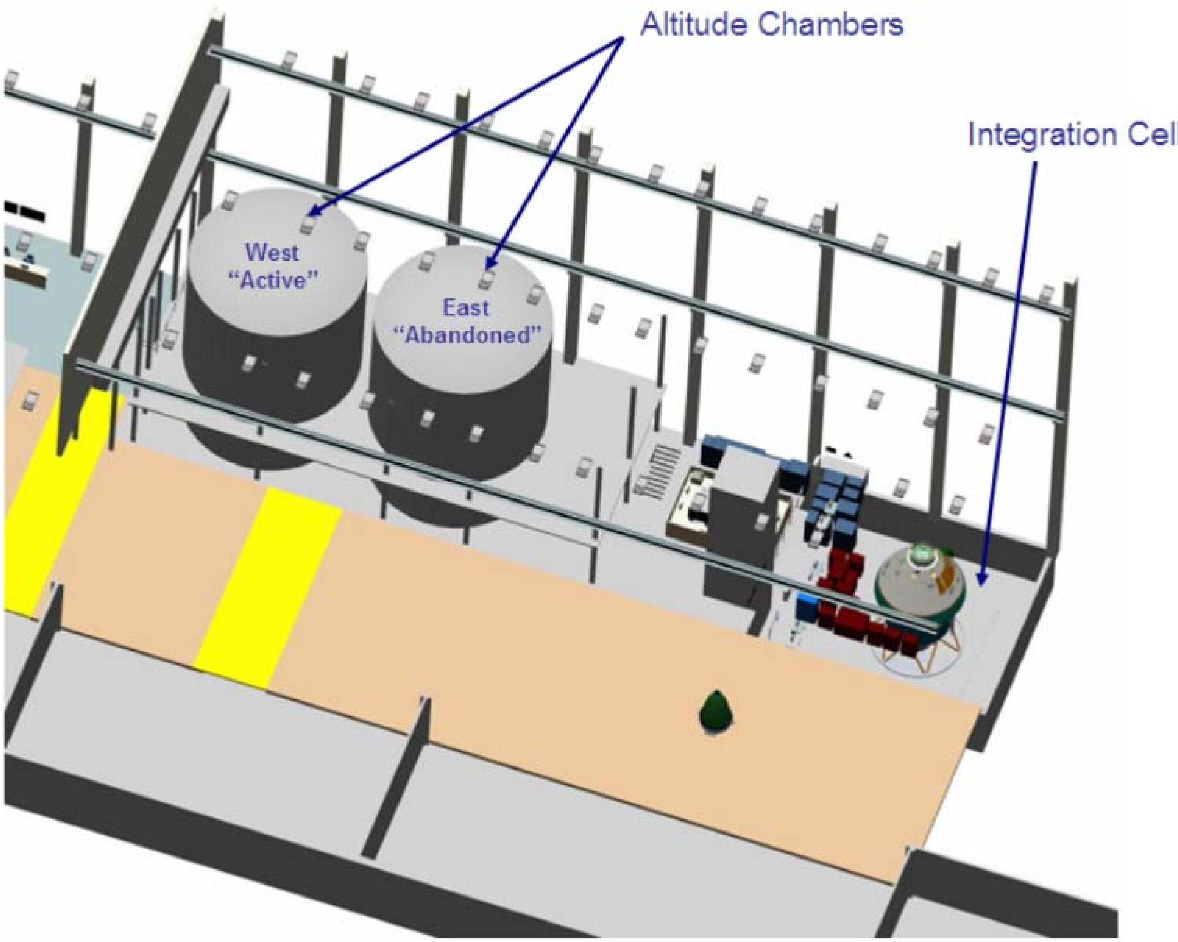

Figure 6: Detailed View of Eastern IOZ

3.1.2.3 Off-Line Processing Areas

Offline Processing Areas are located on the south side of the IOZ and include the following areas: TPS/Chemical Dispensing, Flight Inventory, Receiving and Inspection, Tooling and Bulk Inventory, Tool Crib, and Vendor Areas.

3.1.2.3.1 TPS/Chemical Dispensing Area

The TPS/Chemical Dispensing Area is located in Room 1461. The primary function of the TPS/Chemical Dispensing Area is the safe storage and dispensing of commodities utilized during the day to day production operations at the O&C.

3.1.2.3.2 Flight Inventory Area

The Flight Inventory Area is located in Room 1480. The primary function of the Flight Inventory Area is the storage of flight hardware items used in the assembly and integration of the spacecraft. Hardware to be installed on the vehicle will be kitted in Flight Inventory Area. To optimize manufacturing operations, when possible hardware will be stored as kitted items in the Flight Inventory Area prior to delivery at the appropriate manufacturing station.

3.1.2.3.3 Receiving and Inspection Area

The Receiving and Inspection Area is located in Room 1469. The Receiving and Inspection Area also includes the Material Review Board (MRB) Crib, Flight Inventory Area and the Tooling and Bulk Storage Area. The primary function of the Receiving and Inspection Area is to provide a dedicated area to receive and inspect material that arrives at the IOZ. The function of the MRB Crib is to provide a separate storage for material that is awaiting MRB disposition. The Flight Inventory Stores area in Room 1469 serves as an overflow Flight Inventory Area. The purpose of the Tooling and Bulk Inventory Area is to store tooling items such as lifting fixtures and test stands.

3.1.2.3.4 Tool Crib

The Tool Crib, Room 1463, is the largest material storage area in the O&C and it is the responsibility of Inventory Control. The crib will be managed by LMSSC personnel; however, the daily operations shall be performed by United Space Alliance personnel. The flight hardware material storage area will be managed and run in the same manner. Kits will be initiated from “Pick Lists’ as soon as material starts to arrive. Other than large components, all material will be stored in kits, ready for shop floor delivery. The Tool Crib shall also create kits of commonly used consumables for inclusion with the manufacturing kits. The tool crib consumables area is for storage, inventory and distribution of consumable items such as drill bits, rags and batteries.

3.1.2.3.5 Vendor Areas

The Vendor Areas, Room 1449, in the south west corner of the IOZ are reserved for Vendor Subsystem Set-up and Check-Out. The room will be a certified Class 100,000 CWA and will be supplied with utility suites. The primary users of this area are Hamilton Sundstrand for the ECLSS Subsystem, Honeywell for Avionics, and Aerojet for Propulsion.

3.1.2.3.6 Training Room

As the name implies the Training Room is primarily utilized for training of AI&P personnel. Located in Room 1263 the Training Room contains a large wall display, desks, tables, chairs and computers. To facilitate training, a connection to the Lockheed Martin Intranet (LMI) will be available in the room.

3.1.2.3.7 Control Room

The Control Room located in Room 1255 will provide the centralized command and control interface and monitoring capability to the spacecraft during testing. The Control Room will house the Command Control and Monitor Systems (CCMS) for Station 2, Station 3 and the Integration Cell. The Control Center will contain operator control consoles, test conductor consoles and monitor consoles. Network connectivity, motion imagery, and a voice communications capability to the unit under test (UUT) will be provided in the Control Center.

3.1.2.3.8 Server Room

The Server Room located in Room 1460 is the demarcation point for the IOZ intranet to the LMI. LMI is required to support the Training Room activities and infrastructure of the AI&P organization at KSC.

3.1.2.3.9 Proof Test Cell

The Proof Test Cell area, Room 1486, is utilized for providing final proof testing of subsystems (i.e. propellant, ELCSS, high pressure gas systems, etc.) on the CM and SM spacecraft. Proof test activities are primarily conducted between Station 1 and Station 2 buildup activities. Out of sequence proof testing may occur whenever high pressure tubing, valves, or tanks are replaced or modified in the spacecraft flow through the manufacturing process. Specific details regarding the Proof Test Cell pressure and volume capabilities are presented in the Special Structural (Section 3.10) of this document.

3.1.2.3.10 Proof Test Cell Control Room

The Proof Test Cell Control Room, Room 1493, contains the necessary GSE and equipment to control and monitor proof test activities in the adjacent proof test cell. Physical interfaces to the proof test cell are though the blast wall.

3.1.2.3.11 Miscellaneous Off-Line Areas

In addition to the areas described, numerous corridors, break rooms, office areas, mechanical, electrical, and conference rooms exist in the offline processing areas. Infrastructure required to support these areas includes phone, Heating Ventilation and Air-Conditioning (HVAC), and connectivity will be addressed in this document.

3.1.2.4 Basement Area

3.1.2.4.1 Basement Area

The Basement Area, Room 0108, runs the entire length of the Low Bay and High Bay. It is situated on the North side of the Low and High Bays. The roof structure of the Basement Area is welded steel plate and serves as the floor for those areas of the Low and High Bay that are over the basement. Both Altitude Chambers are mounted to the Basement floor. The basement level of the Integration Cell, Room 0100, is where tooling will be staged during erection operations in the Integration Cell. Numerous facilities systems are routed through the basement and mounted in cable trays. GSE may be stored in the basement area and in some cases be operated in the basement. No GSE will be operated in the basement without first obtaining approval for its use by NASA, LM and all authorities having jurisdiction.

3.1.3 FACILITY SYSTEM DESCRIPTIONS

The following section is intended to be an overview and provides a narrative description of the function and purpose of the various facility systems. Specific details as well as requirements will be provided in subsequent sections of Section 3.

3.1.3.1 Electrical System

The electrical power system in the IOZ provides the interface from commercial power to facility systems and technical power. Facility power typically includes lighting, HVAC and general use receptacles. Technical power provides uninterruptible power to the tooling and support equipment that directly supports spacecraft operations. The electrical power system includes all wiring, power distribution and conditioning throughout the facility.

3.1.3.2 Ground System

The ground system is composed of two distinct systems, the facility ground and the technical ground. The facility grounding system provides protection to hardware and personnel by providing a current primary path to ground to prevent shorts from passing through electrical equipment or personnel. The primary purpose of the technical, also known as static ground, system is to reduce the likelihood of electro-magnetic interference (EMI).

3.1.3.3 Fluid System

Fluid systems provide gaseous nitrogen supply and vent, gaseous helium supply and vent, and chilled water to support spacecraft operations. These fluid commodities are provided in the utility suites. Gaseous nitrogen is utilized primarily for proof/leak checks and purges. Gaseous helium is primarily utilized for proof and leak checks. Chilled water is utilized by ground cooling carts and heat exchangers.

3.1.3.4 HVAC System

The HVAC System function provides heating, cooling, humidity control, filtration, and particulate count for the IOZ. The HVAC System is the critical link in maintaining the CWA environment in the assembly, integration, and production areas of the IOZ.

3.1.3.5 Debris Vacuum System

The Debris Vacuum System function is to provide a central vacuum capability for debris cleanup. The debris vacuum connection points are located in the utility suites.

3.1.3.6 Material Handling System

The Material Handling System consists of overhead cranes, hoists, and lifts utilized to move flight hardware, GSE, and other materials in the IOZ. Two existing cranes will remain in place but will not be certified for flight hardware operations. These cranes will be reserved for future use in the facility following upgrades or other refurbishment to bring them up to current standards.

3.1.3.7 Compressed Air System

The Compressed Air System is utilized to drive air powered GSE such as boost pumps and air bearing pallets. Filtered service outlets are located in utility suites and at service outlets throughout the facility.

3.2 HAZARD IDENTIFICATION

The Hazard Identification section identifies, classifies, and quantifies the various hazardous materials, chemicals, and energetics to be present in the O&C facility during the component, module, and vehicle level verification procedures. The following classes of hazards will be identified: Propellants, Vents, Purges, Pressurized Gases, Maximum Fuel/Oxidizer Propellants Quantities, Ordnance, Electrical Energy, Acoustic Energy (Noise), Radio Frequency (RF) Radiation Levels, and Batteries.

Prior to performing any hazardous operations LM will perform a safety assessment to identify potentially hazardous operations. One aspect of this is to indentify the effects of hazardous operations and their impacts to areas outside the IOZ. LM will follow the NASA Hazard Analysis Process and will comply with the Ground Systems Safety Analysis process DRD-S-005000.

3.2.1 Types of Propellants

The IOZ Facility Baseline does not currently include provisions for any spacecraft propellants. Crew Modules which have been processed, flown and designated for refurbishment, within the IOZ will not contain residual quantities of hypergolic propellants. The IOZ is not sited by KSC NASA or equipped to handle hypergolic liquids or residuals (only vapor levels < 10 parts per billion (ppb)). No other spacecraft propellants including solid rocket motors, monopropellants, or bipropellants are permitted or will be present in the IOZ.

3.2.2 Types of Vents

A vent for gasses (GN_2 and GHe) will be provided in each utility suite. The vent will interface to the facility vent manifold which discharges outside the IOZ and above the roof line. Gaseous Oxygen (GOx) will be utilized to perform checkout of the ECLSS systems. No dedicated utility suite vents are provided for GOx venting. A GOx vent will be provided in the Vendor Area. Controlled venting of limited amounts of GOx will performed within the IOZ.

3.2.3 Types of Purges

Argon gas will utilized as a weld purge gas and will be provided by dedicated bottles and is not part of the facility. GN_2 and GHe will be provided in each utility suite as purge gases. GN_2 will be the primary purge gas and will be utilized for tube, tank, and connector purges. GHe will primarily be utilized in the Proof Test Cell as a purge gas to remove argon gas used in the welding process prior to leak checks.

3.2.4 Pressurized Gases

GN_2 and GHe will be provided in each utility suite. GN_2 and GHe will be optimally supplied by the facility at 3000 pounds per square inch gauge (PSIG) maximum operating pressure (MOP) with the potential to increase to 6000 PSIG for future growth. A Mechanical Ground Support Equipment (MGSE) boost pump will be utilized in the proof pressure cell to increase GN2 and GHe pressure to 6000 PSIG for proof testing. A pass through will also be provided on the proof test cell south wall for an external high pressure supply for proof testing. Gaseous Oxygen will not be supplied by the facility. MGSE will supply GOx for ECLSS testing with portable bottles at 2500 Pounds per Square Inch (PSI).

3.2.5 Maximum Fuel/Oxidizer Propellent Quantities

The IOZ Facility Baseline does not currently include provisions for any spacecraft propellants. Crew Modules which have been processed, flown and designated for refurbishment, within the IOZ will not contain residual quantities of Hydrazine (N2H4). The IOZ is not cited by KSC NASA or equipped to handle hypergolic liquids or residuals (only vapor levels < 10 ppb).

3.2.6 Ordnance

Ordnance will be installed in the Orion Spacecraft during the AI&P flow. Examples of Ordnance that will be installed are NASA Standard Initiators (NSI) devices, Detonation Booster Assemblies (DBA) and Flexible Confined Detonation Cord (FCDC). The IOZ Facility will not include provisions for storage of Ordnance. Ordnance will be stored offsite and delivered to the point-of-use just prior to installation in the spacecraft. Transportation and handling of all ordnance will be strictly controlled and in accordance with Kennedy Space Center Practices Procedural Requirements, KNPR 8715.3 and LM Common Integrated Processes (CIPS) Packaging, Handling, Storage and Transportation Guidebook, 2.3.6-T1-ProdProt-1.0-G. Installation of these devices in the IOZ will conform to NASA Safety Standards for Explosives, Propellants, and Pyrotechnics, NSS/GO 1740.12 as well as LM controlled LM CIPS Test Engineering Guidebook, 2.3.8.1-T1-test-1.1-G. Per these applicable guidelines, The IOZ will require a KSC NASA Ordnance License prior to receiving, processing, performing any ordnance operations.

3.2.7 Power Voltages and Frequencies

Numerous hazardous voltages including 120 Volts Alternating Current (VAC), 120/208 VAC, 208 VAC and 480 VAC are present in the IOZ. Hazardous voltages are defined by MIL-HDBK-454B as between 70 and 500 VAC. These voltages are required to supply facility power to GSE, HVAC, facility lighting, and Uninterruptible Power Supplies (UPS) used to supply technical power. The utility power grid provides dual medium voltage feeds, 13.2 KVAC, in the O&C substation located in a dedicated electrical room in the IOZ. The substation is provided with a tie breaker which will maintain 100% facility functionality should one of the utility power grid feeds be lost. The substation is a double ended unit with a dual transformer which can support the entire facility with a single end. The IOZ Electrical System will comply with National Fire Prevention Act (NFPA) 70, more commonly called the National Electric Code (NEC). The maximum voltage present within the IOZ manufacturing area is 480V at 60Hz.

3.2.8 Noise Levels

Spacecraft processing in the IOZ will include operations, such as high pressure venting, that may generate noise in excess of 80dBA. LM Environmental Safety and Health (ESH) will limit exposures to sound pressure levels equal to or greater than 80dBA in accordance with the IOZ Environmental, Safety and Health Plan and LMSSC CIPS Media covering Hearing Protection.

3.2.9 RF Radiation Levels

No open loop RF Testing will be permitted in the IOZ.

3.2.10 Spacecraft Batteries

Lithium Ion flight batteries will be installed in the spacecraft as part of the AI&P process. The primary hazards associated with Li Ion batteries in the IOZ will be due to overcharging and shorting. Overcharge conditions can cause over-pressure conditions inside the cell leading to smoke and flame if the gases are not vented benignly. If charging needs to occur, the battery will need to be transported to a more capable facility where SOC balancing may be conducted. External and internal shorts in Lithium Ion cells can result in venting and explosions. High temperature conditions can also cause similar results as internally shorted batteries resulting in venting, fire, smoke and thermal runaway.

3.2.11 Pressurized Components

During the normal AI&P flow spacecraft tanks, valves, and tubing will be pressurized in the IOZ. Proof testing will take place in the Proof Pressure Cell and will consist of pressurizing tanks, including Composite Overwrap Pressure Vessels (COPV), valves, and associated tubing/piping to a specified overpressure to verify the integrity of the system. During system testing of the spacecraft pressurized components may be charged to allow realistic test like you fly scenarios.

3.2.12 Refrigerants

The IOZ Facility Baseline does not currently include provisions for ammonia utilized as a refrigerant by the CM. Crew Modules which have been processed, flown and designated for refurbishment, within the IOZ will not contain residual quantities of ammonia. The IOZ is not cited by KSC NASA or equipped to handle ammonia (only vapor levels < 20 parts per million (ppm)).

