NORTHROP GRUMMAN

Integrated Air and Missile Defense (IAMD) Battle Command System (IBCS)

IBCS Failure Modes, Effects and Criticality Analysis Hardware (FMECA) Results

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1. Introduction

This section provides the purpose and scope of the Integrated Air and Missile Defense (IAMD) Battle Command System (IBCS) Failure Modes, Effects and Criticality Analysis (FMECA) Results, as well as application of analysis results, a document overview, updates for the results, and a program overview.

The FMECA supplements the Failure Modes and Effects Analysis (FMEA) and will be incorporated in the submission of the report. The FMECA is an essential reliability task, it also provides information for other purposes. The use of the FMECA is called for in maintainability, safety analysis (Refer to System Safety Program Plan, CDRL IBCS-A028), survivability and vulnerability, logistics support analysis, maintenance plan analysis, and for failure detection and isolation subsystem design. The basic interrelationships of the tasks called out in MIL-STD-1629A are shown in Figure 1-1. The tasks to be performed are shown by the heavy black lines.

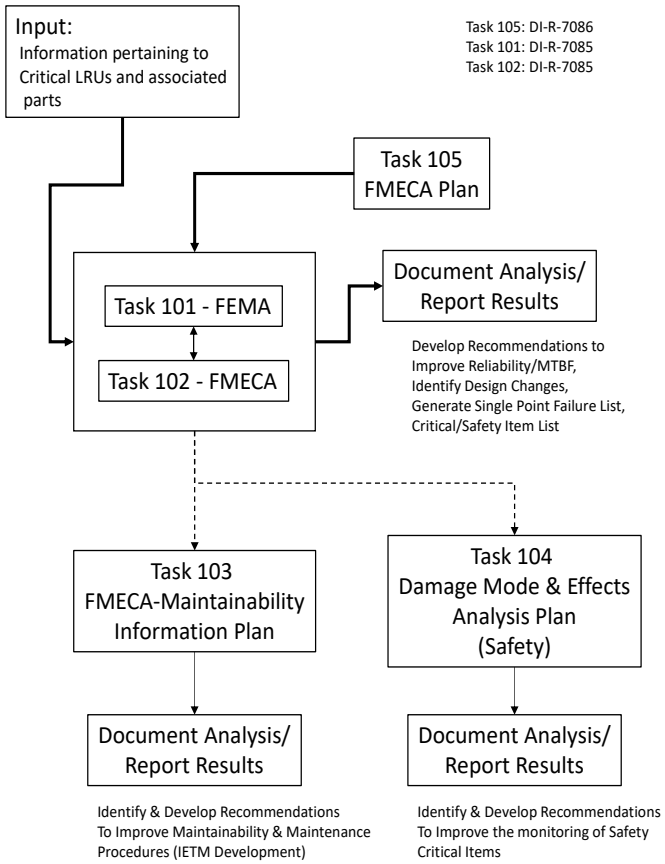


Figure 1-1. Interrelationships of the Tasks

1.1. Purpose

The IBCS FMECA Results establish requirements and procedures to systematically evaluate and document, by item failure mode analysis, the potential impact of each functional, hardware, or software failure. The impact of this failure is then evaluated in light of: mission success, personnel and system safety, system performance, and maintainability and maintenance requirements. Each potential failure is classified by the severity of its effect in order that appropriate corrective actions may be taken to eliminate or control the high risk items.

1.2. Scope

These results apply to all IBCS product hardware and software and will be used during the design phase to analyze the hardware and software design and any modifications thereafter. The results apply to IBCS, Command Posts (also known as Engagement Operation Centers), and Plug and Fight B-Kits (also known as IFCN [Integrated Fire Control Network] Relays). The IBCS FMECA Results were developed as Contract Data Requirements List (CDRL) IBCS-A243 and developed using MIL-STD-1629A, Task 105 and TM 5-698-4 as guides.

1.3. Application of Analysis Results

The results of this FMECA will be used to identify all catastrophic and critical failures so they can be eliminated or controlled through design or procedural modifications at the earliest possible time. The FMECA is also used to improve the reliability and availability of the system, to design testability into the system, and as an aid to developing corrective and preventive maintenance tasks. And, can assist in establishing a Reliability Centered Maintenance (RCM) program. It also supports personnel safety assessments, logistics analysis, risk assessment, and mission performance analysis in conjunction with supporting the development of a fix or fight criteria. Sections 6 and 7 provide more details as to how the results will be applied.

1.4. Document Overview

Section 1	Introduction: Describes purpose, scope, application of results, and updates, and provides document and program overviews
Section 2	Applicable Documents: Lists reference documents, standards, and handbooks related to these results
Section 3	Output Products: Lists documents generated based on the FMECA results
Section 4	System Overview: Provides a description of IBCS and the major end items from a reliability modeling perspective
Section 5	Analysis Guidelines:
Section 6	FMECA Planning: Describes ground rules and assumptions as well as indenture levels, the coding system, and FMECA reviews and schedules
Section 7	Abbreviations and Acronyms: Lists abbreviations and acronyms used in this document
Appendix A	IFCN Relay Data
Appendix B.1	“Shelter”

Appendix B.2 "ICE"
Appendix C Link to Software Failure Mode, Effects and Criticality Analysis (SWFMECA)

1.5. Results Updates

This FMECA Results are updated due to changes in the contract, customer direction, program scope, requirements, available and estimated resources, organizational policies or processes, or when actual values vary significantly from the existing results. The results shall be reviewed for updates at least every six months and revised as contracted for. More frequent reviews and updates are performed as necessary to ensure that the results are current and useful. There have been no design changes to IBCS since the release of IBCS-A052-012 (previous report) that necessitate changes to these results. Updates are subject to the configuration and change management process defined in CDRL IBCS-A058, the IBCS Configuration Management Plan (CMP).

1.6. Program Overview

The Army Integrated Air and Missile Defense (AIAMD) System of Systems (ASoS) integrates current and future sensors, weapons, and their respective Mission Command (MC) into a networked Air and Missile Defense (AMD) system. The materiel solution for the ASoS MC is the IAMD Battle Command System (IBCS).

