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Ares I Upper Stage (US)
Development Flight Instrumentation (DFI)
Data Acquisition System (DAS)
Component End Item Specification (CEIS)

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Title: Ares I Upper Stage (US) - DFI DAS CEI Specification	Document No.: GRC-AVI-SPEC-0001	Revision: Baseline
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Ares I Upper Stage (US)
Development Flight Instrumentation (DFI) Data Acquisition System (DAS)
Component End Item Specification (CEIS)

Signature Page

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1 SCOPE

This Contractor End Item Specification document defines and describes the design, performance and verification requirements for the ARES I Upper Stage Development Flight Instrumentation (DFI) Data Acquisition System (DAS).

1.1 Classification

1.2.1 Flight Unit

A Flight Unit (FU) is equipment that must conform to this procurement specification to the fullest extent.

[Rationale: The Flight Units shall meet all acceptance testing requirements and be able to process all discrete signals and sensor requirements listed in Table 3.]

1.2.2 Qualification Unit

A Qualification Unit (QU) is a Flight Unit designated for qualification testing purposes and will not be used as a flight unit due to overstressing of components.

1.2.3 Engineering Development Unit

An Engineering Development Unit (EDU) conforms to the form, fit, and function of an FU, but does not necessarily meet the natural and induced environmental requirements of the FU.

[Rationale: Since NASA will just be using the DAUs for development testing and evaluation, the EDUs shall be able to acquire data from approximately *half of the discretes and sensor count* for each type of sensor listed in Table 3. It is expected that this will lead to an arrangement of at least two DAUs that shall be connected to one another in order to be able to communicate.]

1.2.4 Wording Convention

The conventions used in this document, which indicates requirements, goals, statements of facts, rationale, and notes are as follows:

1) Shall: Used to indicate a binding requirement which must be implemented and its implementation verified, unless otherwise specified herein.

2) Should: Used to indicate a non-binding goal which must be addressed by the design but is not formally verified.

3) Will: Used to indicate a non-binding statement of fact and is not verified.

4) Rationale: Rationales are included for many requirements. The rationales are intended to provide clarification, justification, purpose, and/or source of the requirement. It is important to

note that the rationales are not binding and only provide supporting information. In the event there is an inconsistency between the requirement and the rationale, only the requirements will be binding and take precedence.

5) Note: Notes are included for many requirements. Notes explain the allocation of how the requirement was met by enforcing specific requirement values from separate, but interacting components. Notes do not contain binding language and only provide supporting information. In the event there is an inconsistency between the requirement and the note, only the requirement will be binding and take precedence.

2 APPLICABLE DOCUMENTS

2.1 General

The following documents of the issue in effect on the date of invitation of bids or request for proposal form a part of this document to the extent contained herein.

The documents listed in this section are specified in Sections 3 or 4 of the specification. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Sections 3 or 4 of the standard, whether or not they are listed.

2.2 Applicable Government Documents

The specifications, standards, and handbooks in Table 1 form a part of this document to the extent specified herein.

Document Title	Document Number	Revision
Constellation Program Design Specification For Natural Environments	CxP 70023	
Human-Systems Integration Requirements (HSIR)	CxP 70024	
Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR)	CxP 70036	
Constellation Program Electrical Power System Specification, Volume 2: Electrical Power Quality Performance for 28 Vdc	CxP 70050-02	
Constellation Program (CxP) Integrated Safety, Reliability, and Quality Assurance (SR&QA) Requirements	CxP 70059	
CONSTELLATION PROGRAM STRUCTURAL DESIGN AND VERIFICATION REQUIREMENTS	CxP 70135	
Constellation Program Contamination Control Requirements	CxP 70145	

ARES I Electromagnetic Environmental Effects (E3) Requirements Document	CxP 72043	
CLV (Crew Launch Vehicle) Requirements for the Control of Electromagnetic Interference Requirements of Subsystems and Equipment	CxP 72047	
EEE Parts Management and Control Plan	CxP 72053	
Ares I Vibroacoustic and Shock Environments Data book	CxP 72169	
Design Requirements for Rigid Printed Circuit Boards and Assemblies	MFSC-STD-3425	
Department of Defense Standard Practice Identification Marking of U.S. Military Property	MIL-STD-130	December 17, 2007
Standard Practice for Military Packaging	MIL-STD-2073	
MSFC Fastener Management & Control Practices	MSFC-STD-2594C	
MSFC Tailoring Guide For NASA-STD-8739.4, Crimping, Interconnecting Cables, Harness, And Wiring	MSFC-STD-2905	
EEE Parts Management and Control for MSFC Space Flight Hardware	MSFC-STD-3012	
Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits	NASA Technical Memorandum 102179	
Standard Materials and Processes Requirements for Spacecraft	NASA-STD-(I)-6016	
Man-Systems Integration Standards	NASA-STD-3000	
Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment	NASA-STD-4003	
Loads analysis of spacecraft and payloads	NASA-STD-5002	
Fracture Control Requirements for Spaceflight Hardware	NASA-STD-5019	
CRIMPING, INTERCONNECTING CABLES, HARNESSES, AND WIRING	NASA-STD-8739.4	
Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components	NPR 6000.1G	
Ares I Upper Stage Electrical Ground Support Equipment (EGSE) Requirements Document	USO-CLV-DE-25135	
ARES I UPPER STAGE AVIONICS & SOFTWARE SUBSYSTEM SPECIFICATION	USO-CLV-DE-25107	
Human Factors Engineering Design Criteria	USO-CLV-LS-25404	

Table 1 Applicable Government Documents

2.3 Non-Government Publications

The publications in Table 2 form a part of this document to the extent specified herein.

Document Title	Document Number	Revision
ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (excluding Electrically Initiated Explosive Devices).	ANSI/ESD S20.20-1999	
Engineering Drawing Practices	ASME Y14.100	
Types and Applications of Engineering Drawings	ASME Y14.24	
Associated Lists	ASME Y14.34	
Revision of Engineering Drawings and Associated Documents	ASME Y14.35M-1997	
Generic Performance Specification for Printed Boards	IPC-6011	
Telemetry Standards	IRIG 106	
Inter Range Instrumentation Group	IRIG-B	
Requirements for Soldered Electrical and Electronic Assemblies	IPC J-STD-001D	
Space Applications Electronic Hardware Addendum to J-STD-001D Requirements for Soldered Electrical and Electronic Assemblies	IPC J-STD-001DS	

Table 2 Non-Government Publications

2.4 Order of Precedence

In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3 DFI DATA ACQUISITION SYSTEM (DFI DAS) REQUIREMENTS

3.1 DFI DAS Description

The Development Flight Instrumentation (DFI) Data Acquisition System (DAS) is part of the Ares I Upper Stage (US) Development Flight Instrumentation System (DFIS). The purpose of the Developmental Flight Instrumentation System (DFIS) is to collect, and telemeter non-critical data that will verify engineering models of the CLV Upper Stage design.

The DFI DAS is a distributed system. Components of the distributed system that make up the DAS for this procurement specification are a Master Data Acquisition Unit (MDAU), two Remote DAUs (RDAU) and a portable workstation. The portable workstation will interface with the DAUs for programming, testing and real-time evaluation of PCM data and video images. Video images will be generated by two cameras. Both cameras will take video of Liquid Hydrogen (LH2) slosh activity. The DFI DAS will be powered by the DFI Power Distribution Unit (PDU). Figure 2 shows the DFIS Architecture.

The MDAU and RDAUs will be mounted on the US Instrument Unit (IU) and on the US Aft Skirt. Figure 1 shows the US Sections that will house DFI DAS components. The J-2X engine program will have an additional RDAU that will mount on the engine and will interface with the DFI DAS units. The J-2X Engine RDAU is not part of this procurement specification.

The MDAU and RDAUs will receive sensor data from the measurements identified in Table 3, and generate Pulse Code Modulation (PCM) stream data. The MDAU will output PCM data to the telemetry system for downlink during the entire DFI mission, approximately 10 minutes. The MDAU will also output PCM data to a First Stage DFI recorder for storage during the FS burn, until FS separation, for approximately the initial 2 minutes of flight. During the FS burn, until First Stage separation, the MDAU will also receive PCM data from a First Stage Data Acquisition Unit and then send that data to the telemetry system for downlink.

The MDAU and RDAUs are considered to be Line Replaceable Units (LRUs). Each LRU is replaceable at any processing facility used by the Ares I vehicle.

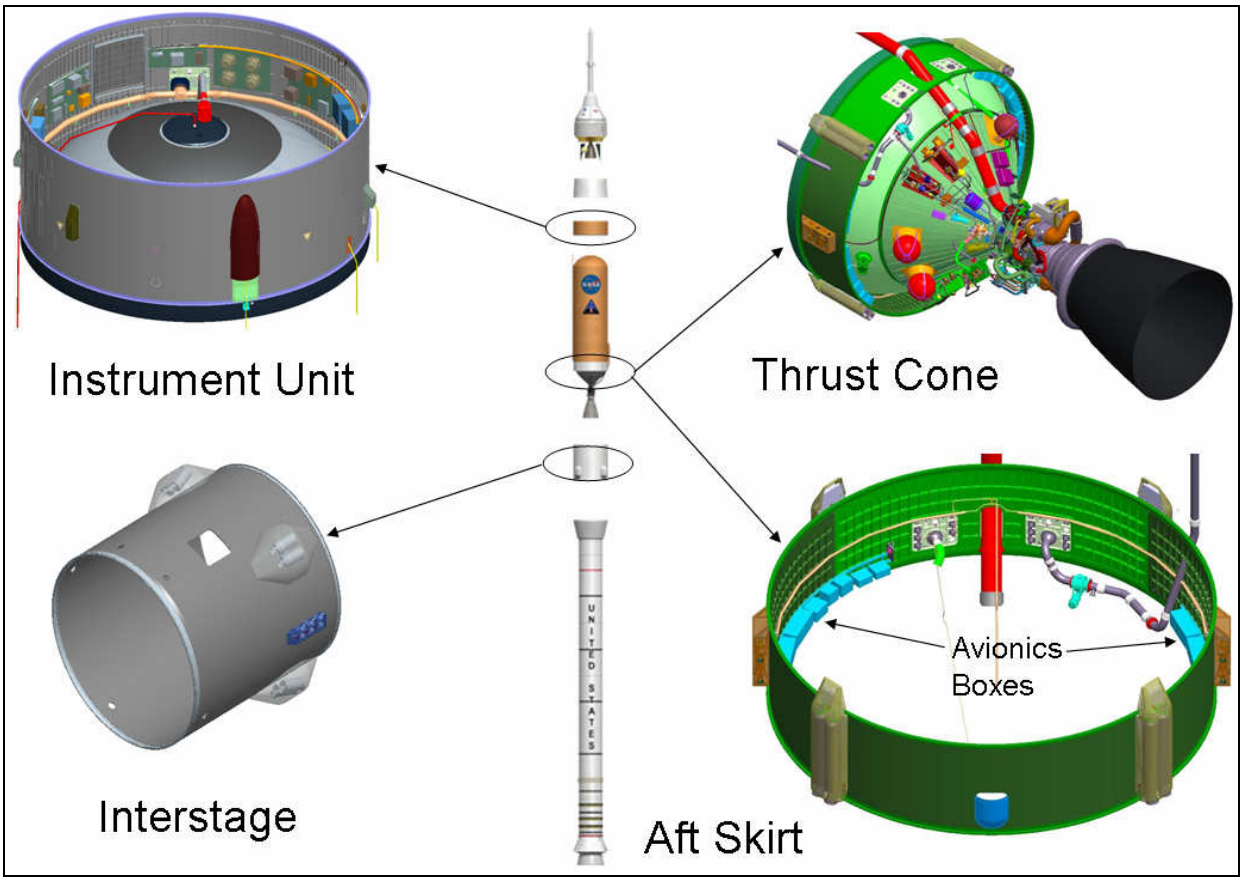

Figure 1 Upper Stage Sections

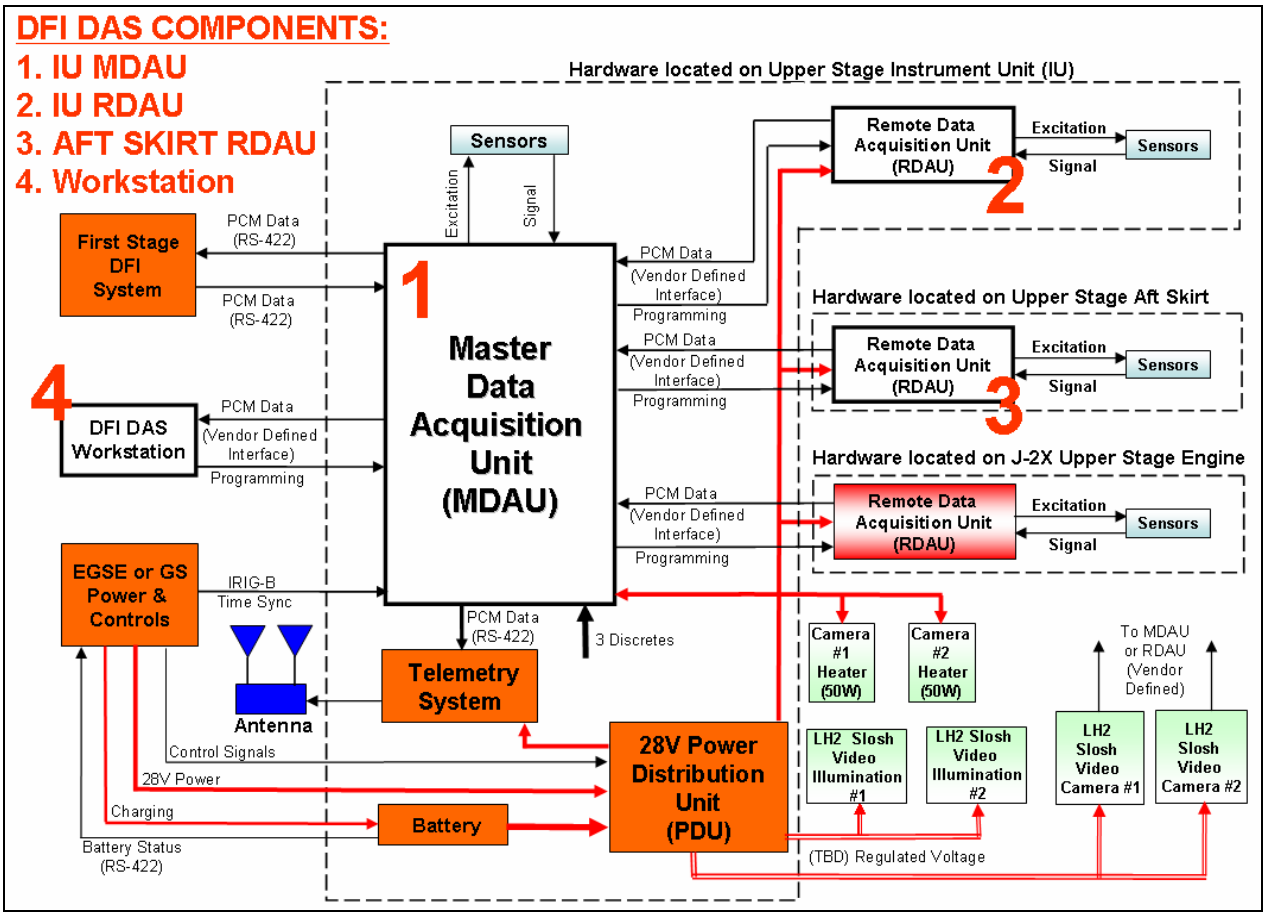

Figure 2 DFI Architecture

3.2 DFI DAS Characteristics

3.2.1 Data Acquisition

3.2.1.1 Initialization to Known PCM Frame Format

Upon power application, the DFI DAS shall initialize to a selected PCM frame format configuration that will be identified at a later date, based on the final measurement list.

[Note: The PCM frame format configuration is not known at this time and will not be specified until the final measurement list for Table 3 is determined.]

3.2.1.2 Power Application Data Output

The DFI DAS shall begin outputting data from the input channels within 3 seconds of power application.

3.2.1.3 Power Interruption Data Output
The DFI DAS shall begin outputting data from the input channels within 3 seconds of a power interruption.

3.2.1.4 Sensor Data Acquisition
The DFI DAS shall acquire data from DFI sensors listed in Table 3 – Measurement Input Channels with characteristics defined in paragraph 3.2.2, Input Channels.

3.2.1.5 PCM Data Acquisition
The DFI DAS shall receive external source PCM data configured per IRIG 106, NRZ Class II Telemetry Standards.

[Rationale: IRIG 106 is a comprehensive telemetry standard to ensure interoperability in aeronautical telemetry applications. Class II includes bit rates greater than 10 Mbps, format changes, and other more complex characteristics than Class I. IRIG 106 is available at http://www.irig106.org/docs/106-05/]

3.2.1.6 PCM Frame Generation
The DFI DAS shall generate PCM frame format structure per IRIG 106, NRZ, Class II Telemetry Standards from all acquired data without any nominal data loss.

[Rationale: IRIG 106 is a comprehensive telemetry standard to ensure interoperability in aeronautical telemetry applications. Class II includes bit rates greater than 10 Mbps, format changes, and other more complex characteristics than Class I. IRIG 106 is available at http://www.irig106.org/docs/106-05/]

3.2.1.7 User Programmable
The DFI DAS configuration, with respect to channel sampling and scheduling, shall be contained in non-volatile memory accessible and programmable by the user.

3.2.1.8 Sampling and Formatting
The DFI DAS shall control the sampling, gains, offset, filtering, formatting and sub-formatting.

3.2.1.9 Number of Data Formats
The DFI DAS shall have a minimum of 8 different PCM frame formats.

3.2.1.10 Format Change via Discrete Signal
The DFI DAS shall be able to change PCM formats via a state change in a minimum of three discrete signals as defined in section 3.2.6.4 5V Discrete Characteristics and 3.2.6.5 28V Discrete Characteristics .

3.2.1.11 DAS Interface Requirements

3.2.1.11.1 MDAU to Telemetry System Interface

The DFI DAS shall use a RS-422 data interface to transmit PCM data to the DFI Telemetry system.

3.2.1.11.1.1 MDAU to Telemetry System Bit Rate

The DFI DAS shall be capable of providing a maximum bit rate of 20Mbps at a distance of 40 feet.

[Rationale: A distance of 40 feet is the estimated worst-case calculated distance from the DFI DAS MDAU to the DFI DAS Telemetry System unit located on the US IU.]

3.2.1.11.1.2 MDAU to Telemetry System Impedance

The DFI DAS shall be capable of interfacing with a cable impedance of 100 ohms, ± 10%.

3.2.1.11.2 MDAU to First Stage DFI System Interface

The DFI DAS shall use four (4) RS-422 data interfaces to transmit PCM data to the First Stage DFI System.

3.2.1.11.2.1 MDAU to First Stage DFI System Bit Rate

The DFI DAS shall be capable of providing a total maximum bit rate of 20Mbps at a distance of 175 feet.

[Rationale: A distance of 175 feet is the estimated worst-case calculated distance from the DFI DAS MDAU to the First Stage recorder unit located on the FS Forward Skirt.]

3.2.1.11.2.2 MDAU to First Stage DFI System Impedance

The DFI DAS shall be capable of providing an impedance of 100 ohms, ± 10%.

3.2.1.11.3 First Stage DFI System to MDAU Interface

The DFI DAS shall use a RS-422 data interface to accept transmitted PCM data from the First Stage DFI System.

3.2.1.11.3.1 First Stage DFI System to MDAU Bit Rate

The DFI DAS shall be capable of receiving a maximum bit rate of 6Mbps at a distance of 175 feet.

[Rationale: A distance of 175 feet is the estimated worst-case calculated distance from the DFI DAS MDAU to the First Stage DFIM unit located on the FS Forward Skirt.]

3.2.1.11.3.2 First Stage DFI System to MDAU Impedance

The DFI DAS shall be capable of providing an impedance of 100 ohms, ± 10%.

3.2.1.11.4 MDAU with RDAU Interface

The DFI DAS data interfaces between the MDAU and RDAUs shall be defined by the vendor.

3.2.1.11.4.1 MDAU with RDAU Interface Distance

The DFI DAS data interfaces between the MDAU and RDAUs shall transmit PCM data at a maximum distance of 155 feet.

[Rationale: A distance of 155 feet is the estimated worst-case calculated distance from the DFI DAS MDAU to a unit located the farthest distance (worst-case) which is the RDAU located on the J-2X Engine. Data rate maximum may be 5Mbps between each RDAU and the MDAU.]

3.2.1.11.5 Workstation Interface

The workstation shall be capable of interfacing with the DFI DAS during ground operations programming, testing and real-time evaluation of PCM data.

[Note: The workstation interface may be determined by the vendor.]

3.2.1.11.6 EGSE Interface

All DFI DAS EGSE interfaces shall meet the requirements described in section 3.6, Interfaces, of USO-CLV-DE-25135, The Upper Stage (US) EGSE Subsystems Requirements Document.

3.2.1.11.7 Test and Programming

The DFI DAS shall provide a minimum of one port for use as a test and programming port.

3.2.2 Input Channels

The DFI DAS shall have unique input channels for the measurements list identified in Table 3, Measurement Input Channels.

3.2.2.1 Input Channel Characteristics

The DFI DAS input channels shall support the types, quantities and data rates of all measurements listed in Table 3, Measurement Input Channels, of this section.

3.2.2.1.1 Sample Rates

The DFI DAS shall be capable of sampling all sensors at the rates identified in Table 3, Measurement Input Channels.

3.2.2.1.2 A/D Resolution

The DFI DAS shall provide A/D conversion to a resolution identified in Table 3, Measurement Input Channels.

3.2.2.1.3 Output/Sample

The DFI DAS shall be able to output/sample per Table 3, Measurement Input Channels.

3.2.2.1.4 Excitation

The DFI DAS shall provide for current or voltage excitation, as identified in Table 3, Measurement Input Channels.

3.2.2.1.5 Signal Conditioning

The DFI DAS shall provide signal conditioning as identified in Table 3, Measurement Input Channels.

3.2.2.1.6 Accuracy

The DFI DAS shall have accuracy as identified in Table 3, Measurement Input Channels.

3.2.2.1.7 Charge Amplifier

The DFI DAS shall provide a Charge Amplifier capability as identified in Table 3, Measurement Input Channels.

3.2.2.1.8 Programmable Filter

The DFI DAS shall provide programmable filters as identified in Table 3, Measurement Input Channels.

3.2.2.1.9 Programmable Gains

The DFI DAS shall provide for programmable gains with programmable offset for each channel as identified in Table 3, Measurement Input Channels.

3.2.2.1.10 Reference Junction Compensation

The DFI DAS shall provide for Reference Junction Compensation as identified in Table 3, Measurement Input Channels.

Sensor / Measurement Type	Number of Measurements	Sampling Rate	Resolution	Output/ Sample	Excitation	Signal Conditioning	Accuracy	Filter	Other
Thermocouple (Type=J,K,E,T)	176	0.1 to 10	12 and 16 bit				+/- 0.8 % full scale		Programmable Gains, 10, 0.01V to 0.5V Reference Junction Compensation
Pressure	256	10 to 10k	12 and 16 bit	simultaneous	voltage up to ±10 V	½ and full bridge completion	+/- 0.8 % full scale	programmable 5 pole	
Strain Gage (50 triaxial)	112	10 to 250	12 and 16 bit	simultaneous	constant current or voltage	½ and full bridge completion	+/- 0.8 % full scale	programmable 5 pole	
Calorimeter / Heat Flux	72	50	12 and 16 bit				+/- 0.8 % full scale		
A/D (Current)	12	0.2 to 1	12 and 16 bit		voltage up to ±10 V, current to 15 mA				
A/D (Voltage)	48	0.2 to 1	12 and 16 bit				± 0.3 % full scale		
Frequency	2	1	12 and 16 bit		voltage up to ±5 V, current to 15 mA		+/- 0.8 % full scale		
Accelerometer	64	100 to 5k	12 and 16 bit	simultaneous	constant voltage and constant current	½ and full bridge completion	+/- 0.8 % full scale	programmable 5 pole	Charge Amplifier
Microphones	24	1k to 5k	12 and 16 bit	simultaneous	constant current or voltage	½ and full bridge completion	+/- 0.8 % full scale	programmable 5 pole	
Position	4	250	12 and 16 bit		3V rms AC Excitation Source		+/- 0.8 % full scale		
Video	2	N/A	12 and 16 bit						
Haz Gas	12	10	12 and 16 bit		28V		±25 ppm/± 10 % of reading		
Total	784								

One Bit Discretes	0	1	1 bit
Two Bit Discretes	0	1	2 bit
Discretes	0	1	
Total Number of Measurements:	784		

Last update
March 21, 20

Table 3 - Measurement Input Channels

3.2.2.1.11 Video

3.2.2.1.11.1 Video Format

The DFI DAS shall interface video image data via GigE (Pro-E-Vision) or Camera Link or IEEE1394.

3.2.2.1.11.2 Video Resolution

The DFI DAS shall receive video with a resolution of at least 640 x 480 pixels.

3.2.2.1.11.3 Video Frame Rate

The DFI DAS shall receive video with progressive scan at up to 60 frames/second and as low as 5 frames/sec.

3.2.2.1.11.4 Video Image Compression

The DFI DAS shall have an average image compression ratio of approximately 20:1 to 30:1.

[Rationale: An image compression ratio of approximately 20:1 to 30:1 may be needed to fit within system bandwidth allocations.]

3.2.3 Time

3.2.3.1 Receiving Time

The DFI DAS shall be able to receive time per IRIG-B time signal from an external source to set its internal clock.

3.2.3.2 Internal Clock

The DFI DAS shall have an internal time circuit to allow continuous time stamp of data per IRIG-106-05, Telemetry Standards.

[Rationale: IRIG 106 is a comprehensive telemetry standard to ensure interoperability in aeronautical telemetry applications. Chapter 4, Section 4.7 describes the formatting of time words within a PCM stream. This standard allows for 1 microsecond resolution. IRIG 106 is available at http://www.irig106.org/docs/106-05/.]

3.2.3.3 Time Stamp of Data

The DFI DAS shall time stamp each major frame per IRIG-106 format.

[Rationale: IRIG 106 is a comprehensive telemetry standard to ensure interoperability in aeronautical telemetry applications. Chapter 4, Section 4.7 describes the formatting of time words within a PCM stream. This standard allows for 1 microsecond resolution. IRIG 106 is available at http://www.irig106.org/docs/106-05/.]

3.2.3.4 Time Stamp Accuracy
The DFI DAS shall time stamp each major frame with an accuracy of a minimum of 1 millisecond of the IRIG B input time signal.

3.2.3.5 Time Stamp Precision
The DFI DAS shall time stamp each major frame with precision per IRIG-106 format.

[Rationale: IRIG 106 is a comprehensive telemetry standard to ensure interoperability in aeronautical telemetry applications. Section 4.7 describes the formatting of time words within a PCM stream. This standard allows for 1 microsecond resolution. IRIG 106 is available at http://www.irig106.org/docs/106-05/.]

3.2.4 Workstation Characteristics
3.2.4.1 Workstation Computer
The DFI DAS Workstation shall use a Windows based computer.

3.2.4.2 Data Channel Configuration
The DFI DAS Workstation shall be capable of configuring every data channel.

3.2.4.3 Configurable Channel Sampling Rates
The DFI DAS Workstation shall be capable of configuring independent sampling rates for each data channel.

3.2.4.4 Configurable Channel Gain
The DFI DAS Workstation shall be capable of configuring the gain for each data channel.

3.2.4.5 Configurable Channel Offset
The DFI DAS Workstation shall be capable of configuring the offset for each data channel.

3.2.4.6 Configurable Channel Calibration
The DFI DAS Workstation shall be capable of configuring calibration information for each data channel.

3.2.4.7 Configurable Channel Range
The DFI DAS Workstation shall be capable of configuring A/D range for each data channel.

3.2.4.8 Receiving Channel Data
The DFI DAS Workstation shall be capable of receiving sensor data from every data channel.

3.2.4.9 Display Data in Counts Format
The DFI DAS Workstation shall display data in counts format.

3.2.4.10 Display Data in Units Format
The DFI DAS Workstation shall display data in engineering unit's format.

3.2.4.11 Display Data in Strip Chart Format
The DFI DAS Workstation shall display data in strip chart format.

3.2.4.12 Display Data with Alarms
The DFI DAS Workstation shall display data with alarms to be uniquely configurable for each data channel and capable of generating alarms for out of range data.

3.2.4.13 Portability
The DFI DAS Workstation shall be portable like a laptop or a portable desktop computer.

3.2.4.14 Display Parameters
The Workstation shall provide display of all DFI DAS parameters during ground operations programming and testing.

3.2.4.15 Built In Test (BIT)
The DFI DAS Workstation shall be capable of performing a Built In Test (BIT) to indicate system health.

[Rationale: BIT must indicate system power on and DAU configuration integrity.

3.2.4.16 Reliability
The DFI DAS shall have a Mean Time To Failure (MTTF) of at least 20,000 hours.

3.2.4.16.1 Reliability Data
The DFI DAS vendor shall supply sufficient data to support the reliability assessment in accordance with section 3.1.6, Commercial of the Shelf Hardware/Software, of CxP 70059 Constellation Program (CxP) Integrated Safety, Reliability, and Quality Assurance (SR&QA) Requirements.

3.2.4.17 Failure Propagation
The DFI DAS shall not cause damage to or failures of interfacing elements due to transient out-of-tolerance conditions or a failure.

3.2.4.18 Flight Operation Life
The DFI DAS shall meet flight operational performance for a flight time of 10 minutes per the requirements of section 3.2, DFI DAS Characteristics.

3.2.4.19 Calibration
The DFI DAS shall provide for calibration.

3.2.5 Environmental Conditions

3.2.5.1 Natural Environments

The DFI DAS shall meet all functional and performance requirements within the range of environmental conditions specified in CxP 70023 Constellation Program Design Specification For Natural Environments, Sections 3.1, 3.2.

3.2.5.2 Induced Environments

3.2.5.2.1 Transportation (packaged)

The DFI DAS shall meet the operating performance requirements contained herein after exposure to transportation conditions when packaged in accordance with the Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components, NPR.6000.1G. The worst-case values of the following parameters will determine the vendor's shipping method. These values will determine qualification test values of section 3.2.5.3, Qualification Test Requirements.

3.2.5.2.2 Non-Operating Environment

3.2.5.2.2.1 Storage

The DFI DAS shall be stored in a controlled environment.

3.2.5.2.2.1.1 Storage Time

The DFI DAS shall meet the operating performance requirements contained herein after being in storage for a period of 5 years.