3.3 ENVIRONMENTAL REQUIREMENTS

Environmental requirements include HVAC load, temperature, humidity, filtration, pressure, and particulate count for the various work areas within the facility. For clarity, physical locations in the IOZ having the same environmental requirements have been grouped. Environmental grouping includes computer room areas, basement areas, clean work areas, and the airlock area.

3.3.1 Computer Room

Computer Room Areas include the CCMS Control Room (Room 1255), Server Room (Room 1460) and the Training Room (Room 1263). Figure 7 provides a notional view of the CCMS Control Room Layout.

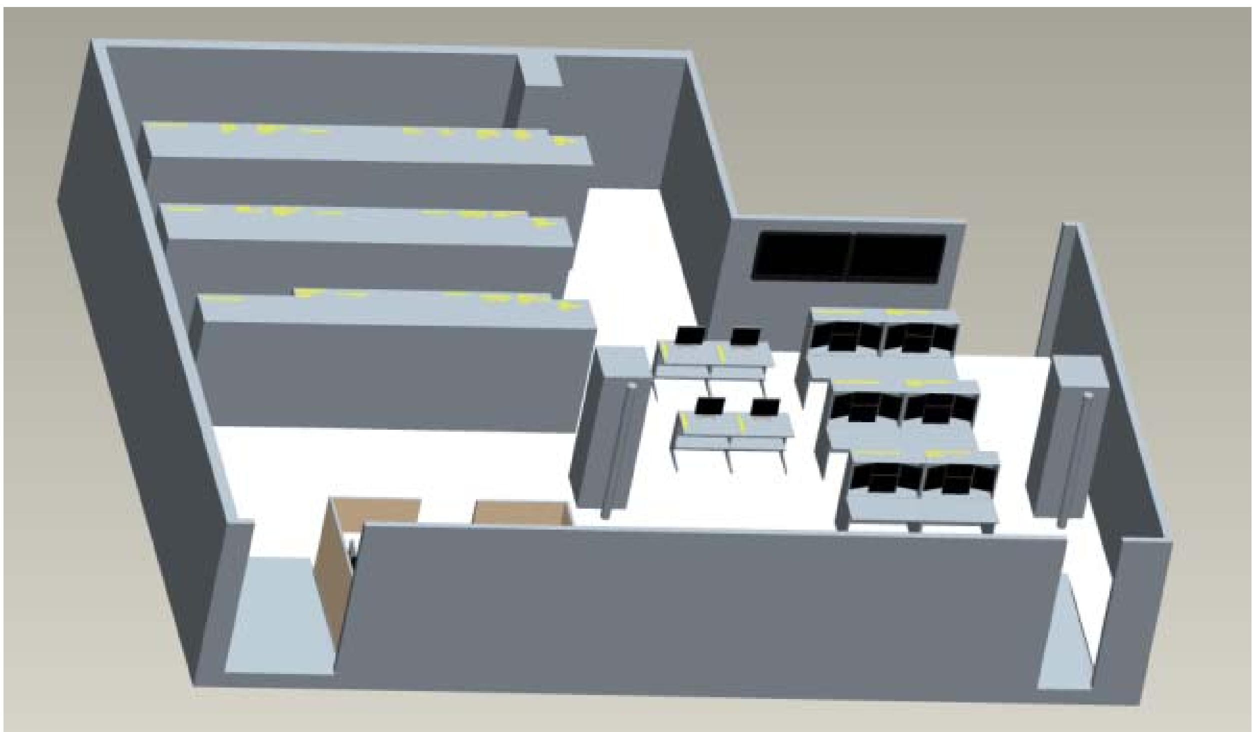

Figure 7: CCMS Control Room

3.3.1.1 Computer Room air conditioning system shall be independent to the CWA system.

<u>Rationale</u>: *To maintain environmental requirements Control Room, Server Room and Training Rooms needs to have dedicated unit.*

3.3.1.2 Computer Room air conditioning system shall maintain temperature at 71° F ± 6°F.

Rationale: Temperature must be maintained for proper CCMS operation.

3.3.1.3 CCMS Control Room air conditioning system shall maintain relative humidity at 35% ≤ RH ≤ 60%.

Rationale: Relative Humidity (RH) must be maintained to prevent condensation and minimize potential ESD effects.

3.3.1.4 CCMS Control Room air conditioning system shall provide filtration at MERV 11 (ASHRAE 52, 60-65%).

Rationale: Filtration must be provided to maintain cleanliness.

3.3.1.5 Server and Training Room air conditioning system shall maintain relative humidity at 30% ≤ RH ≤ 60%.

Rationale: Relative Humidity (RH) must be maintained to prevent condensation and minimize potential ESD effects.

3.3.1.6 Server and Training Room air conditioning system shall provide filtration at MERV 11 (ASHRAE 52, 60-65%).

Rationale: Filtration must be provided to maintain cleanliness.

3.3.1.7 Computer Room air conditioning system pressure shall be less than the CWA and greater than adjacent spaces.

Rationale: Pressures less than CWA ensures no contamination towards CWA; Pressure greater than adjacent spaces prevents contamination to Computer Room Area.

3.3.1.8 CCMS Control Room doors shall automatically close and seal when closed.

Rationale: Necessary to maintain environmental requirements.

3.3.1.9 CCMS Control Room air conditioner shall be sized for a 154KBTU/HR equipment cooling load and 15 people within space.

Rationale: Air Conditioner sizing must be adequate to support CCMS.

3.3.1.10 Server Room air conditioner shall be sized for a 50KBTU/HR equipment cooling load.

Rationale: Air Conditioner sizing must be adequate to support Server Racks.

3.3.2 Basement Areas

Basement Areas include the Lower Integration Cell (Room 0100), East and West Basement Areas (Room 0108).

3.3.2.1 The air conditioning system shall maintain a temperature at 71° F ± 6°F in the Basement.

Rationale: Temperature must be maintained in line with ORION Contamination Control Plan.

3.3.2.2 The air conditioning system shall maintain a relative humidity at 35% ≤ RH ≤ 60% in the Basement.

Rationale: Relative Humidity must be maintained to prevent condensation and minimize potential ESD effects.

3.3.2.3 The air conditioning system shall provide filtration at MERV 16 (ASHRAE 52, 90-95%) in the Basement.

Rationale: Filtration must be provided to maintain cleanliness.

3.3.2.4 The air conditioning system pressure shall be 0.05 in-H_2O (adjustable) in the Basement.

Rationale: Must maintain proper pressure balance to prevent contamination.

3.3.3 Clean Work Area (CWA) Requirements

CWA includes High and Low Bay Area (Room 1400), Personnel Preparation Area (Room 1456), Receiving and Inspection Area (Room 1469), Flight Inventory Area (Room 1480), Proof Test Cell (Room 1486), TPS/Chemical Dispensing Area (Room 1461).

3.3.3.1 The air conditioning system shall maintain a temperature at 71° F ± 6°F in the CWA.

Rationale: Temperature must be maintained in line with ORION Contamination Control Plan.

3.3.3.2 The air conditioning system shall maintain a relative humidity at 35% ≤ RH ≤ 60% in the CWA.

Rationale: Relative Humidity must be maintained to prevent condensation and minimize potential ESD effects as specified in the ORION Contamination Control Plan.

3.3.3.3 The air conditioning system shall provide filtration at HEPA MERV 18 (99.99%; non-DOP tested HEPA filters; Dioctylphthalate) in the CWA.

Rationale: Filtration must be provided to maintain CWA.

3.3.3.4 The air conditioning system pressure shall be 0.05 in-H_2O (adjustable) in the CWA, including all spaces connected to clean work area.

Rationale: Must maintain proper pressure balance to prevent contamination.

3.3.3.5 The air conditioner shall accommodate a maximum of 2 air changes per hour in the CWA.

Rationale: Necessary to maintain CWA environment.

3.3.3.6 The air conditioner shall maintain a particulate count per ISO 14644-1 Class 8 (as-built, at rest, operational) in the CWA

Rationale: Necessary to maintain CWA environment.

3.3.3.7 CWA air conditioner Cleanliness shall be Certified by an independent third party.

Rationale: Independent evaluation ensures compliance with requirements.

3.3.3.8 CWA air conditioner shall be sized for a 50KBTU/HR equipment cooling load from the CCMS Front End Hardware.

Rationale: Air Conditioner sizing must take in to account CCMS Front End Loading.

3.3.3.9 CWA air conditioner shall be sized for one person per 300 square feet.

Rationale: Air Conditioner sizing must take in to account personnel. 300 square foot estimate is based on 300 persons.

3.3.3.10 Receiving and Inspection Room shall be equipped with door that can be closed when exterior doors are open.

Rationale: Receiving and Inspection environmental requirements are the same as for the CWA. Interior door shall remain closed when exterior doors are opened. Environmental excursions are allowed when the exterior doors are opened.

3.3.4 Airlock Area Requirements

The Airlock Area, Room 1492, includes the West end of the Low Bay Area that is walled off from the CWA proper,

3.3.4.1 The air conditioning system shall maintain a temperature at 71° F ± 6°F in the Airlock.

Rationale: Temperature must be maintained in line with ORION Contamination Control Plan.

3.3.4.2 The air conditioning system shall maintain a relative humidity at 35% ≤ RH ≤ 60% in the Airlock.

Rationale: Relative Humidity must be maintained to prevent condensation and minimize potential ESD effects in line with the ORION Contamination Control Plan.

3.3.4.3 The air conditioning system shall provide filtration at HEPA MERV 18 Non-DOP tested ISO 14644-1 Class 5 delivered at HEPA filters in the Airlock Area.

Rationale: Filtration must be provided to maintain CWA.

3.3.4.4 The air conditioning system pressure shall be less than remainder of low bay and greater than ambient within the Airlock during vehicle refurbishment mode of operation.

Rationale: Must maintain proper pressure balance to prevent contamination.

3.3.4.5 The air conditioning system pressure shall be 0.05 in-H_2O (adjustable) within the Airlock during airlock mode of operation.

Rationale: *Must maintain proper pressure balance to prevent contamination.*

3.3.4.6 The air conditioner shall accommodate a maximum of 2 air changes per hour in the Airlock.

Rationale: *Necessary to maintain CWA environment.*

3.3.4.7 The air conditioner shall maintain a particulate count per ISO 14644-1 Class 8 (as-built, at rest, operational) in the Airlock

Rationale: *Necessary to maintain CWA environment.*

3.4 ENVIRONMENTAL POLLUTION CONTROL

To ensure compliance to federal, state, and local environmental laws and regulations, all KSC organizational elements including tenant organizations, such as LM at the O&C, will comply with the IOZ Environmental, Safety and Health Plan and NASA KSC Environmental Pollution Control requirements. NASA KNPR 8500.1 Revision A details responsibilities of the KSC Environmental Program Branch and other organizational elements. To ensure compliance, routine inspections of facilities or operations are performed by the facility manager or qualified operational personnel. Requirements for routine inspections and recordkeeping are specified in these regulations. Examples of required routine inspections include weekly inspection of secondary containment for storage tanks and weekly inspections of hazardous waste storage facilities.

3.4.1 Facility, Waste Material Disposal

3.4.1.1 The IOZ waste material management shall follow the IOZ Environmental, Safety and Health Plan as well as the KSC Environmental Policy Requirements a set forth in KSC KNPR 8500.1 Revision A.

Rationale: *IOZ is located on KSC Property, KSC Policy directs LM follow existing KSC Waste Management Policy.*

3.4.1.2 LM Environmental Safety and Health (ESH) shall implement a process for weekly internal inspections.

Rationale: *Internal inspections ensure readiness for compliance inspections by KSC Environmental Program Branch (EPB).*

3.5 POWER, GROUNDING, AND LIGHTING

The IOZ facility's electrical power, grounding, and lighting systems requirements are specified in the following sections. Special or unique system requirements are detailed in specific sub-sections appropriate for each system.

3.5.1 Power

The power requirements and electrical systems definition for the O&C facility are contained within the following sections. This portion of the document identifies requirements for power classifications and specifies the power distribution requirements for the secondary and uninterruptible power subsystems.

3.5.1.1 Facility Power Source

3.5.1.1.1 Facility power shall be provided directly from the utility source.

Rationale: No local generated power available at KSC.

3.5.1.1.2 The Primary power system to the O&C substation shall consist of 13.2KV, 3 phase, 3 wire 60 Hz service provided from the base power grid.

Rationale: IOZ must be compatible with Utility Grid.

3.5.1.1.3 The primary power system to the IOZ shall be independent of other O&C areas.

Rationale: IOZ area is independent facility and required dedicated power source.

3.5.1.1.4 A failure of one of the primary power system shall not cause the building to lose its HVAC pressurization criteria.

Rationale: Tie Breaker will switch during loss of a single power supply feed to the IOZ maintaining power to all HVAC units.

3.5.1.1.5 The nominal facility power voltage level shall be maintained to ±5%.

Rationale: Maximum acceptable power fluctuation.

3.5.1.2 CM and SM Manufacturing Stations

3.5.1.2.1 Three phase, 480V, 100 A, 5 wire receptacle shall be provided to the CM and SM test stations.

Rationale: 480V Facility Power for UPS.

3.5.1.2.2 Three phase, 208V, 100 A, 4 wire receptacle shall be provide to the CM and SM test stations.

Rationale: 208V Facility Power for GSE.

3.5.1.2.3 Three phase, 120/208V, 100A, 5 wire receptacle shall be provided to the CM and SM test stations.

Rationale: 120/208V Facility Power for GSE.

3.5.1.2.4 Three phase, 120/208 50A, 5 wire receptacle shall be provided to the CM and SM test stations.

Rationale: 120/208V Facility Power for GSE.

3.5.1.3 Integration Cell

3.5.1.3.1 Three phase, 480V, 100 A, 5 wire receptacle shall be provided to the Integration Cell.

Rationale: 480V Facility Power for UPS.

3.5.1.3.2 Three phase, 208V, 100 A, 4 wire receptacle shall be provide to the Integration Cell.

<u>Rationale</u>: 208V Facility Power for GSE.

3.5.1.3.3 Three phase, 120/208V, 100A, 5 wire receptacle shall be provided to the Integration Cell.

<u>Rationale</u>: 120/208V Facility Power for GSE.

3.5.1.3.4 Three phase, 120/208 50A, 5 wire receptacle shall be provided to the Integration Cell.

<u>Rationale</u>: 120/208V Facility Power for GSE

3.5.1.4 Proof Pressure Cell

3.5.1.4.1 Technical power to the proof pressure cell will be via the proof pressure control room.

<u>Rationale</u>: Control room will be primary interface to test cell.

3.5.1.4.2 Three phase 480V, 100A, 60 Hz shall be provided to the Proof Pressure Cell Control room.

<u>Rationale</u>: 480V Facility Power for GSE.

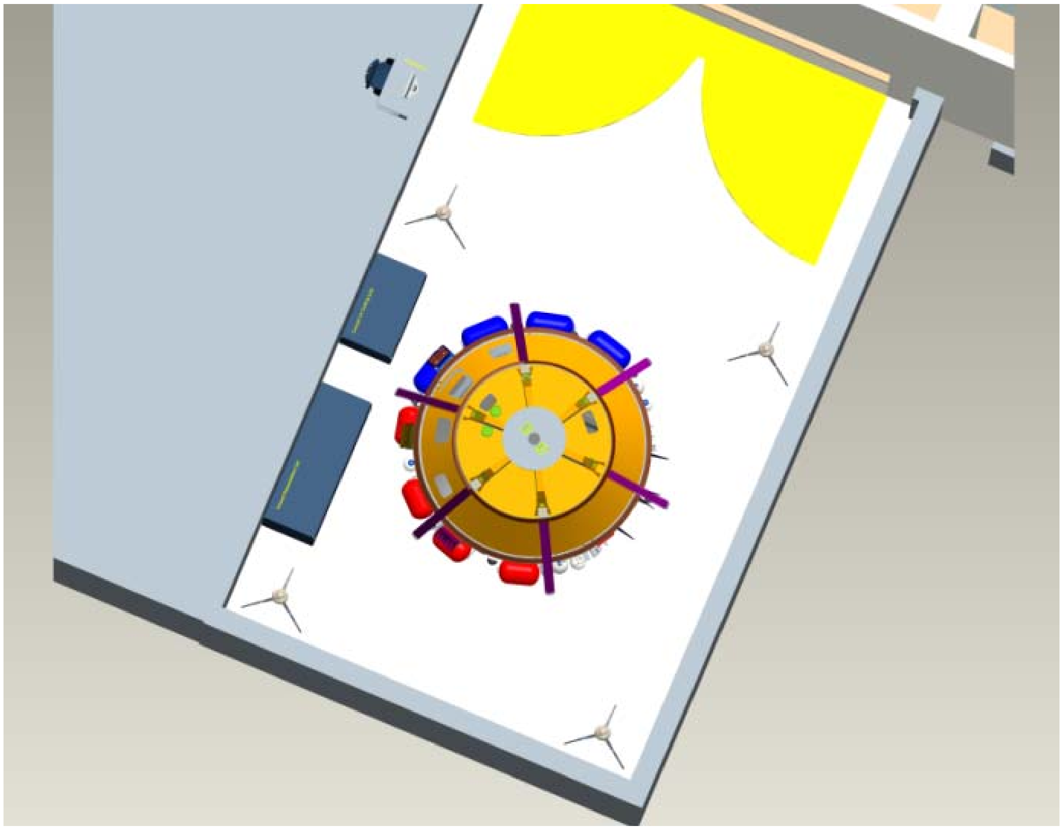

Figure 8: Notional View of Proof Pressure Cell

3.5.1.4.3 Three phase 120/208V, 30A 5 wire technical power with load center shall feed the Proof Pressure Cell and Control room outlets.

Rationale: 120/208V Facility Power for GSE.

3.5.1.4.4 Three phase 120/208V, 100A, 60Hz shall be provided to the Proof Pressure Cell Control room.

Rationale: 120/208V Facility Power for GSE.