IBCS provides the net-centric, Plug and Fight (P&F), SoS Command, Control, and Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) capability of the IAMD architecture. IBCS consists of two Major End Items (MEIs): the Engagement Operations Center (EOC) (also known as the Command Post (CP)), and the IBCS IFCN Relay (also known as the P&F B-Kit). The IBCS EOC provides C4ISR functions at battalion (BN), battery (BTRY), and platoon (PLT) echelons within the AMD Task Force (TF), while the IFCN Relays adapt IAMD weapon and sensor components to fight in the net-centric ASoS. The P&F A-Kit provides the component-unique portion of the P&F Kit and is developed under the purview of the affected component's project/product office. The IFCN Relay (P&F B-Kit) provides the interface between the component P&F A-Kit and IBCS. Northrop Grumman is supplying the IBCS EOCs and the IBCS IFCN Relays. The EOCs and the IFCN Relays draw from a set of common software modules that provide track management, engagement operations, interface services (both human and machine), planning, training and supporting software infrastructural needs. In addition, IAMD weapon and sensor program offices provide the unique hardware and software items used for integration of IBCS IFCN Relays with their system's P&F A-Kit. Northrop Grumman is also developing the IBCS IFCN that provides the framework to distribute fire control quality data, commands, and messaging among IBCS EOCs and ASoS enabled weapons and sensors. The IBCS EOC serves as the AMD MC node at BN, BTRY and PLT levels within the AMD TF.

The AIAMD FY16 Architecture Concept, as defined by the IAMD Project Office (PO), is shown in Figure 1-1, and includes IBCS, Lower Tier Project Office (LTPO) sensors and weapons, Cruise Missile Defense Systems (CMDS) Project Office sensors and weapons, as well as the IFCN.

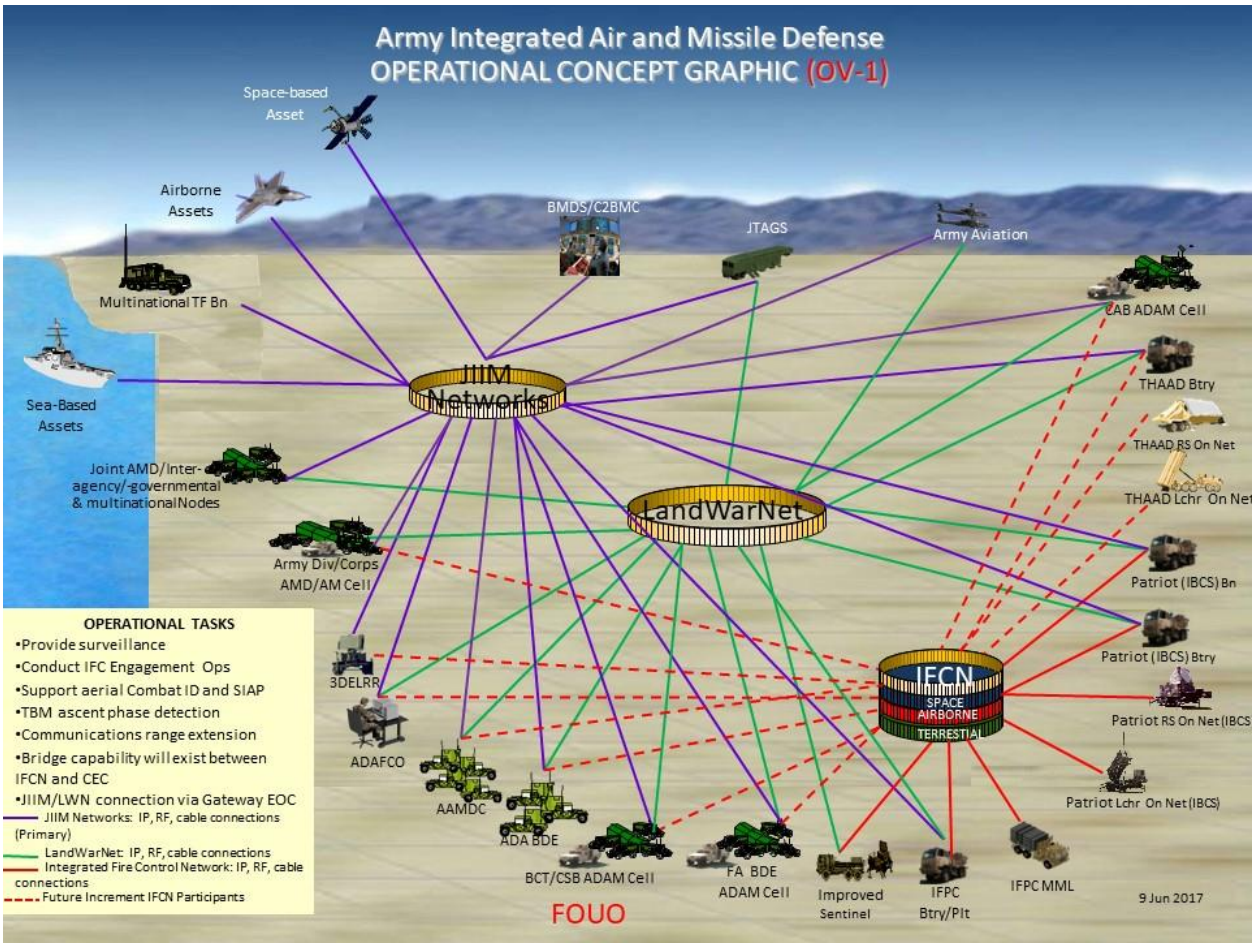


Figure 1-2. OV1- High Level Operational Concept.

The IBCS architecture enhances the Warfighter's ability to execute AMD battle command. By modernizing command and control, the kinematic capabilities of all weapons and detection and tracking envelopes of all sensors can be fully utilized. By establishing and invoking the common standards sought by the Joint IAMD, the vision of a truly joint IAMD is realized. This innovative approach at modernization reduces manpower, enhances training, and reduces operation and support cost while at the same time providing a more robust and effective AMD.

2. Applicable Documents

The documents listed in this section form a part of this report to the extent specified herein.

2.1. Government Documents

Table 2-1 lists Government documents relevant to the FMECA effort.