3.2.5.2.2.2 Non-Operating Temperature

The DFI DAS shall be stored within a temperature range of -65°F (-54°C) to 126°F (52°C)

[Rationale: The non-operating temperature and humidity conditions cover worst case for storage, transport, and roll-out. Purge will not be provided to control temperature and humidity except during rollout. The non-operating conditions specified above are currently thought to represent worst case and are representative of transport environments on a covered barge.]

3.2.5.2.2.3 Non-Operating Humidity

The DFI DAS shall be stored with a humidity not to exceed 90% RH.

[Rationale: The non-operating temperature and humidity conditions cover worst case for storage, transport, and roll-out. Purge will not be provided to control temperature and humidity except during rollout. The non-operating conditions specified above are currently thought to represent worst case and are representative of transport environments on a covered barge.]

3.2.5.2.3 Operating Environment

The DFI DAS will be used during ground operations as well as flight. Sections 3.2.5.2.3.1 through 3.2.5.2.3.6 cover the worst case operational ground and flight conditions.

3.2.5.2.3.1 Operating Temperature

The DFI DAS shall meet all performance requirements after exposure to temperatures in the range of 0°F (-18°C) to 150°F (66°C).

3.2.5.2.3.2 Operating Humidity

The DFI DAS shall meet all performance requirements after exposure to a humidity level up to 90% RH.

3.2.5.2.3.3 Random Vibration and Shock

The DFI DAS shall satisfy all flight performance requirements after exposure to vibration and shock environments as defined in Upper Stage sections from CxP 72169, Ares I Vibroacoustic and Shock Environments Data book. Section 3.1.2, Random Vibration; Section 3.2.2, Shock Environments; Section 3.3.2, Internal Acoustic Environments.

3.2.5.2.3.4 Pressure Change

The DFI DAS shall be able to operate when exposed to a pressure change from 760 Torr/1 atm (Sea Level) to 10^{-5} Torr (near vacuum).

3.2.5.2.3.5 Pressure Rate of Change

The DFI DAS shall be able to operate when exposed to a pressure rate change starting at a pressure of 14 psi and decreasing in 26 seconds to 1 psi.

3.2.5.2.3.6 Loads Analysis

The DFI DAS shall comply with the requirements of NASA-STD-5002 for loads analysis of spacecraft and payloads.

3.2.5.3 Qualification Test Requirements

The DFI DAS shall successfully comply with qualification test requirements per section 4.0 of the Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

[Rationale: Proof pressure, leak test are not required as the DFI DAS is not sealed or a pressure vessel with specified leak rate. Acoustic vibration, thermal gradient, plasma/arcing testing are not required for electrical or Electronic Equipment per Table 4-3 of CxP 70036. Corona/arcing testing is not required if voltages are below 150V per 4.15 of CxP 70036.] Oxygen compatibility qualification is normally conducted by analysis per the requirements documented in NASA-STD-(I)-6016, per 4.18.1 of CxP 70036.]

3.2.5.4 Acceptance Test Requirements

The DFI DAS units submitted for acceptance testing under the contract shall successfully comply with acceptance test requirements per the Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

[Rationale: Proof pressure, leak test are not required as the DFI DAS is not sealed or a pressure vessel with specified leak rate. Acoustic vibration, thermal gradient, plasma/arcing testing are not required for electrical or Electronic Equipment per Table 4-3 of CxP 70036. Flight (acceptance) units are not subjected to life testing, climatic testing, acceleration testing, or sinusoidal testing per 4.11, 4.13, 4.14, and 4.15, respectively, of CxP 70036. Corona/arcing testing is not required if voltages are below 150V per 4.15 of CxP 70036. Oxygen compatibility testing is not required if the maximum design pressure is less than 265 psia per 4.18.1 of CxP 70036.]

3.2.6 Electrical Design

3.2.6.1 Input Power

The DFI DAS input power shall not exceed 350 watts over a steady state input voltage range of 23 to 36 VDC.

3.2.6.2 Input Voltage Range

The DFI DAS shall meet the requirements of CxP 70050-02, Constellation Program Electrical Power System Specification, Volume 2: Electrical Power Quality Performance for 28 Vdc.

3.2.6.3 Short Circuit Protection

The DFI DAS shall comply with the requirements of NASA Technical Memorandum 102179, Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits.

3.2.6.4 5V Discrete Characteristics

The DFI DAS 5V discrete inputs shall have the following characteristics:

a. ON: 0.6 mA maximum sink current and 3.25VDC minimum input voltage
b. OFF: 1VDC maximum; 50 μA maximum sink current.

3.2.6.4.1 Pull Down Characteristic

The input shall be pulled down to the OFF voltage specified in 3.2.6.4, 5V Discrete Input Characteristics when not connected.

3.2.6.4.2 Quantity

There shall be a minimum of one 5V discrete inputs.

3.2.6.5 28V Discrete Input Characteristics

The DFI DAS 28V discrete inputs shall have the following characteristics:

a. ON: 22 to 32 VDC; 100 mA maximum sink current
b. OFF: 1.0 VDC maximum, 250 μA maximum sink current

3.2.6.5.1 Pull Down Characteristic

The input shall be pulled down to the OFF voltage specified in 3.2.7.5 when not connected.

3.2.6.5.2 Quantity

There shall be a minimum of two 28V discrete inputs.

3.2.6.6 Electrical Bonding

The DFI DAS shall meet the electrical bonding requirements of NASA-STD-4003, Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment.

[Rationale: NASA-STD-4003 is applicable as a whole. It is expected that DFI DAS will require several types of bonds. Section 6.1, Design Requirements, of NASA-STD-4003 gives guidance in this situation. NASA-STD-4003 is available online at http://standards.nasa.gov/released/4003/NASA-STD-4003.pdf

3.2.6.7 Electrical Grounding

The DFI DAS shall meet the electrical grounding requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

[Rationale: Section 3.11 Grounding of CxP 72043 indicates the requirements for implementing single point grounding.]

3.2.6.8 Lightning Protection

The DFI DAS shall meet the lightning protection requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

[Rationale: Section 3.5, Lightning, of CxP 72043 indicates the design requirements for lightning. The specific environment for the DFI DAS location has not been defined, a conservative design for a direct lightning strike to the DFI DAS or indirect strike through any connector on the DFI DAS should provide adequate protection. Applicable Crew Launch
Vehicle mission segments in section 3.5 are On-pad Operations, Launch and Ascent. Sections 3.5.1.1, Zoning, and 3.5.1.2 Zone Lightning Environment, do not apply to the DFI DAS. The DFI DAS test specifications for lightning are located in 3.2.6.16 Electromagnetic Interference, of this specification.]

3.2.6.9 Electrostatic Discharge (ESD) Protection

The DFI DAS shall meet the electrostatic discharge (ESD) protection requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

[Rationale: Section 3.7, Electrostatic Charge Control, of CxP 72043 specifies the design requirements for ESD protection and refers to the Class H and Class S requirements of NASASTD-4003. The DFI DAS test specifications for ESD are located in 3.2.6.16 Electromagnetic Interference, of this specification.]

3.2.6.10 Isolation of Test Points

The DFI DAS shall isolate test points and internal circuits such that a test point short to ground does not damage the Upper Stage Avionics hardware.

3.2.6.11 Electrical, Electronic, Electromechanical (EEE) Parts

The DFI DAS shall meet the requirements of MSFC-STD-3012, EEE Parts Management and Control for MSFC Space Flight Hardware, as tailored by CxP 72053, EEE Parts Management and Control Plan.

[Rationale: These documents indicate part selection requirements according to the criticality of the assembly. The DFI DAS is criticality 3. Consequently, Grade 4 parts as defined in the documents are the minimum grade allowed, however, higher grade parts may be needed to meet the assembly level MTTF and qualification requirements of this DFI DAS specification.]

3.2.6.12 Inadvertent Disconnect

The DFI DAS shall prevent inadvertent disconnects.

3.2.6.13 Printed Wiring Boards

The DFI DAS shall meet the design requirements of MFSC-STD-3425, Design Requirements for Rigid Printed Circuit Boards and Assemblies and be constructed in accordance with the Class 3 requirements of IPC-6011, Generic Performance Specification for Printed Boards.

[Rationale: MSFC-STD-3425 is a tailoring document for IPC-2221 and IPC-2222 which specify design requirements for printed circuit boards. The tailoring places further restrictions on board design to further increase uniformity and reliability. MSFC-STD-3425 is available at https://repository.msfc.nasa.gov/docs/multiprogram/MSFC-STD-3425.pdf]

3.2.6.14 Ignition Source Avoidance

The DFI DAS electrical components and wiring shall be conformal coated or otherwise ignition-proof to prevent ignition of potentially flammable or explosive gases/fluids existing in the Instrument Unit and Aft Skirt locations volume.

3.2.6.15 Electromagnetic Interference

The DFI DAS shall meet the electromagnetic interference requirements of CxP 72047, CLV Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment.

[Rationale: CxP 72047 is applicable as a whole with the exception that only the tests specified for non-antenna battery powered electronic units apply to the DFI DAS. CxP 72047 is applicable to Ground Support Equipment as stated in CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document, section 3.6.1.3 NDI/Commercial Items used in Electrical Ground Support Equipment.]

3.2.6.16 Circuit Classification

The DFI DAS shall meet the electrical circuit classification requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

[Rationale: Section 3.12.1, Cable and Wire Design for Electromagnetic Compatibility, of CxP 72043, indicates the characteristics of signals and the classification to which each signal type is assigned.]

3.2.6.17 Connector Location and Pin Function Assignments

The DFI DAS connector location and pin function assignments shall be provided.

3.2.6.18 Wire and Cable Shielding, Separation, and Routing

The DFI DAS shall meet the wire and cable shielding, separation, and routing requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

[Rationale: Section 3.12.2, Cable and Wire Design for Electromagnetic Compatibility, of CxP 72043, indicates that signals of different classifications should be separated by separating wires or cables physically, using cable trays, or shielding.]

3.2.6.19 Electrostatic Discharge (ESD) Controls

The CEI shall be produced/manufactured using ESD controls in accordance with ANSI/ESD S20.20-1999, ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (excluding Electrically Initiated Explosive Devices).

3.2.7 Structural and Mechanical

3.2.7.1 Materials and Processes

Components/hardware shall meet the requirements of USO-CLV-MP-25502 which implements the requirements of NASA-STD-(I)-6016 for materials and processes. Guidance specific to this procurement is provided in sections a-d below.

Guidance/Rationale:

a. For COTS hardware, complete materials and processes information and the Material Item Usage List (MIUL) may not be available. If accepted by M&P of the procuring authority, a complete as-built drawing package may be evaluated in lieu of an MIUL. However, the information will need to be sufficient, down to the manufactured parts level, to assess the overall safety of the hardware, and to verify the effect of any materials or processes (M&P) failure that will create a hazard or compromise mission success.

b. Vendor will inform procuring authority M&P of wire insulation other than PTFE Teflon

c. Vendor will inform procuring authority M&P of any use of tin not containing at least 3% lead.

d. Materials used in the design will meet the flammability requirements of NASA-STD-6001. A flammability assessment may be used to evaluate the flammability of a component or assembly. Flammability assessment and logic will be consistent with the approach provided in the in JSC 29353A, Flammability Configuration Analysis for Spacecraft Applications. If some minor use materials in COTS cannot be identified, the flammability assessment will be conducted to evaluate the flammability of the COTS hardware as an assembly.

The following are examples, but not a complete list, of areas considered in the overall acceptability of COTS hardware, to assure that failure of materials and processes used in the hardware does not create a hazard or compromise mission success: stress corrosion cracking, corrosion, adhesive failure, contamination/FOD, materials degradation, incompatibility of materials with fluids or natural and induced environments, defects from material joining, unauthorized material substitution, use of pure tin.

3.2.7.2 Fracture Control
The DFI DAS system shall meet the fracture control requirements in accordance with NASA-STD-5019, Fracture Control Requirements for Spaceflight Hardware.

3.2.7.3 Drawing Quality
The DFI DAS drawings and associated lists shall be prepared in accordance with ASME Y14.100, Engineering Drawing Practices, ASME Y14.24, Types and Applications of Engineering Drawings, ASME Y14.34, Associated Lists and ASME Y14.35M-1997, Revision of Engineering Drawings and Associated Documents.

[Rationale: ASME Y14.100, Engineering Drawing Practices, ASME Y14.24, Types and Applications of Engineering Drawings, ASME Y14.34, Associated Lists and ASME Y14.35M-1997, Revision of Engineering Drawings and Associated Documents supersede/replace MIL-STD-100, D.O.D. Standard for Engineering Drawings.]

3.2.7.4 Cooling
The DFI DAS shall not require active cooling.

3.2.7.5 Captive Fasteners
The DFI DAS shall use captive fasteners in accordance with MSFC-STD-2594C, MSFC Fastener Management & Control Practices.

3.2.7.6 Factors of Safety
The DFI DAS shall comply with the requirements of CxP 70135, CONSTELLATION PROGRAM STRUCTURAL DESIGN AND VERIFICATION REQUIREMENTS, section 3.10.

3.2.7.7 Debris Prevention
The DFI DAS shall be designed to preclude the generation or shedding of debris during pre-launch or ascent which might jeopardize personnel or other vehicle equipment.

3.2.7.8 Chemical Exposure in the Instrument Unit (IU)
The DFI DAS materials that will be exposed to the atmospheric environment in the IU shall be selected to be compatible with monomethyl hydrazine (MMH) and nitrogen tetroxide (NTO) as identified in the Materials and Processes Technical Information System (MAPTIS) database.

[Rationale: MAPTIS is Marshall Space Flight Center's single-point source for materials properties for NASA and NASA associated contractors and organizations. The MAPTIS-II system contains physical, mechanical and environmental properties for metallic and non-metallic materials. http://maptis.nasa.gov/index.asp]

3.2.7.9 LRU Interchangeability
The DFI DAS shall have Line Replaceable Units (LRU) that are interchangeable with LRUs of the same end item specification design within all applicable vehicle and laboratory mounting locations.

3.2.7.10 Connector Mismating
The DFI DAS shall use connector keying to prevent mismating.

3.2.7.11 DAU Chassis Size
The DFI DAS shall have the same size chassis for all DAUs.

3.2.7.12 Distributed System
The DFI DAS shall be a distributed system with a minimum of two chassis boxes.

3.2.8 Product Marking
3.2.8.1 Identification and Marking
The DFI DAS shall be manufactured with identification and marking methods in accordance with MIL-STD-130, DEPARTMENT OF DEFENSE STANDARD PRACTICE IDENTIFICATION MARKING OF U.S. MILITARY PROPERTY.

3.2.8.2 ESD Identification and Marking
The DFI DAS shall be manufactured with ESD (electrostatic discharge) identification and marking methods in accordance with MIL-STD-130, DEPARTMENT OF DEFENSE STANDARD PRACTICE IDENTIFICATION MARKING OF U.S. MILITARY PROPERTY.

3.2.8.3 Serial Numbers
The DFI DAS components shall be identified by a serial number.

3.2.9 Workmanship

3.2.9.1 Soldering
The DFI DAS shall be manufactured in accordance with J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

3.2.9.2 Crimping
The DFI DAS shall be manufactured in accordance with NASA-STD-8739.4, as tailored by MSFC-STD-2905, MSFC Tailoring Guide for NASA-STD-8739.4, Crimping, Interconnecting Cables, Harness, and Wiring.

3.2.9.3 Soldering of Surface Mount Components
The DFI DAS shall be manufactured with soldering methods for Surface Mount Technology (SMT) components in accordance with J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

3.2.9.4 Conformal Coating and Staking
The DFI DAS shall be manufactured with fabrication controls and processes used in staking and conformal coating of printed wiring boards and electronic assemblies in accordance with J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

3.2.9.5 Tin Whisker Mitigation
The DFI DAS shall be manufactured using Tin Whisker Mitigation methods in accordance with J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

[Rationale: Section 1.5.1 and 1.5.2, J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies, indicates that RoHS, 3% minimum lead (Pb) must be used.]

3.2.10 Human Engineering
3.2.10.1 Human Engineering Guidelines
The DFI DAS shall meet the human engineering guidelines of NASA-STD-3000, Man-Systems Integration Standards, and CxP 70024Constellation Human-Systems Integration Requirements (HSIR).

3.2.10.2 Sharp Edges
The DFI DAS shall comply with the requirements of Human Factors Engineering Design Criteria, USO-CLV-LS-25404, to protect operators against injury from sharp edges and corners.

3.2.10.3 Maximum Touch Temperature
The DFI DAS maximum touch temperature shall meet the requirements of Human Factors Engineering Design Criteria, USO-CLV-LS-25404, section 5.13.4.6, Table X, for surfaces that are exposed to personnel while the Upper Stage Avionics equipment is installed and being operated.

[Rationale: Human Factors Engineering Design Criteria, USO-CLV-LS-25404 refers to detailed requirements from MIL-STD-1472F, "DOD Design Criteria Standard, Human Engineering", table XXI. Values exceeding maximum limits shall be appropriately guarded.]

3.2.10.4 Minimum Touch Temperature

The DFI DAS minimum touch temperature shall meet the requirements of Human Factors Engineering Design Criteria, USO-CLV-LS-25404, section 5.13.4.6, for surfaces that are exposed to personnel while the Upper Stage Avionics equipment is installed and being operated.

3.2.10.5 General Safety

The DFI DAS vendor shall supply sufficient drawings, documents, process plans, and procedures to support the development of hazard analyses and hazard reports in accordance with sections 2.2.1, Hazard Analysis, of CxP 70059 Constellation Program (CxP) Integrated Safety, Reliability, and Quality Assurance (SR&QA) Requirements.

[Rationale: Hazard analyses will be performed by the Project at the integrated level of assembly.]

3.2.10.6 Contamination Control

The DFI DAS external and internal surfaces shall be cleaned to Visibly Clean-Standard as a minimum per the requirements in CxP 70145, Constellation Program Contamination Control Requirements.

3.2.10.7 Box Integration for Ground Operations

The DFI DAS shall meet the box integration requirements for ground operations in accordance with Human-Systems Integration Requirements (HSIR), CxP 70024, Section 3.9.

3.3 Packaging Requirements

The methods of preservation, packaging and packing utilized for shipment together with necessary special control during transportation shall adequately protect the DFI DAS from damage or degradation of performance due to the natural and induced environments encountered during transportation and subsequent indoor storage per NPR.6000.1G. The requirements herein govern the preparation for shipment and the transport of the DFI DAS to all Buyer and Government facilities.

3.3.1 Packaging Design Requirement (Structural)

Preservation, packaging, and packing shall withstand the rough handling package requirements of NPR.6000.1G as defined in accordance with the following:

(a) Free fall flat drop
(b) Free fall corner drop
(c) Sinusoidal vibration

3.3.2 Reusable Containers

Where analysis indicates a requirement for reusable containers, maximum practical utilization shall be made of standard off-the-shelf, low cost, metal or plastic containers.

3.3.3 Monitoring Devices

Utilization of instrumentation for monitoring or recording in-transit environments (e.g., shock, vibration, temperature, humidity, etc.) to assure safe arrival is required and shall be approved by the Buyer prior to implementation.

3.3.4 Temporarily Installed Hardware Identification

All temporarily installed devices such as caps, plugs, covers, support bracketry, protective plates, etc., shall be marked "NOT FLIGHT" or otherwise indicated as not for flight to ensure they are easily identified under casual observation.

3.3.5 Marking for Shipment

Interior and exterior containers shall be marked and labeled in accordance with MIL-STD-130 including precautionary markings necessary to ensure safety of personnel and facilities and to ensure safe handling, transport, and storage.

3.3.6 Marking for Reuse

Packages with reuse capability shall be identified with the words "REUSABLE CONTAINER – DO NOT DESTROY – RETAIN FOR REUSE."

3.3.7 NASA Critical Item Labels

NASA Critical Item Labels shall be applied in accordance with MIL-STD-2073 and NPR.6000.1G.

3.3.8 Identification Format

Identification information on the interior and exterior containers shall be in the following format MIL-STD-2073 and NPR.6000.1G.

4 VERIFICATION

The verification program shall ensure that the DFI DAS will conform to the design and performance requirements specified in Section 3. For each Section 3 requirement, there is a corresponding Section 4 verification requirement that contains the requirements necessary to show compliance with each “shall” statement. The verification requirement must have three parts: the method of verification, a description of the verification work to be performed, and success criteria that determines when the verification is complete. Non- “shall” statements will not have a verification requirement for compliance.

This following section identifies the how, what, and when the requirements will be verified and the various organizations and personnel that will conduct and support verification.

Description

4.1.1 Verification Methods

Verification methods are the methods by which the requirements in Section 3.0 are to be verified. One or more of the following methods will be used:
1. Test—Verification by test is the actual operation of equipment during ambient conditions or when hardware is subjected to specified environments to evaluate performance.

1a. Functional Test—Functional testing is an individual test or series of electrical or mechanical performance tests conducted on flight or flight-configured hardware and/or software at conditions equal to or less than design specifications. Its purpose is to establish that the system performs satisfactorily in accordance with design and performance specifications. Functional testing generally is performed at ambient conditions. Functional testing is performed before and after each environmental test or major move in order to verify system performance prior to the next test/operation.

1b. Environmental Test—Environmental testing is an individual test or series of tests conducted on flight or flight-configured hardware and/or software to assure the hardware will perform satisfactorily in its flight environment. Environmental tests include vibration, acoustic and thermal vacuum and may or may not be combined with functional testing depending on the objectives of the test.

2. Analysis—Verification by analysis is a process used in lieu of or in addition to testing to verify compliance to requirements. The selected techniques may include systems engineering analysis, statistics and qualitative analysis, computer and hardware simulations, analog modeling, similarity assessment, and verification of records.

3. Demonstration—Verification by demonstration is the use of actual demonstration techniques in conjunction with requirements such as operational performance, serviceability, accessibility, transportability, human engineering features, and display data.

4. Inspection—Verification by inspection is the physical evaluation of hardware and/or documentation/drawings to verify design features. Inspection is used to verify construction features, workmanship, dimension and physical condition, such as cleanliness, surface finish, and locking hardware.

4.1.2 Verification Cross Reference Matrix

A Verification Cross Reference Matrix (VCRM) is generated to show the requirement trace and closure methods. The VCRM is an appendix to this document.

4.1.3 Responsibility for Inspection

The manufacturer shall be responsible for the performance of all inspection requirements as herein and to the requirements of the production, test, and inspection plan. The manufacturer may utilize his own or any other inspection facilities and services acceptable to the Government. The Government reserves the right to witness or separately perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.4 Test Equipment and Facilities

All test equipment shall be calibrated. Calibration standards shall be traceable to the National Institute of Standards.

4.1.5 Standard Test Conditions

The DFI DAS tests shall be performed in an open area having a temperature of 23°±10°C, a relative humidity 50±30%, and a barometric pressure of 101 + 2/–23 kilopascals (29.9 + 0.6/–6.8 Hg).

[Rationale: These ambient conditions are defined by CxP 70036, Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR).]

4.1.6 Acceptance and Rejection Criteria

The DFI DAS which has passed all of the requirements of section 3.2.5.2 Acceptance Test Requirements shall be accepted. Assemblies which are not accepted will be considered rejected. The full particulars concerning rejection and the necessary action taken to correct the defect will be made available to the Government inspector before resubmittal of the assembly for retest.

4.1.7 Government Acceptance Inspections

The Government acceptance inspection shall be conducted in accordance with the provisions of the contract and shall include inspections of hardware, software, electrical drawings, mechanical drawings, procedures, reports, and analyses used to complete verifications.

4.1.8 Acceptance Tests
Each assembly submitted for acceptance under the contract shall successfully comply with acceptance test requirements of section 3.2.5.4 Acceptance Test Requirements.

4.1.9 Reliability Tests
See section 3.2.4.16 Reliability for reliability requirements.

4.1.10 Environmental Tests
Verification of the qualification requirements of 3.2.5.3 Qualification Test Requirements shall be conducted before delivery of the first acceptance DFI DAS.

4.2 DFI DAS Characteristics

No verification required.

4.2.1 Data Acquisition
No verification required.

4.2.1.1 Initialization to Known PCM Frame Format
This verification shall be by test and inspection.

A test shall be conducted to verify that the DFI DAS initializes to a selected PCM frame format after power has been applied. An inspection of the user documentation shall be conducted to verify that the state after initialization is described in the documentation.

This verification shall be considered successfully met when the DFI DAS initializes to a selected frame format upon application of power and user documentation describes the initialization state.

4.2.1.2 Power Application Data Output
This verification shall be by test.

A test of the DFI DAS shall be conducted which verifies that data collection begins within 3 seconds of power application.

This test shall be considered successful when output data timestamps begin within 3 seconds of DFI DAS power application.

4.2.1.3 Power Interruption Data Output
This verification shall be by test.

A test of the DFI DAS shall be conducted which verifies that data collection begins within 3 seconds of power restoration after a power interruption.

This test shall be considered successful when output data timestamps begin within 3 seconds of power restoration after a DFI DAS power interruption.

4.2.1.4 Sensor Data Acquisition

This verification shall be by test and inspection.

A test of the DFI DAS shall be conducted to verify that the DFI DAS can acquire data from the sensors in Table 3. The test shall include at least one sensor of each kind in Table 3. Each channel shall be tested. An inspection of the user documentation shall be conducted to verify that the DFI DAS is compatible with each type of sensor in Table 3.

This verification shall be considered successful when output data is data is generated for each channel and when the inspection of user documentation indicates compatibility with each type of sensor listed in Table 3.

4.2.1.5 PCM Data Acquisition

This verification shall be by test and inspection.

A test shall be conducted to verify that the DFI DAS acquires external source PCM data per IRIG 106, NRZ, Class II Telemetry Standard. An inspection of the user documentation shall be conducted to verify that the DFI DAS user documentation indicates the procedure required to acquire external PCM data.

This verification shall be considered successful when the DFI DAS generates output from PCM data input per IRIG 106, NRZ, Class II Telemetry Standard and when user documentation indicates the procedure for acquiring PCM data.

4.2.1.6 PCM Frame Generation

This verification shall be by test.

A test shall be conducted to verify that the DFI DAS generates PCM data in accordance with IRIG 106, NRZ, Class II Telemetry Standards with no data loss.

This verification shall be considered successful when the DFI DAS output conforms to IRIG 106, NRZ, Class II Telemetry Standards with no data loss.

4.2.1.7 User Programmable

This verification shall be by test and inspection.

The test shall include programming the DFI DAS channel sampling and scheduling. The test shall include objective evidence that the sampling and scheduling program resides in non-volatile memory (for example, the program is accessible after cycling power)

An inspection of the user documentation shall verify that a procedure for programming the DFI DAS in non-volatile memory is included in the user documentation.

This verification shall be considered successfully met when the test results indicate the DFI DAS program has been saved in non-volatile memory and the inspection of the user documentation indicates the procedure for programming the DFI DAS into non-volatile memory.

4.2.1.8 Sampling and Formatting

This verification shall be by test and inspection.

The test shall include setting the parameters of the DFI DAS indicated in the requirement; sampling, gains, offset, filtering formatting and sub-formatting for each type of channel in Table 3. The inspection of the user documentation shall verify the procedures for setting the parameters are included in the user documentation.

This verification shall be considered successfully met when the data collected from the test of each DFI DAS channel type listed in Table 3 indicates that the channel parameters have been set as intended and when the inspection verifies the procedure for setting up each channel is included in the user documentation.

4.2.1.9 Number of Data Formats

This verification shall be by test and inspection.

The test shall include collecting output data in a minimum of 8 different PCM frame formats. The inspection of the user documentation shall verify that the procedure exists for configuring the DFI DAS in a minimum of 8 different PCM frame formats.

This verification shall be considered successfully met when the data collected from the test shows the DFI DAS is capable of sending data in at least 8 PCM frame formats and when the inspection report indicates the location of the procedure for configuring the DFI DAS in each of the 8 or more output PCM formats.

4.2.1.10 Format Change via Discrete Signal

This verification shall be by test and inspection.

The test shall include collecting DFI DAS output data while each of, a minimum of, 3 discrete inputs is toggled individually. The discrete signals shall be produced in accordance with section 4.2.6.4, 5V

Discrete Characteristics, and 4.2.6.5, 28V Discrete Characteristics. The inspection of the user documentation shall verify that the user documentation includes a procedure for configuring the DFI DAS for a change in output format based on the individual change of state of a minimum of 3 discretes.

This verification shall be considered successfully met when the data collected from the test shows the output format changed as a result of the individual change in state of, a minimum of, 3 discrete inputs, as defined in section 4.2.6.4, 5V Discrete Characteristics, and 4.2.6.5, 28V Discrete Characteristics, and when the inspection report indicates the location in the user documentation of the procedure for configuring the DFI DAS to change output format based on a discrete input change in state.

4.2.1.11 DAS Interface Requirements

No verification required.

4.2.1.11.1 MDAU to Telemetry System Interface

This verification shall be by inspection.

An inspection of the DFI DAS drawings and user documentation shall be performed.

This verification shall be considered successfully met when the inspection report indicates that interface to the telemetry system is an RS-422 interface that is capable of transmitting PCM data.

4.2.1.11.1.1 MDAU to Telemetry System Bit Rate

This verification shall be by test.

The test shall include transmitting PCM data from the MDAU to Telemetry interface at 20Mbps through a 40 foot shielded twisted pair cable with impedance as indicated in 3.2.1.11.1.2, MDAU to Telemetry System Impedance.

This verification shall be considered successfully met when the test report indicates that the interface to the telemetry system has successfully transmitted PCM data at 20Mbps through a 40 foot shielded twisted pair cable with impedance as indicated in 3.2.1.13.1.2, MDAU to Telemetry System Impedance.

4.2.1.11.1.2 MDAU to Telemetry System Impedance

This requirement shall be verified when the verification of 4.2.1.11.1.1, MDAU to Telemetry System Bit Rate, has been successfully completed.

4.2.1.11.2 MDAU to First Stage DFI System Interface

This verification shall be by inspection.

An inspection of the DFI DAS drawings and user documentation shall be performed.

This verification shall be considered successfully met when the inspection report indicates that this interface from the First Stage DFI system is four (4) RS-422 interfaces that are capable of transmitting PCM data.

4.2.1.11.2.1 MDAU to First Stage DFI System Bit Rate

This verification shall be by test.

The test shall include transmitting PCM data from the MDAU to First Stage DFI interface at 20Mbps through four (4) 175 foot shielded twisted pair cable with impedance as indicated in 3.2.1.11.2.2., MDAU to First Stage DFI Impedance.