3.5.1.5 CCMS Control Room

3.5.1.5.1 Three phase 480 VAC, 225A, 60 Hz Service disconnect shall be provided to the CCMS control room.

Rationale: 480V Facility Power for UPS.

3.5.1.6 TPS/Chemical Dispensing Room

3.5.1.6.1 Two 120V, 20A, 4-cluster convenience outlets shall be provided to the TPS/Chemical Dispensing Room.

Rationale: 120V Facility Power for TPS/Chemical dispensing equipment.

3.5.1.6.2 TPS/Chemical Dispensing Room convenience outlets shall be located approximately 20 feet apart on the west wall.

Rationale: 120V Facility Power for TPS/Chemical Dispensing equipment

3.5.1.7 O&C Power Classification Usage

3.5.1.7.1 Perimeter lighting shall be powered by Facility power.

Rationale: Critical and emergency lighting will be provided by battery and generator backup supplied systems upon loss of perimeter lighting.

3.5.1.7.2 IOZ Server Room communications racks shall be powered by Technical Power provided by the Facility.

Rationale: Integrity of critical test data needs to be maintained during power failures or other outages.

3.5.1.7.3 Electronic Security system shall be powered by Technical Power provided by existing O&C Building system UPS outside the IOZ.

Rationale: Required during outages for security monitoring.

3.5.1.7.4 Building High and Low Bay Emergency Lighting shall be powered by Facility power with generator backup.

Rationale: During Facility Power outages High and Low Bay are critical area that needs additional lighting due to height. This requirement is in addition to standard battery backup emergency lighting per SDR 3.5.3.2.2.

3.5.1.7.5 General Purpose Receptacles shall be powered by Facility power.

Rationale: General use receptacles will not be used for critical hardware and do not require Technical Power.

3.5.1.7.6 Communications shall be powered by Technical Power provided by existing O&C Building system UPS outside the IOZ.

Rationale: Communications required during outages for safety and security reasons.

3.5.1.7.7 Utility Suite receptacles used to energize GSE shall be powered by Technical Power.

Rationale: GSE specifications states GSE that interfaces to flight hardware must be on UPS/Technical power.

3.5.1.7.8 Receptacles or panels used to energize CCMS hardware shall be powered by Technical Power.

Rationale: GSE specifications states GSE that interfaces to flight hardware must be on UPS/Technical power.

3.5.1.8 Power Systems

3.5.1.8.1 The secondary power distribution system shall consist of a 480/277VAC, 3Φ, 60 Hz system.

Rationale: Secondary power distribution requires compatibility with Primary capability.

3.5.1.8.2 Secondary power shall be distributed to the various building load centers for distribution as 480VAC or reduced through transformers for lower voltage usage.

Rationale: Secondary power distribution required at same locations and voltages as Primary power distribution.

3.5.1.8.3 Secondary power shall be distributed from the O&C site substation locations.

Rationale: Secondary power distributed from same location as Primary.

3.5.1.9 Uninterruptible Power Systems

3.5.1.9.1 Technical power shall be provided with the addition of Uninterruptible Power Supplies (UPS).

Rationale: UPS support required to critical circuits, systems, GSE, and power distribution to spacecraft.

3.5.1.9.2 The UPS shall be fed by facility power with a minimum full load battery backup time of 15 minutes.

Rationale: Minimal time required to safely perform controlled shutdown of GSE, spacecraft, and IOZ from test.

3.5.1.9.3 The UPS shall also contain a separately powered static bypass switch, which will transfer the UPS output load to an alternate power feed if the UPS unit should fail.

Rationale: Automatic switchover required to maintain power to critical circuits.

3.5.1.9.4 UPS output power shall be continuous throughout specified period of backup usage.

Rationale: UPS output power must be maintained for period of backup usage (15 minutes minimum) regardless of UPS input conditions.

3.5.1.9.5 Technical UPS Power nominal voltage tolerance shall be ±5%.

Rationale: Maximum acceptable power fluctuation.

3.5.1.9.6 Technical UPS Power nominal frequency tolerance shall be ±1 Hz.

Rationale: Maximum acceptable frequency tolerance in Hertz (Hz).

3.5.1.9.7 Technical UPS Power total harmonic distortion tolerance shall be < 5%.

Rationale: Maximum acceptable harmonic distortion.

3.5.1.10 General Receptacle Requirements

3.5.1.10.1 Receptacles shall be polarized.

Rationale: National Electric Code (NFPA 70) general requirement to ensure receptacle is designed for application.

3.5.1.10.2 Receptacles shall be of a type suitable for the environment in which they are installed.

Rationale: National Electric Code (NFPA 70) general requirement to ensure receptacle is designed for application.

3.5.1.10.3 It shall not be possible to insert a plug of one voltage rating into a receptacle of another voltage rating.

Rationale: National Electric Code (NFPA 70) general requirement to ensure plug is designed for proper receptacle.

3.5.1.10.4 Each technical power receptacle shall be marked with circuit number and panel number.

Rationale: National Electric Code (NFPA 70) general requirement to properly identify circuit.

3.5.1.10.5 All receptacles, except 120-Volt general-purpose convenience outlets, shall be marked with amperage rating, voltage, frequency characteristics, and panel of origin.

Rationale: National Electric Code (NFPA 70) general requirement to ensure receptacle is properly sized for circuit.

3.5.1.10.6 General purpose, 120-Volt convenience outlets, shall be marked with panel source and circuit number using black lettering and white background per KSC-SPEC-E-0026(A).

Rationale: KSC Specification for Electrical Facilities Installation.

3.5.2 Facility and Technical Grounding and Lightning Protection

The IOZ requirements for facility and technical grounding, lightning protection, bonding, and EMI prevention are delineated within this section.

3.5.2.1 Grounding and Lightning Protection Systems General Requirements

3.5.2.1.1 The grounding and lightning protection systems shall comply with Article 250 of NFPA 70 and NFPA 780 as a minimum.

<u>Rationale</u>: Applicable National Standards are National Electric Code (NFPA 70) Article 250 for grounding and NFPA 780 for Installation of Lightning Protection.

3.5.2.1.2 The grounding systems shall incorporate three separate systems including, Facility ground system, Technical ground system, and Lightning protection system.

<u>Rationale</u>: Requirement separates grounding system into three distinct systems.

3.5.2.1.3 Grounding System Isolation: The technical and facility ground systems shall be isolated from each other except at connection to the single point ground.

<u>Rationale</u>: Requirement specifies isolation between the three distinct systems.

3.5.2.1.4 Grounding System Return Conductors: Ground return conductors shall be a minimum of a #4/0 bare stranded copper conductor and connected to the building ground counterpoise.

<u>Rationale</u>: Requirement specifies minimum conductor size for all grounding systems.

3.5.2.2 Facility Ground System

3.5.2.2.1 Facility Ground System maximum ground counterpoise resistance shall be 5 ohms.

Rationale: Facility specific requirement identifying counterpoise resistance per NFPA Code.

3.5.2.2.2 Facility Ground System maximum electrical bonding resistance between metal facility structural members shall be 1.0 ohm.

Rationale: Facility specific requirement identifying maximum bonding resistance per NFPA Code.

3.5.2.3 Technical Ground System

3.5.2.3.1 Technical Ground System plates shall be identified on the ground plate as "Technical Ground" to distinguish them from the Facility Ground System ground plates.

Rationale: Technical Ground System labeling requirement to eliminate confusion with Facility Ground System.

3.5.2.3.2 The feeders from the Technical Ground System to the various areas shall be electrically isolated from all other grounds except at the single point connection.

Rationale: Technical Ground System isolation requirement per NFPA Code.

3.5.2.3.3 Technical Ground System ground cables shall have 600V type insulation.

Rationale: Technical Ground System insulation requirement per NFPA.

3.5.2.3.4 Technical Ground System ground riser shall be an insulated stranded copper cable routed inside a 2-inch rigid conduit.

Rationale: Technical Ground System conduit requirement.

3.5.2.3.5 The Technical Ground System riser conduit shall stub up 6 inches above the floor with the cable at least 18 inches longer than the conduit.

Rationale: Technical Ground System service loop requirement.

3.5.2.3.6 The Technical Ground shall be isolated from all other facility users.

Rationale: Technical Ground System isolation requirement.

3.5.2.3.7 Technical Ground System ground resistance shall not exceed 1 ohm from the technical ground plate to the earth ground grid.

Rationale: Technical Ground System maximum ground resistance requirement per NFPA Code.

3.5.2.4 Lightning Protection System

3.5.2.4.1 The IOZ facility shall have lightning protection in accordance with NFPA 780 “Standard for the Installation of Lightning Protection Systems, Chapter 4, Protection for Ordinary Structures.

Rationale: Applicable NFPA Standards for Lightning Protection.

3.5.2.5 Bonding

3.5.2.5.1 Grounding System bonding practices utilized shall be in accordance with NFPA 70, Article 250, Section G.

Rationale: National Electric Code specifies bonding practices.

3.5.2.5.2 All bonding and grounding wire shall be insulated or protected above grade.

Rationale: Bonding and grounding wire require protection.

3.5.2.5.3 Bonds, which are located not reasonable accessible for maintenance, shall be sealed with permanent waterproof compound.

Rationale: Bonding and grounding wire require sealing for protection.

3.5.2.5.4 All metal non-current carrying parts of the facility shall be electrically bonded together.

Rationale: National Electric Code (NFPA 70).

3.5.2.5.5 Bonding of ground cables to the counterpoise shall be by exothermic weld.

Rationale: National Electric Code (NFPA 70).

3.5.2.5.6 Ground Plate Bond Resistance shall not exceed 1 milliohm.

Rationale: National Electric Code (NFPA 70).

3.5.2.5.7 Bonds for ground conductors (power circuits, control circuits, signal circuits or lightning protection) shall be 2.5 milliohms or less.

Rationale: National Electric Code (NFPA 70).

3.5.2.6 EMI Prevention

3.5.2.6.1 Conduit installed in the IOZ shall be grounded metallic conduit to provide EMI shielding at the IOZ.

Rationale: National Electric Code (NFPA 70).

3.5.2.6.2 Except for solid conduit shields, shields will be isolated from each other and from any metallic component by at least 1.0 megohms (DC) when shield grounds are lifted.

Rationale: National Electric Code (NFPA 70) isolation specification.

3.5.2.6.3 Solid conduit shields shall not be isolated from each other or from structure.

Rationale: To minimize EMI, conduit may not float.

3.5.3 Facility Lighting

3.5.3.1 Lighting System Design

3.5.3.1.1 Illumination and recommended lighting levels for all areas of the IOZ shall conform to Illumination Engineering Society of North America, Lighting Handbook.

Rationale: Illumination Engineering Society (IES) is Industry Standard for Illumination Levels. Specific level will be defined for each area in the IOZ by area type.

3.5.3.1.2 Lighting in the CWA of the IOZ shall be 35 -50 foot candle 3ft above floor, mid-range correlated color temperature (white light), 3500- 5500 degree Kelvin, color rendering index 65-70 – true color.

Rationale: Based on IES Standards.

3.5.3.2 Emergency Lighting System

3.5.3.2.1 Emergency lighting shall be provided at critical areas to protect personnel and secure operations in the event of power failure in accordance with NFPA 101 and NFPA 70.

Rationale: Emergency Backup Lighting needed for safe egress and facility/GSE/spacecraft securing.

3.5.3.2.2 Emergency lighting units with battery back up shall be used in offline, basement, and stair areas.

Rationale: Emergency Backup Lighting needed for safe egress and facility/GSE/spacecraft securing.

3.6 BACKUP AND CONTINGENCY

3.6.1 Backup Power

3.6.1.1 Any electrical powered system that supports personnel safety shall have back-up power or secure itself in a fail-safe manner.

Rationale: Backup power required or fail-safe securing required for personnel safety.

3.6.1.2 Any electrical powered system that supports flight hardware or GSE that interfaces to flight hardware shall have back-up power.

Rationale: Backup power required to protect flight hardware assets by allowing orderly shutdown of assets and preserving test/vehicle configuration during testing.

3.6.1.3 Backup power with automatic switching shall be provided to the HVAC system.

Rationale: Maintain clean room during loss of primary power feed to O&C.

3.6.1.4 Batteries utilized for all IOZ backup systems shall be rated for human occupancy areas.

Rationale: OSHA, NASA, and LM requirement for personnel safety.

3.6.2 Data Backup

3.6.2.1 Environmental data parameters including temperature and humidity at a minimum shall be continuously monitored and maintained in the event of failure of the primary HVAC monitoring system.

Rationale: Need to capture environmental conditions at all times.

3.7 PLUMBING/VENTING AND COMMODITIES FOR TEST OPERATIONS ACTIVITIES

Plumbing and venting identifies the venting capability requirements for facilities plumbing and vent system. Commodities include pressurized air used for GSE support as well as GHe and GN_2 used for spacecraft processing. Potable water is used for emergency eye wash and showers in the TPS/Chemical Dispensing Area (Room 1461). Also included in the plumbing and venting components are a debris vacuum system, chilled water supply and return, and drain piping. The debris vacuum and chilled water is included in all utility suites with the exception of the vendor support and proof test cell areas.

3.7.1 Venting Requirements

3.7.1.1 The Proof Test Cell (Room 1486) vent shall be rated for 6000 psi maximum initial vent pressure.

Rationale: *Based on maximum facility rated inlet pressure.*

3.7.1.2 The Vendor Support (Room 1449) vent shall be rated for 6000 psi maximum initial vent pressure.

Rationale: *Based on maximum facility rated inlet pressure.*

3.7.1.3 Provide GHe vent for each utility suite to outside of facility above roofline for pneumatic venting.

Rationale: *Utility Suite Vents needed for purges.*

3.7.1.4 Provide GN_2 vent for each utility suite to outside of facility above roofline for pneumatic venting.

Rationale: *Utility Suite Vents needed for purges.*

3.7.2 Commodities

3.7.2.1 Each utility suite shall have access to compressed air system.

<u>Rationale</u>: Needed to drive GSE.

3.7.2.2 Compressed air cleanliness requirements shall meet KSC-C-123 level VC.

<u>Rationale</u>: Based on NASA cleanliness specifications.

3.7.2.3 Each utility suite shall have access to the GHe system.

<u>Rationale</u>: GHe needed for purges and leak checks.

3.7.2.4 GHe system shall provide 3000 psi nominal facility (200 scfm minimum), 6000 psi capability.

<u>Rationale</u>: Pressure and flow sized to accommodate supply requirements. Higher capability piping for future growth, components will be validated to maximum capability.

3.7.2.5 GHe system cleanliness requirements shall meet KSC-C-123 level 300A.

<u>Rationale</u>: Based on NASA cleanliness specifications.

3.7.2.6 Each utility suite shall have access to the GN_2 system.

<u>Rationale</u>: GN_2 needed for purges and leak checks.

3.7.2.7 GN_2 system shall provide 3000 psi nominal facility (200 scfm minimum), 6000 psi capability.

Rationale: Pressure and flow sized to accommodate supply requirements. Higher capability piping for future growth, components will be validated to maximum capability

3.7.2.8 GN_2 system cleanliness requirements shall meet KSC-C-123 level 300A.

Rationale: Based on NASA cleanliness specifications.

3.7.2.9 Provide compressed air service outlets along south IOZ wall sized and spaced to accommodate air bearing pallet operation.

Rationale: South transfer aisle is where air bearing transport will be utilized.

3.7.3 Potable Water

3.7.3.1 Potable water supply shall be provided for fixed eye wash, sinks and emergency showers in TPS/Chemical Dispensing Area.

Rationale: Safety requirement around hazardous chemicals.

3.8 FIRE AND ENVIRONMENTAL PROTECTION

Fire Protection at the IOZ will conform to existing NASA Safety Standard for Fire Protection, NASA-STD-8719.11. This standard is applicable to all NASA Centers and is a compilation of pertinent requirements from the Occupational Safety and Health Administration (OSHA), National Fire Protection Association (NFPA), and unique NASA requirements. As documented in the Standard, compliance with this standard is mandatory for all NASA owned and/or occupied facilities, both new and existing. The IOZ refurbishment effort is unique in that it is located in an existing NASA facility that interfaces to existing infrastructure. Therefore requirements are limited and primarily consist of ensuring that the IOZ conforms with the latest NASA and NFPA codes, and is capable of interfacing to the existing infrastructure.

The IOZ will follow existing environmental LMSS media as well as local KSC requirements for the protection of the environment as required by KNPR 8500.1.

3.8.1 Facility Fire Detection

3.8.1.1 The IOZ fire detection and alarm system shall interface to existing KSC Central Fire Alarm System.

Rationale: NASA Standards for alarm notification identified in NASA-STD-8719.11.

3.8.1.2 The fire alarm system shall have battery backup with battery charger.

Rationale: System needs a battery backup to function during power failures.

3.8.1.3 Unique general fire alarm audio warning devices shall be located throughout the facility for general alarm signal and be distinguishable from other alarms.

Rationale: Personnel need to be able to hear and easily distinguish fire alarm per NASA-STD-8719.11.

3.8.1.4 Manual pull stations shall be located at exit routes.

Rationale: Personnel need way to actuate alarm.

3.8.1.5 Electrical devices shall be rated for the appropriate commodity in the area they are installed in.

Rationale: NFPA 72 requirement.

3.8.1.6 The fire detection and alarm systems shall provide or be tied into existing central interface panels with provision for remote monitor and transmitter for alarm signals to the KSC Central Fire Alarm Systems.

Rationale: NASA Standards for notification per NASA-STD-8719.11.

3.8.1.7 Existing fire detection and alarm system components removed shall be replaced with new components that conform to most current NFPA 72 and NFPA 90A Standards.

Rationale: Fire detection and alarm capabilities will conform to current NFPA Standards and NASA-STD-8719.11.

3.8.2 Fire Suppression Systems

3.8.2.1 All areas of the IOZ shall comply with the most current NFPA 72, NFPA 90A codes and NASA-STD-8719.11 regarding fire suppression systems.

Rationale: Current codes applicable at IOZ.

3.8.2.2 Water lines shall not be routed above ceiling in CWA.

Rationale: CWA low and high bay will not have fire suppression. Ceiling height prohibits effective water spray of sprinkler system. No active suppression lines in ceiling eliminates risk of water on flight hardware.