Table 2-1. Government Reference Documents

Document ID	Title
W31P4Q-08-C-0418 Attachment 001	Statement of Work for the Integrated Air & Missile Defense (IAMD) Battle Command System (IBCS) Development Program
No Number, dated 23 May 2006	Army Integrated Air and Missile Defense System-of-Systems (ASoS) Operational Mode Summary/Mission Profile
No Number, dated 27 January 2016	Failure Definition and Scoring Criteria (FDSC) for Integrated Air and Missile Defense System-of-Systems (AIAMD SoS) Increment 2
MIL-PRF-49506 Notice 1 dated 18 January 2005	Performance Specification**:** Logistics Management Information
MIS-PRF-56500E	System Specification for the Army Integrated Air and Missile Defense System of Systems Increment 2
MIL-HDBK-217F	Reliability Prediction for Electronic Equipment
MIL-M-24100	Manual, Technical; Functionally Oriented Maintenance Manuals for Systems and Equipment
MIL-STD-756B	Reliability Program for Systems and Equipment Development and Production
MIL-STD-1629A Notice 2 dated 28 November 1984	Procedure for Performing a Failure Modes, Effects and Criticality Analysis
Army Technical Manual TM 5-698-4 dated 29 September, 2006	Failure Modes, Effects and Criticality Analysis (FMECA) for Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance (C4ISR) Facilities

2.2. Northrop Grumman Documents

Table 2-2 lists documents generated by Northrop Grumman or other team members used in development of the IBCS FMECA and this report.

Table 2-2. Northrop Grumman Documents

Document ID	Title
IBCS-A220-001	IBCS Software Development Plan
IBCS-A006-005	System Engineering Management Plan
IBCS-A274-001	IBCS System Architecture
IBCS-A258-001	Configuration Management Plan (CMP)
IBCS-A234-001	System Safety Program Plan
IBCS-A237-001	Program Product Assurance Plan (PPAP)
IBCS-A240-001	Non-Developmental Items (NDI) Reliability Plan
IBCS-A241-001	Reliability, Availability, Maintainability Prediction Report
IBCS-A242-001	Failure Modes, Effects and Criticality Analysis Hardware (FMECA) Plan
IBCS-A306-001	Maintainability Test Plan

3. Output Products

The following items are produced as a result of performing a FMECA and will be provided to the MEI designers for design improvement considerations:

- Design and maintainability information for fault detection implementing Built-In Test (BIT) and/or Continuous-BIT (C-BIT) capability data and maintenance tasks will be incorporated into the Reliability, Availability and Maintainability (RAM) Prediction and Analysis Report (CDRL IBCS A241-003). As the system matures, information will be updated. At the present time C-BIT is limited due to lack of funding.
- Critical Items List (CIL) (See Section 6.6.1) (MIL-STD 1629A General Requirement 4.5.2.1) To be incorporated as the system matures
- Criticality Matrix (See Section 6.6.4) (MIL-STD 1629A Figure 102.2 Task 102) To be determined

4. System Overview

The IBCS capability includes the IBCS EOC, IFCN Relays, and the IFCN. All three components are tied together and driven by the IBCS software. The IBCS architecture enables IBCS EOCs capable of supporting operations at echelons Platoon through Battalion IAMD TF connected via the IFCN to sensor and weapons through IFCN Relays which provide the means to interoperate with existing sensors and weapons.

4.1. S-280 EOC

IBCS S-280 EOCs are configurable facilities used by IAMD ASoS commanders and staffs to control AMD forces. Each will contain a similar capability tailored to the mission requirements of each respective echelon. The configurations of the EOC at each echelon are scaled to match required capabilities both in size and capability. The IBCS EOC consists of a standard Army prime mover (Family of Mobile Tactical Vehicles [FMTV] M1148A1P2), S-280 shelter with IFCN communications equipment, and trailer containing a tactical generator, deployable IBCS Collaboration Environment (ICE) tent, ICE Environmental Control Unit (ECU) ICE primary operational components, and ancillary support equipment. Additionally, the IBCS EOC will use Non-Developmental-Item (NDI), Commercial Off-the-Shelf (COTS), Government-furnished equipment (GFE), and developed Common Software Modules (CSMs) within EOC software builds. The IBCS EOC design maximizes commonality across BN, BTRY, and Platoon echelons. IBCS uses a common vehicle and shelter as the EOC for all echelons to maximize commonality.

IBCS EOC hardware design maximizes the use of the Army's Standardized Integrated Command Post System (SICPS) Highband Digital Transceiver (HDT) Small Tactical Air Beam Tent (STAT, model 2021). The FMTV (shown in Figure 4-1 with IBCS EOC components) replaced the originally selected prime mover due to availability of the vehicle.

4.1.1. Engagement Center Trailer (ECT)

The ICE is transported and stored on the Engagement Operation Center Trailer (ECT) (Figure 4-1), an Army standard M1061A1P2 cargo trailer which carries a standard Army standard 60Kw Generator and an improved ECU, and the HDT AirBeam tent. The ECT provides cargo transport capability for the ICE and Ancillary equipment (e.g. transit cases).

The EOC Prime Mover subsystem includes Joint Battle Command Platform (JBC-P) (incorporating updated Force XXI Battle Command Brigade and Below (FBCB2) Joint Capabilities Release (JCR) and Blue Force Tracker 2 (BFT) capabilities) in the FMTV M1148A1P2 cab and auxiliary power generator, cabling, breakout boxes and work platforms externally.