This verification shall be considered successfully met when the test report indicates that the interface to the First Stage DFI has successfully transmitted PCM data at 20Mbps through four (4) 175 foot shielded twisted pair cable with impedance as indicated in 3.2.1.11.1.2, MDAU to Telemetry System Impedance.

4.2.1.11.2.2 MDAU to First Stage DFI System Impedance

This requirement shall be verified when the verification of 4.2.1.11.2.1, MDAU to First Stage DFI Bit Rate, has been successfully completed.

4.2.1.11.3 First Stage DFI System to MDAU Interface

This verification shall be by inspection.

An inspection of the DFI DAS drawings and user documentation shall be performed.

This verification shall be considered successfully met when the inspection report indicates that this interface to the First Stage DFI system is two (2) RS-422 interfaces that are capable of transmitting PCM data.

4.2.1.11.3.1 First Stage DFI System to MDAU Bit Rate

This verification shall be by test.

The test shall include transmitting PCM data from a DFI simulator to the MDAU interface at 6Mbps through two (2) 175 foot shielded twisted pair cable with impedance as indicated in 3.2.1.11.3.2., First Stage DFI System to MDAU Impedance.

This verification shall be considered successfully met when the test report indicates that the interface to the First Stage DFI has successfully transmitted PCM data at 6Mbps through two (2) 175 foot shielded twisted pair cable with impedance as indicated in 3.2.1.11.1.2, MDAU to Telemetry System Impedance.

4.2.1.11.3.2 First Stage DFI System to MDAU Impedance

This requirement shall be verified when the verification of 4.2.1.11.3.1, First Stage DFI System to MDAU Bit Rate, has been successfully completed.

4.2.1.11.4 MDAU with RDAU Interface

This requirement shall be verified when the verification of 4.2.1.11.4.1, MDAU with RDAU Interface Distance, has been successfully completed.

4.2.1.11.4.1 MDAU with RDAU Interface Distance

This verification shall be by test.

The test shall include assembling the DFI DAS with each chassis interconnected with cables measuring 155 feet. The aggregate data acquisition shall be such that the throughput from the MDAU to Telemetry Interface shall be 20Mbps.

This verification shall be considered successfully met when the test report indicates that the DFI DAS units can acquire and output 20Mbps of data while interconnected with 155 foot cables.

4.2.1.11.5 Workstation Interface

This verification shall be by test.

The test shall include assembling the DFI DAS with each chassis interconnected. The aggregate data acquisition shall be such that the throughput from the MDAU to Workstation Interface shall be 20Mbps.

This verification shall be considered successfully met when the test report indicates that the DFI DAS workstation can interface with the DFI DAS for programming, testing and real-time evaluation of PCM data while collecting and transmitting data at 20 Mbps.

4.2.1.11.6 EGSE Interface

This verification shall be by inspection.

An inspection of the DFI DAS drawings and user documentation shall be performed.

This verification shall be considered successfully met when the inspection report indicates that this interface meets the requirements described in section 3.6, Interfaces, of USO-CLV-DE-25135, Upper Stage (US) EGSE Subsystems Requirements Document.

4.2.1.11.7 Test and Programming

This verification shall be by inspection.

An inspection of the DFI DAS drawings and user documentation shall be performed.

This verification shall be considered successfully met when the inspection report indicates that the DFI DAS provides a minimum of one port for use as a test and programming port.

4.2.2 Input Channels

This requirement shall be verified when the verification of section 4.2.1.4, Sensor Data Acquisition, is successfully completed

4.2.2.1 Input Channel Characteristics

This requirement shall be verified when the verification of section 4.2.1.4, Sensor Data Acquisition, is successfully completed.

4.2.2.1.1 Sample Rates

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving input from a calibrated source on each input channel. The sample rates shall be set to those listed in Table 3.

This verification shall be considered successfully met when the data collected from the test of each channel shows that the sample rate meets those in Table 3 within 1%.

4.2.2.1.2 A/D Resolution

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving input from a calibrated source on each input channel.

This verification shall be considered successfully met when the data collected from the test of each channel shows that output resolution is configurable as specified in Table 3 for each channel.

4.2.2.1.3 Output/Sample

This requirement shall be verified when the verification of section 4.2.1.4 is successfully completed.

4.2.2.1.4 Excitation

This verification shall be by inspection.

The inspection of the DFI DAS drawings shall confirm the capability to provide constant current or constant voltage to the sensor as required in Table 3.

The verification shall be considered successful when the inspection report shows that the DFI/DAS includes a constant voltage excitation or constant current excitation that is compatible with the sensors in Table 3.

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4.2.2.1.5 Signal Conditioning

This verification shall be by inspection.

The inspection of the DFI DAS drawings and user documentation shall confirm the signal conditioning capability to meet the requirement of the sensors in Table 3.

The verification shall be considered successful when the inspection report shows that the DFI DAS provides signal conditioning sufficient for the sensors listed in Table 3.

4.2.2.1.6 Accuracy

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving sensor data from each type of sensor in Table 3.

This verification shall be considered successfully met when the test results verify that the DFI DAS has accuracy specified in Table 3.

4.2.2.1.7 Charge Amplifier

This verification shall be by inspection.

The inspection of the DFI DAS drawings and user documentation shall confirm the capability of the DFI DAS to provide a Charge Amplifier as required by the sensors listed in Table 3.

The verification shall be considered successful when the inspection report indicates the DFI DAS provides charge amplifier capability sufficient for the sensors listed in Table 3.

4.2.2.1.8 Programmable Filter

This verification shall be by inspection.

Inspection of the DFI DAS drawings and user documentation shall confirm the filtering capability of the DFI DAS is sufficient to meet the filtering requirements of Table 3.

The verification shall be considered successful when the inspection report indicates that the DFI DAS can provide filters sufficient to meet the filtering requirements of Table 3.

4.2.2.1.9 Programmable Gains

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS drawings and user documentation to verify that the DFI DAS is designed to configure the gain and offset for every data channel as required by the sensor list in Table 3.

This verification shall be considered successfully met when the results of the inspection conclude the DFI DAS can provide programmable gains and offsets sufficient for the sensor list in Table 3.

4.2.2.1.10 Reference Junction Compensation

This verification shall be by inspection.

The inspection of the DFI DAS drawings and user documentation shall confirm the use of an internal Reference Junction Compensation as required per Table 3.

The verification shall be successfully verified when the inspection report indicates the DFI DAS provides internal reference junction compensation sufficient for the sensor list in Table 3.

4.2.2.1.11 Video

No verification required.

4.2.2.1.11.1 Video Format

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving simulated data with one of the video formats specified in the requirement.

This verification shall be considered successfully met when the test results verify that the DFI DAS can receive input from one of the required formats while maintaining the required resolution and accuracy.

4.2.2.1.11.2 Video Resolution

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving data with the video resolution stated in the requirement.

This verification shall be considered successfully met when the test results verify that the DFI DAS can receive input with the resolution stated in the requirement.

4.2.2.1.11.3 Video Frame Rate

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving data with the video frame rates stated in the requirement.

This verification shall be considered successfully met when the test results verify that the DFI DAS can receive progressive scan video with at the frame rates specified in the requirement.

4.2.2.1.11.4 Video Image Compression

This verification shall be by test.

The test shall include testing the image data files created from collecting video.

This verification shall be considered successfully met when the test results verify that the DFI DAS can compress video at the compression rate specified in the requirement.

4.2.3 Time

No verification required.

4.2.3.1 Receiving Time

This verification shall be by test.

The verification shall include a test of the DFI DAS hardware and its ability to receive time in IRIG-B format.

An inspection of the user documentation shall include verifying the inclusion of procedures for receiving time in accordance with the IRIG-B format.

This verification shall be considered successfully met when the test results verify that the DFI DAS can receive time in accordance with IRIG-B format and inspection of the user documentation verifies the inclusion of procedures for receiving time in IRIG-B format.

4.2.3.2 Internal Clock

This verification shall be by test and inspection.

The test shall include receiving DFI DAS data from each channel type while the data is time-stamped in accordance with IRIG-106 format.

An inspection of the user documentation shall verify the inclusion of procedures for time stamping each channel type in accordance with IRIG-106 format.

This verification shall be considered successfully met when the test results verify that the DFI DAS can time stamp data in accordance with IRIG-106 format from each channel type and inspection of the user

documentation verifies the inclusion of procedures for time stamping data in accordance with IRIG-106 format

4.2.3.3 Time Stamp of Data

This verification shall be by analysis.

The verification shall include an analysis of the DFI DAS hardware and its ability to comply with the time stamp precision in accordance with IRIG 106 time code format.

This verification shall be considered successfully met when the results of the analysis verify that the DFI DAS can time stamp data in accordance with IRIG 106 time code format.

4.2.3.4 Time Stamp with Accuracy

This verification shall be by analysis.

The verification shall include an analysis of the DFI DAS hardware and its ability to comply with the time stamp accuracy requirement.

This verification shall be considered successfully met when the results of the analysis verify that the DFI DAS time stamp accuracy is 1 millisecond or better.

4.2.3.5 Time Stamp with Precision

This verification shall be by analysis.

The verification shall include an analysis of the DFI DAS hardware and its ability to comply with the time stamp precision in accordance with IRIG 106 time code format.

This verification shall be considered successfully met when the results of the analysis verify that the DFI DAS can receive time in accordance with IRIG 106 time code format.

4.2.4 Workstation Characteristics

No verification required.

4.2.4.1 Workstation Computer

This verification shall be by inspection.

The inspection of the user interface and user documentation shall determine the method of interface with the DFI DAS through the workstation.

The verification shall be considered successful when the inspection report shows that the DFI DAS interfaces with the workstation via a Windows-based computer.

4.2.4.2 Data Channel Configuration

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure every data channel of the DFI DAS.

4.2.4.3 Configurable Channel Sampling Rates

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure independent sample rates for every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure sample rates for every data channel of the DFI DAS.

4.2.4.4 Configurable Channel Gain

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure the gain for every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure the gain for every data channel of the DFI DAS.

4.2.4.5 Configurable Channel Offset

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure the channel offset of every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure the channel offset of every data channel of the DFI DAS.

4.2.4.6 Configure Channel Calibration

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure the calibration information for every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure the calibration information for every data channel of the DFI DAS.

4.2.4.7 Configurable Channel Range

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure the analog-to-digital (A/D) range of every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure the A/D range of every data channel of the DFI DAS.

4.2.4.8 Receiving Channel Data

This verification shall be by test and inspection.

The verification shall include a test which displays the results from input on each DFI DAS channel.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure every data channel.

This verification shall be considered successfully met when results have been displayed on the Workstation display from each channel and when an inspection of the user documentation verifies the inclusion of procedures to receive data from each data channel.

4.2.4.9 Display Data in Counts Format

This verification shall be by inspection.

The verification shall include an inspection of the Workstation display to verify the inclusion of display fields in counts on the Workstation display. The verification shall also include an inspection of the user documentation to verify the inclusion of procedures to display data in counts format

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can display data in counts and when inspection of the user documentation shows inclusion of procedures to display data in counts format.

4.2.4.10 Display Data in Units Format

This verification shall be by inspection.

The verification shall include an inspection of the Workstation display to verify the inclusion of display fields in engineering units on the Workstation display.

The verification shall also include an inspection of the user documentation to verify the inclusion of procedures to display data in engineering units.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can display data in engineering units and when inspection of the user documentation shows inclusion of procedures to display data in engineering units.

4.2.4.11 Display Data in Strip Chart Format

This verification shall be by inspection.

The verification shall include an inspection of the Workstation to verify the inclusion of strip chart output capability in the Workstation.

The verification shall also include an inspection of the user documentation to verify the inclusion of procedures to display data on strip charts.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can display data on strip charts and when inspection of the user documentation shows inclusion of procedures to display data on strip charts.

4.2.4.12 Display Data with Alarms

This verification shall be by test and inspection.

The test shall include collecting DFI DAS simulated data from each type of channel and forcing the simulated data out of programmed ranges.

The verification shall also include an inspection of the user documentation to verify the inclusion of procedures for detecting out of range alarms for out-of-range data.

This verification shall be considered successfully met when out of range input data activates alarms on the Workstation and when inspection of the user documentation shows inclusion of procedures to detect alarms.

4.2.4.13 Portability

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and packing and setup procedures.

The verification shall be considered successfully met when the inspection of the Workstation and packing and setup procedures show that the DFI DAS Workstation is portable by a single ground crew member; like a laptop or desktop computer.

4.2.4.14 Display Parameters

This verification shall be by test and inspection.

The test shall include collecting DFI DAS simulated data from each type of channel and recording the channel parameters.

The verification shall also include an inspection of the user documentation to verify the inclusion of procedures for displaying DFI DAS parameters.

This verification shall be considered successfully met when channel parameters are displayed on the Workstation and when inspection of the user documentation shows inclusion of procedures to display channel parameters.

4.2.4.15 Built In Test (BIT)

This verification shall be by test.

A Built In Test shall be performed in several configurations, not less than 3 different configurations which the Built In Test can detect and report.

The verification shall be considered successful when the Built In Test status reports accurate status for each configuration of the test.

4.2.4.16 Reliability

This verification shall be by analysis.

The verification shall include a reliability analysis of the DFI DAS hardware.

The verification shall be considered successfully met when the reliability analysis report shows that the DFI DAS meets or exceeds the minimum MTTF listed in the requirement.

4.2.4.16.1 Reliability Data

This verification shall be by inspection.

The verification shall include an inspection of the delivered documentation to ensure that data inputs for the reliability analysis are included with the delivered data package.

The verification shall be considered successfully met when the inspection shows that the delivered data package includes the data inputs for the reliability analysis.

4.2.4.17 Failure Propagation

This verification shall be by analysis.

The analysis of the DFI DAS design shall show that any failure in the DFI DAS shall not propagate from the DFI DAS.

The verification shall be considered successful when the analysis report shows that the failure in the DFI DAS shall not cause damage to or failures of interfacing elements due to transient out-of-tolerance conditions or a failure.

4.2.4.18 Flight Operation Life

This verification shall be by analysis.

The verification shall include an analysis of the DFI DAS for the flight time duration specified in the requirement.

The verification shall be considered successfully met when the analysis report indicates the DFI DAS meets all requirements for the flight time specified in the requirement.

4.2.4.19 Calibration

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS user documentation for calibration procedures.

The verification shall be considered successfully met when the inspection report indicates the DFI DAS user documentation includes calibration procedures.

4.2.5 Environmental Conditions

No verification required.

4.2.5.1 Natural Environments

This verification shall be verified by analysis.

An analysis shall be performed of the DFI DAS design to show that it will meet all functional and performance requirements within the range of environmental conditions specified in the Exploration Architecture Design Specification for Natural Environments, CxP 70023, Sections 3.1and 3.2.

Verification shall be considered successful when the analysis shows that the DFI DAS meets all functional and performance requirements within the range of environmental conditions specified in the Exploration Architecture Design Specification for Natural Environments, CxP 70023, Sections 3.1, 3.2.

4.2.5.2 Induced Environments

No verification required.

4.2.5.2.1 Transportation (packaged)

This verification shall be by test and inspection.

The vendor shall inspect the user documentation for specifications of environmental parameters for transportation listed in the requirement.

This verification shall be considered successfully met when an inspection of the user documentation indicates the vendor environmental specifications for transportation of the DFI DAS hardware and when the test verifications of 4.2.5.3, Qualification Test Requirements, are successfully met.

4.2.5.2.2 Non-Operating Environment

No verification required.

4.2.5.2.2.1 Storage

No verification required.

4.2.5.2.2.1.1 Storage Time

This verification shall be by analysis.

An analysis shall confirm the storage life of the DFI DAS hardware.

This verification shall be successfully met when the analysis report indicates that the DFI DAS will perform after the storage time of 5 years.

4.2.5.2.2.2 Non-Operating Temperature

This verification shall be by analysis.

An analysis shall confirm the storage temperature of the DFI DAS hardware.

This verification shall be successfully met when the analysis report indicates that the DFI DAS will perform after stored in the temperature range of -65°F (-54°C) to 126°F (52°C).

[Rationale: The non-operating temperature and humidity conditions cover worst case for storage, transport, and roll-out. Purge will not be provided to control temperature and humidity except during rollout. The non-operating conditions specified above are currently thought to represent worst case and are representative of transport environments on a covered barge.]

4.2.5.2.2.3 Non-Operating Humidity

This verification shall be by analysis.

An analysis shall confirm the storage humidity of the DFI DAS hardware.

This verification shall be successfully met when the analysis report indicates that the DFI is fully compatible with humidity levels up to and including 90% relative humidity.

[Rationale: The non-operating temperature and humidity conditions cover worst case for storage, transport, and roll-out. Purge will not be provided to control temperature and humidity except during rollout. The non-operating conditions specified above are currently thought to represent worst case and are representative of transport environments on a covered barge.]

4.2.5.2.3 Operating Environment

No verification required.

4.2.5.2.3.1 Operating Temperature

This verification shall be by test.

These tests shall be implemented in accordance with the qualification and acceptance test requirements of CxP 70036, Constellation Program Environmental Qualification and Acceptance Testing Requirements.

This verification shall be met when the thermal test results demonstrate that the DFI DAS is fully compatible with the flight operational temperature range of 0°F (-18°C) to 150°F (66°C)

4.2.5.2.3.2 Operating Humidity

This verification shall be by test.

These tests shall be implemented in accordance with the qualification and acceptance test requirements of CxP 70036, Constellation Program Environmental Qualification and Acceptance Testing Requirements.

This verification shall be met when the verification tests results show that the DFI DAS is compatible with a flight operational relative humidity of 90% relative humidity.

4.2.5.2.3.3 Random Vibration and Shock

This verification shall be by test.

These tests shall be implemented in accordance with the qualification and acceptance test requirements of CxP 70036, Constellation Program Environmental Qualification and Acceptance Testing Requirements.

This verification shall be met when the vibration and shock verification tests have been successfully completed in accordance with the levels specified in CxP 72169, Ares I Vibroacoustic and Shock Environments Data book. Section 3.1.2, Random Vibration; Section 3.2.2, Shock Environments; Section 3.3.2, Internal Acoustic Environments.

4.2.5.2.3.4 Pressure Change

This verification shall be by test.

These tests shall be implemented in accordance with the qualification and acceptance test requirements of CxP 70036, Constellation Program Environmental Qualification and Acceptance Testing Requirements.

This verification shall be met when the test results show that the DFI DAS is fully compatible with a flight operational pressure change 760 Torr/1 atm (Sea Level) to 10^{-5} Torr (near vacuum).

4.2.5.2.3.5 Pressure Rate of Change

This verification shall be by test.

These tests shall be implemented in accordance with the qualification and acceptance test requirements of CxP 70036, Constellation Program Environmental Qualification and Acceptance Testing Requirements.

This verification shall be met when the test results show that the DFI DAS is fully compatible with a flight operational pressure rate change starting at a pressure of 14 psi and decreasing in 26 seconds to 1 psi.

4.2.5.2.3.6 Loads Analysis

This verification shall be by analysis.

The verification shall include an analysis of the DFI DAS design relative to launch and flight loads derived from CxP 72169, Ares I Vibroacoustic and Shock Environments Data book. Section 3.1.2, Random Vibration; Section 3.2.2, Shock Environments; Section 3.3.2, Internal Acoustic Environments that will be encountered by the hardware.

The verification shall be considered successfully met when the analysis report indicates the DFI DAS can withstand launch and flight loads with a margin defined in NASA-STD-5002.

4.2.5.3 Qualification Test Requirements

This verification shall be by test and inspection.

The verification shall include testing qualification units of the DFI DAS in accordance with Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

The verification shall also include inspection of the qualification test procedures to verify each test encompasses the worst-case environmental conditions (including, but not limited to, transportation, storage, integration, flight) seen by the DFI DAS and to verify compliance with Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

The verification shall be considered successfully met when the qualification test reports indicate that the DFI DAS and Workstation are in compliance with CxP 70036 and the inspection report indicates the test procedures encompass the worst-case environmental conditions seen by the DFI DAS and the procedures comply with CxP 70036.

4.2.5.4 Acceptance Test Requirements.

This verification shall be by test and inspection.

The verification shall include testing each DFI DAS unit in accordance with Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

The verification shall also include inspection of the acceptance test procedures to verify compliance with Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

The verification shall be considered successfully met when the acceptance test reports indicate that the DFI DAS and Workstation are in compliance with CxP 70036 and the inspection report indicates the test procedures comply with CxP 70036.

4.2.6 Electrical Design

No verification required.

4.2.6.1 Input Power

This verification shall be by test.

The verification shall include a test of the DFI DAS with input voltages at 23VDC, 28VDC, and 36VDC.

The verification shall be considered successful when the results of the test show that the DFI DAS did not exceed 350 watts over a steady state input voltage range of 23Vdc to 36Vdc.

4.2.6.2 Input Voltage Range

This verification shall be by test, analysis, and inspection as outlined in CxP 70050-02, Constellation Program Electrical Power System Specification, Volume 2: Electrical Power Quality Performance for 28 Vdc. The DAU provider shall be responsible to provide test plans and data to successfully meet all the verification requirements of the Electrical Power Quality Specifications Volume 2. Power Quality Verification only needs to be done on one unit as part of the Qualification testing.

4.2.6.3 Short Circuit Protection

This verification shall be by analysis.

The verification shall include a fault current analysis of the DFI DAS drawings.

The verification shall be considered successful when inspection of the design drawings and fault analysis show that wire size selection and wire protective devices will prevent damage to DFI DAS as result of short circuits in compliance with NASA Technical Memorandum 102179.

4.2.6.4 5V Discrete Characteristics

This verification shall be by test.

The verification shall include a test of the DFI DAS drawings. Discrete input circuits shall be tested to confirm compliance with the characteristics described in the requirement.

The verification shall be considered successful when the test report shows that the DFI DAS 5V discrete inputs comply with the voltage and current profiles

4.2.6.4.1 Pull Down Characteristic

This verification shall be by test.

The verification shall include a test of the DFI DAS drawings. Discrete input circuits shall be tested to confirm compliance with the characteristics described in the requirement.

The verification shall be considered successful when the test report shows that the DFI DAS 5V discrete inputs are pulled down to the OFF level specified in 3.2.6.4, 5V Discrete Input Characteristics, when not connected.

4.2.6.4.2 Quantity

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS drawings and user documentation.

The verification shall be considered successful when the inspection report indicates there is a minimum of one 5V discrete input in the DFI DAS.

4.2.6.5 28V Discrete Characteristics

This verification shall be by test.

The verification shall include a test of the DFI DAS drawings. Discrete input circuits shall be tested to confirm compliance with the characteristics described in the requirement.

The verification shall be considered successful when the test report shows that the DFI DAS 28V discrete inputs comply with the voltage and current profiles

4.2.6.5.1 Pull Down Characteristic

This verification shall be by test.

The verification shall include a test of the DFI DAS drawings. Discrete input circuits shall be tested to confirm compliance with the characteristics described in the requirement.

The verification shall be considered successful when the test report shows that the DFI DAS 28V discrete inputs are pulled down to the OFF level specified in 3.2.6.4, 28V Discrete Input Characteristics, when not connected.

4.2.6.5.2 Quantity

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS drawings and user documentation.

The verification shall be considered successful when the inspection report indicates there is a minimum of two 28V discrete input in the DFI DAS.

4.2.6.6 Electrical Bonding

This verification shall be by analysis, inspection, and test

Testing shall verify the adequacy of electrical bonding processes and procedures for each bonding class. Analysis shall verify that correct bond classes have been identified and bonding paths are designed to meet identified bonding class requirements. Inspection shall verify that proper bonding processes, procedures, and classes have been identified in hardware drawings and documentation. Inspection shall also verify that hardware fabrication and installation measurements demonstrate proper electrical bonding has been achieved.

The verification shall be considered successful when each bonding joint is shown to have the correct bonding class requirement, the fabrication and installation procedure will result in a proper electrical bond, and the tested bonds meet the identified bond class resistance limits in accordance with NASA-STD-4003.

4.2.6.7 Electrical Grounding

The DFI DAS grounding shall be verified by analysis and inspection.

Successful verification shall be achieved when analysis and inspection of drawings and installation records shall verify conformance with CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

4.2.6.8 Lightning Protection

The CEI lighting protection shall be verified by a combination of analysis and tests.

Successful verification shall be achieved when analysis of lower-level component test data, and equipment tests for immunity to damage or upset due to lightning transient design levels, demonstrate compliance with CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

4.2.6.9 Electrostatic Discharge (ESD) Protection

The verification of the DFI DAS subsystem compliance with the ESD requirements shall be verified by tests and analysis.

Analysis shall verify that adequate control measures have been incorporated into the design, such as transient absorbing devices, series resistance, or proper electrical grounding and bonding. Testing shall verify compliance with Constellation requirements through exposure to standard electrostatic discharge waveforms, either to pins, case, or a combination thereof.

The verification shall be considered successful when the analysis and test results indicated that the DFI DAS meets the ESD protection requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

4.2.6.10 Isolation of Test Points

This verification shall be by inspection.

The DFI DAS hardware drawings shall be inspected to confirm that the test points are isolated.

The verification shall be successful when the inspection report shows that the DFI DAS isolates test points and internal circuits such that a test point short to ground does not damage the Upper Stage Avionics hardware.

4.2.6.11 Electronic, Electrical, Electromechanical (EEE) Parts

Verification method shall be analysis by verification of records.
(a) EEE Parts Control Plan data items shall be analyzed to determine what EEE parts management and control processes are applied. (b) As-designed EEE Parts List data items shall be analyzed to determine what EEE parts are used by design. (c) Nonstandard Part Approval Requests (NSPAR) data items shall be analyzed to determine the terms for acceptance and use of the applicable EEE parts. Grade 4 parts will not require NSPARS. (d) EEE Parts Derating Analysis Report data items shall be analyzed to determine what derating is achieved for the application. (e) As-built EEE Parts List data items shall be analyzed to determine that only traceable approved EEE parts and sources are used. Success criteria shall be that the analyses of (a), (b), (c), (d), and (e) show compliance with CxP 72053, EEE Parts Management and Control Plan.

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4.2.6.12 Inadvertent Disconnect

This verification shall be by analysis.

The analysis of the DFI DAS hardware shall assess the connectors to determine if their design precludes inadvertent disconnect.

The verification shall be considered successful when the analysis report indicates the DFI DAS prevents inadvertent disconnects.

4.2.6.13 Printed Wiring Boards

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS printed circuit boards and all associated drawings including schematics and assembly drawings.

The verification shall be successful when the inspection report indicates that the DFI DAS printed circuit boards meet the design requirements of MFSC-STD-3425, Design Requirements for Rigid Printed Circuit Boards and Assemblies and are constructed in accordance with the Class 3 requirements of IPC-6011, Generic Performance Specification for Printed Boards.

[Rationale: MSFC-STD-3425 is a tailoring document for IPC-2221 and IPC-2222 which specify design requirements for printed circuit boards. The tailoring places further restrictions on board design to further increase uniformity and reliability. MSFC-STD-3425 is available at https://repository.msfc.nasa.gov/docs/multiprogram/MSFC-STD-3425.pdf]

4.2.6.14 Ignition Source Avoidance

This verification shall be by inspection.

The inspection of the design drawings shall confirm the use of conformal coating or other means to isolate potential ignition sources from the ambient environment which may contain flammable gases or

fluids. The inspection of the hardware shall confirm that all potential ignition sources are isolated from the environment.

The verification shall be considered successful when inspection of all electrical components and wiring show that have been conformably coated or other provisions have been made to prevent ignition of potentially flammable or explosives gases that have been determined to be present in the unit volume.

4.2.6.15 Electromagnetic Interference

The CEI electromagnetic interference and susceptibility shall be verified by tests.

Testing shall verify that equipment and subsystems comply with emissions and susceptibility requirements. Verification shall be considered successful when: 1) emissions are below limits, and 2) equipment and subsystems are immune to interference when subjected to susceptibility test levels.

Successful verification shall be achieved when testing validates compliance with CxP 72047, CLV (Crew Launch Vehicle) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment.

4.2.6.16 Circuit Classification

The CEI circuit classification shall be verified by analysis.

The analysis shall verify that wiring and cabling has been classified according to frequency or rise/fall times, circuit impedance, circuit voltage, and circuit sensitivity.

Verification shall be considered successful when wiring and cabling classifications are found to be in accordance with the circuit classifications of Table 2 in CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

4.2.6.17 Connector Location and Pin Function Assignments

This verification shall be by inspection.

The inspection of the DFI DAS user documentation shall confirm the inclusion of connector locations and pin functions.

The verification shall be considered successful when the DFI DAS connector location and pin function assignments are provided.

4.2.6.18 Wire and Cable Shielding Separation and Routing

Verification of cable shielding and separation shall be verified by inspection.

The inspection shall verify that cabling and wiring are labeled with circuit class and separated and routed in accordance with classification requirements.

The verification shall be considered successful when inspection of drawings and installation documentation shows that wiring and cabling are properly labeled with circuit class and separated and routed in accordance with classification requirements in accordance with CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

4.2.6.19 Electrostatic Discharge (ESD) Controls

Electrostatic Discharge (ESD) Control shall be verified by inspection.

An inspection shall be performed to verify that adequate control measures have been incorporated into the (DFI DAS fabrication, assembly, testing, transportation, and storage) processes such as use of static protective packaging, anti static-wrist straps, and proper labeling in accordance with ANSI/ESD S20.20-1999, ESD Association Standard for the Development of an Electrostatic Discharge Control Program.

The verification shall be considered successful when the inspection shows that the (DFI DAS fabrication, assembly, testing, transportation, and storage) processes meet the requirements of an ESD Control Program that has been set up to conform with the guidance of ANSI/ESD S20.20-1999.

4.2.7 Structural and Mechanical

No verification required.

4.2.7.1 Materials and Processes

This verification shall be by inspection.

Verification shall be considered successful when the vendor of COTS components/assemblies have made available to the procuring authority, any materials and processes information requested, down to the manufactured parts level, for the procuring authority to verify the acceptability of materials and processes used in construction.

Verification, by the procuring authority, of the acceptability for materials and processes used in construction will be consistent with the requirements of paragraph 4.3 of USO-CLV-MP-25502.

4.2.7.2 Fracture Control

This verification shall be by analysis, inspection, and test.

The analysis of the DFI DAS as-built drawings, procedures, and reports shall assess the fracture control of the design using structural analysis tools or analysis by similarity. Where applicable to the DFI DAS design, inspections and tests of the hardware and material samples shall also be conducted in accordance with NASA-STD-5019 to assess the adequacy of the materials, hardware, and design.

The verification shall be considered successful when the analysis, inspection, and test reports show the DFI DAS complies with the requirements of NASA-STD-5019, Fracture Control Requirements for Spaceflight Hardware.