3.8.2.3 HVAC supply and return smoke detectors shall be installed and interlocked as a system.

Rationale: NFPA 72 requirement.

3.8.2.4 Air handlers shall shut down in the event of smoke detection.

Rationale: NFPA 72 requirement.

3.8.2.5 Specific suppression design for each room/area will be provided in Facility Drawing and approved by KSC Authority Having Jurisdiction and Lockheed Martin.

Rationale: System details, including code compliance, will be contained in Facility Drawings.

3.8.2.6 Class D fire extinguishers shall be provided where the fire hazard is due to Lithium Ion Spacecraft Batteries.

Rationale: NASA 8719.11 Standard for metal fires such as from lithium ion batteries.

3.8.3 Environmental Protection

3.8.3.1 The hazardous material/waste management shall follow LMSSC Command Media and KSC Environmental Policy Requirements as set forth in KSC KNPR 8500.1 Revision A.

Rationale: NASA Environmental Policy must be adhered to at all Centers.

3.8.3.2 The use of low volatile organic compounds for surface coatings shall be used.

Rationale: KSC Environmental Policy Requirements.

3.8.3.3 No Class I or Class II Ozone Depleting Substances (i.e. Freon or other halogenated hydrocarbons) will be used.

Rationale: *KSC Environmental Policy Requirements.*

3.8.3.4 No asbestos containing material (i.e. drywall, mastic, tile, felt, sealants, caulk, coatings, insulation, etc.) will be used.

Rationale: *KSC Environmental Policy Requirements*.

3.8.3.5 No lead, chromium or mercury based coatings shall be used.

Rationale: *KSC Environmental Policy Requirements.*

3.9 COMMUNICATIONS AND DATA NETWORKING SYSTEMS

Section 3.9 specifies requirements for the Operational Voice System (OISD), telephone, aural and visual warning, public addressing systems, and the data communication and networking system.

3.9.1 Audio/Visual Communication Systems

3.9.1.1 Operational Voice System

3.9.1.1.1 KSC supplied OISD shall be provided in the IOZ.

Rationale: *OISD communications system is essential for safe activities during normal day- to-day as well as critical operations.*

3.9.1.1.2 As a minimum, KSC supplied OISD shall be provided to the IOZ CCMS Control Room (Room 1255), High/Low Bay and Airlock (Rooms 1400 and 1492), Integration Cell (Room 1415), Tool Crib (Room 1463), Proof Test Cell (Room 1486), TPS/Chemical Dispensing Area (Room 1461), and Proof Test Control Room (Room 1493).

Rationale: *OISD system is required to ensure communications during normal day- to-day activities as well as critical operations.*

3.9.1.1.3 Specific KSC supplied OISD box locations will be detailed in facilities drawings and approved by Lockheed Martin prior to installation.

Rationale: *OISD details will be contained in Architectural and Engineering (A&E) Drawings.*

3.9.1.2 Telephone System

3.9.1.2.1 A telephone system shall be provided in the IOZ.

Rationale: *Telephone system is required for internal and external communications.*

3.9.1.2.2 As a minimum, Telephones shall be provided to the IOZ East and West Basement Areas (Room 0108), CCMS Control Room (Room 1255), High/Low Bay and Airlock (Rooms 1400 and 1492), Integration Cell (Room 1415), Vendor Areas (Room 1449), Conference Room (Room 1465), Office Areas (Room 1465), Personnel Prep Area (Room 1456), Tool Crib (Room 1463), Flight Inventory Area (Room 1480), Proof Test Cell (Room 1486), TPS/Chemical Dispensing Area (Room 1461), and Proof Test Control Room (Room 1493).

Rationale: *Telephone system is required for internal and external communications.*

3.9.1.2.3 Specific Telephone locations will be detailed in facilities drawings and approved by Lockheed Martin prior to installation.

Rationale: *Telephone details will be contained in A&E Drawings.*

3.9.1.2.4 The IOZ telephone system shall include an audio paging system.

Rationale: *Audio paging is required to provide local audible alerts.*

3.9.1.3 Public Address System

3.9.1.3.1 A public address system shall be provided in the IOZ.

Rationale: *Public address is required to provide KSC area warnings.*

3.9.1.3.2 The public address service shall be audible in all areas of the IOZ.

Rationale: Warnings need to be audible to all personnel.

3.9.1.4 Warning System

3.9.1.4.1 An aural warning system shall be provided for use during critical move and hazardous operations.

Rationale: Aural warnings needed during operations to alert personnel.

3.9.1.4.2 A visual warning system shall be provided for use during critical move and hazardous operations.

Rationale: Visual warnings needed during operations to alert personnel.

3.9.1.5 Work Imaging System

3.9.1.5.1 A Work Imaging System shall be provided to visually document the CEV spacecraft configuration during IOZ assembly, integration, and closeout.

Rationale: Imaging required by CEV Imagery Plan CEV-T-088.

3.9.1.5.2 The Work Imaging System will document required events, as defined in the CEV Imagery Plan, using a combination of digitally formatted still and motion imagery.

Rationale: Still and motion imagery required per CEV Imagery Plan CEV-T-088.

3.9.1.5.3 Work Imagery System will include four portable digital cameras for still photographs that meet the requirements of the CEV Imagery Plan for format, resolution, storage size, and storage portability.

Rationale: Still photos must be of sufficient detail as well as be compatible with existing NASA Imagery infrastructure as defined in the CEV Imagery Plan.

3.9.1.5.4 The Work Imagery System will include two high definition portable motion imagery cameras with tripods.

Rationale: Required to capture detailed images during critical operations per the CEV Imagery Plan.

3.9.1.6 Data Communication and Networking Systems

3.9.1.6.1 The IOZ shall have a Work Control System (Data Communication Network).

Rationale: Data Communications Network required for Work Order Control system implementation.

3.9.1.6.2 As a minimum, Network drops shall be provided to the IOZ CCMS Control Room (Room 1255), Server Room (Room 1460), Low Bay Assembly Station Utility Suites (Room 1400), Integration Cell (Room 1415), Vendor Areas (Room 1449), Conference Room (Room 1465), Office Areas (Room 1465), Tool Crib (Room 1463), Receiving and Inspection (Room 1469), Flight Inventory Area (Room 1480), Proof Test Cell (Room 1486), TPS/Chemical Dispensing Area (Room 1461), and Proof Test Control Room (Room 1493).

Rationale: Data Communications Network required to support Work Order Control in these areas.

3.9.1.6.3 The Data Communication Network shall be provided to all Lockheed Martin occupied office areas as designated by NASA.

Rationale: Offices require connectivity for Work Order Control as well as administrative functions.

3.9.1.6.4 Network Architecture details will be provided in facilities drawings and approved by Lockheed Martin prior to installation.

Rationale: Network analysis and architecture needs to be developed based on bandwidth needs.

3.9.2 Connections to other Facilities

3.9.2.1 The IOZ shall have LMI connectivity to the LM backbone.

Rationale: Connection needed to other LM facilities for Work Order Control, CCMS to EDL communications, and day-to-day administrative functions.

3.9.2.2 Range IRIG B input shall be provided to the CCMS Control Room (Room 1255).

Rationale: CCMS and other EGSE require range timing for time data correlation.

3.10 SPECIAL STRUCTURAL NEEDS

Minimal structural changes are being made in the IOZ. Two areas that need to be primarily considered in the structural design are floor loading and the design of the Proof Test Cell.

3.10.1 Floor Loading

Tooling stands with integrated air bearing pallets will be used to support and transport the spacecraft within the IOZ. Additionally electric fork lift and other material handling conveyances will be utilized to move materials. Uniform and point load limits were previously established for the concrete flooring in the facility and need to be observed in the IOZ. Minor structural changes are planned that may change established floor loading limits for the steel floored areas in the IOZ. Specific structural changes that may change floor loading limits will be indentified in the O&C Main Level Floor Plan drawing 82K007806. Revised load limits will be calculated and captured on 82K007806 and be observed per the following requirements.

3.10.1.1 Floor load limits as detailed in O&C Main Level Floor Plan drawing 82K007806 shall be observed in the IOZ.

Rationale: *Minimal structural changes to IOZ floor are being made however all users need to be cognizant that potentially revised limits need to be observed.*

3.10.1.2 Tooling stands shall observe uniform and point floor load limits as detailed in O&C Main Level Floor Plan drawing 82K007806.

Rationale: *Minimal structural changes to IOZ floor are being made however all users need to be cognizant that potentially revised limits need to be observed.*

3.10.1.3 Transportation tooling design shall observe uniform and point floor load limits as detailed in O&C Main Level Floor Plan drawing 82K007806.

Rationale: *Minimal structural changes to IOZ floor are being made however all users need to be cognizant that potentially revised limits need to be observed.*

3.10.2 Proof Test Cell

The Proof Test Chamber (Room 1486) will support high pressure proof test of the spacecraft. Structural changes will be made to the walls, ceiling, and doors to contain an instantaneous depressurization of the spacecraft in the unlikely event of a tank or line burst during proof testing. Structural changes need to be made based on the volume and pressure of the tanks.

3.10.2.1 The Proof Test Cell shall have wall, ceiling, and doors capable of withstanding overpressure and shrapnel release conditions associated with instantaneous rupture of pressure vessel of 20 ft^3 volume at 6750 pounds per square inch gauge (PSIG).

Rationale: Based on 606C SM design with additional margin added to allow for spacecraft design changes.

3.10.2.2 The Proof Test Cell door shall be sized to accommodate a CM including its associated transportation tooling stand.

Rationale: Proof Test door needs to be sized to be large enough to accommodate UUT.

3.10.2.3 The Proof Test Cell door shall be sized to accommodate an SM including its associated transportation tooling stand.

Rationale: Proof Test door needs to be sized to be large enough to accommodate UUT.

3.10.3 Flooring

The Flooring in the IOZ requires a substantial rehabilitative effort. Structural test stand supports from previous programs need to be removed and patched. Variations in floor smoothness and levelness need to be established to support air bearing pallet operation. In addition to being air bearing capable, coatings need to also be clean room compatible.

3.10.3.1 All holes and other penetrations in the high and low bays shall be patched and sealed.

<u>Rationale</u>: *Preparation of flooring to receive new coating.*

3.10.3.2 Variations in floor smoothness shall be no greater than 5/16" in 10 feet.

<u>Rationale</u>: *Required to support air bearing operations.*

3.10.3.3 Replace floor coatings in High Bay, Low Bay, Integration Cell, and Offline Areas with clean room compatible industrial standard floor coating.

<u>Rationale</u>: *Support CWA Operations.*

3.10.3.4 Floor coatings in High Bay, Low Bay, Integration Cell, and Offline Areas shall maintain current floor load.

<u>Rationale</u>: *Floors need to resist deterioration caused by dynamic and static stresses.*

3.10.3.5 Basement floor shall be sealed to minimize water intrusion.

<u>Rationale</u>: *Floor has history of water intrusion that requires mitigation.*

3.11 SECURITY

Security within the IOZ will be managed and controlled by Lockheed Martin. Lockheed Martin will develop and maintain a Security Plan. In an effort to maintain a security posture consistent with KSC, Lockheed Martin Space Systems Company will adopt and or comply with existing local KSC policy for access to KSC. Lockheed Martin will comply with all physical security requirements external to the IOZ consistent with KSC policy. The IOZ is a restricted area and personnel access control in the IOZ will be controlled through the use of an automated entry system. Only personnel possessing the proper credentials will be allowed access to the facility. Lockheed Martin will be responsible for all personnel access control into and out of the Facility. Lockheed Martin Space Systems Company will establish a staff of security personnel to manage and coordinate the following security processes:

(a) Facilitate coordination with KSC Protective Services the implementation of access procedures to KSC including badging of all Lockheed Martin employees, subcontractors/vendors and any foreign national employees.

(b) Manage and coordinate with Kennedy Space Center Protective Services, visitor control to include foreign nationals or other dignitaries on KSC.

(d) Implement procedures that address all ITAR and or Export Control Issues associate with spacecraft manufacturing and assembly.

(e) Administer, manage, and coordinate internal access control procedure within the IOZ.

(g) Establish workplace violence policies consistent with Lockheed Martin. Additionally, coordinate any workplace violence issues that may require KSC Security involvement/support.

In addition, Lockheed Martin will also develop a System Security Plan that will utilize a systems engineering approach to determine the total protection for all IOZ system disciplines including physical, information, information systems, communications, personnel, operations, product, and emissions. The Process to develop the System Security Plan will utilize Lockheed Martin CIPS “System Security Engineering” 2.3.5-T2-SysSec-1.0-P as a guide.

3.11.1 Facility

3.11.1.1 Lockheed Martin will adopt and or comply with existing local KSC policy for access to KSC.

Rationale: IOZ is located within existing KSC Facility (O&C).

3.11.1.2 IOZ Facility Security System will interface with existing O&C and KSC Protective Services.

<u>Rationale</u>: *IOZ exists within existing KSC Facilities and must have interface capability with KSC infrastructure.*

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3.11.1.3 All external IOZ access shall have alarms connected to the Facility Security System.

<u>Rationale</u>: *Alarms needed to detect unauthorized entry.*

3.11.1.4 All HVAC passages and underground conduits that lead into the IOZ large enough for a person to crawl through shall be grated and securely locked in a closed position.

<u>Rationale</u>: *Alarms needed to detect unauthorized entry.*

3.11.1.5 Upon alarm detection, Facility Security System shall automatically notify KSC Protective Services.

<u>Rationale</u>: *KSC Protective Services is the Physical Plant Security that needs to respond.*

3.11.1.6 The Training Room shall be equipped with a keyed and cipher lock.

<u>Rationale</u>: *LMI Present in Room, LM Corporate Information Protection Manual requirement per IPM-105 "Physical and Environmental Security".*

3.11.1.7 The Server Room shall be equipped with a keyed and cipher lock.

Rationale: LMI Present in Room, LM Corporate Information Protection Manual requirement per IPM-105 "Physical and Environmental Security".

3.11.1.8 Lockheed Martin shall develop a Facility Memorandum of Agreement for facility use with KSC.

Rationale: Roles and responsibilities need to be identified.

3.11.2 Personnel

3.11.2.1 All Lockheed Martin and subcontractors/venders will be cleared and badged to KSC.

Rationale: LM controls access to IOZ, but IOZ personnel require KSC access to get to IOZ.

3.11.2.2 Lockheed Martin will establish a foreign national visitor program.

Rationale: Foreign visitors require additional security requirements.

3.11.2.3 Lockheed Martin will ensure security Corporate Policy Statements are met to include CPS-569 (Security) and CPS-565 (Workplace Security-Maintaining a Safe and Respectful Workplace Free from Threats and Violence).

Rationale: Maintaining safe and respectful violence-free workplace paramount in LM and NASA cultures.

3.11.3 Access Control Badging

3.11.3.1 LMSSC will provide an IOZ external access system design, procurement, and installation.

Rationale: Need to limit access to facility, May utilize existing or future KSC electronic access as provided for in the memorandum of agreement for facility use

3.11.3.2 Access Control Badge will be required by Personnel to enter the IOZ.

<u>Rationale</u>: Restricted access to critical electrical and HVAC systems that affect production of the CEV and or other flight hardware.

3.11.3.3 Access Control Badge will be required by Personnel to enter the CCMS Control Room.

<u>Rationale</u>: Restricted access needs to be limited to authorized personnel only.

3.11.3.4 Lockheed Martin will ensure all external maintenance areas adjacent to the IOZ are controlled access and are integrated in the external access control system.

<u>Rationale</u>: Allows continuous access monitoring of individuals that have access to critical electrical and HVAC systems that affect production of the CEV and or other flight hardware.

3.11.4 Computer System Security

3.11.4.1 Lockheed Martin shall develop a System Security Plan.

<u>Rationale</u>: Lockheed Martin CIPS requirement per 2.3.4-T2-SysSec-1.0-P.

3.12 MATERIAL HANDLING

Facilities material handling in the IOZ is limited to a single new bridge crane, powered industrial trucks, and elevators. Elevators that were previously installed in the IOZ for personnel and equipment are being refurbished to carry cargo only, such as hardware or tools, and will no longer be rated for personnel. Consequently these elevators will be primarily be referenced as lifts although legacy requirements or drawings may still reference them as elevators. The primary objective is to provide a crane and lifts that are safe and reliable and meet current engineering codes & standards. A low bay bridge crane will be utilized in the Integration Cell for spacecraft erection, integration and transport of the completed CEV spacecraft. All overhead crane operations will adhere to Lockheed Martin CIPS 1.3.3-T1-ESH-12.0-S. The existing high bay crane will remain in place but will not be certified for flight hardware operations. Lifts refurbished or replaced to support IOZ operations and will be utilized for test equipment transportation only. The lifts are not rated for personnel and will only be utilized to transfer equipment.

All other hardware handling, including spacecraft and spacecraft components, will be accomplished by tooling or MGSE and is not in the scope of this facilities document. These tooling and MGSE handling requirements are documented in DRD CEV-T-086.

3.12.1 Cranes

3.12.1.1 One, top-running double girder, bridge crane with a minimum rating of 25 tons shall be provided in the IOZ.

Rationale: Based on maximum rating of existing rails, capacity well exceeds 606C CEV Stack weight including lifting fixtures and tooling.

3.12.1.2 The bridge crane will be located on the existing lower runway rails and will travel the length of the high and low bays.

Rationale: Crane required throughout IOZ, lower rails travel length of IOZ.

3.12.1.3 Design, fabrication, test and installation of the new crane shall comply with the following documents: ASME B30.2 “Overhead and Gantry Cranes”, CMAA 70 “Crane Manufacturer’s Association of America”, OSHA 29 CFR 1910.179 “Overhead and Gantry Cranes”, and NASA-STD-8719.9 “Standard for Lifting Devices and Equipment”.

Rationale: To ensure safety crane needs to comply with Industry and Government Standards.