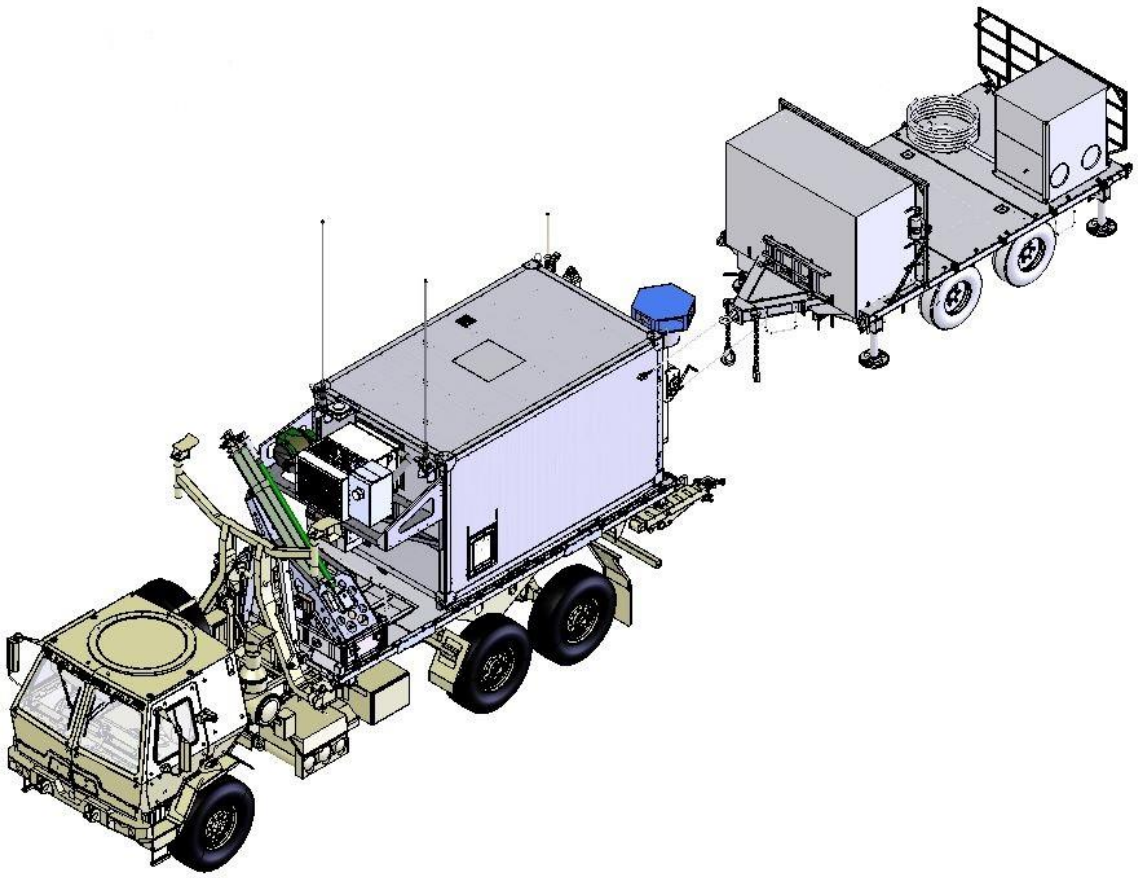


Figure 4-1. FMTV with IBCS S-280 EOC and Trailer

4.1.2. FMTV

The M1148A1P2 is a 6x6 wheeled vehicle with a long wheelbase. The IBCS design will utilize the vehicle chassis for mounting the S-280 EOC shelter on a Container Roll-On/Off Platform (CROP).

The FMTV includes an armor-ready cab with seating for a driver and two passengers. The cab can be upgraded with additional bolt-on armor for increased crew protection. The turbocharged diesel engine produces 330 hp (246 kW), and the fuel system includes a 56 gal (212 L) capacity fuel tank. The overall length is 29 ft. 4 in. (8.9 m), overall width is 8 ft. (2.4 m), and overall height is 9 ft. 4 in. (2.8 m). The curb weight is 26,041 lbs. (11,812 kg) without IBCS components installed. The maximum operating speed without the bolt-on armor or installation of IBCS components is 55 miles per hour.

4.1.3. IBCS S-280 EOC Shelter

The S-280 EOC Shelter, as shown in Figures 4-2, 4-3, and 4-4, is the basic building block for IBCS EOCs.