4.2.7.3 Drawing Quality

This verification shall be by inspection.

The inspection of DFI DAS as-built drawings shall confirm the use of drawings standards.

Verification shall be considered successful when inspection shows the DFI DAS drawings conform to the drawing standards specified in the requirement; ASME Y14.100, Engineering Drawing Practices, ASME Y14.24, Types and Applications of Engineering Drawings, ASME Y14.34, Associated Lists and ASME Y14.35M-1997, Revision of Engineering Drawings and Associated Documents.

4.2.7.4 Cooling

This verification shall be by test and inspection.

The DFI DAS thermal test procedures as required by 4.2.5.3, Qualification Test Requirements, shall be inspected to ensure instrumentation during the test will measure the outside and internal temperature of the DFI DAS to ensure that cooling is not required. The most sensitive component (with the lowest maximum operating temperature) within the DFI DAS shall be instrumented to determine its case temperature.

Verification shall be considered a success when the inspection of the thermal test procedures indicates adequate instrumentation to determine flight touch temperature and adequate cooling to the most heat-sensitive component and when the thermal test verifications of 4.2.5.1, Qualification Test Requirements, shall are successfully completed.

4.2.7.5 Captive Fasteners

This verification shall be by inspection.

The inspection of DFI DAS as-built drawings shall confirm the use of fasteners that meet the structural requirements of the indicated specifications and confirm the use of positive locking mechanisms where possible. Chemical locking compounds may be used for small fasteners with permission.

Verification shall be considered successful when inspection shows the DFI DAS contains fasteners that are in compliance with MSFC-STD-2594C, MSFC Fastener Management & Control Practices, and positive mechanical locking fasteners are used where possible.

4.2.7.6 Factors of Safety

This verification shall be by analysis.

The analysis of the DFI DAS as-built drawings shall assess the structural integrity of the design and quantify factors of safety in the launch environment using structural analysis tools or analysis by similarity.

The verification shall be considered successful when the analysis shows the DFI DAS complies with the requirements of CxP 70135, CONSTELLATION PROGRAM STRUCTURAL DESIGN AND VERIFICATION REQUIREMENTS, section 3.10.

4.2.7.7 Debris Prevention

This verification shall be by analysis.

The analysis of the DFI DAS as-built drawings shall assess the potential for debris generation during pre-launch or ascent.

The verification shall be considered successful when the analysis shows that the DFI DAS is designed to preclude the generation or shedding of debris during pre-launch or ascent which might jeopardize personnel or other vehicle equipment.

4.2.7.8 Chemical Exposure in the Instrument Unit (IU)

This verification shall be by analysis.

An analysis of the Material Usage List shall be performed to determine the compatibility of the DFI DAS with MMH and NTO.

Verification shall be considered successful when analysis of the material usage list (MUL) shows that all materials which may be exposed to the atmospheric environment are compatible with monomethyl hydrazine (MMH) and nitrogen tetroxide (NTO) as identified in the MAPTIS database.

4.2.7.9 LRU Interchangeability

This verification shall be by inspection.

The inspection of the DFI DAS drawings, hardware, and user documentation shall indicate the interchangeability of each DFI DAS units with the initial production unit.

The verification shall be successful when the inspection indicates that DFI DAS are interchangeable with previous DFI DAS units and the inspection of the user documentation indicates the procedure for replacing DFI DAS units.

4.2.7.10 Connector Mismating

This verification shall be by analysis.

The analysis of the connectors on the DFI DAS shall assess the potential for mismating.

The verification shall be considered successful when the analysis shows that the DFI DAS connector keying to prevents mismating.

4.2.7.11 DAU Chassis Size

This verification shall be by inspection.

The inspection shall include an inspection of applicable DFI DAS drawings and user documentation and all DAUs.

The verification shall be considered successfully met when the inspection report indicates that all DAUs have the same size chassis to ±1mm tolerance for each dimension.

4.2.7.12 Distributed System

This verification shall be by inspection and demonstration.

The inspection shall include a review of the applicable drawings and user documentation to confirm the design of the DFI DAS as a multi-unit system, with at least two units.

The demonstration shall include operating the DFI DAS with a workstation and all DAUs.

The verification shall be considered successful when the inspection of the user documentation indicates the design of a multi-unit DFI DAS with at least two units and when a demonstration of the DFI DAS indicates each unit's connection to the workstation is acknowledged on the user interface.

4.2.8 Product Marking

No verification required.

4.2.8.1 Identification and Marking

This verification shall be by inspection.

The production drawings shall be inspected to determine whether the drawings contain the requirement for identification and marking methods in compliance with MIL-STD-130, DEPARTMENT OF DEFENSE STANDARD PRACTICE IDENTIFICATION MARKING OF U.S. MILITARY PROPERTY.

Verification shall be considered successful when inspection of the drawings shows that the DFI DAS has been manufactured with identification and marking methods in accordance with MIL-STD-130.

4.2.8.2 ESD Identification and Marking

This verification shall be by inspection.

The production drawings shall be inspected to determine whether the drawings contain the requirement for identification and marking methods in compliance with MIL-STD-130, DEPARTMENT OF DEFENSE STANDARD PRACTICE IDENTIFICATION MARKING OF U.S. MILITARY PROPERTY.

The verification shall be considered successfully met when the inspection report indicates the DFI DAS has been manufactured with ESD (electrostatic discharge) identification and marking methods in accordance with MIL-STD-130.

4.2.8.3 Serial Numbers

This verification shall be by inspection.

The production DFI DAS shall be inspected to determine whether it is identified by a serial number assigned in accordance with contractor's configuration management guidelines.

The verification shall be considered successfully met when the inspection report shows that the DFI DAS is identified by a serial number.

4.2.9 Workmanship

No verification required.

4.2.9.1 Soldering

This verification shall by inspection.

The inspection of DFI DAS drawings and assembly procedures and as-built process plans shall assess the conformance to soldering requirements of J-STD-001DS.

The verification shall be considered successful when the inspection of documentation shows that the soldering workmanship conforms to J-STD-001DS.

4.2.9.2 Crimping

This verification shall by inspection.

The inspection of DFI DAS drawings and assembly procedures and as-built process plans shall assess the conformance to crimping requirements of NASA-STD-8739.4, as tailored by MSFC-STD-2905.

The verification shall be considered successful when the inspection of documentation shows that the crimping workmanship conforms to NASA-STD-8739.4, as tailored by MSFC-STD-2905, MSFC Tailoring Guide for NASA-STD-8739.4, Crimping, Interconnecting Cables, Harness, and Wiring.

4.2.9.3 Soldering of Surface Mount Components

This verification shall by inspection.

The inspection of DFI DAS drawings and assembly procedures and as-built process plans shall assess the conformance to surface mount soldering requirements of J-STD-001DS.

The verification shall be considered successful when the inspection of documentation shows that the surface mount soldering workmanship conforms to J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

4.2.9.4 Conformal Coating and Staking

This verification shall by inspection.

The inspection of DFI DAS drawings and assembly procedures and as-built process plans shall assess the conformance to conformal coating and staking requirements of J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

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The verification shall be considered successful when the inspection of documentation shows that the conformal coating and staking workmanship conforms to J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

4.2.9.5 Tin Whisker Mitigation

This verification shall be by inspection.

Bills of material, process plans, and procedures shall be inspected to verify compliance with the tin whisker mitigation methods in J-STD-001DS.

The verification shall be successfully met with the inspection of the as-built documentation verifies that the DFI DAS units are manufactured using Tin Whisker Mitigation methods in accordance with J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

4.2.10 Human Engineering

No verification required.

4.2.10.1 Human Engineering Guidelines

This verification shall be by inspection.

The inspection of the DFI DAS shall assess compliance with NASA-STD-3000 CxP 70024 Constellation Human-Systems Integration Requirements (HSIR)

The verification shall be considered successful when the inspection shows that the DFI DAS meets the human engineering guidelines of NASA-STD-3000, Man-Systems Integration Standards, and CxP 70024 Constellation Human-Systems Integration Requirements (HSIR).

4.2.10.2 Sharp Edges

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS hardware and Workstation to verify sharp edges, corners, and protrusions are broken.

The verification shall be considered successfully met when the inspection of the DFI DAS hardware and Workstation verifies that all accessible edges, corners, and protrusions have been broken in compliance with Human Factors Engineering Design Criteria, USO-CLV-LS-25404.

4.2.10.3 Maximum Touch Temperature

This verification shall be by test and inspection and analysis.

The DFI DAS thermal test procedures as required by 3.2.5.3, Qualification Test Requirements and 3.2.5.4, Acceptance Test Requirements, shall be inspected to ensure instrumentation during the test will measure the outside and internal temperature of the DFI DAS to ensure that cooling is not required. An analysis of the test results and the flight operational ambient temperature shall be performed.

Verification shall be considered a success when the inspection of the thermal test procedures indicates adequate instrumentation to determine flight touch temperature and when the thermal test verifications of 3.2.5.3, Qualification Test Requirements and 3.2.5.4, Acceptance Test Requirements, show that the maximum external touch temperature of the DFI DAS while operating in the Upper Stage thermal environment complies with Human Factors Engineering Design Criteria, USO-CLV-LS-25404, section 5.13.4.6, Table X.

4.2.10.4 Minimum Touch Temperature

This verification shall be by test and inspection.

The DFI DAS thermal test procedures as required by3.2.5.3, Qualification Test Requirements and 3.2.5.4, Acceptance Test Requirements, shall be inspected to ensure instrumentation during the test will measure the outside and internal temperature of the DFI DAS to ensure that cooling is not required.

Verification shall be considered a success when the inspection of the thermal test procedures indicates adequate instrumentation to determine flight touch temperature and when the Environmental Conditions verifications of 4.2.5 show that the minimum internal touch temperature of the DFI DAS while operating in the Upper Stage thermal environment complies with Human Factors Engineering Design Criteria, USO-CLV-LS-25404, section 5.13.4.6, Table X.

4.2.10.5 General Safety

This verification shall be by inspection.

The verification shall include an inspection of the manuals, drawings, process plans, procedures and hardware to determine sufficient detail to perform a system safety analysis of the DFI DAS

The verification shall be considered successfully met when the inspection of the DFI DAS indicates sufficient documentation to perform a safety analysis per 2.2.1, Hazard Analysis, of CxP 70059 Constellation Program (CxP) Integrated Safety, Reliability, and Quality Assurance (SR&QA) Requirements.

4.2.10.6 Contamination Control

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS and Workstation for cleanliness and the as-built process plans indicate cleaning of internal surfaces.

The verification shall be considered successfully met when the inspection report shows the DFI DAS and Workstation are visibly clean in accordance with CxP 70145, Constellation Program Contamination Control Requirements and as-built process plans indicate cleaning of internal surfaces.

4.2.10.7 Box Integration for Ground Operations

This verification shall be by inspection.

The inspection of the DFI DAS design drawings and procedures shall assess compliance with CxP 70024, Section 3.9.

The verification shall be considered successful when the inspection shows that the DFI DAS meets the box integration requirements for ground operations in accordance with Human-Systems Integration Requirements (HSIR), CxP 70024, Section 3.9.

4.3 Packaging Requirements

This verification shall be by analysis.

An analysis of the shipping origin, route, destination, packaging, handling, and transportation shall be performed to verify conformance with NPR 6000.1G.

This requirement shall be successfully met when the analysis confirms that the shipping origin, route, destination, packaging, handling, and transportation meet the requirements of NPR 6000.1G.

4.3.1 Packaging Design Requirement (Structural)

This verification shall be by analysis and inspection.

An analysis of the transportation environment shall be performed to determine the values of the parameters in the requirement and to determine the protection provided by the packaging. An inspection of the user documentation shall confirm the documentation of the environmental parameter values.

This verification shall be successfully met when the analysis of the preservation, packaging, and packing conforms to the free fall flat drop, free fall corner drop, and sinusoidal vibration requirements of MIL-STD-2073 and NPR 6000.1G and the transportation environment and when the user documentation indicates the transportation shock and vibration environment.

4.3.2 Reusable Containers

This verification shall be by analysis.

If reusable containers are required, an analysis of commercially available standard off-the-shelf, low cost, metal or plastic containers shall be performed.

This verification shall be successfully met when the analysis determines whether suitable off-the-shelf reusable containers are available if reusable containers are required.

4.3.3 Monitoring Devices

This verification shall be by inspection.

The inspection of the approval-to-ship documentation shall include a description of instrumentation for monitoring or recording in-transit environments (e.g., shock, vibration, temperature, humidity, etc.).

The verification shall be successfully met when the Buyer approves, by signature, the approval-to-ship documentation.

4.3.4 Temporarily Installed Hardware Identification

This verification shall be by inspection.

An inspection of all temporarily installed devices such as caps, plugs, covers, support bracketry, protective plates, etc., shall confirm these items are marked “NOT FLIGHT” or otherwise indicated as not for flight to ensure they are easily identified under casual observation.

This verification shall be successfully met when the inspection confirms temporarily installed non-flight items are marked “NOT FLIGHT” or otherwise indicated as not for flight.

4.3.5 Marking for Shipment

This verification shall be by inspection.

An inspection of the interior and exterior containers markings for shipment shall be performed to verify conformance with MIL-STD-130.

This verification shall be successfully met when the inspection verifies shipping markings are in accordance with MIL-STD-130.

4.3.6 Marking for Reuse

This verification shall be by inspection.

An inspection of the markings on reusable containers shall be performed to verify the words "REUSABLE CONTAINER –DO NOT DESTROY – RETAIN FOR REUSE" are used.

This verification shall be successfully met when the inspection verifies the markings are visible on reusable containers.

4.3.7 NASA Critical Item Labels

This verification shall be by inspection.

An inspection of the interior and exterior containers NASA critical item labels for shipment shall be performed to verify conformance with MIL-STD-2073 and NPR 6000.1G.

This verification shall be successfully met when the inspection verifies that NASA critical item labels are in accordance with MIL-STD-2073 and NPR 6000.1G.

4.3.8 Identification Format

This verification shall be by inspection.

An inspection of the interior and exterior container identification markings shall be performed to verify conformance with MIL-STD-2073 and NPR 6000.1G.

This verification shall be successfully met when the inspection verifies that identification markings are in accordance with MIL-STD-2073 and NPR 6000.1G.

APPENDIX A ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviations

AWG	American Wire Gage
ASME	American Society of Mechanical Engineers
BIT	Built in Test
BITE	Built in Test Equipment
C	Celsius
CEI	Component End Item
CEQATR	Constellation Environmental Qualification and Acceptance Testing Requirements
CEV	Crew Exploration Vehicle
CLV	Crew Launch Vehicle
CxP	Constellation Program
dB	decibel
DAS	Data Acquisition System
DAU	Data Acquisition Unit
DFI	Development Flight Instrumentation
DFIS	Development Flight Instrumentation System
E3	Electromagnetic Environmental Effects
EDU	Engineering Development Unit
ESD	Electro Static Discharge
EEE	Electrical, Electronic, and Electromechanical
EMC	Electro Magnetic Compatibility
EOM	End of Message
F	Fahrenheit
FC	Flight Computer
FDIR	Fault Detection, Isolation, and Recovery
FU	Flight Units
g	gravity
EGSE	Electrical Ground Support Equipment
HSIR	Human-Systems Integration Requirements
Hz	Hertz
IEEE	Institute of Electrical & Electronics Engineers, Inc.
IRIG	Inter-Range Instrumentation Group (Range Commanders Council)
ITAR	International Traffic in Arms Regulations
LH2	Liquid Hydrogen
LOX	Liquid Oxygen
LRU	Line Replaceable Unit
MDAU	Master Data Acquisition Unit
MAPTIS	Materials and Processes Technical Information System

Mpbs	Mega Bits per Second
MMH	Monomethyl Hydrazine
MTTF	Mean Time To Failure
NASA	National Aeronautics and Space Administration
NEDD	Natural Environments Design Document
NTO	Nitrogen Tetroxide
OA	Organic Acid
OFI	Operational Flight Instrumentation
PCM	Pulse Code Modulation
PDU	Power Distribution Unit
PWB	Printed Wiring Board
RDAU	Remote Data Acquisition Unit
RH	Relative Humidity
RMS	Root Mean Square
SBU	Sensitive But Unclassified
SDU	Software Development Unit
SMT	Surface Mounted Technology
SRU	Shop Replaceable Unit
SR&QA	Safety, Reliability, and Quality Assurance
TBD	To Be Determined
TBR	To Be Resolved
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Agency
VDC	Volts Direct Current

APPENDIX B REQUIREMENTS TRACE MATRIX CEI 3.2 REQUIREMENTS

Requirements Trace Matrix CEI 3.2 Requirements

Section No.	Requirement ID	Section / Requirement Title	Method					Verification ID
			N/A	A	T	D	I	

APPENDIX C VERIFICATION CROSS REFERENCE MATRIX 3.2 REQUIREMENTS

Verification Cross Reference Matrix 3.2 Requirements

Section No.	*EDU*	*Qualification*	*Acceptance.*	*Section / Requirement Title*	*Methods*					*Verification ID*
					N / A	*A*	*T*	*D*	*I*	
3.1				DFI DAS Description	X					
3.2				DFI DAS Characteristics	X					4.2
3.2.1				Data Acquisition	X					4.2.1
3.2.1.1	X	X	X	Initialization to Known PCM Frame Format			X		X	4.2.1.1
3.2.1.2	X	X	X	Power Application Data Output			X			4.2.1.2
3.2.1.3	X	X	X	Power Interruption Data Output			X			4.2.1.3
3.2.1.4	X	X	X	Sensor Data Acquisition			X		X	4.2.1.4
3.2.1.5	X	X	X	PCM Data Acquisition			X		X	4.2.1.5
3.2.1.6	X	X	X	PCM Frame Generation			X			4.2.1.6
3.2.1.7	X	X	X	User Programmable			X		X	4.2.1.7
3.2.1.8	X	X	X	Sampling and Formatting			X		X	4.2.1.8
3.2.1.9	X	X	X	Number of Data Formats			X		X	4.2.1.9
3.2.1.10	X	X	X	Format Change via Discrete Signal			X		X	4.2.1.10
3.2.1.11				DAS Interface Requirements	X					4.2.1.11
3.2.1.11.1	X	X	X	MDAU to Telemetry System Interface					X	4.2.1.11.1
3.2.1.11.1.1	X	X	X	MDAU to Telemetry System Bit Rate			X			4.2.1.11.1.1
3.2.1.11.1.2	X	X	X	MDAU to Telemetry System Impedance			X			4.2.1.11.1.2
3.2.1.11.2	X	X	X	MDAU to First Stage DFI System Interface					X	4.2.1.11.2
3.2.1.11.2.1	X	X	X	MDAU to First Stage DFI System Bit Rate			X			4.2.1.11.2.1
3.2.1.11.2.2	X	X	X	MDAU to First Stage DFI System Impedance			X			4.2.1.11.2.2
3.2.1.11.3	X	X	X	First Stage DFI System to MDAU Interface					X	4.2.1.11.3
3.2.1.11.3.1	X	X	X	First Stage DFI System to MDAU Bit Rate			X			4.2.1.11.3.1
3.2.1.11.3.2	X	X	X	First Stage DFI System to MDAU Impedance			X			4.2.1.11.3.2
3.2.1.11.4	X	X	X	MDAU with RDAU Interface			X			4.2.1.11.4

Section No.	*EDU*	*Qualification*	*Acceptance.*	*Section / Requirement Title*	*Methods*					*Verification ID*
					N / A	*A*	*T*	*D*	*I*	
3.2.1.11.4.1	X	X	X	MDAU with RDAU Interface Distance			X			4.2.1.11.4.1
3.2.1.11.5	X	X	X	Workstation Interface			X			4.2.1.11.5
3.2.1.11.6	X	X	X	EGSE Interface					X	4.2.1.11.6
3.2.1.11.7	X	X	X	Test and Programming					X	4.2.1.11.7
3.2.2	X	X	X	Input Channels			X		X	4.2.2
3.2.2.1	X	X	X	Input Channels Characteristics			X		X	4.2.2.1
3.2.2.1.1	X	X		Sample Rates			X			4.2.2.1.1
3.2.2.1.2	X	X		A/D Resolution			X			4.2.2.1.2
3.2.2.1.3	X	X	X	Output/Sample			X		X	4.2.2.1.3
3.2.2.1.4	X	X		Excitation					X	4.2.2.1.4
3.2.2.1.5	X	X		Signal Condition					X	4.2.2.1.5
3.2.2.1.6	X	X	X	Accuracy			X			4.2.2.1.6
3.2.2.1.7	X	X		Charge Amplifier					X	4.2.2.1.7
3.2.2.1.8	X	X		Programmable Filter					X	4.2.2.1.8
3.2.2.1.9	X	X		Programmable Gains					X	4.2.2.1.9
3.2.2.1.10	X	X		Reference Junction Compensation					X	4.2.2.1.10
3.2.2.1.11				Video	X					4.2.2.1.11
3.2.2.1.11.1	X	X		Video Format			X			4.2.2.1.11.1
3.2.2.1.11.2	X	X	X	Video Resolution			X			4.2.2.1.11.2
3.2.2.1.11.3	X	X	X	Video Frame Rate			X			4.2.2.1.11.3
3.2.2.1.11.4	X	X	X	Video Image Compression			X			4.2.2.1.11.4
3.2.3				Time	X					4.2.3
3.2.3.1	X	X	X	Receiving Time			X			4.2.3.1
3.2.3.2	X	X	X	Internal Clock			X		X	4.2.3.2
3.2.3.3	X	X	X	Time Stamp of Data		X				4.2.3.3
3.2.3.4	X	X	X	Time Stamp with Accuracy		X				4.2.3.4
3.2.3.5	X	X	X	Time Stamp with Precision		X				4.2.3.5
3.2.4				Workstation Characteristics	X					4.2.4
3.2.4.1	X	X		Workstation Computer					X	4.2.4.1
3.2.4.2	X	X		Data Channel Configuration					X	4.2.4.2
3.2.4.3	X	X		Configurable Channel Sampling Rates					X	4.2.4.3
3.2.4.4	X	X		Configurable Channel Gain					X	4.2.4.4
3.2.4.5	X	X		Configurable Channel Offset					X	4.2.4.5
3.2.4.6	X	X		Configurable Channel Calibration					X	4.2.4.6
3.2.4.7	X	X		Configurable Channel Range					X	4.2.4.7
3.2.4.8	X	X	X	Receiving Channel Data			X		X	4.2.4.8
3.2.4.9	X	X	X	Display Data in Counts Format					X	4.2.4.9
3.2.4.10	X	X		Display Data in Units Format					X	4.2.4.10
3.2.4.11	X	X		Display Data in Strip Chart					X	4.2.4.11

Section No.	*EDU*	*Qualification*	*Acceptance.*	*Section / Requirement Title*	*Methods*					*Verification ID*
					N / A	*A*	*T*	*D*	*I*	
				Format						
3.2.4.12	X	X	X	Display Data with Alarms			X		X	4.2.4.12
3.2.4.13	X	X		Portability					X	4.2.4.13
3.2.4.14	X	X		Display Parameters			X		X	4.2.4.14
3.2.4.15	X	X	X	Built In Test			X			4.2.4.15
3.2.4.16		X		Reliability		X				4.2.4.16
3.2.4.16.1		X		Reliability Data					X	4.2.4.16.1
3.2.4.17		X		Failure Propagation		X				4.2.4.17
3.2.4.18		X		Flight Operation Life		X				4.2.4.18
3.2.4.19		X		Calibration					X	4.2.4.19
3.2.5				Environmental Conditions	X					4.2.5
3.2.5.1		X		Natural Environments		X				4.2.5.1
3.2.5.2		X		Induced Environments	X					4.2.5.2
3.2.5.2.1		X		Transportation (packaged)			X		X	4.2.5.2.1
3.2.5.2.2		X		Non-Operating Environment	X					4.2.5.2.2
3.2.5.2.2.1		X		Storage	X					4.2.5.2.2.1
3.2.5.2.2.1.1		X		Storage Time		X				4.2.5.2.2.1.1
3.2.5.2.2.2		X		Non-Operating Temperature		X				4.2.5.2.2.2
3.2.5.2.2.3		X		Non-Operating Humidity		X				4.2.5.2.2.3
3.2.5.2.3		X		Operating Environment	X					4.2.5.2.3
3.2.5.2.3.1		X		Operating Temperature			X			4.2.5.2.3.1
3.2.5.2.3.2		X		Operating Humidity			X			4.2.5.2.3.2
3.2.5.2.3.3		X		Random Vibration and Shock			X			4.2.5.2.3.3
3.2.5.2.3.4		X		Pressure Change			X			4.2.5.2.3.4
3.2.5.2.3.5		X		Pressure Rate of Change			X			4.2.5.2.3.5
3.2.5.2.3.6		X		Loads Analysis		X				4.2.5.2.3.6
3.2.5.3		X		Qualification Test Requirements			X		X	4.2.5.3
3.2.5.4			X	Acceptance Test Requirements.			X		X	4.2.5.4
3.2.6				Electrical Design	X					4.2.6
3.2.6.1	X	X	X	Input Power			X			4.2.6.1
3.2.6.2	X	X		Input Voltage Range		X	X		X	4.2.6.2
3.2.6.3	X	X		Short Circuit Protection		X				4.2.6.3
3.2.6.4	X	X	X	5V Discrete Characteristics			X			4.2.6.4
3.2.6.4.1	X	X	X	Pull Down Characteristic			X			4.2.6.4.1
3.2.6.4.2	X	X	X	Quantity					X	4.2.6.4.2
3.2.6.5	X	X	X	28V Discrete Characteristics			X			4.2.6.5
3.2.6.5.1	X	X	X	Pull Down Characteristic			X			4.2.6.5.1
3.2.6.5.2	X	X	X	Quantity					X	4.2.6.5.2
3.2.6.6		X	X (I, T)	Electrical Bonding		X	X		X	4.2.6.6
3.2.6.7		X		Electrical Grounding		X			X	4.2.6.7
3.2.6.8		X		Lightning Protection		X	X			4.2.6.8

Section No.	*EDU*	*Qualification*	*Acceptance.*	*Section / Requirement Title*	*Methods*					*Verification ID*
					N / A	*A*	*T*	*D*	*I*	
3.2.6.9		X		Electrostatic Discharge (ESD) Protection		X	X			4.2.6.9
3.2.6.10		X	X	Isolation of Test Points					X	4.2.6.10
3.2.6.11		X	X	Electronic, Electrical, Electromechanical (EEE) Parts		X				4.2.6.11
3.2.6.12		X	X	Inadvertent Disconnect		X				4.2.6.12
3.2.6.13		X	X	Printed Wiring Boards					X	4.2.6.13
3.2.6.14		X		Ignition Source Avoidance					X	4.2.6.14
3.2.6.15		X	X	Electromagnetic Interference			X			4.2.6.15
3.2.6.16		X		Circuit Classification		X				4.2.6.16
3.2.6.17		X	X	Connector Location and Pin Function Assignments					X	4.2.6.17
3.2.6.18		X	X	Wire and Cable Shielding Separation and Routing					X	4.2.6.18
3.2.6.19		X	X	Electrostatic Discharge (ESD) Control					X	4.2.6.19
3.2.7		X		Structural and Mechanical	X					4.2.7
3.2.7.1		X		Materials and Processes					X	4.2.7.1
3.2.7.2		X		Fracture Control		X	X		X	4.2.7.2
3.2.7.3		X		Drawing Quality					X	4.2.7.3
3.2.7.4		X		Cooling			X		X	4.2.7.4
3.2.7.5		X	X	Captive Fasteners					X	4.2.7.5
3.2.7.6		X		Factors of Safety		X				4.2.7.6
3.2.7.7		X		Debris Prevention		X				4.2.7.7
3.2.7.8		X		Chemical Exposure in the Instrument Unit (IU)		X				4.2.7.8
3.2.7.9		X		LRU Interchangeability					X	4.2.7.9
3.2.7.10		X		Connector Mismating		X				4.2.7.10
3.2.7.11	X	X	X	DAU Chassis Size					X	4.2.7.11
4.2.7.12	X	X	X	Distributed System				X	X	4.2.7.12
3.2.8				Product Marking	X					4.2.8
3.2.8.1		X	X	Identification and Marking					X	4.2.8.1
3.2.8.2		X	X	ESD Identification and Marking					X	4.2.8.2
3.2.8.3		X	X	Serial Numbers					X	4.2.8.3
3.2.9				Workmanship	X					4.2.9
3.2.9.1		X	X	Soldering					X	4.2.9.1
3.2.9.2		X	X	Crimping					X	4.2.9.2
3.2.9.3		X	X	Soldering of Surface Mount Components					X	4.2.9.3
3.2.9.4		X	X	Conformal Coating and Staking					X	4.2.9.4
3.2.9.5		X	X	Tin Whisker Mitigation					X	4.2.9.5
3.2.10				Human Engineering	X					4.2.10
3.2.10.1	X	X	X	Human Engineering Guidelines					X	4.2.10.1
3.2.10.2	X	X	X	Sharp Edges					X	4.2.10.2
3.2.10.3	X	X		Maximum Touch Temperature		X	X		X	4.2.10.3

Section No.	*EDU*	*Qualification*	*Acceptance.*	*Section / Requirement Title*	*Methods*					*Verification ID*
					N / A	*A*	*T*	*D*	*I*	
3.2.10.4	X	X		Minimum Touch Temperature		X	X		X	4.2.10.4
3.2.10.5		X		General Safety					X	4.2.10.5
3.2.10.6		X	X	Contamination Control					X	4.2.10.6
3.2.10.7		X		Box Integration for Ground Operations					X	4.2.10.7
3.3		X		Packaging Requirements		X				4.3
3.3.1		X		Packaging Design Requirement (Structural)		X			X	4.3.1
3.3.2		X	X	Reusable Containers		X				4.3.2
3.3.3		X	X	Monitoring Devices					X	4.3.3
3.3.4		X	X	Temporarily Installed Hardware Identification					X	4.3.4
3.3.5		X	X	Marking for Shipment					X	4.3.5
3.3.6		X	X	Marking for Reuse					X	4.3.6
3.3.7		X	X	NASA Critical Item Labels					X	4.3.7
3.3.8		X	X	Identification Format					X	4.3.8

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Exploration Launch Office/Crew Launch Vehicle Project
National Aeronautics and Space Administration
Marshall Space Flight Center, AL 35812

Ares I Upper Stage (US)
Development Flight Instrumentation (DFI)
Data Acquisition System (DAS)
Component End Item Specification (CEIS)

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	Effective Date: May 28, 2008	Page 3 of 78

Ares I Upper Stage (US)
Development Flight Instrumentation (DFI) Data Acquisition System (DAS)
Component End Item Specification (CEIS)

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LIST OF FIGURES AND TABLES

1 SCOPE

This Contractor End Item Specification document defines and describes the design, performance and verification requirements for the ARES I Upper Stage Development Flight Instrumentation (DFI) Data Acquisition System (DAS).