3.12.1.4 A Functional Failure Modes and Effects Analysis (FFMEA) shall be performed on each crane.

Rationale: Performed per Lockheed Martin CIPS requirement FFMEA for Ground Processing Equipment 2.3.8.1-T1-Test-7.0-P.

3.12.1.5 The east side existing crane, located on the lower runway rails shall be removed and replaced with a new crane.

Rationale: One low bay crane being replaced with new, legacy crane needs to be removed.

3.12.1.6 The existing crane on the upper runway will remain for future use without modifications.

Rationale: No new high bay crane, High bay capability needs to remain.

3.12.1.7 The new crane shall be suitable for operation in Class 100k Clean Work Area.

Rationale: Crane needs to be compatible with CWA.

3.12.1.8 The crane shall be fail safe design to maintain load position during all power, control and mechanical failures.

Rationale: Fail safe design required for personnel and hardware protection.

3.12.1.9 Crane design shall allow loads to be safely lowered under emergency conditions due to crane component/system failures.

Rationale: Contingency emergency control required for personnel and hardware protection.

3.12.1.10 Hoist, trolley and bridge motion shall all be variable speed and provide micro inching capability.

Rationale: Protection of flight hardware and personnel safety.

3.12.1.11 The controls for trolley hoist and bridge motion shall employ control features to limit acceleration and deceleration forces imparted to the load.

Rationale: Protection of flight hardware and personnel safety.

3.12.1.12 New crane operations shall utilize radio frequency (RF) controls for primary control system.

Rationale: Provides greater flexibility and control.

3.12.1.13 Crane operations are to be protected from radio interference and the radio frequency control system shall be in compliance with and licensed under FCC Part 90 Rules.

Rationale: Federal Communications Commission requirement.

3.12.1.14 Selection of the radio control operating frequency shall be coordinated with the KSC Radio Frequency Spectrum Management office. A Radio Frequency Authorization will be approved by the KSC Spectrum Manager prior to procurement of the cranes.

Rationale: KSC Radio Frequency Spectrum Management requirement.

3.12.1.15 Pendant control shall be provided as a backup control system in case of RF control system failure.

Rationale: Backup control required in event of primary control failure.

3.12.1.16 Primary versus backup controls shall be selectable on the crane.

Rationale: Ease of use.

3.12.1.17 The existing lower crane runway girders and rails shall be reused. A survey of the runway rails shall be conducted to verify proper alignment and compliance with CMAA 70 requirements.

Rationale: Reuse of rails contingent upon compliance with industry standards.

3.12.1.18 Remote emergency E-Stop controls shall be provided where required to comply with NASA-STD-8719.9.

Rationale: NASA Safety Requirement.

3.12.1.19 Existing Low Bay Crane will remain in Airlock for future use.

Rationale: Will maintain future low bay capability.

3.12.1.20 Existing Hoist in Shipping and Receiving Area will remain for future use.

Rationale: Will maintain future capability. Hoist will require recertification prior to use.

3.12.2 Lifts

3.12.2.1 Lift #9 (Former Elevator #9 - West End of IOZ Basement) shall be upgraded to comply with ASME/ANSI 17.1 requirements for lifts.

Rationale: American Society of Mechanical Engineers elevator refurbishment standards.

3.12.2.2 Lift #11 (Former Elevator #11 - East Platform Area) shall be upgraded to comply with ASME/ANSI 17.1 requirements for lifts.

Rationale: American Society of Mechanical Engineers elevator refurbishment standards.

3.12.2.3 All elevators to be upgraded and utilized as lifts will be refurbished to support an additional 20 years of serviceable life.

Rationale: ASME recommendation.

3.13 HUMAN ENGINEERING

Upgrades to the existing IOZ will consider where feasible human engineering requirements using KSC-DE-512-SM and MIL-STD-1472F as guidelines. Since much of the existing infrastructure has been in place since the 1960's, adherence to Human Engineering (HE) standards will only be considered for new additions or alterations to the facility. The HE planning effort will take the form of a top-level project assessment performed by selected Orion team members from the AI&P Organization. The primary emphasis will be to determine how the facility and facility systems will interface with personnel at all organizational and operational levels. The goal of the analysis is to ensure that new systems installed in the IOZ promote ease of operation and maintenance, personnel safety, and sensitivity to human error.

The assessment will review facility drawings and as-built configuration and will provide the information necessary for the team to understand the level and complexity of potential human involvement with operation and maintenance of the planned system. The assessment will also consider system complexity, potential hazards to which humans might be exposed, and the consequences of human error during system operation/maintenance. To complete the assessment, Lockheed Martin will generate checklist using KSC-DE-512-SM and MIL-STD-1472F as guidelines. The facility drawings and as-built configuration of the facility and facility systems that are being upgraded as part of the Facility refurbishment will then be reviewed using the checklist as a guideline.

3.13.1.1 Lockheed Martin will create a Human Engineering checklist using KSC-DE-512-SM and MIL-STD-1472F as guidelines and evaluate IOZ new and modified facilities and facilities systems using the checklist.

Rationale: Need to consider Human Engineering requirements in IOZ upgrades and retrofits.

3.14 CONFIGURATION MANAGEMENT

The IOZ baseline configuration was captured by requirements definition during the development of the FDC. The initial FDC was generated by capturing requirements from a variety of sources including NASA (JSC and KSC) requirements, Lockheed Martin requirements, subcontractor Partner requirements, and Vendor requirements. These requirements as well as Codes and Standards (NEC, ANSI, OSHA) and Lockheed Martin internal processes formed the bulk of the initial FDC document that was base-lined at Revision 3 (ERB-07-0056 - 08 May 2007) prior to the commencement of the IOZ refurbishment that began in June 2007.

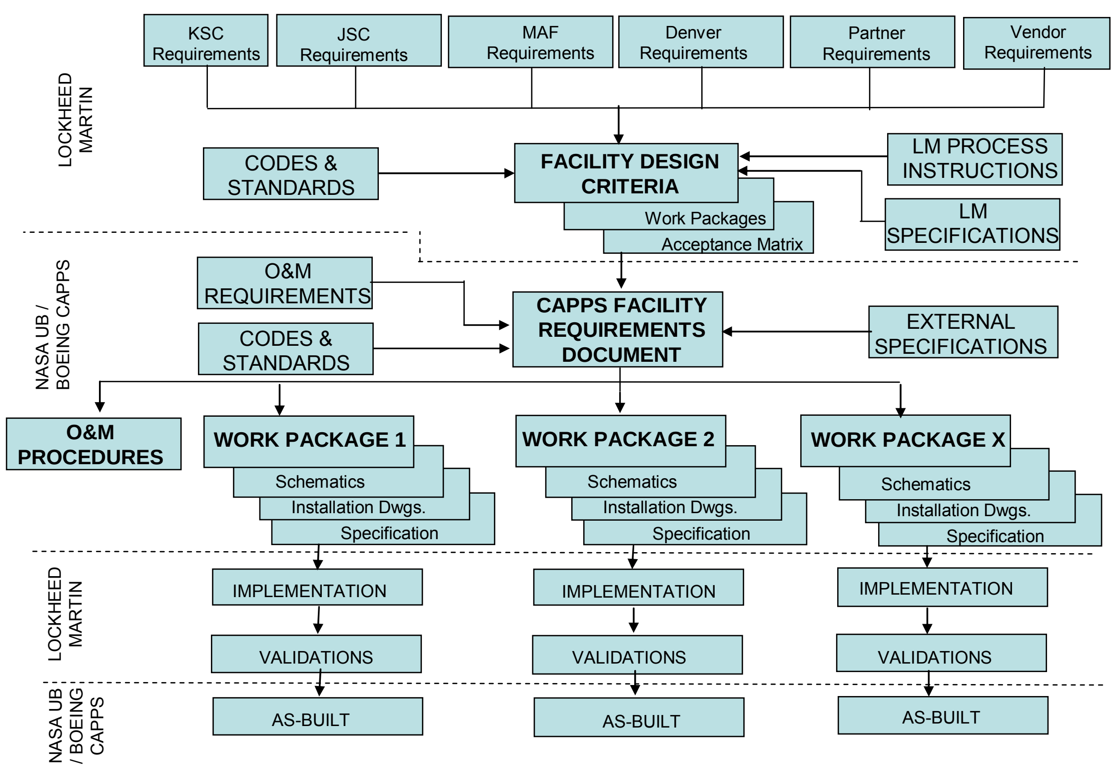

Figure 9: Specification and Drawing Hierarchy

Figure 9 provides the process flow from IOZ requirements definition to implementation. The FDC is decomposed into the Checkout Assembly and Payload Processing Services

(CAPPS) Facility Requirements Document (FRD) which assembles the refurbishment item into individual work packages based on facility system. The work packages establish the initial configuration and contain the installation detailed drawings, schematics, and specifications necessary to implement the systems in the IOZ. Following installation and validations of the systems the as-built configuration will be captured by updating the CAPPS drawings.

Changes to the base-line FDC have been a result of spacecraft design changes, differing conditions found during refurbishment, and design changes due to operational limitations. Configuration Management of these changes is managed by Lockheed Martin and is identified in the Operations and Checkout Building, Facility Concept of Operation, LMSSC-ORION-KSC-008, Revision Basic.

Changes are identified and documented on a Facilities Change Request (FCR). The completed FCR is presented at a pre-approval Board, consisting of NASA and Lockheed Martin, for feasibility. Upon pre-approval Board approval, LM Facilities Group evaluated to cost impacts of the proposed changes and compiles a rough order of magnitude pricing impact. When all the pertinent data is gathered the Board reconvenes and the additional data is presented. If the change is approved the FDC is updated to reflect the change. The change then filters through the process identified in Figure 9. Lockheed Martin owns, manages, and controls this process.

3.14.1 Configuration Management Requirements

3.14.1.1 Configuration of the IOZ will be managed by Lockheed Martin Facilities Engineering.

Rationale: *The IOZ is a LM controlled facility.*

3.15 SCHEDULING

The AI&P Project Planning organization will capture IOZ Facilities activities during the refurbishment of the O&C for the Orion Program. The AI&P Planning Department will utilize industry standard scheduling tools to develop a high fidelity schedule to allow stakeholders to accurately gauge IOZ progress, view upcoming milestones, and coordinate recovery actions. Schedules will be developed using internal Lockheed Martin standard operating processes in accordance with 2.1.3-T1-PgmMgt-1.0-P.

3.15.1.1 Lockheed Martin Planning Department shall develop a Facility Integrated Master Schedule that identifies facility milestones, dependencies, and durations using Microsoft Project.

<u>Rationale</u>: *To effectively manage the Facility a comprehensive schedule is required.*

3.15.1.2 Lockheed Martin Planning Department shall follow established Lockheed Martin standard operating process for schedule development per 2.1.3-T1-PgmMgt-1.0-P.

<u>Rationale</u>: *Schedule guidance is captured in existing command media.*

3.15.1.3 Working schedules (shifts, days, and hours) will be developed by the Contractor that map to the Lockheed Martin Integrated Master Schedule.

<u>Rationale</u>: *Detailed activities are decomposed and captured by lower level working schedules.*

3.16 *FUNCTIONAL CAPABILITIES*

3.16.1 Utility Suites

Utility suites will be provided at various locations throughout the facility. Utility suites will typically be mounted flush to the floor in the processing cells and mounted to vertical walls in all other areas. The suites will provide compressed air, commodities, high and low voltage power, phone, and network connections. Utility suites at each site are actually composed of five separate elements each being dedicated to a specific purpose. Figure 5 shows a typical Processing Station (Gray Area) and flush floor mounted Utility Suites shown. Specific floor locations of the suites will be provided in the engineering drawings for the facility.

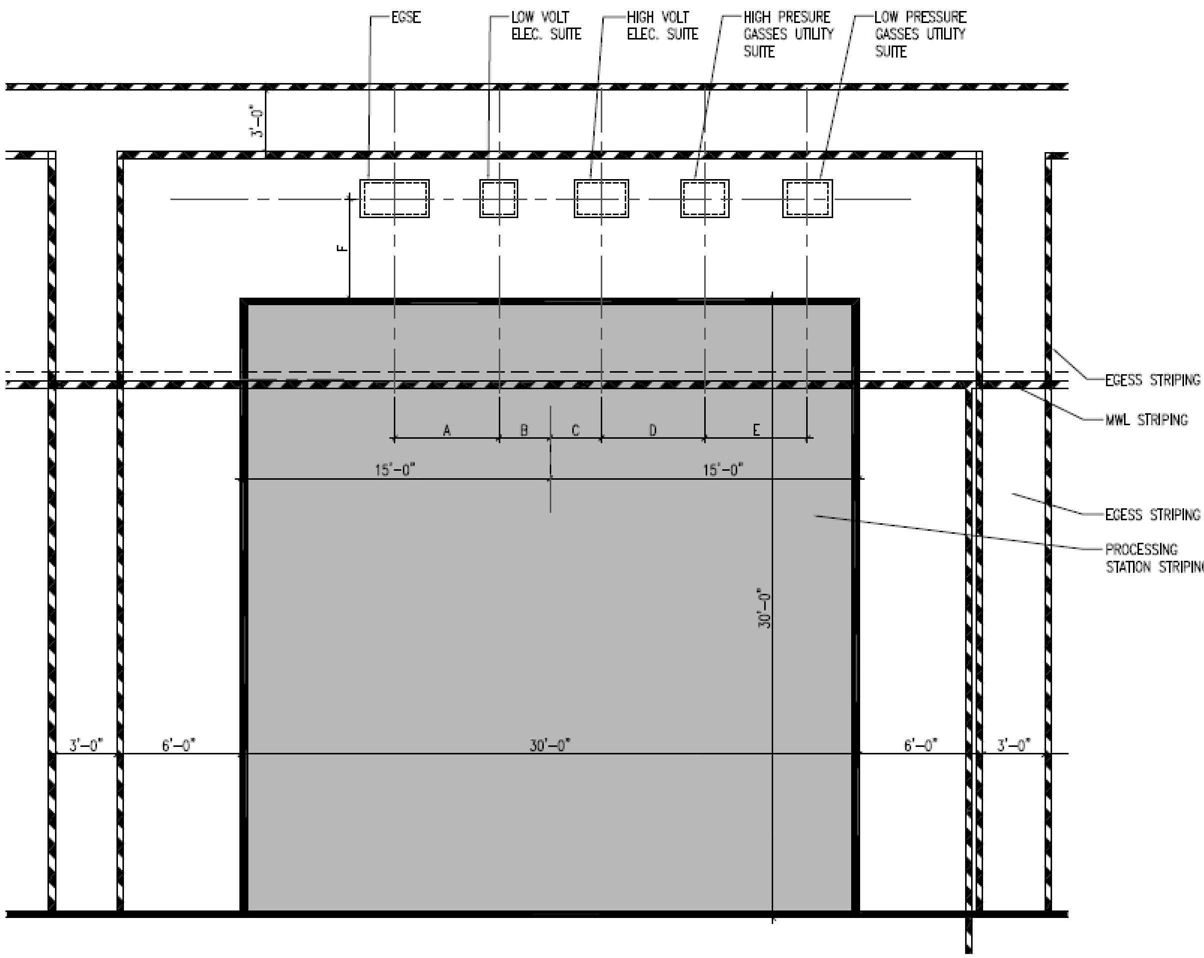

Figure 10: Utility Suite Placement (Typical)

The five elements include the electrical GSE suite, low voltage suite, high voltage suite, high pressure gas suite, and low pressure gas suite. The EGSE suite provides the interface to the CCMS control room, network, and phone connections. The low voltage suite provides 120 VAC facility power for tooling stands. The high voltage suite provides the 208 VAC and 480 VAC facility power. High pressure GN_2 and GHe as well as vents are provided in the high pressure gas suite. Finally, the low pressure gas suite contains compressed air and facility vacuum connections. Specific details of the capabilities of the suites are provided in the requirements below.

3.16.1.1 Utility Suite Locations

3.16.1.1.1 Eight Utility Suites shall be installed in the Low Bay to support the six Processing Stations and two Flex Stations.

Rationale: Provide commodities, power, and communications in each station.

3.16.1.1.2 Processing Station and Flex Station Utility Suites shall have flush mounted covers.

Rationale: Minimize trip hazards on floor mounted suites.

3.16.1.1.3 Two Utility Suites shall be installed in the Vendor Support Area.

Rationale: *Support Environmental Control Life Support System Vendor.*

3.16.1.1.4 One Utility Suite shall be installed in the Integration Cell Area.

Rationale: *Provide commodities, power, and communications in vehicle stack area.*

3.16.1.1.5 One Utility Suite shall be installed in the Airlock Area.

Rationale: *Provide purge gas, power, and communications in refurbishment area.*

3.16.1.1.6 One Utility Suite shall be installed in the Proof Test Cell.

Rationale: Provide commodities for pressurization and leak check.

3.16.1.2 Utility Suite Capabilities

3.16.1.2.1 Utility Suites shall contain a debris vacuum connection.

Rationale: Vacuum utilized to maintain cleanliness around tooling stand.

3.16.1.2.2 Utility Suites shall contain a 120 psi (minimum) compressed air connection with a 5 micron filter.

Rationale: Compressed air required to support GSE.

3.16.1.2.3 Utility Suites shall contain one LAN connection.

Rationale: Provide Network Communications.

3.16.1.2.4 Utility Suites shall contain one telephone connection.

Rationale: Provide Voice Communications.

3.16.1.2.5 Utility Suites shall contain two Building Automation LAN connections dedicated to particle counters.

Rationale: Necessary to evaluate and regulate CWA.

3.16.1.2.6 Utility Suites shall contain one GN_2, 3000 PSI connection. Piping shall be rated for 6000 psi (MAWP) to allow for future system capability.

Rationale: GN_2 required as a purge gas.

3.16.1.2.7 Utility Suites shall contain one GHe, 3000 PSI connection. Piping shall be rated for 6000 psi (MAWP) to allow for future system capability.

Rationale: GHe required for purge gas and leak check.

3.16.1.2.8 Utility Suites shall contain one ground connection tied to technical ground system.

Rationale: Provides technical grounding capability.

3.16.1.2.9 Utility Suites shall contain one ground connection tied to the facility ground system.

Rationale: Provides facility grounding capability.