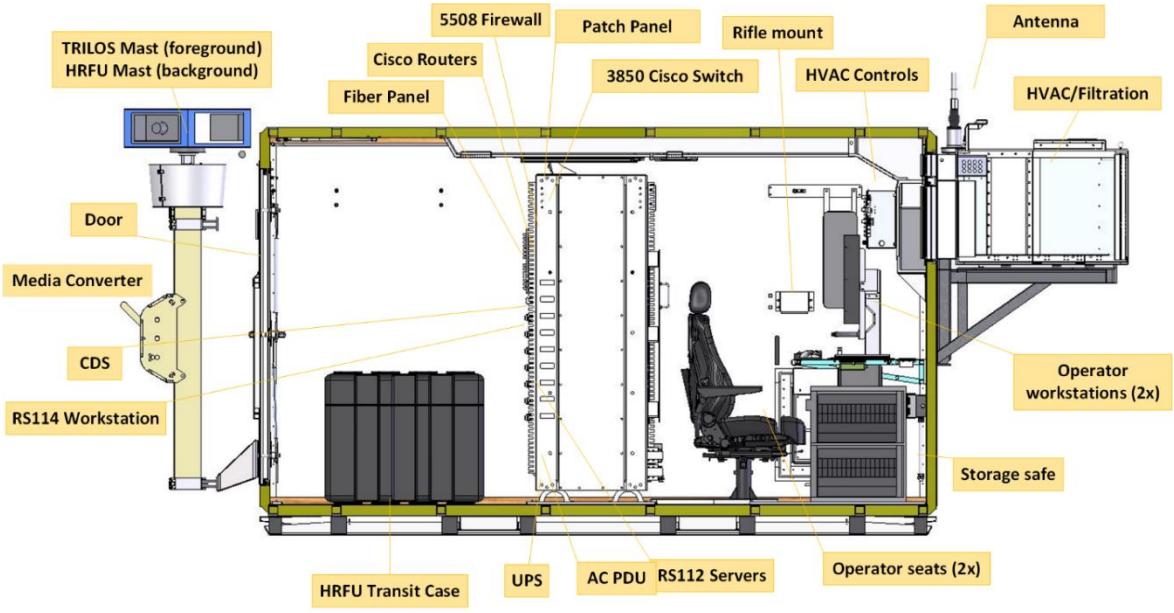


Figure 4-2. IBCS S-280 EOC Shelter Roadside View

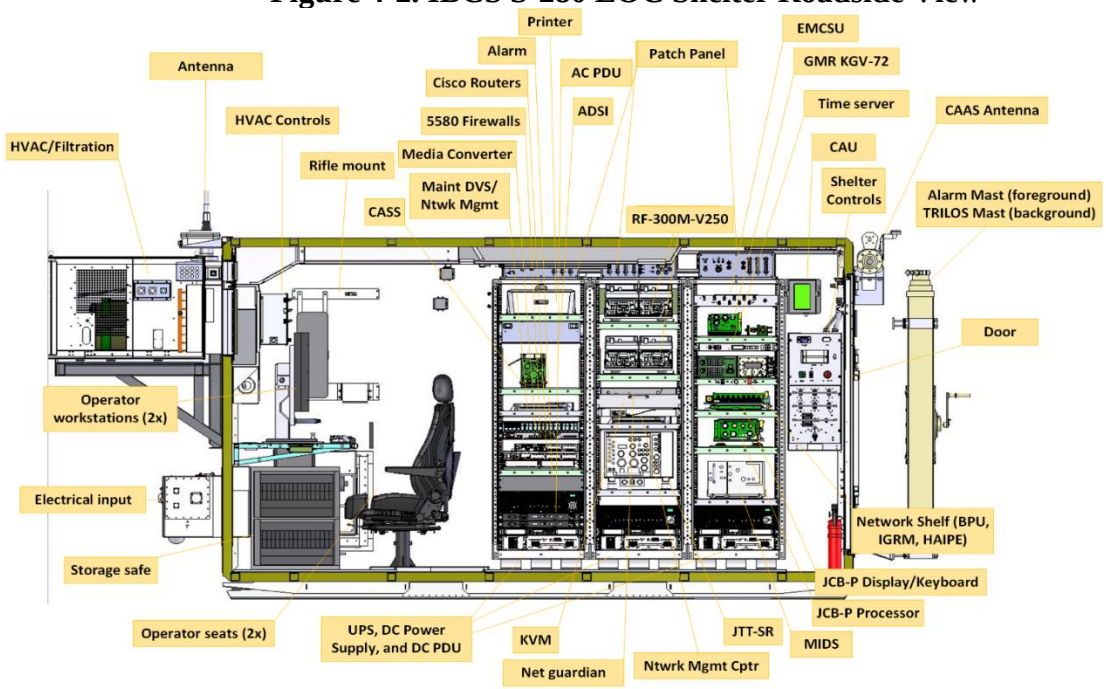


Figure 4-3. IBCS S-280 EOC Shelter Curbside View

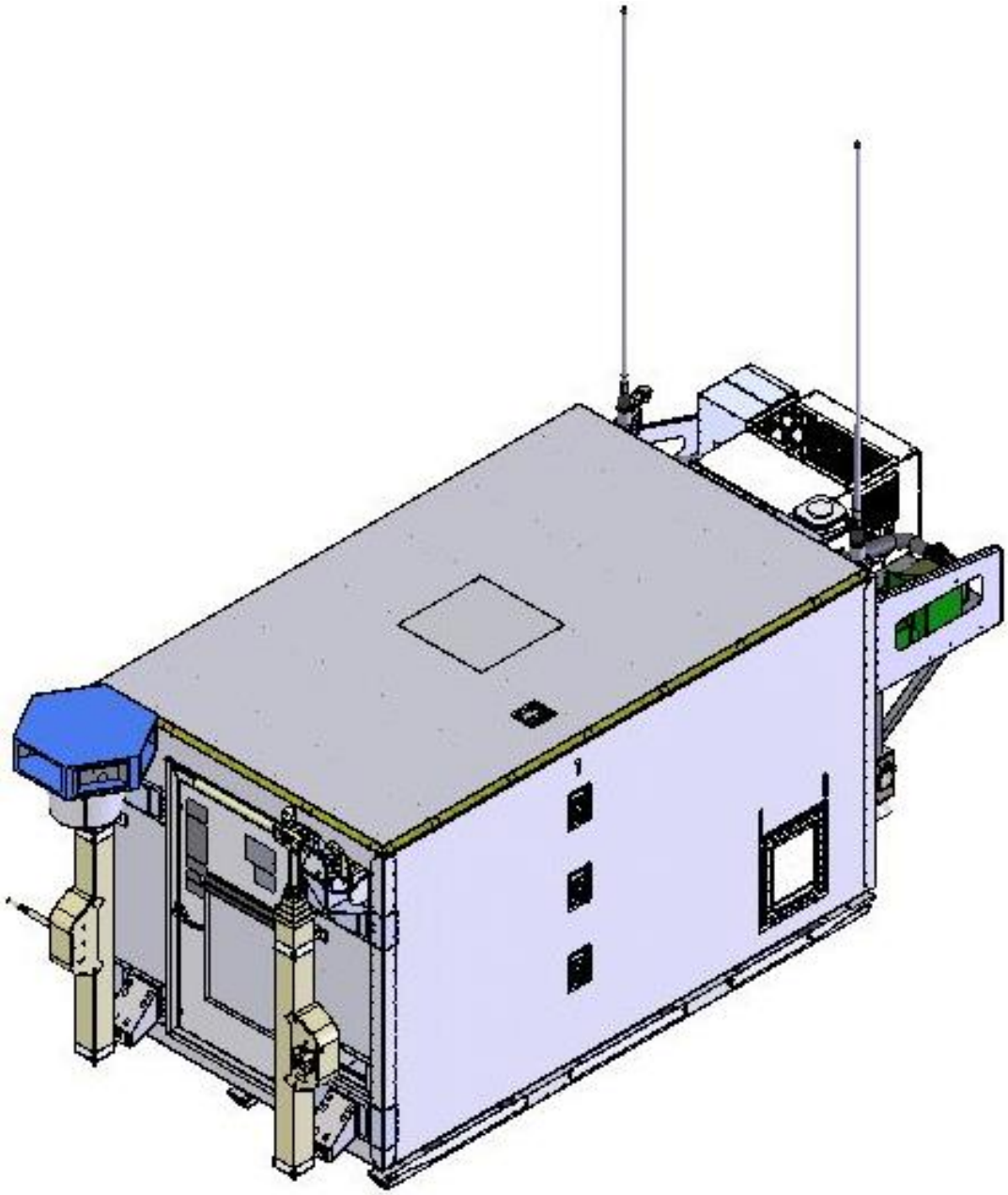


Figure 4-4. IBCS S-280 EOC Shelter Exterior Isometric View

The IBCS S-280 EOC is rapidly-deployable with two operator stations to establish minimum functionality while the ICE is being deployed and maintain minimum functionality should the ICE be unavailable.

The EOC is common at all echelons and host multiple IBCS, battle command and combat service support software suites, and communications equipment, and interface with numerous non-battle command vehicles to serve as an information aggregation point. The common shelter includes rack designs and cabling for installation compatibility of all required IBCS radios. The common cable infrastructure based on the S-280 product line provides common interfaces for data, power, radio frequency (RF), and audio connections in every EOC. The IBCS S-280 EOC development will be an extension of the Northrop Grumman existing Command Post Platform (CPP) hardware product line.