1.1 Classification

1.2.1 Flight Unit

A Flight Unit (FU) is equipment that must conform to this procurement specification to the fullest extent.

[Rationale: The Flight Units shall meet all acceptance testing requirements and be able to process all discrete signals and sensor requirements listed in Table 3.]

1.2.2 Qualification Unit

A Qualification Unit (QU) is a Flight Unit designated for qualification testing purposes and will not be used as a flight unit due to overstressing of components.

1.2.3 Engineering Development Unit

An Engineering Development Unit (EDU) conforms to the form, fit, and function of an FU, but does not necessarily meet the natural and induced environmental requirements of the FU.

[Rationale: Since NASA will just be using the DAUs for development testing and evaluation, the EDUs shall be able to acquire data from approximately *half of the discretes and sensor count* for each type of sensor listed in Table 3. It is expected that this will lead to an arrangement of at least two DAUs that shall be connected to one another in order to be able to communicate.]

1.2.4 Wording Convention

The conventions used in this document, which indicates requirements, goals, statements of facts, rationale, and notes are as follows:

1) Shall: Used to indicate a binding requirement which must be implemented and its implementation verified, unless otherwise specified herein.

2) Should: Used to indicate a non-binding goal which must be addressed by the design but is not formally verified.

3) Will: Used to indicate a non-binding statement of fact and is not verified.

4) Rationale: Rationales are included for many requirements. The rationales are intended to provide clarification, justification, purpose, and/or source of the requirement. It is important to

note that the rationales are not binding and only provide supporting information. In the event there is an inconsistency between the requirement and the rationale, only the requirements will be binding and take precedence.

5) Note: Notes are included for many requirements. Notes explain the allocation of how the requirement was met by enforcing specific requirement values from separate, but interacting components. Notes do not contain binding language and only provide supporting information. In the event there is an inconsistency between the requirement and the note, only the requirement will be binding and take precedence.

2 APPLICABLE DOCUMENTS

2.1 General

The following documents of the issue in effect on the date of invitation of bids or request for proposal form a part of this document to the extent contained herein.

The documents listed in this section are specified in Sections 3 or 4 of the specification. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in Sections 3 or 4 of the standard, whether or not they are listed.

2.2 Applicable Government Documents

The specifications, standards, and handbooks in Table 1 form a part of this document to the extent specified herein.

Document Title	Document Number	Revision
Constellation Program Design Specification For Natural Environments	CxP 70023	
Human-Systems Integration Requirements (HSIR)	CxP 70024	
Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR)	CxP 70036	
Constellation Program Electrical Power System Specification, Volume 2: Electrical Power Quality Performance for 28 Vdc	CxP 70050-02	
Constellation Program (CxP) Integrated Safety, Reliability, and Quality Assurance (SR&QA) Requirements	CxP 70059	
CONSTELLATION PROGRAM STRUCTURAL DESIGN AND VERIFICATION REQUIREMENTS	CxP 70135	
Constellation Program Contamination Control Requirements	CxP 70145	

ARES I Electromagnetic Environmental Effects (E3) Requirements Document	CxP 72043	
CLV (Crew Launch Vehicle) Requirements for the Control of Electromagnetic Interference Requirements of Subsystems and Equipment	CxP 72047	
EEE Parts Management and Control Plan	CxP 72053	
Ares I Vibroacoustic and Shock Environments Data book	CxP 72169	
Design Requirements for Rigid Printed Circuit Boards and Assemblies	MFSC-STD-3425	
Department of Defense Standard Practice Identification Marking of U.S. Military Property	MIL-STD-130	December 17, 2007
Standard Practice for Military Packaging	MIL-STD-2073	
MSFC Fastener Management & Control Practices	MSFC-STD-2594C	
MSFC Tailoring Guide For NASA-STD-8739.4, Crimping, Interconnecting Cables, Harness, And Wiring	MSFC-STD-2905	
EEE Parts Management and Control for MSFC Space Flight Hardware	MSFC-STD-3012	
Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits	NASA Technical Memorandum 102179	
Standard Materials and Processes Requirements for Spacecraft	NASA-STD-(I)-6016	
Man-Systems Integration Standards	NASA-STD-3000	
Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment	NASA-STD-4003	
Loads analysis of spacecraft and payloads	NASA-STD-5002	
Fracture Control Requirements for Spaceflight Hardware	NASA-STD-5019	
CRIMPING, INTERCONNECTING CABLES, HARNESSES, AND WIRING	NASA-STD-8739.4	
Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components	NPR 6000.1G	
Ares I Upper Stage Electrical Ground Support Equipment (EGSE) Requirements Document	USO-CLV-DE-25135	
ARES I UPPER STAGE AVIONICS & SOFTWARE SUBSYSTEM SPECIFICATION	USO-CLV-DE-25107	
Human Factors Engineering Design Criteria	USO-CLV-LS-25404	

Table 1 Applicable Government Documents

2.3 Non-Government Publications

The publications in Table 2 form a part of this document to the extent specified herein.

Document Title	Document Number	Revision
ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (excluding Electrically Initiated Explosive Devices).	ANSI/ESD S20.20-1999	
Engineering Drawing Practices	ASME Y14.100	
Types and Applications of Engineering Drawings	ASME Y14.24	
Associated Lists	ASME Y14.34	
Revision of Engineering Drawings and Associated Documents	ASME Y14.35M-1997	
Generic Performance Specification for Printed Boards	IPC-6011	
Telemetry Standards	IRIG 106	
Inter Range Instrumentation Group	IRIG-B	
Requirements for Soldered Electrical and Electronic Assemblies	IPC J-STD-001D	
Space Applications Electronic Hardware Addendum to J-STD-001D Requirements for Soldered Electrical and Electronic Assemblies	IPC J-STD-001DS	

Table 2 Non-Government Publications

2.4 Order of Precedence

In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3 DFI DATA ACQUISITION SYSTEM (DFI DAS) REQUIREMENTS

3.1 DFI DAS Description

The Development Flight Instrumentation (DFI) Data Acquisition System (DAS) is part of the Ares I Upper Stage (US) Development Flight Instrumentation System (DFIS). The purpose of the Developmental Flight Instrumentation System (DFIS) is to collect, and telemeter non-critical data that will verify engineering models of the CLV Upper Stage design.

The DFI DAS is a distributed system. Components of the distributed system that make up the DAS for this procurement specification are a Master Data Acquisition Unit (MDAU), two Remote DAUs (RDAU) and a portable workstation. The portable workstation will interface with the DAUs for programming, testing and real-time evaluation of PCM data and video images. Video images will be generated by two cameras. Both cameras will take video of Liquid Hydrogen (LH2) slosh activity. The DFI DAS will be powered by the DFI Power Distribution Unit (PDU). Figure 2 shows the DFIS Architecture.

The MDAU and RDAUs will be mounted on the US Instrument Unit (IU) and on the US Aft Skirt. Figure 1 shows the US Sections that will house DFI DAS components. The J-2X engine program will have an additional RDAU that will mount on the engine and will interface with the DFI DAS units. The J-2X Engine RDAU is not part of this procurement specification.

The MDAU and RDAUs will receive sensor data from the measurements identified in Table 3, and generate Pulse Code Modulation (PCM) stream data. The MDAU will output PCM data to the telemetry system for downlink during the entire DFI mission, approximately 10 minutes. The MDAU will also output PCM data to a First Stage DFI recorder for storage during the FS burn, until FS separation, for approximately the initial 2 minutes of flight. During the FS burn, until First Stage separation, the MDAU will also receive PCM data from a First Stage Data Acquisition Unit and then send that data to the telemetry system for downlink.

The MDAU and RDAUs are considered to be Line Replaceable Units (LRUs). Each LRU is replaceable at any processing facility used by the Ares I vehicle.

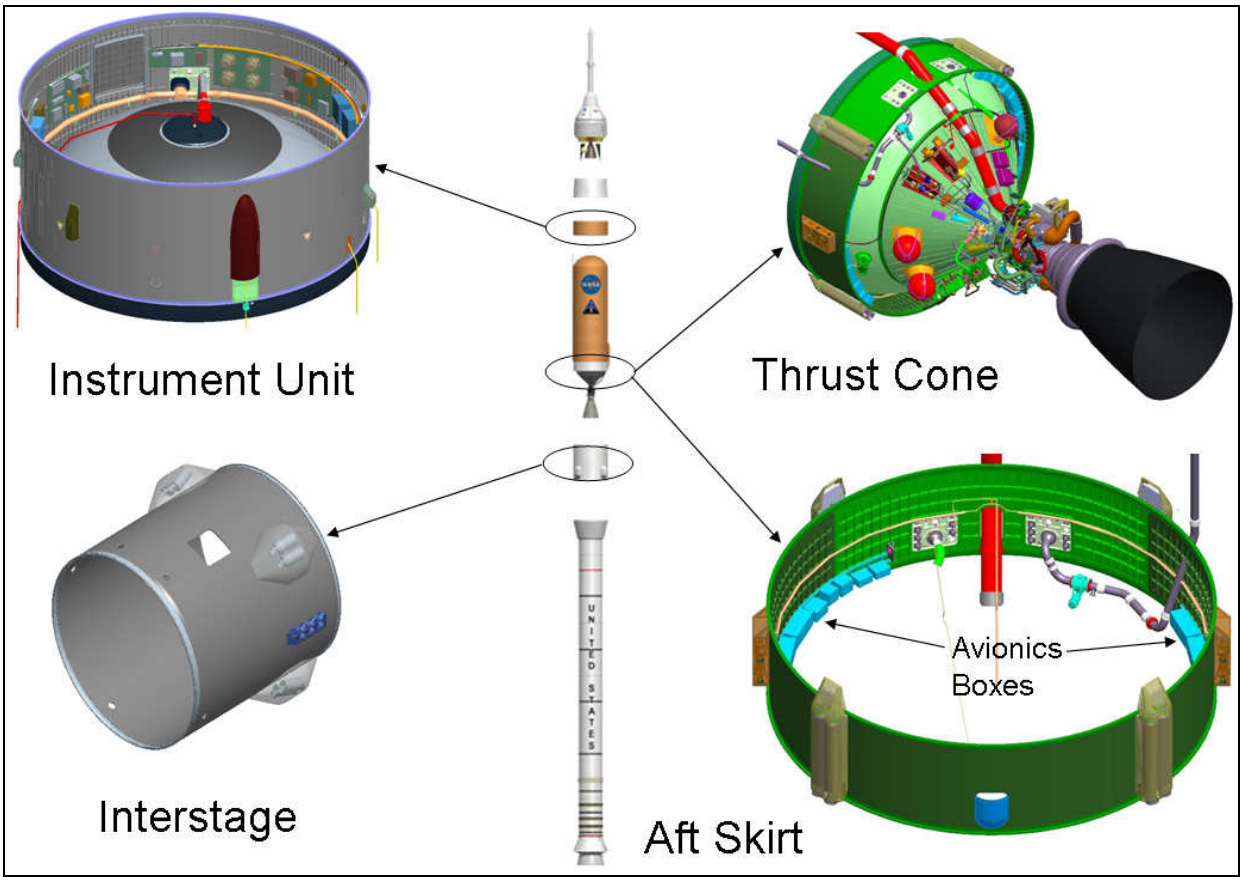

Figure 1 Upper Stage Sections

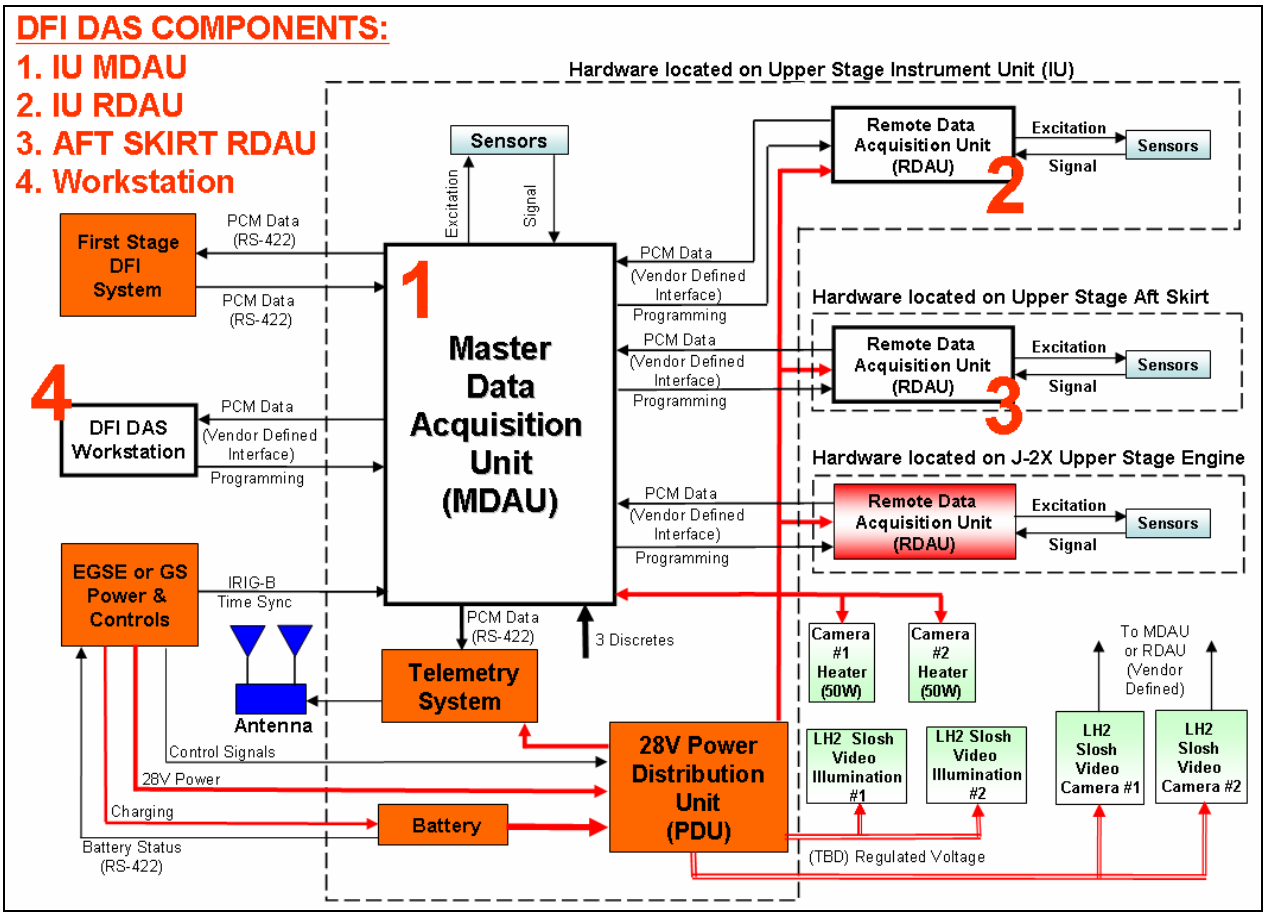

Figure 2 DFI Architecture

3.2 DFI DAS Characteristics

3.2.1 Data Acquisition

3.2.1.1 Initialization to Known PCM Frame Format

Upon power application, the DFI DAS shall initialize to a selected PCM frame format configuration that will be identified at a later date, based on the final measurement list.

[Note: The PCM frame format configuration is not known at this time and will not be specified until the final measurement list for Table 3 is determined.]

3.2.1.2 Power Application Data Output

The DFI DAS shall begin outputting data from the input channels within 3 seconds of power application.

3.2.1.3 Power Interruption Data Output
The DFI DAS shall begin outputting data from the input channels within 3 seconds of a power interruption.

3.2.1.4 Sensor Data Acquisition
The DFI DAS shall acquire data from DFI sensors listed in Table 3 – Measurement Input Channels with characteristics defined in paragraph 3.2.2, Input Channels.

3.2.1.5 PCM Data Acquisition
The DFI DAS shall receive external source PCM data configured per IRIG 106, NRZ Class II Telemetry Standards.

[Rationale: IRIG 106 is a comprehensive telemetry standard to ensure interoperability in aeronautical telemetry applications. Class II includes bit rates greater than 10 Mbps, format changes, and other more complex characteristics than Class I. IRIG 106 is available at http://www.irig106.org/docs/106-05/]

3.2.1.6 PCM Frame Generation
The DFI DAS shall generate PCM frame format structure per IRIG 106, NRZ, Class II Telemetry Standards from all acquired data without any nominal data loss.

[Rationale: IRIG 106 is a comprehensive telemetry standard to ensure interoperability in aeronautical telemetry applications. Class II includes bit rates greater than 10 Mbps, format changes, and other more complex characteristics than Class I. IRIG 106 is available at http://www.irig106.org/docs/106-05/]

3.2.1.7 User Programmable
The DFI DAS configuration, with respect to channel sampling and scheduling, shall be contained in non-volatile memory accessible and programmable by the user.

3.2.1.8 Sampling and Formatting
The DFI DAS shall control the sampling, gains, offset, filtering, formatting and sub-formatting.

3.2.1.9 Number of Data Formats
The DFI DAS shall have a minimum of 8 different PCM frame formats.

3.2.1.10 Format Change via Discrete Signal
The DFI DAS shall be able to change PCM formats via a state change in a minimum of three discrete signals as defined in section 3.2.6.4 5V Discrete Characteristics and 3.2.6.5 28V Discrete Characteristics .

3.2.1.11 DAS Interface Requirements

3.2.1.11.1 MDAU to Telemetry System Interface

The DFI DAS shall use a RS-422 data interface to transmit PCM data to the DFI Telemetry system.

3.2.1.11.1.1 MDAU to Telemetry System Bit Rate

The DFI DAS shall be capable of providing a maximum bit rate of 20Mbps at a distance of 40 feet.

[Rationale: A distance of 40 feet is the estimated worst-case calculated distance from the DFI DAS MDAU to the DFI DAS Telemetry System unit located on the US IU.]

3.2.1.11.1.2 MDAU to Telemetry System Impedance

The DFI DAS shall be capable of interfacing with a cable impedance of 100 ohms, ± 10%.

3.2.1.11.2 MDAU to First Stage DFI System Interface

The DFI DAS shall use four (4) RS-422 data interfaces to transmit PCM data to the First Stage DFI System.

3.2.1.11.2.1 MDAU to First Stage DFI System Bit Rate

The DFI DAS shall be capable of providing a total maximum bit rate of 20Mbps at a distance of 175 feet.

[Rationale: A distance of 175 feet is the estimated worst-case calculated distance from the DFI DAS MDAU to the First Stage recorder unit located on the FS Forward Skirt.]

3.2.1.11.2.2 MDAU to First Stage DFI System Impedance

The DFI DAS shall be capable of providing an impedance of 100 ohms, ± 10%.

3.2.1.11.3 First Stage DFI System to MDAU Interface

The DFI DAS shall use a RS-422 data interface to accept transmitted PCM data from the First Stage DFI System.

3.2.1.11.3.1 First Stage DFI System to MDAU Bit Rate

The DFI DAS shall be capable of receiving a maximum bit rate of 6Mbps at a distance of 175 feet.

[Rationale: A distance of 175 feet is the estimated worst-case calculated distance from the DFI DAS MDAU to the First Stage DFIM unit located on the FS Forward Skirt.]

3.2.1.11.3.2 First Stage DFI System to MDAU Impedance

The DFI DAS shall be capable of providing an impedance of 100 ohms, ± 10%.

3.2.1.11.4 MDAU with RDAU Interface

The DFI DAS data interfaces between the MDAU and RDAUs shall be defined by the vendor.

3.2.1.11.4.1 MDAU with RDAU Interface Distance

The DFI DAS data interfaces between the MDAU and RDAUs shall transmit PCM data at a maximum distance of 155 feet.

[Rationale: A distance of 155 feet is the estimated worst-case calculated distance from the DFI DAS MDAU to a unit located the farthest distance (worst-case) which is the RDAU located on the J-2X Engine. Data rate maximum may be 5Mbps between each RDAU and the MDAU.]

3.2.1.11.5 Workstation Interface

The workstation shall be capable of interfacing with the DFI DAS during ground operations programming, testing and real-time evaluation of PCM data.

[Note: The workstation interface may be determined by the vendor.]

3.2.1.11.6 EGSE Interface

All DFI DAS EGSE interfaces shall meet the requirements described in section 3.6, Interfaces, of USO-CLV-DE-25135, The Upper Stage (US) EGSE Subsystems Requirements Document.

3.2.1.11.7 Test and Programming

The DFI DAS shall provide a minimum of one port for use as a test and programming port.

3.2.2 Input Channels

The DFI DAS shall have unique input channels for the measurements list identified in Table 3, Measurement Input Channels.

3.2.2.1 Input Channel Characteristics

The DFI DAS input channels shall support the types, quantities and data rates of all measurements listed in Table 3, Measurement Input Channels, of this section.

3.2.2.1.1 Sample Rates

The DFI DAS shall be capable of sampling all sensors at the rates identified in Table 3, Measurement Input Channels.

3.2.2.1.2 A/D Resolution

The DFI DAS shall provide A/D conversion to a resolution identified in Table 3, Measurement Input Channels.

3.2.2.1.3 Output/Sample

The DFI DAS shall be able to output/sample per Table 3, Measurement Input Channels.

3.2.2.1.4 Excitation

The DFI DAS shall provide for current or voltage excitation, as identified in Table 3, Measurement Input Channels.

3.2.2.1.5 Signal Conditioning

The DFI DAS shall provide signal conditioning as identified in Table 3, Measurement Input Channels.

3.2.2.1.6 Accuracy

The DFI DAS shall have accuracy as identified in Table 3, Measurement Input Channels.

3.2.2.1.7 Charge Amplifier

The DFI DAS shall provide a Charge Amplifier capability as identified in Table 3, Measurement Input Channels.

3.2.2.1.8 Programmable Filter

The DFI DAS shall provide programmable filters as identified in Table 3, Measurement Input Channels.

3.2.2.1.9 Programmable Gains

The DFI DAS shall provide for programmable gains with programmable offset for each channel as identified in Table 3, Measurement Input Channels.

3.2.2.1.10 Reference Junction Compensation

The DFI DAS shall provide for Reference Junction Compensation as identified in Table 3, Measurement Input Channels.

Sensor / Measurement Type	Number of Measurements	Sampling Rate	Resolution	Output/ Sample	Excitation	Signal Conditioning	Accuracy	Filter	Other
Thermocouple (Type=J,K,E,T)	176	0.1 to 10	12 and 16 bit				+/- 0.8 % full scale		Programmable Gains, 10, 0.01V to 0.5V Reference Junction Compensation
Pressure	256	10 to 10k	12 and 16 bit	simultaneous	voltage up to ±10 V	½ and full bridge completion	+/- 0.8 % full scale	programmable 5 pole	
Strain Gage (50 triaxial)	112	10 to 250	12 and 16 bit	simultaneous	constant current or voltage	½ and full bridge completion	+/- 0.8 % full scale	programmable 5 pole	
Calorimeter / Heat Flux	72	50	12 and 16 bit				+/- 0.8 % full scale		
A/D (Current)	12	0.2 to 1	12 and 16 bit		voltage up to ±10 V, current to 15 mA				
A/D (Voltage)	48	0.2 to 1	12 and 16 bit				± 0.3 % full scale		
Frequency	2	1	12 and 16 bit		voltage up to ±5 V, current to 15 mA		+/- 0.8 % full scale		
Accelerometer	64	100 to 5k	12 and 16 bit	simultaneous	constant voltage and constant current	½ and full bridge completion	+/- 0.8 % full scale	programmable 5 pole	Charge Amplifier
Microphones	24	1k to 5k	12 and 16 bit	simultaneous	constant current or voltage	½ and full bridge completion	+/- 0.8 % full scale	programmable 5 pole	
Position	4	250	12 and 16 bit		3V rms AC Excitation Source		+/- 0.8 % full scale		
Video	2	N/A	12 and 16 bit						
Haz Gas	12	10	12 and 16 bit		28V		±25 ppm/± 10 % of reading		
Total	784								

One Bit Discretes	0	1	1 bit
Two Bit Discretes	0	1	2 bit
Discretes	0	1	
Total Number of Measurements:	784		

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Table 3 - Measurement Input Channels

3.2.2.1.11 Video

3.2.2.1.11.1 Video Format

The DFI DAS shall interface video image data via GigE (Pro-E-Vision) or Camera Link or IEEE1394.

3.2.2.1.11.2 Video Resolution

The DFI DAS shall receive video with a resolution of at least 640 x 480 pixels.

3.2.2.1.11.3 Video Frame Rate

The DFI DAS shall receive video with progressive scan at up to 60 frames/second and as low as 5 frames/sec.

3.2.2.1.11.4 Video Image Compression

The DFI DAS shall have an average image compression ratio of approximately 20:1 to 30:1.

[Rationale: An image compression ratio of approximately 20:1 to 30:1 may be needed to fit within system bandwidth allocations.]

3.2.3 Time

3.2.3.1 Receiving Time

The DFI DAS shall be able to receive time per IRIG-B time signal from an external source to set its internal clock.

3.2.3.2 Internal Clock

The DFI DAS shall have an internal time circuit to allow continuous time stamp of data per IRIG-106-05, Telemetry Standards.

[Rationale: IRIG 106 is a comprehensive telemetry standard to ensure interoperability in aeronautical telemetry applications. Chapter 4, Section 4.7 describes the formatting of time words within a PCM stream. This standard allows for 1 microsecond resolution. IRIG 106 is available at http://www.irig106.org/docs/106-05/.]

3.2.3.3 Time Stamp of Data

The DFI DAS shall time stamp each major frame per IRIG-106 format.

[Rationale: IRIG 106 is a comprehensive telemetry standard to ensure interoperability in aeronautical telemetry applications. Chapter 4, Section 4.7 describes the formatting of time words within a PCM stream. This standard allows for 1 microsecond resolution. IRIG 106 is available at http://www.irig106.org/docs/106-05/.]

3.2.3.4 Time Stamp Accuracy
The DFI DAS shall time stamp each major frame with an accuracy of a minimum of 1 millisecond of the IRIG B input time signal.

3.2.3.5 Time Stamp Precision
The DFI DAS shall time stamp each major frame with precision per IRIG-106 format.

[Rationale: IRIG 106 is a comprehensive telemetry standard to ensure interoperability in aeronautical telemetry applications. Section 4.7 describes the formatting of time words within a PCM stream. This standard allows for 1 microsecond resolution. IRIG 106 is available at http://www.irig106.org/docs/106-05/.]

3.2.4 Workstation Characteristics
3.2.4.1 Workstation Computer
The DFI DAS Workstation shall use a Windows based computer.

3.2.4.2 Data Channel Configuration
The DFI DAS Workstation shall be capable of configuring every data channel.

3.2.4.3 Configurable Channel Sampling Rates
The DFI DAS Workstation shall be capable of configuring independent sampling rates for each data channel.

3.2.4.4 Configurable Channel Gain
The DFI DAS Workstation shall be capable of configuring the gain for each data channel.

3.2.4.5 Configurable Channel Offset
The DFI DAS Workstation shall be capable of configuring the offset for each data channel.

3.2.4.6 Configurable Channel Calibration
The DFI DAS Workstation shall be capable of configuring calibration information for each data channel.

3.2.4.7 Configurable Channel Range
The DFI DAS Workstation shall be capable of configuring A/D range for each data channel.

3.2.4.8 Receiving Channel Data
The DFI DAS Workstation shall be capable of receiving sensor data from every data channel.

3.2.4.9 Display Data in Counts Format
The DFI DAS Workstation shall display data in counts format.

3.2.4.10 Display Data in Units Format
The DFI DAS Workstation shall display data in engineering unit's format.

3.2.4.11 Display Data in Strip Chart Format
The DFI DAS Workstation shall display data in strip chart format.

3.2.4.12 Display Data with Alarms
The DFI DAS Workstation shall display data with alarms to be uniquely configurable for each data channel and capable of generating alarms for out of range data.

3.2.4.13 Portability
The DFI DAS Workstation shall be portable like a laptop or a portable desktop computer.

3.2.4.14 Display Parameters
The Workstation shall provide display of all DFI DAS parameters during ground operations programming and testing.

3.2.4.15 Built In Test (BIT)
The DFI DAS Workstation shall be capable of performing a Built In Test (BIT) to indicate system health.

[Rationale: BIT must indicate system power on and DAU configuration integrity.

3.2.4.16 Reliability
The DFI DAS shall have a Mean Time To Failure (MTTF) of at least 20,000 hours.

3.2.4.16.1 Reliability Data
The DFI DAS vendor shall supply sufficient data to support the reliability assessment in accordance with section 3.1.6, Commercial of the Shelf Hardware/Software, of CxP 70059 Constellation Program (CxP) Integrated Safety, Reliability, and Quality Assurance (SR&QA) Requirements.

3.2.4.17 Failure Propagation
The DFI DAS shall not cause damage to or failures of interfacing elements due to transient out-of-tolerance conditions or a failure.

3.2.4.18 Flight Operation Life
The DFI DAS shall meet flight operational performance for a flight time of 10 minutes per the requirements of section 3.2, DFI DAS Characteristics.

3.2.4.19 Calibration
The DFI DAS shall provide for calibration.

3.2.5 Environmental Conditions

3.2.5.1 Natural Environments

The DFI DAS shall meet all functional and performance requirements within the range of environmental conditions specified in CxP 70023 Constellation Program Design Specification For Natural Environments, Sections 3.1, 3.2.

3.2.5.2 Induced Environments

3.2.5.2.1 Transportation (packaged)

The DFI DAS shall meet the operating performance requirements contained herein after exposure to transportation conditions when packaged in accordance with the Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components, NPR.6000.1G. The worst-case values of the following parameters will determine the vendor's shipping method. These values will determine qualification test values of section 3.2.5.3, Qualification Test Requirements.

3.2.5.2.2 Non-Operating Environment

3.2.5.2.2.1 Storage

The DFI DAS shall be stored in a controlled environment.

3.2.5.2.2.1.1 Storage Time

The DFI DAS shall meet the operating performance requirements contained herein after being in storage for a period of 5 years.

3.2.5.2.2.2 Non-Operating Temperature

The DFI DAS shall be stored within a temperature range of -65°F (-54°C) to 126°F (52°C)

[Rationale: The non-operating temperature and humidity conditions cover worst case for storage, transport, and roll-out. Purge will not be provided to control temperature and humidity except during rollout. The non-operating conditions specified above are currently thought to represent worst case and are representative of transport environments on a covered barge.]