3.16.1.2.10 Utility Suites shall contain one 480 VAC, 100 Amp, 3 phase, 5 wire receptacle.

Rationale: Provides power for UPS System.

3.16.1.2.11 Utility Suites shall contain one 208VAC, 100 Amp, 3 phase, 4 wire receptacle.

Rationale: Provides technical power for GSE.

3.16.1.2.12 Utility Suites shall contain one 120/208 VAC, 100 Amp, 3 phase, 5 wire receptacle.

Rationale: Provides technical power for GSE and tooling.

3.16.1.2.13 Utility Suites shall contain one 120/208 VAC, 50 Amp, 3 phase, 5 wire receptacle.

Rationale: Provides technical power for GSE and tooling.

3.16.1.2.14 One set of chilled water supply and return connections shall be provided in Processing and Flex Utility Suites.

Rationale: Provides chilled water for ground cooling unit.

3.16.1.3 Particle Counters

3.16.1.3.1 Particle Counters shall be located throughout the Facility.

Rationale: Necessary to evaluate and regulate CWA.

3.16.1.3.2 Specific location and capability of particle counters will be shown on the Facilities drawing and approved by Lockheed Martin.

Rationale: Need to be integrated into facility based on layout and HVAC flows.

3.17 FACILITY, FACILITY SYSTEMS, AND SUPPORT EQUIPMENT CERTIFICATION REQUIREMENTS

Operations and Checkout Building, Facility Concept of Operation, LMSSC-ORION-KSC-008, Revision Basic, identifies the means and methods for the IOZ facility operation, maintenance, and modifications including facility and facility systems. LM Facilities Engineering will establish the standards for facilities systems, generate test procedures to validate the systems, and maintain an archive of pertinent artifacts. Detailed Test Plan (CEV-T-084, O&C Spacecraft Test and Verification Facility Certification Plan) will identify how systems will be validated and the roles and responsibilities of participating stakeholders.

3.17.1 Facility and Facility Systems

3.17.1.1 Lockheed Martin Facilities Engineering will establish minimum standards of performance for the facility and facilities systems.

Rationale: *IOZ is a LM controlled facility. Facilities assets must be validated to Government and LM Standards that have been established in LMSSC-ORION-KSC-003 Operations and Checkout Facility Design Criteria.*

3.17.1.2 Lockheed Martin Facilities Engineering or a designated Representative shall develop test procedures to validate the performance of the facility and facilities systems.

Rationale: *Subject Matter Expert (SME) expertise on IOZ resides in LM Facilities Engineering.*

3.17.1.3 A database will be maintained by LM Facilities Engineering to capture all relevant parametric performance data for the facility and facilities systems validation.

Rationale: *Artifacts qualifying facility and facilities systems need to be archived and available for review.*

3.17.1.4 An FFMEA will be performed on the High Bay East door.

Rationale: *Performed per Lockheed Martin CIPS 2.3.8.1-T1-Test-7.0-P.*

3.17.1.5 An FFMEA will be performed on the Low Bay West door.

Rationale: Performed per Lockheed Martin CIPS 2.3.8.1-T1-Test-7.0-P.

3.17.2 Support Equipment

Support equipment is not considered part of the Facility and will not be addressed in this document. Support equipment certification requirements will meet or exceed Lockheed Martin and NASA standards and will be captured in EGSE, MGSE and Tooling specifications. Certifications for Vendor supplied support equipment will be provided by the Vendor.

3.18 OPERATIONS REQUIREMENTS

The Operations and Checkout Building, Facility Concept of Operation (CONOP), LMSSC-ORION-KSC-008, will identify the means and methods for the IOZ facility operation and maintenance. Within the facilities, CONOP Lockheed Martin Facilities Engineering will identify how the facility will manage, schedule, and coordinate all services such as scheduled maintenance, janitorial services, and non-scheduled maintenance. The facilities CONOP will identify the types of personnel and services required to operationally support the facility.

Additional operational requirements will be derived from the AI&P Concept of Operations. The AI&P CONOP will identify the roles and responsibilities of the various AI&P disciplines such as Test Operations, Manufacturing Engineering, Quality Engineering, and Safety. Decomposition of the roles and responsibilities will translate to procedural requirements for facility operations such as lockout/tagout, operations control, scheduling, foreign object elimination (FOE), facility availability, training, and configuration control.

3.18.1.1 Lockheed Martin Facilities Engineering shall develop an IOZ Concept of Operations that identifies the means and methods for facility operation, maintenance, and modifications.

Rationale: *CONOP specifies the IOZ facility operation.*

3.18.1.2 Lockheed Martin Assembly, Integration, and Production shall develop an IOZ, Concept of Operations that identifies the roles and responsibilities of the AI&P Team.

Rationale: *CONOP specifies the IOZ facility manufacturing operation.*

3.18.1.3 Lockheed Martin Assembly, Integration, and Production shall develop an FOE Plan.

Rationale: Lockheed Martin CIPS requirement per 2.4-T1-Ops-1.1-P “FOE Process”.

3.19 MAINTENANCE REQUIREMENTS

Operations and Checkout Building, Facility Concept of Operation, LMSSC-ORION-KSC-008, Revision Basic, identifies the means and methods for the IOZ facility operation, maintenance, and modifications. LM Facilities will manage the maintenance of the facility. All work will be preformed by NASA approved contractors. A change process will be identified in the Concept of Operations and executed by Lockheed Martin.

3.19.1 Maintenance Requirements

3.19.1.1 Maintenance of this facility will be managed by Lockheed Martin Facilities Engineering.

Rationale: *The IOZ is a LM controlled facility.*

3.19.1.2 Maintenance of this facility will be performed by a NASA approved facility maintenance contractor to contract requirements.

Rationale: *The IOZ is a NASA owned facility.*

3.20 SUSTAINING ENGINEERING AND OBSOLESCENCE PLANNING REQUIREMENTS

Operations and Checkout Building, Facility Concept of Operation, LMSSC-ORION-KSC-008, Revision Basic, identifies the means and methods for the IOZ facility operation, maintenance, and modifications. Lockheed Martin will manage the Sustaining Engineering and Obsolescence of the IOZ.

3.20.1 Sustaining Engineering and Obsolescence Requirements

3.20.1.1 Sustaining Engineering and Obsolescence Planning of this facility will be managed by Lockheed Martin Facilities Engineering.

Rationale: *The IOZ is a LM controlled facility.*

4 VERIFICATION

This section provides a brief description of test methods that will be utilized establishes the relationship between each system requirement and its verification requirements. This section also describes the methods that will be used to accomplish the indicated verification actions. For requirements detailed in this DRD that specifically map to Facilities Design Criteria document requirements, Lockheed Martin AI&P Facilities Group or the applicable Contractor will develop verification test procedures that will be executed by Lockheed Martin or a Lockheed Martin Contractor. The O&C Facilities Test Plan, DRD CEV-T-084, provides a comprehensive test plan that will be utilized to develop the detailed test procedures. The O&C Facilities Test Plan will also contain an enhanced Verification Cross Reference Matrix which provides additional traceability to FDC Requirements that will be validated during the O&C Facility Validation.

The following methods will be used for verification: Analysis, Inspection, Demonstration, and Test. While all are acceptable, test is preferable to other methods that do not specifically demonstrate behavior. More detailed descriptions of these methods is contained in Table 1 at the beginning of this document in Section 1.2 Definition of Terms.

4.1 ENVIRONMENTAL REQUIREMENT VERIFICATION

Environmental requirement verification will include heat load analysis, inspection, demonstration and test included HVAC load, temperature, humidity, filtration, pressure, and particulate count. The verification will include the Computer Room Areas, Basement Areas, Clean Work Areas, and the Airlock Areas. These requirements map directly to Facilities Design Criteria requirements. Validation of the FDC requirements will be by Lockheed Martin or Contractor developed test procedures that are executed by the Contractor. As captured in the requirements, the CWA air conditioner Cleanliness shall be certified by an independent third party. Artifacts gathered to verify the requirements per the FDC will also serve to validate DRD requirements for the Environmental Requirements.

4.2 ENVIRONMENTAL POLLUTION CONTROL REQUIREMENT VERIFICATION

Environmental Compliance will be maintained and verified by Lockheed Martin Environmental, Safety and Health personnel on weekly, monthly, and quarterly basis through participation in on going operations, maintaining required records, and internal inspections and audits of the IOZ. NASA KSC Environmental Program Branch will be allowed to review those inspections as well as other required records and operations to help NASA determine the IOZ environmental compliance status to NASA KNPR-8500.1.

4.3 POWER, GROUNDING, AND LIGHTING VERIFICATION

The O&C facility's electrical power, grounding, and lighting systems requirements will be verified by analysis, inspection , demonstration, and test. Tests procedures for the Power, Facility and Technical Grounding and Lightning Protection, and Facility Lighting will be developed by Lockheed Martin or the Contractor and performed by the Contractor. Special or unique system requirements are detailed in specific sub-sections appropriate for each system. Power, Grounding, and Lighting requirements map directly to Facilities Design Criteria requirements. Artifacts gathered to verify the requirements per the FDC will also serve to validate DRD requirements for the Environmental Requirements.

4.4 BACKUP AND CONTINGENCY VERIFICATION

Backup and Contingency Requirements will be verified by inspection and demonstration by Lockheed Martin and applicable Contractor. Electrical powered systems will be tested by the Electrical Contractor utilizing procedures developed by Lockheed Martin or the Contractor. Back-up power and fail-safe securing may be demonstrated by the Electrical Contractor and or the Crane Contractor utilizing Lockheed Martin or Contractor generated test procedures. Contingency environmental requirement verification will be performed by the HVAC Contractor and may be performed in conjunction with the HVAC functional Checkout. All requirements will map directly to Facilities Design Criteria requirements and may be utilized to verify DRD requirements.

4.5 PLUMBING/VENTING AND COMMODITIES FOR TEST OPERATIONS ACTIVITIES VERIFICATION

Plumbing and Venting requirements will be verified by inspection, demonstration and test by Lockheed Martin and the Mechanical or General Contractor. Lockheed Martin or the Contractor will develop acceptance test procedures that will include inspections, proof tests, flow tests, as well as cleanliness certification. Testing will be performed by the Contractor. All requirements in this section will map directly to Facilities Design Criteria requirements and may be utilized to verify DRD requirements.

4.6 FIRE AND HAZARD PROTECTION VERIFICATION

Fire and Hazard requirements will be verified by inspections, demonstrations and tests by Lockheed Martin, KSC NASA Fire Department, the Fire Alarm Contractor, and or the General Contractor. Since the IOZ is located on NASA property compliance with NASA Safety Standards will be verified by NASA Fire Department with Lockheed Martin Support. Tests and demonstrations of fire alarm and suppression systems will be performed by the Fire Alarm Contractor or General Contractor using test procedures developed by Lockheed Martin or the Contractor. Testing may include use of the NASA Fire Alarm infrastructure during integrated tests. The majority of the requirements in this section maps directly to Facilities Design Criteria requirements and may be utilized to verify DRD requirements.

4.7 COMMUNICATIONS AND DATA NETWORKING SYSTEM VERIFICATION

Communications and Data Network Systems will be verified by inspection, test, and demonstration. As part of the IOZ refurbishment, the OVS and phone systems are being upgraded in the facility. The Contractor is performing the connectivity modifications and the Base Operations Contractor will perform the device installation. Validation of the OVS and phone system will be performed by the Base Operations Contractor or Lockheed Martin using test procedures developed by Lockheed Martin or the Contractor. Public address system verification will be performed by the Base Operations Contractor or Lockheed Martin using test procedures developed by Lockheed Martin or the Contractor. Aural and visual warning systems will be verified by Lockheed Martin using test procedure developed by Lockheed Martin. All systems requiring network validation including the Test Imaging System, Data Communications System, and LMI Connectivity will be validated by Lockheed Martin using test procedures developed by Lockheed Martin or the Contractor. Requirements that map directly to the Facilities Design Criteria requirements may be utilized to verify DRD requirements.

4.8 SPECIAL STRUCTURAL VERIFICATION

Verification of observance of established floor load limits for tooling stands and tooling transporters will be by analysis and will be performed by Lockheed Martin. Analysis will consist of review of USA Tooling designs to insure that point and uniform load limits do not exceed established IOZ Limits.

The Proof Test Chamber (Room 1486) design will be verified by analysis and inspection. Analysis will consist of review of the Architectural and Engineering analysis that determined design based on instantaneous overpressure and shrapnel release based on the required volume vs. pressure. Inspection will consist of verification that proof test cell wall, ceiling, and doors are built per engineering. Satisfaction of the FDC requirement will be used to validate the DRD requirement.

4.9 SECURITY VERIFICATION

Security requirements will be verified by inspections, demonstrations and tests by Lockheed Martin and or the General Contractor. Since the IOZ is located on NASA property, an integrated test may be required. Tests and demonstrations of door entry and alarm systems will be performed by the Alarm Contractor, General Contractor, or Lockheed Martin using test procedures developed by Lockheed Martin or the Contractor. Testing may include use of the KSC Security Forces infrastructure during integrated tests. As run test procedures will serve as the verification artifact. Verification of Security Plans will be by inspection of the Security Plan and System Security Plans following approval of the artifact by all necessary stakeholders.

4.10 MATERIAL HANDLING VERIFICATION

The IOZ facility's Material Handling crane requirements will be verified by analysis, inspection, demonstration, and test by Lockheed Martin, Crane Contractor, and or the General Contractor. Tests procedures for the crane will be developed by Lockheed Martin or the Contractor and may be based on procedures provided by the Crane Contractor. Procedures will performed by the Crane Contractor or the General Contractor. Special or unique system requirements are detailed in specific sub-sections appropriate for each system. Artifacts gathered to verify the requirements per the FDC will also serve to validate DRD requirements for the Crane.

Elevator refurbishment will be verified by inspection, test and demonstration. Inspections of elevators and engineering will validate that upgrades were performed to ASME/ANSI 17.1 requirements. These inspections and will be performed by Lockheed Martin. Demonstrations and tests of the elevators will verify performance requirements.

4.11 HUMAN ENGINEERING VERIFICATION

Upgrades to the existing IOZ will consider where feasible human engineering requirements using KSC-DE-512-SM and MIL-STD-1472F as guidelines. Verification of guidelines will be evaluated by completion of a Human Engineering checklist by Lockheed Martin of newly added items to the IOZ. The completed checklist will be included in the Test Procedure or Acceptance Data Package as an artifact.

4.12 CONFIGURATION MANAGEMENT VERIFICATION

Operations and Checkout Building, Facility Concept of Operation, LMSSC-ORION-KSC-008, Revision Basic, identifies the means and methods for the IOZ facility operation, maintenance, and modifications including Configuration Management. LM Facilities will be responsible for the Configuration Management of the IOZ facility. Verification will consist of inspection of the Configuration management Plan as detailed in the O&C Facilities Concept of Operation LMSSC-Orion-KSC-008.

4.13 SCHEDULING VERIFICATION

The AI&P Project Planning organization will capture IOZ Facilities activities during the refurbishment of the O&C for the Orion Program. Verification of scheduling requirements will be by inspection of the Integrated Master Schedule and Contractor Working schedules developed by Lockheed Martin and the Contractor.

4.14 FUNCTIONAL CAPABILITIES VERIFICATION

Functional Capabilities verification will be accomplished by inspection, demonstration and test. Inspections will be conducted by Lockheed Martin and will verify that utility suites are located in the proper location and are configured per released engineering. Tests and demonstrations will be performed using test procedures developed by Lockheed Martin or the Contractor and performed by Lockheed Martin or the applicable Contractor.

High Pressure Gas Utility Suite requirements will be verified by inspection, demonstration and test by Lockheed Martin and the Mechanical or General Contractor. Lockheed Martin or the Contractor will develop acceptance test procedures that will include inspections, proof tests, flow tests, as well as cleanliness certification. Testing will be performed by the Contractor.

In some cases Utility Suite verification may be accomplished in conjunction with other Facility Testing. For example the Electrical Utility Suit interfaces may be verified during execution of test procedures for the Power, Facility, and Technical Grounding testing performed by the Contractor. The Spacecraft Test and Verification Facility System Test Plan DRD CEV-T-084400 will detail these interdependencies. Utility Suite requirements that map directly to Facilities Design Criteria requirements may be utilized to verify DRD requirements.

4.15 FACILITY, FACILITY SYSTEMS, AND SUPPORT EQUIPMENT CERTIFICATION REQUIREMENT VERIFICATION

The IOZ refurbishment effort is a Facilities and Facilities Systems Modification. LM Facilities Engineering will establish the standards for facilities systems, generate test procedures to validate the systems, and maintain an archive of pertinent artifacts. Section 4 of this DRD has provides overviews of how the various Facility Systems that will be Certified for use by the Orion Program. The O&C Spacecraft Test and Verification Test Plan (CEV-T-084, O&C Spacecraft Test and Verification Facility Certification Plan) will provide additional information and a complete verification traceability matrix. The Test Plan verification traceability matrix will provide mapping to requirements that will be verified as part of the FDC verification activites.

4.16 OPERATIONS REQUIREMENT VERIFICATION

The Operations and Checkout Building, Facility Concept of Operation, LMSSC-ORION-KSC-008, will identify the means and methods for the IOZ facility operation and maintenance. Within the facilities, CONOP Lockheed Martin Facilities Engineering will identify how the facility will manage, schedule, and coordinate all services such as scheduled maintenance, janitorial services, and non-scheduled maintenance. The facilities CONOP will identify the types of personnel and services required to operationally support the facility. The AI&P CONOP will identify the roles and responsibilities of the various AI&P disciplines such as Test Operations, Manufacturing Engineering, Quality Engineering, and Safety. Verification of the Operations requirements will consist of inspection of the plans and procedures identified in the CONOPs.

4.17 MAINTENANCE VERIFICATION

Maintenance of this facility will be performed by the facility maintenance contractor to contract requirements. Verification of Maintenance requirements will be by inspection of the process to request maintenance for the facility maintenance contractor. This process will be identified in the Operations and Checkout Building, Facility Concept of Operation, LMSSC-ORION-KSC-008. Verification of the Maintenance requirements will consist of inspection of the plans and procedures identified in the CONOP.