The key feature and primary assembly of the EOC shelter is the MC Assembly, a common suite of electronics. The MC Assembly consists of a computer/server system, a networking system connecting to the IFCN, a communication system which includes provisions for mounting radios, and the Command Post Communication System (CPCS) Tactical Operations Communications Network (TOCNET). The common MC Assembly eliminates unique parts at each IBCS echelon, reduces the training burden on Soldiers, ensures commonality, and reduces the logistics burden on units. The Tent Interface Panel (TIP) provides NIPR/SIPR fiber connections to the ICE workspace, and the Signal Entry Panel (SEP) provides for fiber connections to A-side interfaces and alternate media. The EOC Shelter contains the common Highband Network Radio (HNR) components.

4.1.4. ICE

The ICE consists of self-contained STAT (Small Tactical Air Beam Tent) in which to conduct battle command at the halt. The STAT systems are quickly erectable, electromagnetic interference (EMI)-protected, and designed to be standalone or connected to other SICPS tents or shelters. Modular by design, they are able to be connected end-to-end, side-to-side, or side-to-end. The tents are employed with operational facilities of IBCS EOCs to provide open ICE workspace, power distribution, lighting, environmental conditioning (heating and cooling), tables, lightweight/integrated flooring, and a common grounding system for the staffs. Figure 4-5 shows an ICE layout.

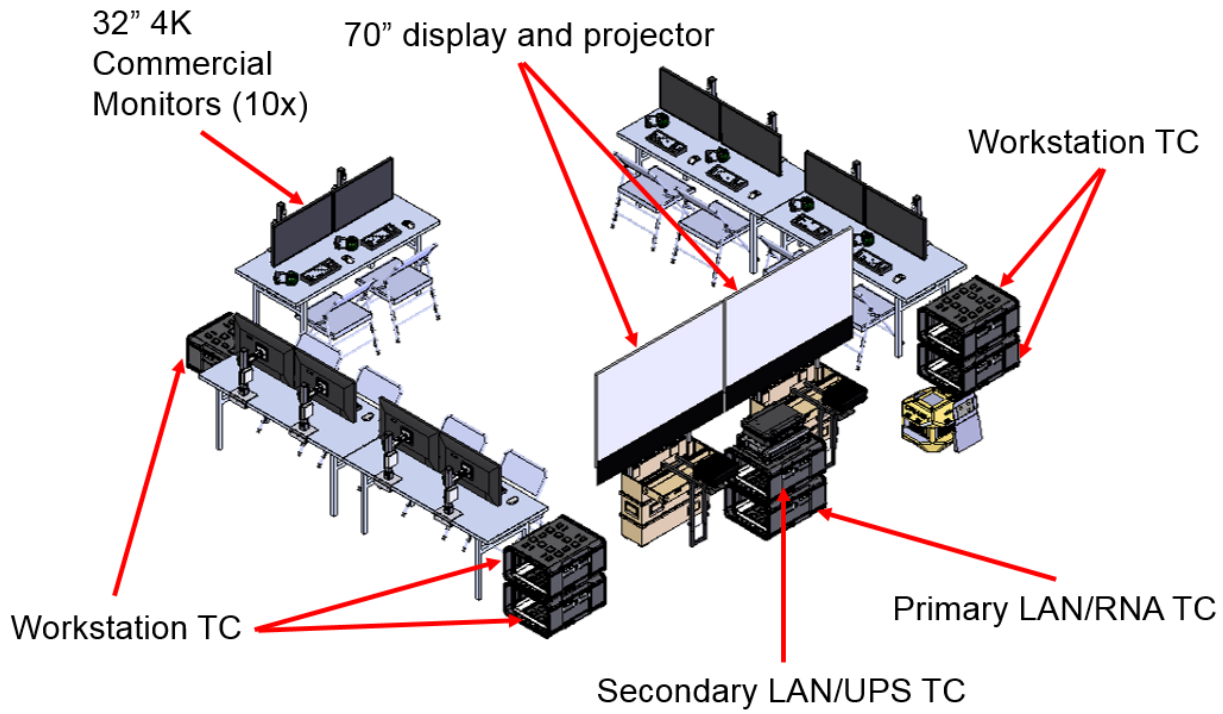


Figure 4-5. ICE Layout

ICE tents and support equipment are transported on a large tactical trailer derived from the standard TMSS (Trailer Mounting Support System) family of products. The trailer provides generator power, an ECU, and cargo space for support equipment. The ICE is issued at BTRY and BN echelons. The ICE at BN echelons supports the full range of AMD operational tasks. The EOC ICE provides for the collocation and integration of Functional and the integrating cell activities. The Platoon echelon consists of one IBCS shelter with prime mover and generator. Addition of one ICE produces the BTRY echelon. The BN echelon is twice the BTRY echelon, consisting two shelters and two ICEs. All shelters and ICEs are common and interchangeable among echelons.

4.1.5. IFF System

As shown in Figure 4-6, the IBCS stand-alone Identification Friend or Foe (IFF) capability is employed through the use of a receiver transceiver located on a rack inside of the EOC Shelter. A corresponding set of IFF system antennas consisting of a Global Positioning System (GPS) and IFF unique antenna is located on the external surface of the EOC Shelter mounted on the roadside rear portion of the shelter.