3.2.5.2.2.3 Non-Operating Humidity

The DFI DAS shall be stored with a humidity not to exceed 90% RH.

[Rationale: The non-operating temperature and humidity conditions cover worst case for storage, transport, and roll-out. Purge will not be provided to control temperature and humidity except during rollout. The non-operating conditions specified above are currently thought to represent worst case and are representative of transport environments on a covered barge.]

3.2.5.2.3 Operating Environment

The DFI DAS will be used during ground operations as well as flight. Sections 3.2.5.2.3.1 through 3.2.5.2.3.6 cover the worst case operational ground and flight conditions.

3.2.5.2.3.1 Operating Temperature

The DFI DAS shall meet all performance requirements after exposure to temperatures in the range of 0°F (-18°C) to 150°F (66°C).

3.2.5.2.3.2 Operating Humidity

The DFI DAS shall meet all performance requirements after exposure to a humidity level up to 90% RH.

3.2.5.2.3.3 Random Vibration and Shock

The DFI DAS shall satisfy all flight performance requirements after exposure to vibration and shock environments as defined in Upper Stage sections from CxP 72169, Ares I Vibroacoustic and Shock Environments Data book. Section 3.1.2, Random Vibration; Section 3.2.2, Shock Environments; Section 3.3.2, Internal Acoustic Environments.

3.2.5.2.3.4 Pressure Change

The DFI DAS shall be able to operate when exposed to a pressure change from 760 Torr/1 atm (Sea Level) to 10^{-5} Torr (near vacuum).

3.2.5.2.3.5 Pressure Rate of Change

The DFI DAS shall be able to operate when exposed to a pressure rate change starting at a pressure of 14 psi and decreasing in 26 seconds to 1 psi.

3.2.5.2.3.6 Loads Analysis

The DFI DAS shall comply with the requirements of NASA-STD-5002 for loads analysis of spacecraft and payloads.

3.2.5.3 Qualification Test Requirements

The DFI DAS shall successfully comply with qualification test requirements per section 4.0 of the Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

[Rationale: Proof pressure, leak test are not required as the DFI DAS is not sealed or a pressure vessel with specified leak rate. Acoustic vibration, thermal gradient, plasma/arcing testing are not required for electrical or Electronic Equipment per Table 4-3 of CxP 70036. Corona/arcing testing is not required if voltages are below 150V per 4.15 of CxP 70036.] Oxygen compatibility qualification is normally conducted by analysis per the requirements documented in NASA-STD-(I)-6016, per 4.18.1 of CxP 70036.]

3.2.5.4 Acceptance Test Requirements

The DFI DAS units submitted for acceptance testing under the contract shall successfully comply with acceptance test requirements per the Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

[Rationale: Proof pressure, leak test are not required as the DFI DAS is not sealed or a pressure vessel with specified leak rate. Acoustic vibration, thermal gradient, plasma/arcing testing are not required for electrical or Electronic Equipment per Table 4-3 of CxP 70036. Flight (acceptance) units are not subjected to life testing, climatic testing, acceleration testing, or sinusoidal testing per 4.11, 4.13, 4.14, and 4.15, respectively, of CxP 70036. Corona/arcing testing is not required if voltages are below 150V per 4.15 of CxP 70036. Oxygen compatibility testing is not required if the maximum design pressure is less than 265 psia per 4.18.1 of CxP 70036.]

3.2.6 Electrical Design

3.2.6.1 Input Power

The DFI DAS input power shall not exceed 350 watts over a steady state input voltage range of 23 to 36 VDC.

3.2.6.2 Input Voltage Range

The DFI DAS shall meet the requirements of CxP 70050-02, Constellation Program Electrical Power System Specification, Volume 2: Electrical Power Quality Performance for 28 Vdc.

3.2.6.3 Short Circuit Protection

The DFI DAS shall comply with the requirements of NASA Technical Memorandum 102179, Selection of Wires and Circuit Protective Devices for STS Orbiter Vehicle Payload Electrical Circuits.

3.2.6.4 5V Discrete Characteristics

The DFI DAS 5V discrete inputs shall have the following characteristics:

a. ON: 0.6 mA maximum sink current and 3.25VDC minimum input voltage
b. OFF: 1VDC maximum; 50 μA maximum sink current.

3.2.6.4.1 Pull Down Characteristic

The input shall be pulled down to the OFF voltage specified in 3.2.6.4, 5V Discrete Input Characteristics when not connected.

3.2.6.4.2 Quantity

There shall be a minimum of one 5V discrete inputs.

3.2.6.5 28V Discrete Input Characteristics

The DFI DAS 28V discrete inputs shall have the following characteristics:

a. ON: 22 to 32 VDC; 100 mA maximum sink current
b. OFF: 1.0 VDC maximum, 250 μA maximum sink current

3.2.6.5.1 Pull Down Characteristic

The input shall be pulled down to the OFF voltage specified in 3.2.7.5 when not connected.

3.2.6.5.2 Quantity

There shall be a minimum of two 28V discrete inputs.

3.2.6.6 Electrical Bonding

The DFI DAS shall meet the electrical bonding requirements of NASA-STD-4003, Electrical Bonding for NASA Launch Vehicles, Spacecraft, Payloads, and Flight Equipment.

[Rationale: NASA-STD-4003 is applicable as a whole. It is expected that DFI DAS will require several types of bonds. Section 6.1, Design Requirements, of NASA-STD-4003 gives guidance in this situation. NASA-STD-4003 is available online at http://standards.nasa.gov/released/4003/NASA-STD-4003.pdf

3.2.6.7 Electrical Grounding

The DFI DAS shall meet the electrical grounding requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

[Rationale: Section 3.11 Grounding of CxP 72043 indicates the requirements for implementing single point grounding.]

3.2.6.8 Lightning Protection

The DFI DAS shall meet the lightning protection requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

[Rationale: Section 3.5, Lightning, of CxP 72043 indicates the design requirements for lightning. The specific environment for the DFI DAS location has not been defined, a conservative design for a direct lightning strike to the DFI DAS or indirect strike through any connector on the DFI DAS should provide adequate protection. Applicable Crew Launch
Vehicle mission segments in section 3.5 are On-pad Operations, Launch and Ascent. Sections 3.5.1.1, Zoning, and 3.5.1.2 Zone Lightning Environment, do not apply to the DFI DAS. The DFI DAS test specifications for lightning are located in 3.2.6.16 Electromagnetic Interference, of this specification.]

3.2.6.9 Electrostatic Discharge (ESD) Protection

The DFI DAS shall meet the electrostatic discharge (ESD) protection requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

[Rationale: Section 3.7, Electrostatic Charge Control, of CxP 72043 specifies the design requirements for ESD protection and refers to the Class H and Class S requirements of NASASTD-4003. The DFI DAS test specifications for ESD are located in 3.2.6.16 Electromagnetic Interference, of this specification.]

3.2.6.10 Isolation of Test Points

The DFI DAS shall isolate test points and internal circuits such that a test point short to ground does not damage the Upper Stage Avionics hardware.

3.2.6.11 Electrical, Electronic, Electromechanical (EEE) Parts

The DFI DAS shall meet the requirements of MSFC-STD-3012, EEE Parts Management and Control for MSFC Space Flight Hardware, as tailored by CxP 72053, EEE Parts Management and Control Plan.

[Rationale: These documents indicate part selection requirements according to the criticality of the assembly. The DFI DAS is criticality 3. Consequently, Grade 4 parts as defined in the documents are the minimum grade allowed, however, higher grade parts may be needed to meet the assembly level MTTF and qualification requirements of this DFI DAS specification.]

3.2.6.12 Inadvertent Disconnect

The DFI DAS shall prevent inadvertent disconnects.

3.2.6.13 Printed Wiring Boards

The DFI DAS shall meet the design requirements of MFSC-STD-3425, Design Requirements for Rigid Printed Circuit Boards and Assemblies and be constructed in accordance with the Class 3 requirements of IPC-6011, Generic Performance Specification for Printed Boards.

[Rationale: MSFC-STD-3425 is a tailoring document for IPC-2221 and IPC-2222 which specify design requirements for printed circuit boards. The tailoring places further restrictions on board design to further increase uniformity and reliability. MSFC-STD-3425 is available at https://repository.msfc.nasa.gov/docs/multiprogram/MSFC-STD-3425.pdf]

3.2.6.14 Ignition Source Avoidance

The DFI DAS electrical components and wiring shall be conformal coated or otherwise ignition-proof to prevent ignition of potentially flammable or explosive gases/fluids existing in the Instrument Unit and Aft Skirt locations volume.

3.2.6.15 Electromagnetic Interference

The DFI DAS shall meet the electromagnetic interference requirements of CxP 72047, CLV Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment.

[Rationale: CxP 72047 is applicable as a whole with the exception that only the tests specified for non-antenna battery powered electronic units apply to the DFI DAS. CxP 72047 is applicable to Ground Support Equipment as stated in CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document, section 3.6.1.3 NDI/Commercial Items used in Electrical Ground Support Equipment.]

3.2.6.16 Circuit Classification

The DFI DAS shall meet the electrical circuit classification requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

[Rationale: Section 3.12.1, Cable and Wire Design for Electromagnetic Compatibility, of CxP 72043, indicates the characteristics of signals and the classification to which each signal type is assigned.]

3.2.6.17 Connector Location and Pin Function Assignments

The DFI DAS connector location and pin function assignments shall be provided.

3.2.6.18 Wire and Cable Shielding, Separation, and Routing

The DFI DAS shall meet the wire and cable shielding, separation, and routing requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

[Rationale: Section 3.12.2, Cable and Wire Design for Electromagnetic Compatibility, of CxP 72043, indicates that signals of different classifications should be separated by separating wires or cables physically, using cable trays, or shielding.]

3.2.6.19 Electrostatic Discharge (ESD) Controls

The CEI shall be produced/manufactured using ESD controls in accordance with ANSI/ESD S20.20-1999, ESD Association Standard for the Development of an Electrostatic Discharge Control Program for Protection of Electrical and Electronic Parts, Assemblies and Equipment (excluding Electrically Initiated Explosive Devices).

3.2.7 Structural and Mechanical

3.2.7.1 Materials and Processes

Components/hardware shall meet the requirements of USO-CLV-MP-25502 which implements the requirements of NASA-STD-(I)-6016 for materials and processes. Guidance specific to this procurement is provided in sections a-d below.

Guidance/Rationale:

a. For COTS hardware, complete materials and processes information and the Material Item Usage List (MIUL) may not be available. If accepted by M&P of the procuring authority, a complete as-built drawing package may be evaluated in lieu of an MIUL. However, the information will need to be sufficient, down to the manufactured parts level, to assess the overall safety of the hardware, and to verify the effect of any materials or processes (M&P) failure that will create a hazard or compromise mission success.

b. Vendor will inform procuring authority M&P of wire insulation other than PTFE Teflon

c. Vendor will inform procuring authority M&P of any use of tin not containing at least 3% lead.

d. Materials used in the design will meet the flammability requirements of NASA-STD-6001. A flammability assessment may be used to evaluate the flammability of a component or assembly. Flammability assessment and logic will be consistent with the approach provided in the in JSC 29353A, Flammability Configuration Analysis for Spacecraft Applications. If some minor use materials in COTS cannot be identified, the flammability assessment will be conducted to evaluate the flammability of the COTS hardware as an assembly.

The following are examples, but not a complete list, of areas considered in the overall acceptability of COTS hardware, to assure that failure of materials and processes used in the hardware does not create a hazard or compromise mission success: stress corrosion cracking, corrosion, adhesive failure, contamination/FOD, materials degradation, incompatibility of materials with fluids or natural and induced environments, defects from material joining, unauthorized material substitution, use of pure tin.

3.2.7.2 Fracture Control
The DFI DAS system shall meet the fracture control requirements in accordance with NASA-STD-5019, Fracture Control Requirements for Spaceflight Hardware.

3.2.7.3 Drawing Quality
The DFI DAS drawings and associated lists shall be prepared in accordance with ASME Y14.100, Engineering Drawing Practices, ASME Y14.24, Types and Applications of Engineering Drawings, ASME Y14.34, Associated Lists and ASME Y14.35M-1997, Revision of Engineering Drawings and Associated Documents.

[Rationale: ASME Y14.100, Engineering Drawing Practices, ASME Y14.24, Types and Applications of Engineering Drawings, ASME Y14.34, Associated Lists and ASME Y14.35M-1997, Revision of Engineering Drawings and Associated Documents supersede/replace MIL-STD-100, D.O.D. Standard for Engineering Drawings.]

3.2.7.4 Cooling
The DFI DAS shall not require active cooling.

3.2.7.5 Captive Fasteners
The DFI DAS shall use captive fasteners in accordance with MSFC-STD-2594C, MSFC Fastener Management & Control Practices.

3.2.7.6 Factors of Safety
The DFI DAS shall comply with the requirements of CxP 70135, CONSTELLATION PROGRAM STRUCTURAL DESIGN AND VERIFICATION REQUIREMENTS, section 3.10.

3.2.7.7 Debris Prevention
The DFI DAS shall be designed to preclude the generation or shedding of debris during pre-launch or ascent which might jeopardize personnel or other vehicle equipment.

3.2.7.8 Chemical Exposure in the Instrument Unit (IU)
The DFI DAS materials that will be exposed to the atmospheric environment in the IU shall be selected to be compatible with monomethyl hydrazine (MMH) and nitrogen tetroxide (NTO) as identified in the Materials and Processes Technical Information System (MAPTIS) database.

[Rationale: MAPTIS is Marshall Space Flight Center's single-point source for materials properties for NASA and NASA associated contractors and organizations. The MAPTIS-II system contains physical, mechanical and environmental properties for metallic and non-metallic materials. http://maptis.nasa.gov/index.asp]

3.2.7.9 LRU Interchangeability
The DFI DAS shall have Line Replaceable Units (LRU) that are interchangeable with LRUs of the same end item specification design within all applicable vehicle and laboratory mounting locations.

3.2.7.10 Connector Mismating
The DFI DAS shall use connector keying to prevent mismating.

3.2.7.11 DAU Chassis Size
The DFI DAS shall have the same size chassis for all DAUs.

3.2.7.12 Distributed System
The DFI DAS shall be a distributed system with a minimum of two chassis boxes.

3.2.8 Product Marking
3.2.8.1 Identification and Marking
The DFI DAS shall be manufactured with identification and marking methods in accordance with MIL-STD-130, DEPARTMENT OF DEFENSE STANDARD PRACTICE IDENTIFICATION MARKING OF U.S. MILITARY PROPERTY.

3.2.8.2 ESD Identification and Marking
The DFI DAS shall be manufactured with ESD (electrostatic discharge) identification and marking methods in accordance with MIL-STD-130, DEPARTMENT OF DEFENSE STANDARD PRACTICE IDENTIFICATION MARKING OF U.S. MILITARY PROPERTY.

3.2.8.3 Serial Numbers
The DFI DAS components shall be identified by a serial number.

3.2.9 Workmanship

3.2.9.1 Soldering
The DFI DAS shall be manufactured in accordance with J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

3.2.9.2 Crimping
The DFI DAS shall be manufactured in accordance with NASA-STD-8739.4, as tailored by MSFC-STD-2905, MSFC Tailoring Guide for NASA-STD-8739.4, Crimping, Interconnecting Cables, Harness, and Wiring.

3.2.9.3 Soldering of Surface Mount Components
The DFI DAS shall be manufactured with soldering methods for Surface Mount Technology (SMT) components in accordance with J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

3.2.9.4 Conformal Coating and Staking
The DFI DAS shall be manufactured with fabrication controls and processes used in staking and conformal coating of printed wiring boards and electronic assemblies in accordance with J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

3.2.9.5 Tin Whisker Mitigation
The DFI DAS shall be manufactured using Tin Whisker Mitigation methods in accordance with J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

[Rationale: Section 1.5.1 and 1.5.2, J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies, indicates that RoHS, 3% minimum lead (Pb) must be used.]

3.2.10 Human Engineering
3.2.10.1 Human Engineering Guidelines
The DFI DAS shall meet the human engineering guidelines of NASA-STD-3000, Man-Systems Integration Standards, and CxP 70024Constellation Human-Systems Integration Requirements (HSIR).

3.2.10.2 Sharp Edges
The DFI DAS shall comply with the requirements of Human Factors Engineering Design Criteria, USO-CLV-LS-25404, to protect operators against injury from sharp edges and corners.

3.2.10.3 Maximum Touch Temperature
The DFI DAS maximum touch temperature shall meet the requirements of Human Factors Engineering Design Criteria, USO-CLV-LS-25404, section 5.13.4.6, Table X, for surfaces that are exposed to personnel while the Upper Stage Avionics equipment is installed and being operated.

[Rationale: Human Factors Engineering Design Criteria, USO-CLV-LS-25404 refers to detailed requirements from MIL-STD-1472F, "DOD Design Criteria Standard, Human Engineering", table XXI. Values exceeding maximum limits shall be appropriately guarded.]

3.2.10.4 Minimum Touch Temperature

The DFI DAS minimum touch temperature shall meet the requirements of Human Factors Engineering Design Criteria, USO-CLV-LS-25404, section 5.13.4.6, for surfaces that are exposed to personnel while the Upper Stage Avionics equipment is installed and being operated.

3.2.10.5 General Safety

The DFI DAS vendor shall supply sufficient drawings, documents, process plans, and procedures to support the development of hazard analyses and hazard reports in accordance with sections 2.2.1, Hazard Analysis, of CxP 70059 Constellation Program (CxP) Integrated Safety, Reliability, and Quality Assurance (SR&QA) Requirements.

[Rationale: Hazard analyses will be performed by the Project at the integrated level of assembly.]

3.2.10.6 Contamination Control

The DFI DAS external and internal surfaces shall be cleaned to Visibly Clean-Standard as a minimum per the requirements in CxP 70145, Constellation Program Contamination Control Requirements.

3.2.10.7 Box Integration for Ground Operations

The DFI DAS shall meet the box integration requirements for ground operations in accordance with Human-Systems Integration Requirements (HSIR), CxP 70024, Section 3.9.

3.3 Packaging Requirements

The methods of preservation, packaging and packing utilized for shipment together with necessary special control during transportation shall adequately protect the DFI DAS from damage or degradation of performance due to the natural and induced environments encountered during transportation and subsequent indoor storage per NPR.6000.1G. The requirements herein govern the preparation for shipment and the transport of the DFI DAS to all Buyer and Government facilities.

3.3.1 Packaging Design Requirement (Structural)

Preservation, packaging, and packing shall withstand the rough handling package requirements of NPR.6000.1G as defined in accordance with the following:

(a) Free fall flat drop
(b) Free fall corner drop
(c) Sinusoidal vibration

3.3.2 Reusable Containers

Where analysis indicates a requirement for reusable containers, maximum practical utilization shall be made of standard off-the-shelf, low cost, metal or plastic containers.

3.3.3 Monitoring Devices

Utilization of instrumentation for monitoring or recording in-transit environments (e.g., shock, vibration, temperature, humidity, etc.) to assure safe arrival is required and shall be approved by the Buyer prior to implementation.

3.3.4 Temporarily Installed Hardware Identification

All temporarily installed devices such as caps, plugs, covers, support bracketry, protective plates, etc., shall be marked "NOT FLIGHT" or otherwise indicated as not for flight to ensure they are easily identified under casual observation.

3.3.5 Marking for Shipment

Interior and exterior containers shall be marked and labeled in accordance with MIL-STD-130 including precautionary markings necessary to ensure safety of personnel and facilities and to ensure safe handling, transport, and storage.

3.3.6 Marking for Reuse

Packages with reuse capability shall be identified with the words "REUSABLE CONTAINER – DO NOT DESTROY – RETAIN FOR REUSE."

3.3.7 NASA Critical Item Labels

NASA Critical Item Labels shall be applied in accordance with MIL-STD-2073 and NPR.6000.1G.

3.3.8 Identification Format

Identification information on the interior and exterior containers shall be in the following format MIL-STD-2073 and NPR.6000.1G.

4 VERIFICATION

The verification program shall ensure that the DFI DAS will conform to the design and performance requirements specified in Section 3. For each Section 3 requirement, there is a corresponding Section 4 verification requirement that contains the requirements necessary to show compliance with each “shall” statement. The verification requirement must have three parts: the method of verification, a description of the verification work to be performed, and success criteria that determines when the verification is complete. Non- “shall” statements will not have a verification requirement for compliance.

This following section identifies the how, what, and when the requirements will be verified and the various organizations and personnel that will conduct and support verification.

Description

4.1.1 Verification Methods

Verification methods are the methods by which the requirements in Section 3.0 are to be verified. One or more of the following methods will be used:
1. Test—Verification by test is the actual operation of equipment during ambient conditions or when hardware is subjected to specified environments to evaluate performance.

1a. Functional Test—Functional testing is an individual test or series of electrical or mechanical performance tests conducted on flight or flight-configured hardware and/or software at conditions equal to or less than design specifications. Its purpose is to establish that the system performs satisfactorily in accordance with design and performance specifications. Functional testing generally is performed at ambient conditions. Functional testing is performed before and after each environmental test or major move in order to verify system performance prior to the next test/operation.

1b. Environmental Test—Environmental testing is an individual test or series of tests conducted on flight or flight-configured hardware and/or software to assure the hardware will perform satisfactorily in its flight environment. Environmental tests include vibration, acoustic and thermal vacuum and may or may not be combined with functional testing depending on the objectives of the test.

2. Analysis—Verification by analysis is a process used in lieu of or in addition to testing to verify compliance to requirements. The selected techniques may include systems engineering analysis, statistics and qualitative analysis, computer and hardware simulations, analog modeling, similarity assessment, and verification of records.

3. Demonstration—Verification by demonstration is the use of actual demonstration techniques in conjunction with requirements such as operational performance, serviceability, accessibility, transportability, human engineering features, and display data.

4. Inspection—Verification by inspection is the physical evaluation of hardware and/or documentation/drawings to verify design features. Inspection is used to verify construction features, workmanship, dimension and physical condition, such as cleanliness, surface finish, and locking hardware.

4.1.2 Verification Cross Reference Matrix

A Verification Cross Reference Matrix (VCRM) is generated to show the requirement trace and closure methods. The VCRM is an appendix to this document.

4.1.3 Responsibility for Inspection

The manufacturer shall be responsible for the performance of all inspection requirements as herein and to the requirements of the production, test, and inspection plan. The manufacturer may utilize his own or any other inspection facilities and services acceptable to the Government. The Government reserves the right to witness or separately perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.4 Test Equipment and Facilities

All test equipment shall be calibrated. Calibration standards shall be traceable to the National Institute of Standards.

4.1.5 Standard Test Conditions

The DFI DAS tests shall be performed in an open area having a temperature of 23°±10°C, a relative humidity 50±30%, and a barometric pressure of 101 + 2/–23 kilopascals (29.9 + 0.6/–6.8 Hg).

[Rationale: These ambient conditions are defined by CxP 70036, Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR).]

4.1.6 Acceptance and Rejection Criteria

The DFI DAS which has passed all of the requirements of section 3.2.5.2 Acceptance Test Requirements shall be accepted. Assemblies which are not accepted will be considered rejected. The full particulars concerning rejection and the necessary action taken to correct the defect will be made available to the Government inspector before resubmittal of the assembly for retest.

4.1.7 Government Acceptance Inspections

The Government acceptance inspection shall be conducted in accordance with the provisions of the contract and shall include inspections of hardware, software, electrical drawings, mechanical drawings, procedures, reports, and analyses used to complete verifications.

4.1.8 Acceptance Tests
Each assembly submitted for acceptance under the contract shall successfully comply with acceptance test requirements of section 3.2.5.4 Acceptance Test Requirements.

4.1.9 Reliability Tests
See section 3.2.4.16 Reliability for reliability requirements.

4.1.10 Environmental Tests
Verification of the qualification requirements of 3.2.5.3 Qualification Test Requirements shall be conducted before delivery of the first acceptance DFI DAS.

4.2 DFI DAS Characteristics

No verification required.

4.2.1 Data Acquisition
No verification required.

4.2.1.1 Initialization to Known PCM Frame Format
This verification shall be by test and inspection.

A test shall be conducted to verify that the DFI DAS initializes to a selected PCM frame format after power has been applied. An inspection of the user documentation shall be conducted to verify that the state after initialization is described in the documentation.

This verification shall be considered successfully met when the DFI DAS initializes to a selected frame format upon application of power and user documentation describes the initialization state.

4.2.1.2 Power Application Data Output
This verification shall be by test.

A test of the DFI DAS shall be conducted which verifies that data collection begins within 3 seconds of power application.

This test shall be considered successful when output data timestamps begin within 3 seconds of DFI DAS power application.

4.2.1.3 Power Interruption Data Output
This verification shall be by test.

A test of the DFI DAS shall be conducted which verifies that data collection begins within 3 seconds of power restoration after a power interruption.

This test shall be considered successful when output data timestamps begin within 3 seconds of power restoration after a DFI DAS power interruption.

4.2.1.4 Sensor Data Acquisition

This verification shall be by test and inspection.

A test of the DFI DAS shall be conducted to verify that the DFI DAS can acquire data from the sensors in Table 3. The test shall include at least one sensor of each kind in Table 3. Each channel shall be tested. An inspection of the user documentation shall be conducted to verify that the DFI DAS is compatible with each type of sensor in Table 3.

This verification shall be considered successful when output data is data is generated for each channel and when the inspection of user documentation indicates compatibility with each type of sensor listed in Table 3.

4.2.1.5 PCM Data Acquisition

This verification shall be by test and inspection.

A test shall be conducted to verify that the DFI DAS acquires external source PCM data per IRIG 106, NRZ, Class II Telemetry Standard. An inspection of the user documentation shall be conducted to verify that the DFI DAS user documentation indicates the procedure required to acquire external PCM data.

This verification shall be considered successful when the DFI DAS generates output from PCM data input per IRIG 106, NRZ, Class II Telemetry Standard and when user documentation indicates the procedure for acquiring PCM data.

4.2.1.6 PCM Frame Generation

This verification shall be by test.

A test shall be conducted to verify that the DFI DAS generates PCM data in accordance with IRIG 106, NRZ, Class II Telemetry Standards with no data loss.

This verification shall be considered successful when the DFI DAS output conforms to IRIG 106, NRZ, Class II Telemetry Standards with no data loss.

4.2.1.7 User Programmable

This verification shall be by test and inspection.

The test shall include programming the DFI DAS channel sampling and scheduling. The test shall include objective evidence that the sampling and scheduling program resides in non-volatile memory (for example, the program is accessible after cycling power)

An inspection of the user documentation shall verify that a procedure for programming the DFI DAS in non-volatile memory is included in the user documentation.

This verification shall be considered successfully met when the test results indicate the DFI DAS program has been saved in non-volatile memory and the inspection of the user documentation indicates the procedure for programming the DFI DAS into non-volatile memory.

4.2.1.8 Sampling and Formatting

This verification shall be by test and inspection.

The test shall include setting the parameters of the DFI DAS indicated in the requirement; sampling, gains, offset, filtering formatting and sub-formatting for each type of channel in Table 3. The inspection of the user documentation shall verify the procedures for setting the parameters are included in the user documentation.

This verification shall be considered successfully met when the data collected from the test of each DFI DAS channel type listed in Table 3 indicates that the channel parameters have been set as intended and when the inspection verifies the procedure for setting up each channel is included in the user documentation.

4.2.1.9 Number of Data Formats

This verification shall be by test and inspection.

The test shall include collecting output data in a minimum of 8 different PCM frame formats. The inspection of the user documentation shall verify that the procedure exists for configuring the DFI DAS in a minimum of 8 different PCM frame formats.

This verification shall be considered successfully met when the data collected from the test shows the DFI DAS is capable of sending data in at least 8 PCM frame formats and when the inspection report indicates the location of the procedure for configuring the DFI DAS in each of the 8 or more output PCM formats.

4.2.1.10 Format Change via Discrete Signal

This verification shall be by test and inspection.

The test shall include collecting DFI DAS output data while each of, a minimum of, 3 discrete inputs is toggled individually. The discrete signals shall be produced in accordance with section 4.2.6.4, 5V

Discrete Characteristics, and 4.2.6.5, 28V Discrete Characteristics. The inspection of the user documentation shall verify that the user documentation includes a procedure for configuring the DFI DAS for a change in output format based on the individual change of state of a minimum of 3 discretes.

This verification shall be considered successfully met when the data collected from the test shows the output format changed as a result of the individual change in state of, a minimum of, 3 discrete inputs, as defined in section 4.2.6.4, 5V Discrete Characteristics, and 4.2.6.5, 28V Discrete Characteristics, and when the inspection report indicates the location in the user documentation of the procedure for configuring the DFI DAS to change output format based on a discrete input change in state.

4.2.1.11 DAS Interface Requirements

No verification required.

4.2.1.11.1 MDAU to Telemetry System Interface

This verification shall be by inspection.

An inspection of the DFI DAS drawings and user documentation shall be performed.

This verification shall be considered successfully met when the inspection report indicates that interface to the telemetry system is an RS-422 interface that is capable of transmitting PCM data.

4.2.1.11.1.1 MDAU to Telemetry System Bit Rate

This verification shall be by test.

The test shall include transmitting PCM data from the MDAU to Telemetry interface at 20Mbps through a 40 foot shielded twisted pair cable with impedance as indicated in 3.2.1.11.1.2, MDAU to Telemetry System Impedance.

This verification shall be considered successfully met when the test report indicates that the interface to the telemetry system has successfully transmitted PCM data at 20Mbps through a 40 foot shielded twisted pair cable with impedance as indicated in 3.2.1.13.1.2, MDAU to Telemetry System Impedance.

4.2.1.11.1.2 MDAU to Telemetry System Impedance

This requirement shall be verified when the verification of 4.2.1.11.1.1, MDAU to Telemetry System Bit Rate, has been successfully completed.

4.2.1.11.2 MDAU to First Stage DFI System Interface

This verification shall be by inspection.

An inspection of the DFI DAS drawings and user documentation shall be performed.

This verification shall be considered successfully met when the inspection report indicates that this interface from the First Stage DFI system is four (4) RS-422 interfaces that are capable of transmitting PCM data.

4.2.1.11.2.1 MDAU to First Stage DFI System Bit Rate

This verification shall be by test.

The test shall include transmitting PCM data from the MDAU to First Stage DFI interface at 20Mbps through four (4) 175 foot shielded twisted pair cable with impedance as indicated in 3.2.1.11.2.2., MDAU to First Stage DFI Impedance.