4.18 SUSTAINING ENGINEERING AND OBSOLESCENCE PLANNING REQUIREMENT VERIFICATION

Operations and Checkout Building, Facility Concept of Operation, LMSSC-ORION-KSC-008, Revision Basic, identifies the means and methods for the IOZ facility operation, maintenance, and modifications. Verification of Sustaining engineering requirements will be by inspection of the sustaining engineering process by the facility maintenance contractor. This process will be identified in the Operations and Checkout Building, Facility Concept of Operation, LMSSC-ORION-KSC-008. Verification of the Sustaining Engineering requirements will consist of inspection of the plans and procedures identified in the CONOP.

4.19 VERIFICATION MATRIX

Table 10 contains the verification cross reference matrix for all IOZ requirements. Requirements are presented in six columns corresponding to the SRD Paragraph Number, Requirement Description, Verification Method (Analysis, Inspection, Demonstration, or Test). Complete descriptions of the verification methods were presented in Table 1. The O&C Facilities Test Plan, DRD CEV-T-084, will contain a similar matrix that will also include an additional column that provides traceability to the corresponding O&C Facility Design Criteria requirements.

Table 10: Verification Cross Reference Matrix

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.3.1.1	Computer Room air conditioning system shall be independent to the CWA system.				X
3.3.1.2	Computer Room air conditioning system shall maintain temperature at 71° F ± 6°F.				X
3.3.1.3	CCMS Control Room air conditioning system shall maintain relative humidity at 35%≤RH≤60%.				X
3.3.1.4	CCMS Control Room air conditioning system shall provide filtration at MERV 11 (ASHRAE 52, 60-65%).				X
3.3.1.5	Server and Training Room air conditioning system shall maintain relative humidity at 30%≤RH≤60%.				X
3.3.1.6	Server and Training Room air conditioning system shall provide filtration at MERV 11 (ASHRAE 52, 60-65%).				X

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.3.1.7	Computer Room air conditioning system pressure shall be less than the CWA and greater than adjacent spaces.				X
3.3.1.8	CCMS Control Room doors shall automatically close and seal when closed.			X	
3.3.1.9	CCMS Control Room air conditioner shall be sized for a 154KBTU/HR equipment cooling load and 15 people within space.	X			
3.3.1.10	Server Room air conditioner shall be sized for a 50KBTU/HR equipment cooling load.	X			
3.3.2.1	The air conditioning system shall maintain a temperature at 71° F ± 6°F in the Basement.				X
3.3.2.2	The air conditioning system shall maintain a relative humidity at 35%≤RH≤60% in the Basement.				X
3.3.2.3	The air conditioning system shall provide filtration at MERV 16 (ASHRAE 52, 90-95%) in the Basement.				X
3.3.2.4	The air conditioning system pressure shall be 0.05 in-H_2O (adjustable) in the Basement.				X
3.3.3.1	The air conditioning system shall maintain a temperature at 71° F ± 6°F in the CWA.				X
3.3.3.2	The air conditioning system shall maintain a relative humidity at 35%≤RH≤60% in the CWA.				X
3.3.3.3	The air conditioning system shall provide filtration at HEPA MERV 18 (99.99%; non-DOP tested HEPA filters; Dioctylphthalate) in the CWA.				X
3.3.3.4	The air conditioning system pressure shall be 0.05 in-H_2O (adjustable) in the CWA, including all spaces connected to clean work area.				X

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.3.3.5	The air conditioner shall accommodate a maximum of 2 air changes per hour in the CWA.				X
3.3.3.6	The air conditioner shall maintain a particulate count per ISO 14644-1 Class 8 (as-built, at rest, operational) in the CWA				X
3.3.3.7	CWA air conditioner Cleanliness shall be Certified by an independent third party.				X
3.3.3.8	CWA air conditioner shall be sized for a 50KBTU/HR equipment cooling load from the CCMS Front End Hardware.	X			
3.3.3.9	CWA air conditioner shall be sized for one person per 300 square feet.	X			
3.3.3.10	Receiving and Inspection Room shall be equipped with door that can be closed when exterior doors are open.		X		
3.3.4.1	The air conditioning system shall maintain a temperature at 71° F ± 6°F in the Airlock.				X
3.3.4.2	The air conditioning system shall maintain a relative humidity at 35%≤RH≤60% in the Airlock.				X
3.3.4.3	The air conditioning system shall provide filtration at HEPA MERV 18 Non-DOP tested ISO 14644-1 Class 5 delivered at HEPA filters in the Airlock Area.				X
3.3.4.4	The air conditioning system pressure shall be less than remainder of low bay and greater than ambient within the Airlock during vehicle refurbishment mode of operation.				X
3.3.4.5	The air conditioning system pressure shall be 0.05 in-H_2O (adjustable) within the Airlock during airlock mode of operation.				X

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.3.4.6	The air conditioner shall accommodate a maximum of 2 air changes per hour in the Airlock.				X
3.3.4.7	The air conditioner shall maintain a particulate count per ISO 14644-1 Class 8 (as-built, at rest, operational) in the Airlock				X
3.4.1.1	The IOZ waste material management shall follow the IOZ Environmental, Safety and Health Plan as well as the KSC Environmental Policy Requirements as set forth in KSC KNPR 8500.1 Revision A.		X		
3.4.1.2	LM Environmental Safety and Health (ESH) shall implement a process for weekly internal inspections.		X		
3.5.1.1.1	Facility power shall be provided directly from the utility source.		X		
3.5.1.1.2	The Primary power system at the O&C shall consist of 13.2KV, 3 phase, 3 wire 60 Hz service provided from the base power grid.		X		
3.5.1.1.3	The primary power system to the IOZ shall be independent of other O&C areas.		X		
3.5.1.1.4	A failure of one of the primary power system shall not cause the building to lose its HVAC pressurization criteria.		X	X	
3.5.1.1.5	The nominal facility power voltage level shall be maintained to ±5%.				X
3.5.1.2.1	Three phase, 480V, 100 A, 5 wire receptacle shall be provided to the CM and SM test stations.		X		X
3.5.1.2.2	Three phase, 208V, 100 A, 4 wire receptacle shall be provide to the CM and SM test stations.		X		X

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.5.1.2.3	Three phase, 120/208V, 100A, 5 wire receptacle shall be provided to the CM and SM test stations.		X		X
3.5.1.2.4	Three phase, 120/208 50A, 5 wire receptacle shall be provided to the CM and SM test stations.		X		X
3.5.1.3.1	Three phase, 480V, 100 A, 5 wire receptacle shall be provided to the Integration Cell.		X		X
3.5.1.3.2	Three phase, 208V, 100 A, 4 wire receptacle shall be provide to the Integration Cell.		X		X
3.5.1.3.3	Three phase, 120/208V, 100A, 5 wire receptacle shall be provided to the Integration Cell.		X		X
3.5.1.3.4	Three phase, 120/208 50A, 5 wire receptacle shall be provided to the Integration Cell.		X		X
3.5.1.4.1	Technical power to the proof pressure cell will be via the proof pressure control room.		X		
3.5.1.4.2	Three phase 480V, 100A, 60 Hz shall be provided to the Proof Pressure Cell Control room.				X
3.5.1.4.3	Three phase 120/208V, 30A 5 wire technical power with load center shall feed the Proof Pressure Cell and Control room outlets.				X
3.5.1.4.4	Three phase 120/208V, 100A, 60Hz shall be provided to the Proof Pressure Cell Control room.				X
3.5.1.5.1	Three phase 480 VAC, 225A, 60 Hz Service disconnect shall be provided to the CCMS control room.				X
3.5.1.6.1	Two 120V, 20A, 4-cluster convenience outlets shall be provided to the TPS/Chemical Dispensing Room.				X

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.5.1.6.2	TPS/Chemical Dispensing Room convenience outlets shall be located approximately 20 feet apart on the west wall.		X		
3.5.1.7.1	Perimeter lighting shall be powered by Facility power.		X	X	
3.5.1.7.2	IOZ Server Room communications racks shall be powered by Technical Power provided by the Facility.		X	X	
3.5.1.7.3	Electronic Security system shall be powered by Technical Power provided by existing O&C Building system UPS outside the IOZ.		X	X	
3.5.1.7.4	Building High and Low Bay Emergency Lighting shall be powered by Facility power with generator backup.		X	X	
3.5.1.7.5	General Purpose Receptacles shall be powered by Facility power.		X	X	
3.5.1.7.6	Communications shall be powered by Technical Power provided by existing O&C Building system UPS outside the IOZ.		X	X	
3.5.1.7.7	Utility Suite receptacles used to energize GSE shall be powered by Technical Power.		X	X	
3.5.1.7.8	Receptacles or panels used to energize CCMS hardware shall be powered by Technical Power.		X	X	
3.5.1.8.1	The secondary power distribution system shall consist of a 480/277V, 3Φ, 60 Hz system.		X		
3.5.1.8.2	Secondary power shall be distributed to the various building load centers for distribution as 480V or reduced through transformers for lower voltage usage.		X		
3.5.1.8.3	Secondary power shall be distributed from the O&C site substation locations.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.5.1.9.1	Technical power shall be provided with the addition of Uninterruptible Power Supplies (UPS).		X		
3.5.1.9.2	The UPS shall be fed by facility power with a minimum full load battery backup time of 15 minutes.			X	
3.5.1.9.3	The UPS shall also contain a separately powered static bypass switch, which will transfer the UPS output load to an alternate power feed if the UPS unit should fail.		X	X	
3.5.1.9.4	UPS output power shall be continuous throughout specified period of backup usage.			X	
3.5.1.9.5	Technical UPS Power nominal voltage tolerance shall be ±5%.				X
3.5.1.9.6	Technical UPS Power nominal frequency tolerance shall be ±1 Hz.				X
3.5.1.9.7	Technical UPS Power total harmonic distortion tolerance shall be < 5%.				X
3.5.1.10.1	Receptacles shall be polarized.		X		
3.5.1.10.2	Receptacles shall be of a type suitable for the environment in which they are installed.		X		
3.5.1.10.3	It shall not be possible to insert a plug of one voltage rating into a receptacle of another voltage rating.		X		
3.5.1.10.4	Each technical power receptacle shall be marked with circuit number and panel number.		X		
3.5.1.10.5	All receptacles, except 120-Volt general-purpose convenience outlets, shall be marked with amperage rating, voltage, frequency characteristics, and panel of origin.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.5.1.10.6	General purpose, 120-Volt convenience outlets, shall be marked with panel source and circuit number using black lettering and white background per KSC-SPEC-E-0026(A).		X		
3.5.2.1.1	The grounding and lightning protection systems shall comply with Article 250 of NFPA 70 and NFPA 780 as a minimum.		X		
3.5.2.1.2	The grounding systems shall incorporate three separate systems including, Facility ground system, Technical ground system, and Lightning protection system.		X		
3.5.2.1.3	The technical and facility ground systems shall be isolated from each other except at connection to the single point ground.		X		
3.5.2.1.4	Ground return conductors shall be a minimum of a #4/0 bare stranded copper conductor and connected to the building ground counterpoise.		X		
3.5.2.2.1	Facility Ground System maximum ground counterpoise resistance shall be 5Ω.				X
3.5.2.2.2	Facility Ground System maximum electrical bonding resistance between metal facility structural members shall be 1.0Ω.				X
3.5.2.3.1	Technical Ground System plates shall be identified on the ground plate as “Technical Ground” to distinguish them from the Facility Ground System ground plates.		X		
3.5.2.3.2	The feeders from the Technical Ground System to the various areas shall be electrically isolated from all other grounds except at the single point connection.		X		
3.5.2.3.3	Technical Ground System ground cables shall have 600V type insulation.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.5.2.3.4	Technical Ground System ground riser shall be an insulated stranded copper cable routed inside a 2-inch rigid conduit.		X		
3.5.2.3.5	The Technical Ground System riser conduit shall stub up 6 inches above the floor with the cable at least 18 inches longer than the conduit.		X		
3.5.2.3.6	The Technical Ground shall be isolated from all other facility users.		X		
3.5.2.3.7	Technical Ground System ground resistance shall not exceed 1 Ω from the technical ground plate to the earth ground grid.				X
3.5.2.4.1	The O&C facility shall have lightning protection in accordance with NFPA 780 “Standard for the Installation of Lightning Protection Systems, Chapter 4, Protection for Ordinary Structures.		X		
3.5.2.5.1	Grounding System bonding practices utilized shall be in accordance with NFPA 70, Article 250, Section G.		X		
3.5.2.5.2	All bonding and grounding wire shall be insulated or protected above grade.		X		
3.5.2.5.3	Bonds, which are located not reasonable accessible for maintenance, shall be sealed with permanent waterproof compound.		X		
3.5.2.5.4	All metal non-current carrying parts of the facility shall be electrically bonded together.		X		
3.5.2.5.5	Bonding of ground cables to the counterpoise shall be by exothermic weld.		X		
3.5.2.5.6	Ground Plate Bond Resistance shall not exceed 1 milliohm.				X

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.5.2.5.7	Bonds for ground conductors (power circuits, control circuits, signal circuits or lightning protection) shall be 2.5 milliohms or less.				X
3.5.2.6.1	Conduit installed in the IOZ shall be grounded metallic conduit to provide EMI shielding at the IOZ.		X		
3.5.2.6.2	Except for solid conduit shields, shields will be isolated from each other and from any metallic component by at least 1.0 megohms (DC) when shield grounds are lifted.				X
3.5.2.6.3	Solid conduit shields shall not be isolated from each other or from structure.		X		
3.5.3.1.1	Illumination and recommended lighting levels for all areas of the IOZ shall conform to Illumination Engineering Society of North America, Lighting Handbook.	X	X		
3.5.3.1.2	Lighting in the CWA of the IOZ shall be 35 -50 foot candle 3ft above floor, mid-range correlated color temperature (white light), 3500- 5500 degree Kelvin, color rendering index 65-70 – true color	X	X		
3.5.3.2.1	Emergency lighting shall be provided at critical areas to protect personnel and secure operations in the event of power failure in accordance with NFPA 101 and NFPA 70.		X		
3.5.3.2.2	Emergency lighting units with battery back up shall be used in offline, basement, and stair areas.		X	X	
3.6.1.1	Any electrical powered system that supports personnel safety shall have back-up power or secure itself in a fail-safe manner.			X	

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.6.1.2	Any electrical powered system that supports flight hardware or GSE that interfaces to flight hardware shall have back-up power.		X		
3.6.1.3	Backup power with automatic switching shall be provided to the HVAC system.		X		
3.6.1.4	Batteries utilized for all IOZ backup systems shall be rated for human occupancy areas.		X		
3.6.2.1	Environmental data parameters including temperature and humidity at a minimum shall be continuously monitored and maintained in the event of failure of the primary HVAC monitoring system.			X	
3.7.1.1	The Proof Test Cell (Room 1486) vent shall be rated for 6000 psi maximum initial vent pressure.		X		X
3.7.1.2	The Vendor Support (Room 1449) vent shall be rated for 6000 psi maximum initial vent pressure.		X		X
3.7.1.3	Provide GHe vent for each utility suite to outside of facility above roofline for pnuematic venting.		X		
3.7.1.4	Provide GN_2 vent for each utility suite to outside of facility above roofline for pnuematic venting.		X		
3.7.2.1	Each utility suite shall have access to compressed air system.		X		
3.7.2.2	Compressed air cleanliness requirements shall meet KSC-C-123 level VC.				X
3.7.2.3	Each utility suite shall have access to the GHe system.		X		
3.7.2.4	GHe system shall provide 3000 psi nominal facility (200 scfm minimum) 6000 psi capability.		X		X