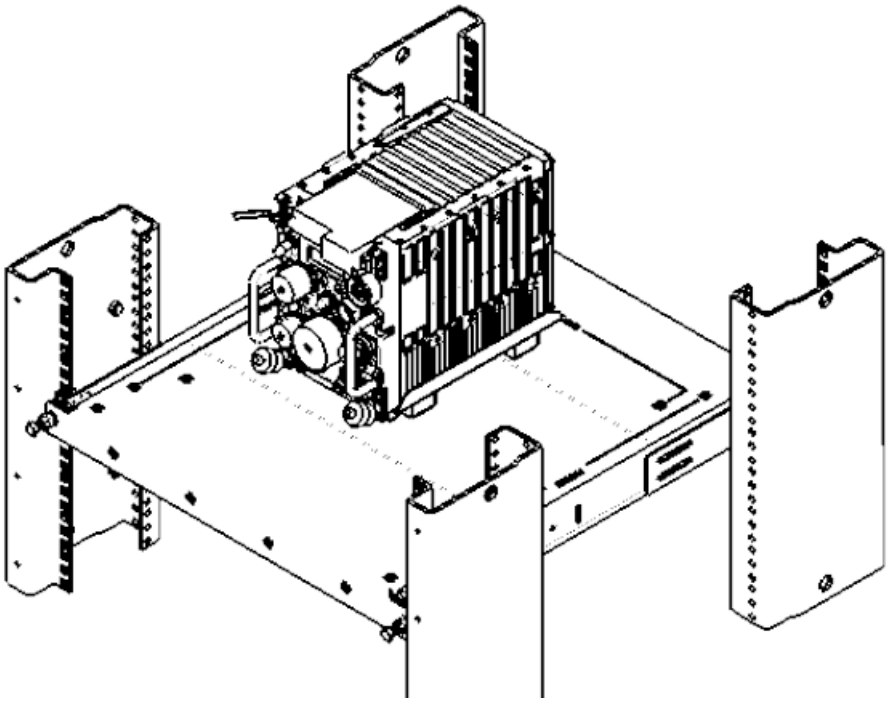
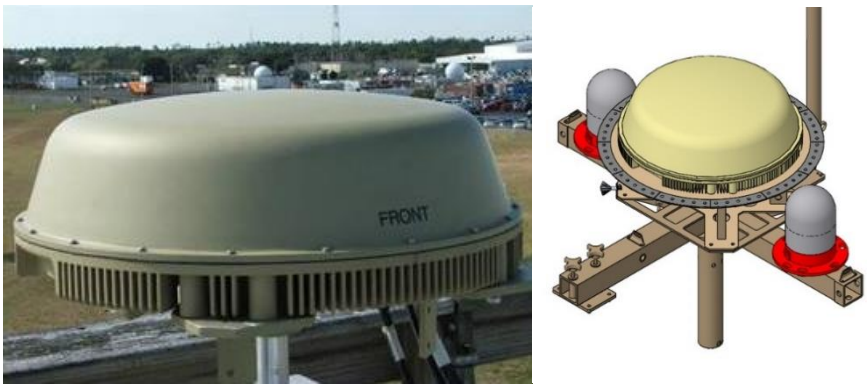


Figure 4-6. IBCS IFF System

4.2. IFCN

The IFCN consists of network components and transport media used for voice, data, and video information exchanges between IBCS components. From a network perspective, a component includes a radio interface to the IFCN connected to an intra-nodal LAN. IBCS uses the Harris Warfighter Information Network Tactical (WIN-T) Increment 2 interoperable HNR, consisting of the Baseband Processing Unit (BPU) and Highband Network Waveform (HNW) RF Unit (HRFUe2-8Wch) antenna. Figure 4-7 shows the HRFUe2-8Wch antenna. The IFCN node hardware is common to and a part of each MEI (EOC, IFCN Relay) described in subsequent sections. Network communications components are integrated within the EOC Shelter with connections to the necessary external antenna components, while on the IFCN Relay they reside within the network with connections to the external antenna components mounted to the mast assembly.



Left: component photograph; Right: as integrated onto IFCN Relay mast

Figure 4-7. HRFU Antenna

The HRFUe2-8Wch antenna utilizes directive beam technology to achieve high-throughput mesh networking over long distances with enhanced spectrum efficiency. The antenna consists of 15 elements in the horizontal plane and one element at zenith. The technology takes advantage of the directive beams to determine links that do not interfere and allows multiple nodes to transmit and receive using the same time slot. This accomplishes a distributed architecture where radios track time division multiple access time slots and transmit on non-interfering links.

The IFCN nodes consist of common hardware across all configurations. All configurations utilize common hardware elements and interfaces across platforms that facilitate integration and maximum effective reuse. Figure 4-8 depicts the IFCN Network Node.

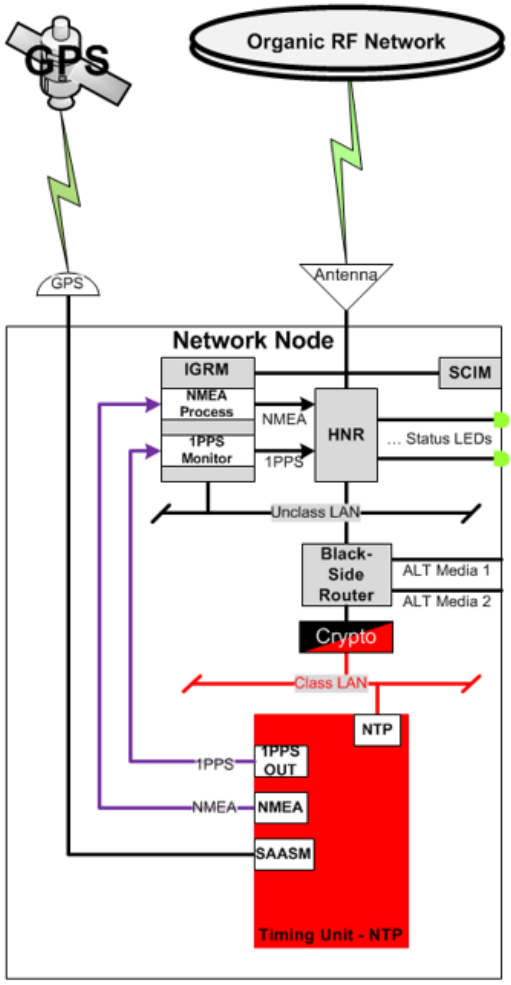


Figure 4-8. IFCN Network Node Architecture

HNR components, including the network encryption elements, are used for all configurations. Hardware commonality and use of WIN-T and COTS components in IFCN hardware ensure easy maintenance and spare parts provisioning.

The HNR components include the BPU and a High Assurance Internet Protocol Encryptor (HAIPE) 3.0 encryption device, with supporting equipment that includes the Timing Unit with Selective Availability Anti-Spoofing Module (SAASM) GPS receiver, Integrated GPS Receiver Module (IGRM), and Status Coordinate Input Module (SCIM). The BPU includes the control processor that hosts the Highband Networking Waveform version 2 (HNWv2) data link control layer and an Orthogonal Frequency-Division Multiplexing burst modem that provides the HNWv2 physical layer. The HAIPE 3.0 encryption device maintains the red/black communication boundary for all IFCN communication. The timing unit and IGRM provide position, timing signal (1 Pulse per Second [1PPS]), and time of day information to the BPU.

4.3. V2 IFCN Relay

During Engineering and Manufacturing Development (EMD) the IFCN Relay has evolved from the original version, called the V1 IFCN Relay to the V2 IFCN Relay. The V2 IFCN Relay, shown in Figure 4-7, is the second version of this MEI. The main difference is the GFE M1061A1P2 trailer and palletized mast assembly, which was changed to allow greater flexibility and increased load. It provides network components and transport media used for voice, data, and video information exchanges between IBCS components to allow a 150-km range. The Tactical Mast Trailer (TMT) is the Government-provided platform in which the hardware and software provide the V2 IFCN Relay (also known as P&F B-Kit) functionality to meet the IBCS performance requirement of a mobile IFCN communications node, with B-Kit functionality and interface, which extends connectivity to remote launchers and sensor platforms. The IFCN Relay can also function as a stand-alone IFCN communications relay to expand the range of Line-Of-Sight (LOS) communications over the horizons and around intervening terrain features.