This verification shall be considered successfully met when the test report indicates that the interface to the First Stage DFI has successfully transmitted PCM data at 20Mbps through four (4) 175 foot shielded twisted pair cable with impedance as indicated in 3.2.1.11.1.2, MDAU to Telemetry System Impedance.

4.2.1.11.2.2 MDAU to First Stage DFI System Impedance

This requirement shall be verified when the verification of 4.2.1.11.2.1, MDAU to First Stage DFI Bit Rate, has been successfully completed.

4.2.1.11.3 First Stage DFI System to MDAU Interface

This verification shall be by inspection.

An inspection of the DFI DAS drawings and user documentation shall be performed.

This verification shall be considered successfully met when the inspection report indicates that this interface to the First Stage DFI system is two (2) RS-422 interfaces that are capable of transmitting PCM data.

4.2.1.11.3.1 First Stage DFI System to MDAU Bit Rate

This verification shall be by test.

The test shall include transmitting PCM data from a DFI simulator to the MDAU interface at 6Mbps through two (2) 175 foot shielded twisted pair cable with impedance as indicated in 3.2.1.11.3.2., First Stage DFI System to MDAU Impedance.

This verification shall be considered successfully met when the test report indicates that the interface to the First Stage DFI has successfully transmitted PCM data at 6Mbps through two (2) 175 foot shielded twisted pair cable with impedance as indicated in 3.2.1.11.1.2, MDAU to Telemetry System Impedance.

4.2.1.11.3.2 First Stage DFI System to MDAU Impedance

This requirement shall be verified when the verification of 4.2.1.11.3.1, First Stage DFI System to MDAU Bit Rate, has been successfully completed.

4.2.1.11.4 MDAU with RDAU Interface

This requirement shall be verified when the verification of 4.2.1.11.4.1, MDAU with RDAU Interface Distance, has been successfully completed.

4.2.1.11.4.1 MDAU with RDAU Interface Distance

This verification shall be by test.

The test shall include assembling the DFI DAS with each chassis interconnected with cables measuring 155 feet. The aggregate data acquisition shall be such that the throughput from the MDAU to Telemetry Interface shall be 20Mbps.

This verification shall be considered successfully met when the test report indicates that the DFI DAS units can acquire and output 20Mbps of data while interconnected with 155 foot cables.

4.2.1.11.5 Workstation Interface

This verification shall be by test.

The test shall include assembling the DFI DAS with each chassis interconnected. The aggregate data acquisition shall be such that the throughput from the MDAU to Workstation Interface shall be 20Mbps.

This verification shall be considered successfully met when the test report indicates that the DFI DAS workstation can interface with the DFI DAS for programming, testing and real-time evaluation of PCM data while collecting and transmitting data at 20 Mbps.

4.2.1.11.6 EGSE Interface

This verification shall be by inspection.

An inspection of the DFI DAS drawings and user documentation shall be performed.

This verification shall be considered successfully met when the inspection report indicates that this interface meets the requirements described in section 3.6, Interfaces, of USO-CLV-DE-25135, Upper Stage (US) EGSE Subsystems Requirements Document.

4.2.1.11.7 Test and Programming

This verification shall be by inspection.

An inspection of the DFI DAS drawings and user documentation shall be performed.

This verification shall be considered successfully met when the inspection report indicates that the DFI DAS provides a minimum of one port for use as a test and programming port.

4.2.2 Input Channels

This requirement shall be verified when the verification of section 4.2.1.4, Sensor Data Acquisition, is successfully completed

4.2.2.1 Input Channel Characteristics

This requirement shall be verified when the verification of section 4.2.1.4, Sensor Data Acquisition, is successfully completed.

4.2.2.1.1 Sample Rates

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving input from a calibrated source on each input channel. The sample rates shall be set to those listed in Table 3.

This verification shall be considered successfully met when the data collected from the test of each channel shows that the sample rate meets those in Table 3 within 1%.

4.2.2.1.2 A/D Resolution

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving input from a calibrated source on each input channel.

This verification shall be considered successfully met when the data collected from the test of each channel shows that output resolution is configurable as specified in Table 3 for each channel.

4.2.2.1.3 Output/Sample

This requirement shall be verified when the verification of section 4.2.1.4 is successfully completed.

4.2.2.1.4 Excitation

This verification shall be by inspection.

The inspection of the DFI DAS drawings shall confirm the capability to provide constant current or constant voltage to the sensor as required in Table 3.

The verification shall be considered successful when the inspection report shows that the DFI/DAS includes a constant voltage excitation or constant current excitation that is compatible with the sensors in Table 3.

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4.2.2.1.5 Signal Conditioning

This verification shall be by inspection.

The inspection of the DFI DAS drawings and user documentation shall confirm the signal conditioning capability to meet the requirement of the sensors in Table 3.

The verification shall be considered successful when the inspection report shows that the DFI DAS provides signal conditioning sufficient for the sensors listed in Table 3.

4.2.2.1.6 Accuracy

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving sensor data from each type of sensor in Table 3.

This verification shall be considered successfully met when the test results verify that the DFI DAS has accuracy specified in Table 3.

4.2.2.1.7 Charge Amplifier

This verification shall be by inspection.

The inspection of the DFI DAS drawings and user documentation shall confirm the capability of the DFI DAS to provide a Charge Amplifier as required by the sensors listed in Table 3.

The verification shall be considered successful when the inspection report indicates the DFI DAS provides charge amplifier capability sufficient for the sensors listed in Table 3.

4.2.2.1.8 Programmable Filter

This verification shall be by inspection.

Inspection of the DFI DAS drawings and user documentation shall confirm the filtering capability of the DFI DAS is sufficient to meet the filtering requirements of Table 3.

The verification shall be considered successful when the inspection report indicates that the DFI DAS can provide filters sufficient to meet the filtering requirements of Table 3.

4.2.2.1.9 Programmable Gains

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS drawings and user documentation to verify that the DFI DAS is designed to configure the gain and offset for every data channel as required by the sensor list in Table 3.

This verification shall be considered successfully met when the results of the inspection conclude the DFI DAS can provide programmable gains and offsets sufficient for the sensor list in Table 3.

4.2.2.1.10 Reference Junction Compensation

This verification shall be by inspection.

The inspection of the DFI DAS drawings and user documentation shall confirm the use of an internal Reference Junction Compensation as required per Table 3.

The verification shall be successfully verified when the inspection report indicates the DFI DAS provides internal reference junction compensation sufficient for the sensor list in Table 3.

4.2.2.1.11 Video

No verification required.

4.2.2.1.11.1 Video Format

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving simulated data with one of the video formats specified in the requirement.

This verification shall be considered successfully met when the test results verify that the DFI DAS can receive input from one of the required formats while maintaining the required resolution and accuracy.

4.2.2.1.11.2 Video Resolution

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving data with the video resolution stated in the requirement.

This verification shall be considered successfully met when the test results verify that the DFI DAS can receive input with the resolution stated in the requirement.

4.2.2.1.11.3 Video Frame Rate

This verification shall be by test.

The test shall include collecting DFI DAS output data while receiving data with the video frame rates stated in the requirement.

This verification shall be considered successfully met when the test results verify that the DFI DAS can receive progressive scan video with at the frame rates specified in the requirement.

4.2.2.1.11.4 Video Image Compression

This verification shall be by test.

The test shall include testing the image data files created from collecting video.

This verification shall be considered successfully met when the test results verify that the DFI DAS can compress video at the compression rate specified in the requirement.

4.2.3 Time

No verification required.

4.2.3.1 Receiving Time

This verification shall be by test.

The verification shall include a test of the DFI DAS hardware and its ability to receive time in IRIG-B format.

An inspection of the user documentation shall include verifying the inclusion of procedures for receiving time in accordance with the IRIG-B format.

This verification shall be considered successfully met when the test results verify that the DFI DAS can receive time in accordance with IRIG-B format and inspection of the user documentation verifies the inclusion of procedures for receiving time in IRIG-B format.

4.2.3.2 Internal Clock

This verification shall be by test and inspection.

The test shall include receiving DFI DAS data from each channel type while the data is time-stamped in accordance with IRIG-106 format.

An inspection of the user documentation shall verify the inclusion of procedures for time stamping each channel type in accordance with IRIG-106 format.

This verification shall be considered successfully met when the test results verify that the DFI DAS can time stamp data in accordance with IRIG-106 format from each channel type and inspection of the user

documentation verifies the inclusion of procedures for time stamping data in accordance with IRIG-106 format

4.2.3.3 Time Stamp of Data

This verification shall be by analysis.

The verification shall include an analysis of the DFI DAS hardware and its ability to comply with the time stamp precision in accordance with IRIG 106 time code format.

This verification shall be considered successfully met when the results of the analysis verify that the DFI DAS can time stamp data in accordance with IRIG 106 time code format.

4.2.3.4 Time Stamp with Accuracy

This verification shall be by analysis.

The verification shall include an analysis of the DFI DAS hardware and its ability to comply with the time stamp accuracy requirement.

This verification shall be considered successfully met when the results of the analysis verify that the DFI DAS time stamp accuracy is 1 millisecond or better.

4.2.3.5 Time Stamp with Precision

This verification shall be by analysis.

The verification shall include an analysis of the DFI DAS hardware and its ability to comply with the time stamp precision in accordance with IRIG 106 time code format.

This verification shall be considered successfully met when the results of the analysis verify that the DFI DAS can receive time in accordance with IRIG 106 time code format.

4.2.4 Workstation Characteristics

No verification required.

4.2.4.1 Workstation Computer

This verification shall be by inspection.

The inspection of the user interface and user documentation shall determine the method of interface with the DFI DAS through the workstation.

The verification shall be considered successful when the inspection report shows that the DFI DAS interfaces with the workstation via a Windows-based computer.

4.2.4.2 Data Channel Configuration

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure every data channel of the DFI DAS.

4.2.4.3 Configurable Channel Sampling Rates

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure independent sample rates for every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure sample rates for every data channel of the DFI DAS.

4.2.4.4 Configurable Channel Gain

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure the gain for every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure the gain for every data channel of the DFI DAS.

4.2.4.5 Configurable Channel Offset

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure the channel offset of every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure the channel offset of every data channel of the DFI DAS.

4.2.4.6 Configure Channel Calibration

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure the calibration information for every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure the calibration information for every data channel of the DFI DAS.

4.2.4.7 Configurable Channel Range

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure the analog-to-digital (A/D) range of every data channel.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can configure the A/D range of every data channel of the DFI DAS.

4.2.4.8 Receiving Channel Data

This verification shall be by test and inspection.

The verification shall include a test which displays the results from input on each DFI DAS channel.

The verification shall include an inspection of the Workstation and user documentation to verify that the Workstation is designed to configure every data channel.

This verification shall be considered successfully met when results have been displayed on the Workstation display from each channel and when an inspection of the user documentation verifies the inclusion of procedures to receive data from each data channel.

4.2.4.9 Display Data in Counts Format

This verification shall be by inspection.

The verification shall include an inspection of the Workstation display to verify the inclusion of display fields in counts on the Workstation display. The verification shall also include an inspection of the user documentation to verify the inclusion of procedures to display data in counts format

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can display data in counts and when inspection of the user documentation shows inclusion of procedures to display data in counts format.

4.2.4.10 Display Data in Units Format

This verification shall be by inspection.

The verification shall include an inspection of the Workstation display to verify the inclusion of display fields in engineering units on the Workstation display.

The verification shall also include an inspection of the user documentation to verify the inclusion of procedures to display data in engineering units.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can display data in engineering units and when inspection of the user documentation shows inclusion of procedures to display data in engineering units.

4.2.4.11 Display Data in Strip Chart Format

This verification shall be by inspection.

The verification shall include an inspection of the Workstation to verify the inclusion of strip chart output capability in the Workstation.

The verification shall also include an inspection of the user documentation to verify the inclusion of procedures to display data on strip charts.

This verification shall be considered successfully met when the results of the inspection verify that the Workstation can display data on strip charts and when inspection of the user documentation shows inclusion of procedures to display data on strip charts.

4.2.4.12 Display Data with Alarms

This verification shall be by test and inspection.

The test shall include collecting DFI DAS simulated data from each type of channel and forcing the simulated data out of programmed ranges.

The verification shall also include an inspection of the user documentation to verify the inclusion of procedures for detecting out of range alarms for out-of-range data.

This verification shall be considered successfully met when out of range input data activates alarms on the Workstation and when inspection of the user documentation shows inclusion of procedures to detect alarms.

4.2.4.13 Portability

This verification shall be by inspection.

The verification shall include an inspection of the Workstation and packing and setup procedures.

The verification shall be considered successfully met when the inspection of the Workstation and packing and setup procedures show that the DFI DAS Workstation is portable by a single ground crew member; like a laptop or desktop computer.

4.2.4.14 Display Parameters

This verification shall be by test and inspection.

The test shall include collecting DFI DAS simulated data from each type of channel and recording the channel parameters.

The verification shall also include an inspection of the user documentation to verify the inclusion of procedures for displaying DFI DAS parameters.

This verification shall be considered successfully met when channel parameters are displayed on the Workstation and when inspection of the user documentation shows inclusion of procedures to display channel parameters.

4.2.4.15 Built In Test (BIT)

This verification shall be by test.

A Built In Test shall be performed in several configurations, not less than 3 different configurations which the Built In Test can detect and report.

The verification shall be considered successful when the Built In Test status reports accurate status for each configuration of the test.

4.2.4.16 Reliability

This verification shall be by analysis.

The verification shall include a reliability analysis of the DFI DAS hardware.

The verification shall be considered successfully met when the reliability analysis report shows that the DFI DAS meets or exceeds the minimum MTTF listed in the requirement.

4.2.4.16.1 Reliability Data

This verification shall be by inspection.

The verification shall include an inspection of the delivered documentation to ensure that data inputs for the reliability analysis are included with the delivered data package.

The verification shall be considered successfully met when the inspection shows that the delivered data package includes the data inputs for the reliability analysis.

4.2.4.17 Failure Propagation

This verification shall be by analysis.

The analysis of the DFI DAS design shall show that any failure in the DFI DAS shall not propagate from the DFI DAS.

The verification shall be considered successful when the analysis report shows that the failure in the DFI DAS shall not cause damage to or failures of interfacing elements due to transient out-of-tolerance conditions or a failure.

4.2.4.18 Flight Operation Life

This verification shall be by analysis.

The verification shall include an analysis of the DFI DAS for the flight time duration specified in the requirement.

The verification shall be considered successfully met when the analysis report indicates the DFI DAS meets all requirements for the flight time specified in the requirement.

4.2.4.19 Calibration

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS user documentation for calibration procedures.

The verification shall be considered successfully met when the inspection report indicates the DFI DAS user documentation includes calibration procedures.

4.2.5 Environmental Conditions

No verification required.

4.2.5.1 Natural Environments

This verification shall be verified by analysis.

An analysis shall be performed of the DFI DAS design to show that it will meet all functional and performance requirements within the range of environmental conditions specified in the Exploration Architecture Design Specification for Natural Environments, CxP 70023, Sections 3.1and 3.2.

Verification shall be considered successful when the analysis shows that the DFI DAS meets all functional and performance requirements within the range of environmental conditions specified in the Exploration Architecture Design Specification for Natural Environments, CxP 70023, Sections 3.1, 3.2.

4.2.5.2 Induced Environments

No verification required.

4.2.5.2.1 Transportation (packaged)

This verification shall be by test and inspection.

The vendor shall inspect the user documentation for specifications of environmental parameters for transportation listed in the requirement.

This verification shall be considered successfully met when an inspection of the user documentation indicates the vendor environmental specifications for transportation of the DFI DAS hardware and when the test verifications of 4.2.5.3, Qualification Test Requirements, are successfully met.

4.2.5.2.2 Non-Operating Environment

No verification required.

4.2.5.2.2.1 Storage

No verification required.

4.2.5.2.2.1.1 Storage Time

This verification shall be by analysis.

An analysis shall confirm the storage life of the DFI DAS hardware.

This verification shall be successfully met when the analysis report indicates that the DFI DAS will perform after the storage time of 5 years.

4.2.5.2.2.2 Non-Operating Temperature

This verification shall be by analysis.

An analysis shall confirm the storage temperature of the DFI DAS hardware.

This verification shall be successfully met when the analysis report indicates that the DFI DAS will perform after stored in the temperature range of -65°F (-54°C) to 126°F (52°C).

[Rationale: The non-operating temperature and humidity conditions cover worst case for storage, transport, and roll-out. Purge will not be provided to control temperature and humidity except during rollout. The non-operating conditions specified above are currently thought to represent worst case and are representative of transport environments on a covered barge.]

4.2.5.2.2.3 Non-Operating Humidity

This verification shall be by analysis.

An analysis shall confirm the storage humidity of the DFI DAS hardware.

This verification shall be successfully met when the analysis report indicates that the DFI is fully compatible with humidity levels up to and including 90% relative humidity.

[Rationale: The non-operating temperature and humidity conditions cover worst case for storage, transport, and roll-out. Purge will not be provided to control temperature and humidity except during rollout. The non-operating conditions specified above are currently thought to represent worst case and are representative of transport environments on a covered barge.]

4.2.5.2.3 Operating Environment

No verification required.

4.2.5.2.3.1 Operating Temperature

This verification shall be by test.

These tests shall be implemented in accordance with the qualification and acceptance test requirements of CxP 70036, Constellation Program Environmental Qualification and Acceptance Testing Requirements.

This verification shall be met when the thermal test results demonstrate that the DFI DAS is fully compatible with the flight operational temperature range of 0°F (-18°C) to 150°F (66°C)

4.2.5.2.3.2 Operating Humidity

This verification shall be by test.

These tests shall be implemented in accordance with the qualification and acceptance test requirements of CxP 70036, Constellation Program Environmental Qualification and Acceptance Testing Requirements.

This verification shall be met when the verification tests results show that the DFI DAS is compatible with a flight operational relative humidity of 90% relative humidity.

4.2.5.2.3.3 Random Vibration and Shock

This verification shall be by test.

These tests shall be implemented in accordance with the qualification and acceptance test requirements of CxP 70036, Constellation Program Environmental Qualification and Acceptance Testing Requirements.

This verification shall be met when the vibration and shock verification tests have been successfully completed in accordance with the levels specified in CxP 72169, Ares I Vibroacoustic and Shock Environments Data book. Section 3.1.2, Random Vibration; Section 3.2.2, Shock Environments; Section 3.3.2, Internal Acoustic Environments.

4.2.5.2.3.4 Pressure Change

This verification shall be by test.

These tests shall be implemented in accordance with the qualification and acceptance test requirements of CxP 70036, Constellation Program Environmental Qualification and Acceptance Testing Requirements.

This verification shall be met when the test results show that the DFI DAS is fully compatible with a flight operational pressure change 760 Torr/1 atm (Sea Level) to 10^{-5} Torr (near vacuum).

4.2.5.2.3.5 Pressure Rate of Change

This verification shall be by test.

These tests shall be implemented in accordance with the qualification and acceptance test requirements of CxP 70036, Constellation Program Environmental Qualification and Acceptance Testing Requirements.

This verification shall be met when the test results show that the DFI DAS is fully compatible with a flight operational pressure rate change starting at a pressure of 14 psi and decreasing in 26 seconds to 1 psi.

4.2.5.2.3.6 Loads Analysis

This verification shall be by analysis.

The verification shall include an analysis of the DFI DAS design relative to launch and flight loads derived from CxP 72169, Ares I Vibroacoustic and Shock Environments Data book. Section 3.1.2, Random Vibration; Section 3.2.2, Shock Environments; Section 3.3.2, Internal Acoustic Environments that will be encountered by the hardware.

The verification shall be considered successfully met when the analysis report indicates the DFI DAS can withstand launch and flight loads with a margin defined in NASA-STD-5002.

4.2.5.3 Qualification Test Requirements

This verification shall be by test and inspection.

The verification shall include testing qualification units of the DFI DAS in accordance with Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

The verification shall also include inspection of the qualification test procedures to verify each test encompasses the worst-case environmental conditions (including, but not limited to, transportation, storage, integration, flight) seen by the DFI DAS and to verify compliance with Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

The verification shall be considered successfully met when the qualification test reports indicate that the DFI DAS and Workstation are in compliance with CxP 70036 and the inspection report indicates the test procedures encompass the worst-case environmental conditions seen by the DFI DAS and the procedures comply with CxP 70036.

4.2.5.4 Acceptance Test Requirements.

This verification shall be by test and inspection.

The verification shall include testing each DFI DAS unit in accordance with Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

The verification shall also include inspection of the acceptance test procedures to verify compliance with Constellation Program environmental Qualification and Acceptance Testing requirements (CEQATR), CxP 70036.

The verification shall be considered successfully met when the acceptance test reports indicate that the DFI DAS and Workstation are in compliance with CxP 70036 and the inspection report indicates the test procedures comply with CxP 70036.

4.2.6 Electrical Design

No verification required.

4.2.6.1 Input Power

This verification shall be by test.

The verification shall include a test of the DFI DAS with input voltages at 23VDC, 28VDC, and 36VDC.

The verification shall be considered successful when the results of the test show that the DFI DAS did not exceed 350 watts over a steady state input voltage range of 23Vdc to 36Vdc.

4.2.6.2 Input Voltage Range

This verification shall be by test, analysis, and inspection as outlined in CxP 70050-02, Constellation Program Electrical Power System Specification, Volume 2: Electrical Power Quality Performance for 28 Vdc. The DAU provider shall be responsible to provide test plans and data to successfully meet all the verification requirements of the Electrical Power Quality Specifications Volume 2. Power Quality Verification only needs to be done on one unit as part of the Qualification testing.

4.2.6.3 Short Circuit Protection

This verification shall be by analysis.

The verification shall include a fault current analysis of the DFI DAS drawings.

The verification shall be considered successful when inspection of the design drawings and fault analysis show that wire size selection and wire protective devices will prevent damage to DFI DAS as result of short circuits in compliance with NASA Technical Memorandum 102179.

4.2.6.4 5V Discrete Characteristics

This verification shall be by test.

The verification shall include a test of the DFI DAS drawings. Discrete input circuits shall be tested to confirm compliance with the characteristics described in the requirement.

The verification shall be considered successful when the test report shows that the DFI DAS 5V discrete inputs comply with the voltage and current profiles

4.2.6.4.1 Pull Down Characteristic

This verification shall be by test.

The verification shall include a test of the DFI DAS drawings. Discrete input circuits shall be tested to confirm compliance with the characteristics described in the requirement.

The verification shall be considered successful when the test report shows that the DFI DAS 5V discrete inputs are pulled down to the OFF level specified in 3.2.6.4, 5V Discrete Input Characteristics, when not connected.

4.2.6.4.2 Quantity

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS drawings and user documentation.

The verification shall be considered successful when the inspection report indicates there is a minimum of one 5V discrete input in the DFI DAS.

4.2.6.5 28V Discrete Characteristics

This verification shall be by test.

The verification shall include a test of the DFI DAS drawings. Discrete input circuits shall be tested to confirm compliance with the characteristics described in the requirement.

The verification shall be considered successful when the test report shows that the DFI DAS 28V discrete inputs comply with the voltage and current profiles

4.2.6.5.1 Pull Down Characteristic

This verification shall be by test.

The verification shall include a test of the DFI DAS drawings. Discrete input circuits shall be tested to confirm compliance with the characteristics described in the requirement.

The verification shall be considered successful when the test report shows that the DFI DAS 28V discrete inputs are pulled down to the OFF level specified in 3.2.6.4, 28V Discrete Input Characteristics, when not connected.

4.2.6.5.2 Quantity

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS drawings and user documentation.

The verification shall be considered successful when the inspection report indicates there is a minimum of two 28V discrete input in the DFI DAS.

4.2.6.6 Electrical Bonding

This verification shall be by analysis, inspection, and test

Testing shall verify the adequacy of electrical bonding processes and procedures for each bonding class. Analysis shall verify that correct bond classes have been identified and bonding paths are designed to meet identified bonding class requirements. Inspection shall verify that proper bonding processes, procedures, and classes have been identified in hardware drawings and documentation. Inspection shall also verify that hardware fabrication and installation measurements demonstrate proper electrical bonding has been achieved.

The verification shall be considered successful when each bonding joint is shown to have the correct bonding class requirement, the fabrication and installation procedure will result in a proper electrical bond, and the tested bonds meet the identified bond class resistance limits in accordance with NASA-STD-4003.

4.2.6.7 Electrical Grounding

The DFI DAS grounding shall be verified by analysis and inspection.

Successful verification shall be achieved when analysis and inspection of drawings and installation records shall verify conformance with CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

4.2.6.8 Lightning Protection

The CEI lighting protection shall be verified by a combination of analysis and tests.

Successful verification shall be achieved when analysis of lower-level component test data, and equipment tests for immunity to damage or upset due to lightning transient design levels, demonstrate compliance with CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

4.2.6.9 Electrostatic Discharge (ESD) Protection

The verification of the DFI DAS subsystem compliance with the ESD requirements shall be verified by tests and analysis.

Analysis shall verify that adequate control measures have been incorporated into the design, such as transient absorbing devices, series resistance, or proper electrical grounding and bonding. Testing shall verify compliance with Constellation requirements through exposure to standard electrostatic discharge waveforms, either to pins, case, or a combination thereof.

The verification shall be considered successful when the analysis and test results indicated that the DFI DAS meets the ESD protection requirements of CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

4.2.6.10 Isolation of Test Points

This verification shall be by inspection.

The DFI DAS hardware drawings shall be inspected to confirm that the test points are isolated.

The verification shall be successful when the inspection report shows that the DFI DAS isolates test points and internal circuits such that a test point short to ground does not damage the Upper Stage Avionics hardware.

4.2.6.11 Electronic, Electrical, Electromechanical (EEE) Parts

Verification method shall be analysis by verification of records.
(a) EEE Parts Control Plan data items shall be analyzed to determine what EEE parts management and control processes are applied. (b) As-designed EEE Parts List data items shall be analyzed to determine what EEE parts are used by design. (c) Nonstandard Part Approval Requests (NSPAR) data items shall be analyzed to determine the terms for acceptance and use of the applicable EEE parts. Grade 4 parts will not require NSPARS. (d) EEE Parts Derating Analysis Report data items shall be analyzed to determine what derating is achieved for the application. (e) As-built EEE Parts List data items shall be analyzed to determine that only traceable approved EEE parts and sources are used. Success criteria shall be that the analyses of (a), (b), (c), (d), and (e) show compliance with CxP 72053, EEE Parts Management and Control Plan.

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4.2.6.12 Inadvertent Disconnect

This verification shall be by analysis.

The analysis of the DFI DAS hardware shall assess the connectors to determine if their design precludes inadvertent disconnect.

The verification shall be considered successful when the analysis report indicates the DFI DAS prevents inadvertent disconnects.

4.2.6.13 Printed Wiring Boards

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS printed circuit boards and all associated drawings including schematics and assembly drawings.

The verification shall be successful when the inspection report indicates that the DFI DAS printed circuit boards meet the design requirements of MFSC-STD-3425, Design Requirements for Rigid Printed Circuit Boards and Assemblies and are constructed in accordance with the Class 3 requirements of IPC-6011, Generic Performance Specification for Printed Boards.

[Rationale: MSFC-STD-3425 is a tailoring document for IPC-2221 and IPC-2222 which specify design requirements for printed circuit boards. The tailoring places further restrictions on board design to further increase uniformity and reliability. MSFC-STD-3425 is available at https://repository.msfc.nasa.gov/docs/multiprogram/MSFC-STD-3425.pdf]

4.2.6.14 Ignition Source Avoidance

This verification shall be by inspection.

The inspection of the design drawings shall confirm the use of conformal coating or other means to isolate potential ignition sources from the ambient environment which may contain flammable gases or

fluids. The inspection of the hardware shall confirm that all potential ignition sources are isolated from the environment.

The verification shall be considered successful when inspection of all electrical components and wiring show that have been conformably coated or other provisions have been made to prevent ignition of potentially flammable or explosives gases that have been determined to be present in the unit volume.

4.2.6.15 Electromagnetic Interference

The CEI electromagnetic interference and susceptibility shall be verified by tests.

Testing shall verify that equipment and subsystems comply with emissions and susceptibility requirements. Verification shall be considered successful when: 1) emissions are below limits, and 2) equipment and subsystems are immune to interference when subjected to susceptibility test levels.

Successful verification shall be achieved when testing validates compliance with CxP 72047, CLV (Crew Launch Vehicle) Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment.

4.2.6.16 Circuit Classification

The CEI circuit classification shall be verified by analysis.

The analysis shall verify that wiring and cabling has been classified according to frequency or rise/fall times, circuit impedance, circuit voltage, and circuit sensitivity.

Verification shall be considered successful when wiring and cabling classifications are found to be in accordance with the circuit classifications of Table 2 in CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

4.2.6.17 Connector Location and Pin Function Assignments

This verification shall be by inspection.

The inspection of the DFI DAS user documentation shall confirm the inclusion of connector locations and pin functions.

The verification shall be considered successful when the DFI DAS connector location and pin function assignments are provided.

4.2.6.18 Wire and Cable Shielding Separation and Routing

Verification of cable shielding and separation shall be verified by inspection.

The inspection shall verify that cabling and wiring are labeled with circuit class and separated and routed in accordance with classification requirements.

The verification shall be considered successful when inspection of drawings and installation documentation shows that wiring and cabling are properly labeled with circuit class and separated and routed in accordance with classification requirements in accordance with CxP 72043, ARES I Electromagnetic Environmental Effects (E3) Requirements Document.

4.2.6.19 Electrostatic Discharge (ESD) Controls

Electrostatic Discharge (ESD) Control shall be verified by inspection.

An inspection shall be performed to verify that adequate control measures have been incorporated into the (DFI DAS fabrication, assembly, testing, transportation, and storage) processes such as use of static protective packaging, anti static-wrist straps, and proper labeling in accordance with ANSI/ESD S20.20-1999, ESD Association Standard for the Development of an Electrostatic Discharge Control Program.

The verification shall be considered successful when the inspection shows that the (DFI DAS fabrication, assembly, testing, transportation, and storage) processes meet the requirements of an ESD Control Program that has been set up to conform with the guidance of ANSI/ESD S20.20-1999.

4.2.7 Structural and Mechanical

No verification required.

4.2.7.1 Materials and Processes

This verification shall be by inspection.

Verification shall be considered successful when the vendor of COTS components/assemblies have made available to the procuring authority, any materials and processes information requested, down to the manufactured parts level, for the procuring authority to verify the acceptability of materials and processes used in construction.

Verification, by the procuring authority, of the acceptability for materials and processes used in construction will be consistent with the requirements of paragraph 4.3 of USO-CLV-MP-25502.