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.7.2.5	GHe system cleanliness requirements shall meet KSC-C-123 level 300A.				X
3.7.2.6	Each utility suite shall have access to the GN2 system.		X		
3.7.2.7	GN2 system shall provide 3000 psi nominal facility (200 scfm minimum), 6000 psi capability.		X		X
3.7.2.8	GN2 system cleanliness requirements shall meet KSC-C-123 level 300A.				X
3.7.2.9	Provide compressed air service outlets along south IOZ wall sized and spaced to accommodate air bearing pallet operation		X		
3.7.3.1	Potable water supply shall be provided for fixed eye wash, sinks and emergency showers in TPS/Chemical Dispensing Area.		X	X	
3.8.1.1	The IOZ fire detection and alarm system shall interface to existing KSC Central Fire Alarm System.		X	X	
3.8.1.2	The fire alarm system shall have battery backup with battery charger.		X		
3.8.1.3	Unique general fire alarm audio warning devices shall be located throughout the facility for general alarm signal and be distinguishable from other alarms.		X	X	
3.8.1.4	Manual pull stations shall be located at exit routes.		X		
3.8.1.5	Electrical devices shall be rated for the appropriate commodity in the area they are installed in.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.8.1.6	The fire detection and alarm systems shall provide or be tied into existing central interface panels with provision for remote monitor and transmitter for alarm signals to the KSC central fire alarm systems.		X	X	
3.8.1.7	Existing fire detection and alarm system components removed shall be replaced with new components that conform to most current NFPA 72 and NFPA 90A Standards.		X		
3.8.2.1	All areas of the IOZ shall comply with the most current NFPA 72, NFPA 90A codes and NASA-STD-8719.22 regarding fire suppression systems.		X		
3.8.2.2	Water lines shall not be routed above ceiling in CWA.		X		
3.8.2.3	HVAC supply and return smoke detectors shall be installed and interlocked as a system.		X	X	
3.8.2.4	Air handlers shall shut down in the event of smoke detection.		X	X	
3.8.2.5	Specific suppression design for each room/area will be provided in Facility Drawing and approved by KSC Authority Having Jurisdiction and Lockheed Martin.		X		
3.8.2.6	Class D fire extinguishers shall be provided where the fire hazard is due to Lithium Ion Spacecraft		X		
3.8.3.1	The hazard material/waste management shall follow LMSSC Command Media and KSC Environmental Policy Requirements a set forth in KSC KNPR 8500.1 Revision A.		X		
3.8.3.2	The use of low volatile organic compounds for surface coatings shall be used.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.8.3.3	No Class I or Class II Ozone Depleting Substances (i.e. Freon or other halogenated hydrocarbons) will be used.		X		
3.8.3.4	No asbestos containing material (i.e. drywall, mastic, tile, felt, sealants, caulk, coatings, insulation, etc.) will be used.		X		
3.8.3.5	No lead, chromium or mercury based coatings shall be used.		X		
3.9.1.1.1	KSC supplied OISD shall be provided in the IOZ.		X		
3.9.1.1.2	As a minimum, KSC supplied OISD shall be provided to the IOZ CCMS Control Room (Room 1255), High/Low Bay and Airlock (Rooms 1400 and 1492), Integration Cell (Room 1415), Tool Crib (Room 1463), Proof Test Cell (Room 1486), TPS/Chemical Dispensing Area (Room 1461), and Proof Test Control Room (Room 1493).		X	X	
3.9.1.1.3	Specific KSC supplied OISD box locations will be detailed in facilities drawings and approved by Lockheed Martin prior to installation.		X		
3.9.1.2.1	A telephone system shall be provided in the IOZ.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.9.1.2.2	As a minimum, Telephones shall be provided to the IOZ East and West Basement Areas (Room 0108), CCMS Control Room (Room 1255), High/Low Bay and Airlock (Rooms 1400 and 1492), Integration Cell (Room 1415), Vendor Areas (Room 1449), Conference Room (Room 1465), Office Areas (Room 1465), Personnel Prep Area (Room 1456), Tool Crib (Room 1463), Flight Inventory Area (Room 1480), Proof Test Cell (Room 1486), TPS/Chemical Dispensing Area (Room 1461), and Proof Test Control Room (Room 1493).		X	X	
3.9.1.2.3	Specific Telephone locations will be detailed in facilities drawings and approved by Lockheed Martin prior to installation.		X		
3.9.1.2.4	The IOZ telephone system shall include an audio paging system.		X	X	
3.9.1.3.1	A public address system shall be provided in the IOZ.		X	X	
3.9.1.3.2	The public address service shall be audible in all areas of the IOZ.			X	
3.9.1.4.1	An aural warning system shall be provided for use during critical move and hazardous operations.			X	
3.9.1.4.2	A visual warning system shall be provided for use during critical move and hazardous operations.			X	
3.9.1.5.1	A Work Imaging System shall be provided to visually document the CEV spacecraft configuration during IOZ assembly, integration, and closeout.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.9.1.5.2	The Work Imaging System will document required events, as defined in the CEV Imagery Plan, using a combination of digitally formatted still and motion imagery.		X		
3.9.1.5.3	Work Imagery System will include four portable digital cameras for still photographs that meet the requirements of the CEV Imagery Plan for format, resolution, storage size, and storage portability.		X		
3.9.1.5.4	Work Imagery System will include two high definition portable motion imagery cameras with tripods.		X		
3.9.1.6.1	The IOZ shall have a Work Control System (Data Communication Network).		X		
3.9.1.6.2	As a minimum, Network drops shall be provided to the IOZ CCMS Control Room (Room 1255), Server Room (Room 1460), Low Bay Assembly Station Utility Suites (Room 1400), Integration Cell (Room 1415), Vendor Areas (Room 1449), Conference Room (Room 1465), Office Areas (Room 1465), Tool Crib (Room 1463), Receiving and Inspection (Room 1469), Flight Inventory Area (Room 1480), Proof Test Cell (Room 1486), TPS/Chemical Dispensing Area (Room 1461), and Proof Test Control Room (Room 1493).		X	X	
3.9.1.6.3	The Data Communication Network shall be provided to all Lockheed Martin occupied office areas as designated by NASA.		X	X	
3.9.1.6.4	Network Architecture details will be provided in facilities drawings and approved by Lockheed Martin prior to installation.		X		
3.9.2.1	The IOZ shall have LMI connectivity to the LM backbone.			X	

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.9.2.2	Range IRIG B input shall be provided to the CCMS Control Room (Room 1255).			X	
3.10.1.1	Floor load limits as detailed in O&C Main Level Floor Plan drawing 82K007806 shall be observed in the IOZ.		X		
3.10.1.2	Tooling stands shall observe uniform and point floor load limits as detailed in O&C Main Level Floor Plan drawing 82K007806.		X		
3.10.1.3	Transportation tooling design shall observe uniform and point floor load limits as detailed in O&C Main Level Floor Plan drawing 82K007806.		X		
3.10.2.1	The Proof Test Cell shall have wall, ceiling, and doors capable of withstanding overpressure and shrapnel release conditions associated with instantaneous rupture of pressure vessel of 20 ft3 volume at 6750 pounds per square inch gauge (psig).	X	X		
3.10.2.2	The Proof Test Cell door shall be sized to accommodate a CM including its associated transportation tooling stand.		X		
3.10.2.3	The Proof Test Cell door shall be sized to accommodate an SM including its associated transportation tooling stand.		X		
3.10.3.1	All holes and other penetrations in the high and low bays shall be patched and sealed.		X		
3.10.3.2	Variations in floor smoothness shall be no greater than 5/16” in 10 feet.		X		X
3.10.3.3	Replace floor coatings in High Bay, Low Bay, Integration Cell, and Offline Areas with clean room compatible industrial standard floor coating.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.10.3.4	Floor coatings in High Bay, Low Bay, Integration Cell, and Offline Areas shall maintain current floor load.		X		
3.10.3.5	Basement floor shall be sealed to minimize water intrusion.		X		
3.11.1.1	Lockheed Martin will adopt and or comply with existing local KSC policy for access to KSC.		X		
3.11.1.2	IOZ Security System will interface with existing O&C and KSC Protective Services.		X	X	
3.11.1.3	All external IOZ access shall have alarms connected to Facility Security System.		X	X	
3.11.1.4	All HVAC passages and underground conduits that lead into the IOZ large enough for a person to crawl through shall be grated and securely locked in a closed position.		X		
3.11.1.5	Upon alarm detection, Facility Security System shall automatically notify KSC Protective Services.		X	X	
3.11.1.6	The Training Room shall be equipped with a keyed and cipher lock.		X	X	
3.11.1.7	The Server Room shall be equipped with a keyed and cipher lock.		X	X	
3.11.1.8	Lockheed Martin shall develop a Facility Memorandum of Agreement for facility use with KSC.		X		
3.11.2.1	All Lockheed Martin and subcontractors/venders will be cleared and badged to KSC		X		
3.11.2.2	Lockheed Martin will establish a foreign national visitor program.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.11.2.3	Lockheed Martin will ensure security Corporate Policy Statements are met to include CPS-569 (Security) and CPS-565 (Workplace Security-Maintaining a Safe and Respectful Workplace Free from Threats and Violence).		X		
3.11.3.1	LMSSC will provide an IOZ external access system design, procurement, and installation.		X	X	
3.11.3.2	Access Control Badge will be required by Personnel to enter the IOZ.		X	X	
3.11.3.3	Access Control Badge will be required by Personnel to enter the CCMS Control Room.		X	X	
3.11.3.4	Lockheed Martin will ensure all external maintenance areas adjacent to the IOZ are controlled access and are integrated in the external access control system.		X	X	
3.11.4.1	Lockheed Martin shall develop a System Security Plan.		X		
3.12.1.1	One, top-running double girder, bridge crane with a minimum rating of 25 tons shall be provided in the IOZ.		X		X
3.12.1.2	The bridge crane will be located on the existing lower runway rails and will travel the length of the high and low bays.		X		
3.12.1.3	Design, fabrication, test and installation of the new crane shall comply with the following documents: ASME B30.2 “Overhead and Gantry Cranes”, CMAA 70 “Crane Manufacturer’s Association of America”, OSHA 29 CFR 1910.179 “Overhead and Gantry Cranes”, and NASA-STD-8719.9 “Standard for Lifting Devices and Equipment”.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.12.1.4	A Functional Failure Modes and Effects Analysis (FFMEA) shall be performed on each crane.	X			
3.12.1.5	The east side existing crane, located on the lower runway rails shall be removed and replaced with a new crane.		X		
3.12.1.6	The existing crane on the upper runway will remain for future use without modifications.		X		
3.12.1.7	The new crane shall be suitable for operation in Class 100k Clean Work Area.		X		
3.12.1.8	The crane shall be fail safe design to maintain load position during all power, control and mechanical failures.			X	
3.12.1.9	Crane design shall allow loads to be safely lowered under emergency conditions due to crane component/system failures.			X	
3.12.1.10	Hoist, trolley and bridge motion shall all be variable speed and provide micro inching capability.			X	
3.12.1.11	The controls for trolley hoist and bridge motion shall employ control features to limit acceleration and deceleration forces imparted to the load.			X	
3.12.1.12	New crane operations shall utilize radio frequency (RF) controls for primary control system.		X		
3.12.1.13	Crane operations are to be protected from radio interference and the radio frequency control system shall be in compliance with and licensed under FCC Part 90 Rules.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.12.1.14	Selection of the radio control operating frequency shall be coordinated with the KSC Radio Frequency Spectrum Management office. A Radio Frequency Authorization will be approved by the KSC Spectrum Manager prior to procurement of the cranes.		X		
3.12.1.15	Pendant control shall be provided as a backup control system in case of RF control system failure.		X	X	
3.12.1.16	Primary versus backup controls shall be selectable on the crane.			X	
3.12.1.17	The existing lower crane runway girders and rails shall be reused. A survey of the runway rails shall be conducted to verify proper alignment and compliance with CMAA 70 requirements.		X		
3.12.1.18	Remote emergency E-Stop controls shall be provided where required to comply with NASA-STD-8719.9.			X	
3.12.1.19	Existing Low Bay Crane will remain in Airlock for future use.		X		
3.12.1.20	Existing Hoist in Shipping and Receiving Area will remain for future use.		X		
3.12.2.1	Lift #9 (Former Elevator #9 - West End of IOZ Basement) shall be upgraded to comply with ASME/ANSI 17.1 requirements.		X		
3.12.2.2	Lift #11 (Former Elevator #11 - East Platform Area) shall be upgraded to comply with ASME/ANSI 17.1 requirements.		X		
3.12.2.3	All elevators to be upgraded and utilized as Lifts will be refurbished to support an additional 20 years of serviceable life.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.13.1.1	Lockheed Martin will create a Human Engineering checklist using KSC-512-SM and MIL-STD-1472F as guidelines and evaluate IOZ new and modified facilities and facilities systems using the checklist.		X		
3.14.1.1	Configuration of the IOZ will be managed by Lockheed Martin Facilities Engineering.		X		
3.15.1.1	Lockheed Martin Planning Department shall develop a Facility integrated master schedule that identifies facility milestones, dependencies, and durations using Microsoft Project.		X		
3.15.1.2	Lockheed Martin Planning Department shall follow established Lockheed Martin standard operating process for schedule development per 2.1.3-T1-PgmMgt-1.0-P.		X		
3.15.1.3	Working schedules (shifts, days, and hours) will be developed by the Contractor that map to the Lockheed Martin Integrated Master Schedule.		X		
3.16.1.1.1	Eight Utility Suites shall be installed in the Low Bay to support the six Processing Stations and two Flex Stations.		X		
3.16.1.1.2	Processing Station and Flex Station Utility Suites shall have flush mounted covers.		X		
3.16.1.1.3	Two Utility Suites shall be installed in the Vendor Support Area.		X		
3.16.1.1.4	One Utility Suite shall be installed in the Integration Cell Area.		X		
3.16.1.1.5	One Utility Suite shall be installed in the Airlock Area.		X		
3.16.1.1.6	One Utility Suite shall be installed in the Proof Test Cell.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.16.1.2.1	Utility Suites shall contain a debris vacuum connection.		X	X	
3.16.1.2.2	Utility Suites shall contain a 120 psi (minimum) compressed air connection with a 5 micron filter.		X		X
3.16.1.2.3	Utility Suites shall contain one LAN connection.		X	X	
3.16.1.2.4	Utility Suites shall contain one telephone connection		X	X	
3.16.1.2.5	Utility Suites shall contain two Building Automation LAN connections dedicated to particle counters.		X	X	
3.16.1.2.6	Utility Suites shall contain one GN2, 3000 PSI connection. Piping shall be rated for 6000 psi (MAWP) to allow for future system capability.		X		X
3.16.1.2.7	Utility Suites shall contain one GHe, 3000 PSI connection. Piping shall be rated for 6000 psi (MAWP) to allow for future system capability.		X		X
3.16.1.2.8	Utility Suites shall contain one ground connection tied to technical ground system.		X		X
3.16.1.2.9	Utility Suites shall contain one ground connection tied to the facility ground system.		X		X
3.16.1.2.10	Utility Suites shall contain one 480 VAC, 100 Amp, 3 phase, 5 wire receptacle.		X		X
3.16.1.2.11	Utility Suites shall contain one 208VAC, 100 Amp, 3 phase, 4 wire receptacle.		X		X
3.16.1.2.12	Utility Suites shall contain one 120/208 VAC, 100 Amp, 3 phase, 5 wire receptacle.		X		X
3.16.1.2.13	Utility Suites shall contain one 120/208 VAC, 50 Amp, 3 phase, 5 wire receptacle.		X		X
3.16.1.2.14	One set of chilled water supply and return connections shall be provided in Processing and Flex Utility Suites.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.16.1.3.1	Particle Counters shall be located throughout the Facility.		X		
3.16.1.3.2	Specific location and capability of particle counters will be shown on the Facilities drawing and approved by Lockheed Martin.		X		
3.17.1.1	Lockheed Martin Facilities Engineering will establish minimum standards of performance for the facility and facilities systems.		X		
3.17.1.2	Lockheed Martin Facilities Engineering or a designated Representative shall develop test procedures to validate the performance of the facility and facilities systems.		X		
3.17.1.3	A database will be maintained by LM Facilities Engineering to capture all relevant parametric performance data for the facility and facilities systems validation.		X		
3.17.1.4	An FFMEA will be performed on the High Bay East door	X	X		
3.17.1.5	An FFMEA will be performed on the Low Bay West door	X	X		
3.18.1.1	Lockheed Martin Facilities Engineering shall develop an IOZ Concept of Operations that identifies the means and methods for facility operation, maintenance, and modifications.		X		
3.18.1.2	Lockheed Martin Assembly, Integration, and Production shall develop an IOZ Concept of Operations that identifies the roles and responsibilities of the AI&P Team.		X		
3.18.1.3	Lockheed Martin Assembly, Integration, and Production shall develop an FOE Plan.		X		
3.19.1.1	Maintenance of this facility will be managed by Lockheed Martin Facilities Engineering.		X		

SRD 082 Paragraph Number	Requirement	Verification Method			
		A	I	D	T
3.19.1.2	Maintenance of this facility will be performed by a NASA approved facility maintenance contractor to contract requirements.		X		
3.20.1.1	Sustaining Engineering and Obsolescence Planning of this facility will be managed by Lockheed Martin Facilities Engineering.		X		

5 ACRONYMS

A	Amperes
A&E	Architectural and Engineering
AI&P	Assembly Integration and Production
CAPPS	Checkout Assembly and Payload Processing Services
CCMS	Checkout Command & Monitoring System
CCTV	Closed-Circuit Television
CEQATR	Constellation Program Environmental Qualification and Acceptance Testing Requirements
CEV	Crew Exploration Vehicle
CIPS	Lockheed Martin Common Integrated Processes
CLV	Crew Launch Vehicle
CM	Crew Module
CONOP	Concept of Operations
COPV	Composite Overwrapped Pressure Vessel
CWA	Clean Work Area
CxP	Constellation Program
DBA	Detonation Booster Assembly
DC	Direct Current
DFI	Developmental Flight Instrumentation
DRD	Data Requirements Description
ECLSS	Environmental Control and Life Support System
EGSE	Electrical Ground Support Equipment
EMI	Electro Magnetic Interference
EPB	Kennedy Space Center Environmental Protection Branch
ESH	Environmental Safety and Health
F	Fahrenheit
FCC	Federal Communications Commission
FCDC	Flexible Confined Detonation Cord
FCR	Facilities Change Request
FDC	Facility Design Criteria
FFMEA	Functional Failure Modes and Effects Analysis
FOE	Foreign Object Elimination
FRD	Facilities Requirements Document

GHe	Gaseous Helium
GN_2	Gaseous Nitrogen
GOx	Gaseous Oxygen
GSE	Ground Support Equipment
HEPA	High Efficiency Particulate Air
HVAC	Heating, Ventilation and Air Conditioning
Hz	Hertz
IES	Illumination Engineering Society of North America
IOZ	Industrial Operating Zone
ITAR	International Traffic in Arms Reduction
JSC	Johnson Space Center
KSC	Kennedy Space Center
LAN	Local Area Network
LEL	Lower Exposure Level
LM	Lockheed Martin
LMI	Lockheed Martin Intranet
LMSSC	Lockheed Martin Space Systems Company
MAWP	Maximum Anticipated Working Pressure
MGSE	Mechanical Ground Support Equipment
MLI	Multi-Layer Insulation
MRB	Material Review Board
MSF	Manned Space Flight
N2H4	Hydrazine
NASA	National Aeronautics and Space Administration
NDE	Non-Destructive Evaluation
NEC	National Electric Code
NFPA	National Fire Protection Act
NSI	NASA Standard Initiator
O&C	Operations and Checkout
OFI	Operational Flight Instrumentation
OSHA	Occupational Safety and Health
OISD	Operational Voice Communications
PHST	Packing, Handling, Storage, and Transportation
PSI	Pounds per Square Inch
PSIA	Pounds per Square Inch Gauge

PC	Personal Computer
PDR	Preliminary Design Review
PTCS	Passive Thermal Control System
RCS	Reaction Control System
RF	Radio Frequency
RH	Relative Humidity
SA	Spacecraft Adapter
SDR	System Design Review
SM	Service Module
SME	Subject Matter Expert
SOC	State of Charge
TPS	Thermal Protection System
UPS	Uninterruptible Power Supply
USA	United Space Alliance
UUT	Unit Under Test
VAC	Volt Alternating Current