4.2.7.2 Fracture Control

This verification shall be by analysis, inspection, and test.

The analysis of the DFI DAS as-built drawings, procedures, and reports shall assess the fracture control of the design using structural analysis tools or analysis by similarity. Where applicable to the DFI DAS design, inspections and tests of the hardware and material samples shall also be conducted in accordance with NASA-STD-5019 to assess the adequacy of the materials, hardware, and design.

The verification shall be considered successful when the analysis, inspection, and test reports show the DFI DAS complies with the requirements of NASA-STD-5019, Fracture Control Requirements for Spaceflight Hardware.

4.2.7.3 Drawing Quality

This verification shall be by inspection.

The inspection of DFI DAS as-built drawings shall confirm the use of drawings standards.

Verification shall be considered successful when inspection shows the DFI DAS drawings conform to the drawing standards specified in the requirement; ASME Y14.100, Engineering Drawing Practices, ASME Y14.24, Types and Applications of Engineering Drawings, ASME Y14.34, Associated Lists and ASME Y14.35M-1997, Revision of Engineering Drawings and Associated Documents.

4.2.7.4 Cooling

This verification shall be by test and inspection.

The DFI DAS thermal test procedures as required by 4.2.5.3, Qualification Test Requirements, shall be inspected to ensure instrumentation during the test will measure the outside and internal temperature of the DFI DAS to ensure that cooling is not required. The most sensitive component (with the lowest maximum operating temperature) within the DFI DAS shall be instrumented to determine its case temperature.

Verification shall be considered a success when the inspection of the thermal test procedures indicates adequate instrumentation to determine flight touch temperature and adequate cooling to the most heat-sensitive component and when the thermal test verifications of 4.2.5.1, Qualification Test Requirements, shall are successfully completed.

4.2.7.5 Captive Fasteners

This verification shall be by inspection.

The inspection of DFI DAS as-built drawings shall confirm the use of fasteners that meet the structural requirements of the indicated specifications and confirm the use of positive locking mechanisms where possible. Chemical locking compounds may be used for small fasteners with permission.

Verification shall be considered successful when inspection shows the DFI DAS contains fasteners that are in compliance with MSFC-STD-2594C, MSFC Fastener Management & Control Practices, and positive mechanical locking fasteners are used where possible.

4.2.7.6 Factors of Safety

This verification shall be by analysis.

The analysis of the DFI DAS as-built drawings shall assess the structural integrity of the design and quantify factors of safety in the launch environment using structural analysis tools or analysis by similarity.

The verification shall be considered successful when the analysis shows the DFI DAS complies with the requirements of CxP 70135, CONSTELLATION PROGRAM STRUCTURAL DESIGN AND VERIFICATION REQUIREMENTS, section 3.10.

4.2.7.7 Debris Prevention

This verification shall be by analysis.

The analysis of the DFI DAS as-built drawings shall assess the potential for debris generation during pre-launch or ascent.

The verification shall be considered successful when the analysis shows that the DFI DAS is designed to preclude the generation or shedding of debris during pre-launch or ascent which might jeopardize personnel or other vehicle equipment.

4.2.7.8 Chemical Exposure in the Instrument Unit (IU)

This verification shall be by analysis.

An analysis of the Material Usage List shall be performed to determine the compatibility of the DFI DAS with MMH and NTO.

Verification shall be considered successful when analysis of the material usage list (MUL) shows that all materials which may be exposed to the atmospheric environment are compatible with monomethyl hydrazine (MMH) and nitrogen tetroxide (NTO) as identified in the MAPTIS database.

4.2.7.9 LRU Interchangeability

This verification shall be by inspection.

The inspection of the DFI DAS drawings, hardware, and user documentation shall indicate the interchangeability of each DFI DAS units with the initial production unit.

The verification shall be successful when the inspection indicates that DFI DAS are interchangeable with previous DFI DAS units and the inspection of the user documentation indicates the procedure for replacing DFI DAS units.

4.2.7.10 Connector Mismating

This verification shall be by analysis.

The analysis of the connectors on the DFI DAS shall assess the potential for mismating.

The verification shall be considered successful when the analysis shows that the DFI DAS connector keying to prevents mismating.

4.2.7.11 DAU Chassis Size

This verification shall be by inspection.

The inspection shall include an inspection of applicable DFI DAS drawings and user documentation and all DAUs.

The verification shall be considered successfully met when the inspection report indicates that all DAUs have the same size chassis to ±1mm tolerance for each dimension.

4.2.7.12 Distributed System

This verification shall be by inspection and demonstration.

The inspection shall include a review of the applicable drawings and user documentation to confirm the design of the DFI DAS as a multi-unit system, with at least two units.

The demonstration shall include operating the DFI DAS with a workstation and all DAUs.

The verification shall be considered successful when the inspection of the user documentation indicates the design of a multi-unit DFI DAS with at least two units and when a demonstration of the DFI DAS indicates each unit's connection to the workstation is acknowledged on the user interface.

4.2.8 Product Marking

No verification required.

4.2.8.1 Identification and Marking

This verification shall be by inspection.

The production drawings shall be inspected to determine whether the drawings contain the requirement for identification and marking methods in compliance with MIL-STD-130, DEPARTMENT OF DEFENSE STANDARD PRACTICE IDENTIFICATION MARKING OF U.S. MILITARY PROPERTY.

Verification shall be considered successful when inspection of the drawings shows that the DFI DAS has been manufactured with identification and marking methods in accordance with MIL-STD-130.

4.2.8.2 ESD Identification and Marking

This verification shall be by inspection.

The production drawings shall be inspected to determine whether the drawings contain the requirement for identification and marking methods in compliance with MIL-STD-130, DEPARTMENT OF DEFENSE STANDARD PRACTICE IDENTIFICATION MARKING OF U.S. MILITARY PROPERTY.

The verification shall be considered successfully met when the inspection report indicates the DFI DAS has been manufactured with ESD (electrostatic discharge) identification and marking methods in accordance with MIL-STD-130.

4.2.8.3 Serial Numbers

This verification shall be by inspection.

The production DFI DAS shall be inspected to determine whether it is identified by a serial number assigned in accordance with contractor's configuration management guidelines.

The verification shall be considered successfully met when the inspection report shows that the DFI DAS is identified by a serial number.

4.2.9 Workmanship

No verification required.

4.2.9.1 Soldering

This verification shall by inspection.

The inspection of DFI DAS drawings and assembly procedures and as-built process plans shall assess the conformance to soldering requirements of J-STD-001DS.

The verification shall be considered successful when the inspection of documentation shows that the soldering workmanship conforms to J-STD-001DS.

4.2.9.2 Crimping

This verification shall by inspection.

The inspection of DFI DAS drawings and assembly procedures and as-built process plans shall assess the conformance to crimping requirements of NASA-STD-8739.4, as tailored by MSFC-STD-2905.

The verification shall be considered successful when the inspection of documentation shows that the crimping workmanship conforms to NASA-STD-8739.4, as tailored by MSFC-STD-2905, MSFC Tailoring Guide for NASA-STD-8739.4, Crimping, Interconnecting Cables, Harness, and Wiring.

4.2.9.3 Soldering of Surface Mount Components

This verification shall by inspection.

The inspection of DFI DAS drawings and assembly procedures and as-built process plans shall assess the conformance to surface mount soldering requirements of J-STD-001DS.

The verification shall be considered successful when the inspection of documentation shows that the surface mount soldering workmanship conforms to J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

4.2.9.4 Conformal Coating and Staking

This verification shall by inspection.

The inspection of DFI DAS drawings and assembly procedures and as-built process plans shall assess the conformance to conformal coating and staking requirements of J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

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The verification shall be considered successful when the inspection of documentation shows that the conformal coating and staking workmanship conforms to J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

4.2.9.5 Tin Whisker Mitigation

This verification shall be by inspection.

Bills of material, process plans, and procedures shall be inspected to verify compliance with the tin whisker mitigation methods in J-STD-001DS.

The verification shall be successfully met with the inspection of the as-built documentation verifies that the DFI DAS units are manufactured using Tin Whisker Mitigation methods in accordance with J-STD-001DS, Space Applications Electronic Hardware Addendum to J-STD-001D, Requirements for Soldered Electrical and Electronic Assemblies.

4.2.10 Human Engineering

No verification required.

4.2.10.1 Human Engineering Guidelines

This verification shall be by inspection.

The inspection of the DFI DAS shall assess compliance with NASA-STD-3000 CxP 70024 Constellation Human-Systems Integration Requirements (HSIR)

The verification shall be considered successful when the inspection shows that the DFI DAS meets the human engineering guidelines of NASA-STD-3000, Man-Systems Integration Standards, and CxP 70024 Constellation Human-Systems Integration Requirements (HSIR).

4.2.10.2 Sharp Edges

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS hardware and Workstation to verify sharp edges, corners, and protrusions are broken.

The verification shall be considered successfully met when the inspection of the DFI DAS hardware and Workstation verifies that all accessible edges, corners, and protrusions have been broken in compliance with Human Factors Engineering Design Criteria, USO-CLV-LS-25404.

4.2.10.3 Maximum Touch Temperature

This verification shall be by test and inspection and analysis.

The DFI DAS thermal test procedures as required by 3.2.5.3, Qualification Test Requirements and 3.2.5.4, Acceptance Test Requirements, shall be inspected to ensure instrumentation during the test will measure the outside and internal temperature of the DFI DAS to ensure that cooling is not required. An analysis of the test results and the flight operational ambient temperature shall be performed.

Verification shall be considered a success when the inspection of the thermal test procedures indicates adequate instrumentation to determine flight touch temperature and when the thermal test verifications of 3.2.5.3, Qualification Test Requirements and 3.2.5.4, Acceptance Test Requirements, show that the maximum external touch temperature of the DFI DAS while operating in the Upper Stage thermal environment complies with Human Factors Engineering Design Criteria, USO-CLV-LS-25404, section 5.13.4.6, Table X.

4.2.10.4 Minimum Touch Temperature

This verification shall be by test and inspection.

The DFI DAS thermal test procedures as required by3.2.5.3, Qualification Test Requirements and 3.2.5.4, Acceptance Test Requirements, shall be inspected to ensure instrumentation during the test will measure the outside and internal temperature of the DFI DAS to ensure that cooling is not required.

Verification shall be considered a success when the inspection of the thermal test procedures indicates adequate instrumentation to determine flight touch temperature and when the Environmental Conditions verifications of 4.2.5 show that the minimum internal touch temperature of the DFI DAS while operating in the Upper Stage thermal environment complies with Human Factors Engineering Design Criteria, USO-CLV-LS-25404, section 5.13.4.6, Table X.

4.2.10.5 General Safety

This verification shall be by inspection.

The verification shall include an inspection of the manuals, drawings, process plans, procedures and hardware to determine sufficient detail to perform a system safety analysis of the DFI DAS

The verification shall be considered successfully met when the inspection of the DFI DAS indicates sufficient documentation to perform a safety analysis per 2.2.1, Hazard Analysis, of CxP 70059 Constellation Program (CxP) Integrated Safety, Reliability, and Quality Assurance (SR&QA) Requirements.

4.2.10.6 Contamination Control

This verification shall be by inspection.

The verification shall include an inspection of the DFI DAS and Workstation for cleanliness and the as-built process plans indicate cleaning of internal surfaces.

The verification shall be considered successfully met when the inspection report shows the DFI DAS and Workstation are visibly clean in accordance with CxP 70145, Constellation Program Contamination Control Requirements and as-built process plans indicate cleaning of internal surfaces.

4.2.10.7 Box Integration for Ground Operations

This verification shall be by inspection.

The inspection of the DFI DAS design drawings and procedures shall assess compliance with CxP 70024, Section 3.9.

The verification shall be considered successful when the inspection shows that the DFI DAS meets the box integration requirements for ground operations in accordance with Human-Systems Integration Requirements (HSIR), CxP 70024, Section 3.9.

4.3 Packaging Requirements

This verification shall be by analysis.

An analysis of the shipping origin, route, destination, packaging, handling, and transportation shall be performed to verify conformance with NPR 6000.1G.

This requirement shall be successfully met when the analysis confirms that the shipping origin, route, destination, packaging, handling, and transportation meet the requirements of NPR 6000.1G.

4.3.1 Packaging Design Requirement (Structural)

This verification shall be by analysis and inspection.

An analysis of the transportation environment shall be performed to determine the values of the parameters in the requirement and to determine the protection provided by the packaging. An inspection of the user documentation shall confirm the documentation of the environmental parameter values.

This verification shall be successfully met when the analysis of the preservation, packaging, and packing conforms to the free fall flat drop, free fall corner drop, and sinusoidal vibration requirements of MIL-STD-2073 and NPR 6000.1G and the transportation environment and when the user documentation indicates the transportation shock and vibration environment.

4.3.2 Reusable Containers

This verification shall be by analysis.

If reusable containers are required, an analysis of commercially available standard off-the-shelf, low cost, metal or plastic containers shall be performed.

This verification shall be successfully met when the analysis determines whether suitable off-the-shelf reusable containers are available if reusable containers are required.

4.3.3 Monitoring Devices

This verification shall be by inspection.

The inspection of the approval-to-ship documentation shall include a description of instrumentation for monitoring or recording in-transit environments (e.g., shock, vibration, temperature, humidity, etc.).

The verification shall be successfully met when the Buyer approves, by signature, the approval-to-ship documentation.

4.3.4 Temporarily Installed Hardware Identification

This verification shall be by inspection.

An inspection of all temporarily installed devices such as caps, plugs, covers, support bracketry, protective plates, etc., shall confirm these items are marked “NOT FLIGHT” or otherwise indicated as not for flight to ensure they are easily identified under casual observation.

This verification shall be successfully met when the inspection confirms temporarily installed non-flight items are marked “NOT FLIGHT” or otherwise indicated as not for flight.

4.3.5 Marking for Shipment

This verification shall be by inspection.

An inspection of the interior and exterior containers markings for shipment shall be performed to verify conformance with MIL-STD-130.

This verification shall be successfully met when the inspection verifies shipping markings are in accordance with MIL-STD-130.

4.3.6 Marking for Reuse

This verification shall be by inspection.

An inspection of the markings on reusable containers shall be performed to verify the words "REUSABLE CONTAINER –DO NOT DESTROY – RETAIN FOR REUSE" are used.

This verification shall be successfully met when the inspection verifies the markings are visible on reusable containers.

4.3.7 NASA Critical Item Labels

This verification shall be by inspection.

An inspection of the interior and exterior containers NASA critical item labels for shipment shall be performed to verify conformance with MIL-STD-2073 and NPR 6000.1G.

This verification shall be successfully met when the inspection verifies that NASA critical item labels are in accordance with MIL-STD-2073 and NPR 6000.1G.

4.3.8 Identification Format

This verification shall be by inspection.

An inspection of the interior and exterior container identification markings shall be performed to verify conformance with MIL-STD-2073 and NPR 6000.1G.

This verification shall be successfully met when the inspection verifies that identification markings are in accordance with MIL-STD-2073 and NPR 6000.1G.

APPENDIX A ACRONYMS AND ABBREVIATIONS

Acronyms and Abbreviations

AWG	American Wire Gage
ASME	American Society of Mechanical Engineers
BIT	Built in Test
BITE	Built in Test Equipment
C	Celsius
CEI	Component End Item
CEQATR	Constellation Environmental Qualification and Acceptance Testing Requirements
CEV	Crew Exploration Vehicle
CLV	Crew Launch Vehicle
CxP	Constellation Program
dB	decibel
DAS	Data Acquisition System
DAU	Data Acquisition Unit
DFI	Development Flight Instrumentation
DFIS	Development Flight Instrumentation System
E3	Electromagnetic Environmental Effects
EDU	Engineering Development Unit
ESD	Electro Static Discharge
EEE	Electrical, Electronic, and Electromechanical
EMC	Electro Magnetic Compatibility
EOM	End of Message
F	Fahrenheit
FC	Flight Computer
FDIR	Fault Detection, Isolation, and Recovery
FU	Flight Units
g	gravity
EGSE	Electrical Ground Support Equipment
HSIR	Human-Systems Integration Requirements
Hz	Hertz
IEEE	Institute of Electrical & Electronics Engineers, Inc.
IRIG	Inter-Range Instrumentation Group (Range Commanders Council)
ITAR	International Traffic in Arms Regulations
LH2	Liquid Hydrogen
LOX	Liquid Oxygen
LRU	Line Replaceable Unit
MDAU	Master Data Acquisition Unit
MAPTIS	Materials and Processes Technical Information System

Mpbs	Mega Bits per Second
MMH	Monomethyl Hydrazine
MTTF	Mean Time To Failure
NASA	National Aeronautics and Space Administration
NEDD	Natural Environments Design Document
NTO	Nitrogen Tetroxide
OA	Organic Acid
OFI	Operational Flight Instrumentation
PCM	Pulse Code Modulation
PDU	Power Distribution Unit
PWB	Printed Wiring Board
RDAU	Remote Data Acquisition Unit
RH	Relative Humidity
RMS	Root Mean Square
SBU	Sensitive But Unclassified
SDU	Software Development Unit
SMT	Surface Mounted Technology
SRU	Shop Replaceable Unit
SR&QA	Safety, Reliability, and Quality Assurance
TBD	To Be Determined
TBR	To Be Resolved
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Agency
VDC	Volts Direct Current

APPENDIX B REQUIREMENTS TRACE MATRIX CEI 3.2 REQUIREMENTS

Requirements Trace Matrix CEI 3.2 Requirements

Section No.	Requirement ID	Section / Requirement Title	Method					Verification ID
			N/A	A	T	D	I	

APPENDIX C VERIFICATION CROSS REFERENCE MATRIX 3.2 REQUIREMENTS

Verification Cross Reference Matrix 3.2 Requirements

Section No.	*EDU*	*Qualification*	*Acceptance.*	*Section / Requirement Title*	*Methods*					*Verification ID*
					N / A	*A*	*T*	*D*	*I*	
3.1				DFI DAS Description	X					
3.2				DFI DAS Characteristics	X					4.2
3.2.1				Data Acquisition	X					4.2.1
3.2.1.1	X	X	X	Initialization to Known PCM Frame Format			X		X	4.2.1.1
3.2.1.2	X	X	X	Power Application Data Output			X			4.2.1.2
3.2.1.3	X	X	X	Power Interruption Data Output			X			4.2.1.3
3.2.1.4	X	X	X	Sensor Data Acquisition			X		X	4.2.1.4
3.2.1.5	X	X	X	PCM Data Acquisition			X		X	4.2.1.5
3.2.1.6	X	X	X	PCM Frame Generation			X			4.2.1.6
3.2.1.7	X	X	X	User Programmable			X		X	4.2.1.7
3.2.1.8	X	X	X	Sampling and Formatting			X		X	4.2.1.8
3.2.1.9	X	X	X	Number of Data Formats			X		X	4.2.1.9
3.2.1.10	X	X	X	Format Change via Discrete Signal			X		X	4.2.1.10
3.2.1.11				DAS Interface Requirements	X					4.2.1.11
3.2.1.11.1	X	X	X	MDAU to Telemetry System Interface					X	4.2.1.11.1
3.2.1.11.1.1	X	X	X	MDAU to Telemetry System Bit Rate			X			4.2.1.11.1.1
3.2.1.11.1.2	X	X	X	MDAU to Telemetry System Impedance			X			4.2.1.11.1.2
3.2.1.11.2	X	X	X	MDAU to First Stage DFI System Interface					X	4.2.1.11.2
3.2.1.11.2.1	X	X	X	MDAU to First Stage DFI System Bit Rate			X			4.2.1.11.2.1
3.2.1.11.2.2	X	X	X	MDAU to First Stage DFI System Impedance			X			4.2.1.11.2.2
3.2.1.11.3	X	X	X	First Stage DFI System to MDAU Interface					X	4.2.1.11.3
3.2.1.11.3.1	X	X	X	First Stage DFI System to MDAU Bit Rate			X			4.2.1.11.3.1
3.2.1.11.3.2	X	X	X	First Stage DFI System to MDAU Impedance			X			4.2.1.11.3.2
3.2.1.11.4	X	X	X	MDAU with RDAU Interface			X			4.2.1.11.4

Section No.	*EDU*	*Qualification*	*Acceptance.*	*Section / Requirement Title*	*Methods*					*Verification ID*
					N / A	*A*	*T*	*D*	*I*	
3.2.1.11.4.1	X	X	X	MDAU with RDAU Interface Distance			X			4.2.1.11.4.1
3.2.1.11.5	X	X	X	Workstation Interface			X			4.2.1.11.5
3.2.1.11.6	X	X	X	EGSE Interface					X	4.2.1.11.6
3.2.1.11.7	X	X	X	Test and Programming					X	4.2.1.11.7
3.2.2	X	X	X	Input Channels			X		X	4.2.2
3.2.2.1	X	X	X	Input Channels Characteristics			X		X	4.2.2.1
3.2.2.1.1	X	X		Sample Rates			X			4.2.2.1.1
3.2.2.1.2	X	X		A/D Resolution			X			4.2.2.1.2
3.2.2.1.3	X	X	X	Output/Sample			X		X	4.2.2.1.3
3.2.2.1.4	X	X		Excitation					X	4.2.2.1.4
3.2.2.1.5	X	X		Signal Condition					X	4.2.2.1.5
3.2.2.1.6	X	X	X	Accuracy			X			4.2.2.1.6
3.2.2.1.7	X	X		Charge Amplifier					X	4.2.2.1.7
3.2.2.1.8	X	X		Programmable Filter					X	4.2.2.1.8
3.2.2.1.9	X	X		Programmable Gains					X	4.2.2.1.9
3.2.2.1.10	X	X		Reference Junction Compensation					X	4.2.2.1.10
3.2.2.1.11				Video	X					4.2.2.1.11
3.2.2.1.11.1	X	X		Video Format			X			4.2.2.1.11.1
3.2.2.1.11.2	X	X	X	Video Resolution			X			4.2.2.1.11.2
3.2.2.1.11.3	X	X	X	Video Frame Rate			X			4.2.2.1.11.3
3.2.2.1.11.4	X	X	X	Video Image Compression			X			4.2.2.1.11.4
3.2.3				Time	X					4.2.3
3.2.3.1	X	X	X	Receiving Time			X			4.2.3.1
3.2.3.2	X	X	X	Internal Clock			X		X	4.2.3.2
3.2.3.3	X	X	X	Time Stamp of Data		X				4.2.3.3
3.2.3.4	X	X	X	Time Stamp with Accuracy		X				4.2.3.4
3.2.3.5	X	X	X	Time Stamp with Precision		X				4.2.3.5
3.2.4				Workstation Characteristics	X					4.2.4
3.2.4.1	X	X		Workstation Computer					X	4.2.4.1
3.2.4.2	X	X		Data Channel Configuration					X	4.2.4.2
3.2.4.3	X	X		Configurable Channel Sampling Rates					X	4.2.4.3
3.2.4.4	X	X		Configurable Channel Gain					X	4.2.4.4
3.2.4.5	X	X		Configurable Channel Offset					X	4.2.4.5
3.2.4.6	X	X		Configurable Channel Calibration					X	4.2.4.6
3.2.4.7	X	X		Configurable Channel Range					X	4.2.4.7
3.2.4.8	X	X	X	Receiving Channel Data			X		X	4.2.4.8
3.2.4.9	X	X	X	Display Data in Counts Format					X	4.2.4.9
3.2.4.10	X	X		Display Data in Units Format					X	4.2.4.10
3.2.4.11	X	X		Display Data in Strip Chart					X	4.2.4.11

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					N / A	*A*	*T*	*D*	*I*	
				Format						
3.2.4.12	X	X	X	Display Data with Alarms			X		X	4.2.4.12
3.2.4.13	X	X		Portability					X	4.2.4.13
3.2.4.14	X	X		Display Parameters			X		X	4.2.4.14
3.2.4.15	X	X	X	Built In Test			X			4.2.4.15
3.2.4.16		X		Reliability		X				4.2.4.16
3.2.4.16.1		X		Reliability Data					X	4.2.4.16.1
3.2.4.17		X		Failure Propagation		X				4.2.4.17
3.2.4.18		X		Flight Operation Life		X				4.2.4.18
3.2.4.19		X		Calibration					X	4.2.4.19
3.2.5				Environmental Conditions	X					4.2.5
3.2.5.1		X		Natural Environments		X				4.2.5.1
3.2.5.2		X		Induced Environments	X					4.2.5.2
3.2.5.2.1		X		Transportation (packaged)			X		X	4.2.5.2.1
3.2.5.2.2		X		Non-Operating Environment	X					4.2.5.2.2
3.2.5.2.2.1		X		Storage	X					4.2.5.2.2.1
3.2.5.2.2.1.1		X		Storage Time		X				4.2.5.2.2.1.1
3.2.5.2.2.2		X		Non-Operating Temperature		X				4.2.5.2.2.2
3.2.5.2.2.3		X		Non-Operating Humidity		X				4.2.5.2.2.3
3.2.5.2.3		X		Operating Environment	X					4.2.5.2.3
3.2.5.2.3.1		X		Operating Temperature			X			4.2.5.2.3.1
3.2.5.2.3.2		X		Operating Humidity			X			4.2.5.2.3.2
3.2.5.2.3.3		X		Random Vibration and Shock			X			4.2.5.2.3.3
3.2.5.2.3.4		X		Pressure Change			X			4.2.5.2.3.4
3.2.5.2.3.5		X		Pressure Rate of Change			X			4.2.5.2.3.5
3.2.5.2.3.6		X		Loads Analysis		X				4.2.5.2.3.6
3.2.5.3		X		Qualification Test Requirements			X		X	4.2.5.3
3.2.5.4			X	Acceptance Test Requirements.			X		X	4.2.5.4
3.2.6				Electrical Design	X					4.2.6
3.2.6.1	X	X	X	Input Power			X			4.2.6.1
3.2.6.2	X	X		Input Voltage Range		X	X		X	4.2.6.2
3.2.6.3	X	X		Short Circuit Protection		X				4.2.6.3
3.2.6.4	X	X	X	5V Discrete Characteristics			X			4.2.6.4
3.2.6.4.1	X	X	X	Pull Down Characteristic			X			4.2.6.4.1
3.2.6.4.2	X	X	X	Quantity					X	4.2.6.4.2
3.2.6.5	X	X	X	28V Discrete Characteristics			X			4.2.6.5
3.2.6.5.1	X	X	X	Pull Down Characteristic			X			4.2.6.5.1
3.2.6.5.2	X	X	X	Quantity					X	4.2.6.5.2
3.2.6.6		X	X (I, T)	Electrical Bonding		X	X		X	4.2.6.6
3.2.6.7		X		Electrical Grounding		X			X	4.2.6.7
3.2.6.8		X		Lightning Protection		X	X			4.2.6.8

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					N / A	*A*	*T*	*D*	*I*	
3.2.6.9		X		Electrostatic Discharge (ESD) Protection		X	X			4.2.6.9
3.2.6.10		X	X	Isolation of Test Points					X	4.2.6.10
3.2.6.11		X	X	Electronic, Electrical, Electromechanical (EEE) Parts		X				4.2.6.11
3.2.6.12		X	X	Inadvertent Disconnect		X				4.2.6.12
3.2.6.13		X	X	Printed Wiring Boards					X	4.2.6.13
3.2.6.14		X		Ignition Source Avoidance					X	4.2.6.14
3.2.6.15		X	X	Electromagnetic Interference			X			4.2.6.15
3.2.6.16		X		Circuit Classification		X				4.2.6.16
3.2.6.17		X	X	Connector Location and Pin Function Assignments					X	4.2.6.17
3.2.6.18		X	X	Wire and Cable Shielding Separation and Routing					X	4.2.6.18
3.2.6.19		X	X	Electrostatic Discharge (ESD) Control					X	4.2.6.19
3.2.7		X		Structural and Mechanical	X					4.2.7
3.2.7.1		X		Materials and Processes					X	4.2.7.1
3.2.7.2		X		Fracture Control		X	X		X	4.2.7.2
3.2.7.3		X		Drawing Quality					X	4.2.7.3
3.2.7.4		X		Cooling			X		X	4.2.7.4
3.2.7.5		X	X	Captive Fasteners					X	4.2.7.5
3.2.7.6		X		Factors of Safety		X				4.2.7.6
3.2.7.7		X		Debris Prevention		X				4.2.7.7
3.2.7.8		X		Chemical Exposure in the Instrument Unit (IU)		X				4.2.7.8
3.2.7.9		X		LRU Interchangeability					X	4.2.7.9
3.2.7.10		X		Connector Mismating		X				4.2.7.10
3.2.7.11	X	X	X	DAU Chassis Size					X	4.2.7.11
4.2.7.12	X	X	X	Distributed System				X	X	4.2.7.12
3.2.8				Product Marking	X					4.2.8
3.2.8.1		X	X	Identification and Marking					X	4.2.8.1
3.2.8.2		X	X	ESD Identification and Marking					X	4.2.8.2
3.2.8.3		X	X	Serial Numbers					X	4.2.8.3
3.2.9				Workmanship	X					4.2.9
3.2.9.1		X	X	Soldering					X	4.2.9.1
3.2.9.2		X	X	Crimping					X	4.2.9.2
3.2.9.3		X	X	Soldering of Surface Mount Components					X	4.2.9.3
3.2.9.4		X	X	Conformal Coating and Staking					X	4.2.9.4
3.2.9.5		X	X	Tin Whisker Mitigation					X	4.2.9.5
3.2.10				Human Engineering	X					4.2.10
3.2.10.1	X	X	X	Human Engineering Guidelines					X	4.2.10.1
3.2.10.2	X	X	X	Sharp Edges					X	4.2.10.2
3.2.10.3	X	X		Maximum Touch Temperature		X	X		X	4.2.10.3

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					N / A	*A*	*T*	*D*	*I*	
3.2.10.4	X	X		Minimum Touch Temperature		X	X		X	4.2.10.4
3.2.10.5		X		General Safety					X	4.2.10.5
3.2.10.6		X	X	Contamination Control					X	4.2.10.6
3.2.10.7		X		Box Integration for Ground Operations					X	4.2.10.7
3.3		X		Packaging Requirements		X				4.3
3.3.1		X		Packaging Design Requirement (Structural)		X			X	4.3.1
3.3.2		X	X	Reusable Containers		X				4.3.2
3.3.3		X	X	Monitoring Devices					X	4.3.3
3.3.4		X	X	Temporarily Installed Hardware Identification					X	4.3.4
3.3.5		X	X	Marking for Shipment					X	4.3.5
3.3.6		X	X	Marking for Reuse					X	4.3.6
3.3.7		X	X	NASA Critical Item Labels					X	4.3.7
3.3.8		X	X	Identification Format					X	4.3.8