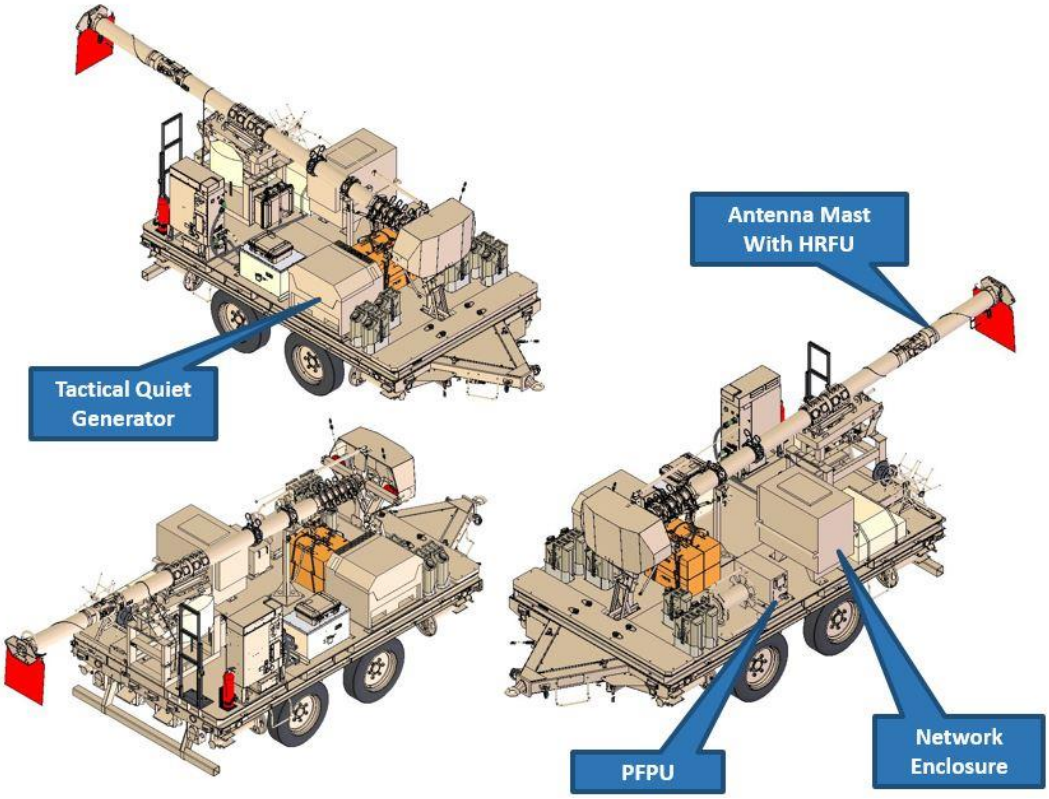


Figure 4-9. V2 IFCN Relay

An IFCN Relay contains a HRFU, a ePFPU and a fully integrated network enclosure. The network enclosure consists of the IFCN radio and its components, a time and frequency reference system, encryption devices, a classified Ethernet switch, and fiber media converters for A-side connectivity. All necessary external connections including A-Kit adapted sensors and weapons utilize media converters with Tactical Fiber Optic Assembly (TFOCA-II) cable.

The IFCN Relay platform includes a 3kW generator. It includes an antenna mast housing the HRFUe2-8Wch antenna and HRFU connections for power, control, and RF that feed into the network enclosure.

Each Relay is connected to the receiving platform's A-kit, Launcher Integration Network Kit (LINK), or other A-side connection. Details of the Relay interface with the Component Acquisition Programs (CAPs) may be found in MIS-DTL-56502, P&F B-Kit to A-Kit Interface Control Document (ICD).

4.4. ePFPU

The ruggedized Enhanced Plug and Fight Processing Unit (ePFPU) consists of two Line Replaceable Units (LRUs) – the ePFPU and a Network Attached Storage (NAS). The ePFPU is a ruggedized enclosure containing six Single Board Computers (SBC), an Ethernet switch, two 800w power supplies, and supporting hardware (e.g., power distribution, structure). The ruggedized ePFPU operates at a nominal 28 VDC. The Processing Unit is a forced-air-over-conduction cooled 3U Open Voice Protocol Exchange (VPX) chassis. The forced air is pulled by the fan assembly through the air inlets along the front of the unit, and expelled out the rear. A 3U Open VPX form factor has been selected for its compact size and heat dissipation qualities.

Processors are loosely coupled via ten-gigabit backplane Ethernet connections. Ethernet also supports all connections external to the ePFPU. Within the red domain, a multi-layer Ethernet switch manages switching. These switches have transient voltage suppressors on each port to protect from Electrostatic Discharge (ESD), cable discharge, lightning, and other induced voltage surges. They have built-in test capability, security features, and Internet Protocol (IPv6) capability, while supporting speeds up to ten gigabit (Gb) per second. The ePFPU provides computing capabilities suitable for rugged, all-weather environments.

The NAS is a rugged enclosure housing solid state drives and control electronics. The NAS is the storage/hard drive for the ePFPU. The NAS has a removable storage bay at the top of the device that can be used for data harvesting and data transfer. The ePFPU chassis provides accommodations for mounting the NAS directly to it, either on the top or the side.

At the present time (10-10-2019), the ePFPU being re-designed.

5. Analysis Guidelines

This section of the report lists the ground rules and assumptions used for Reliability Availability, and Maintainability (RAM) modeling, and describes the mission phases, operational modes and environmental profiles. It also explains the data source hierarchy used for RAM modeling and explains the block diagrams employed.

The Reliability Block Diagrams (RBDs) and mathematical models are not used only to assess the reliability metrics of IBCS and its sub-systems. These models are also used to improve these metrics for the systems. The RBDs and mathematical models are contained in CDRL IBCS-A241, the Reliability, Availability, and Maintainability Prediction (RAM) Report

5.1. Mission Phases and Operational Modes

In this initial FMECA, the results are looked at a high level, as the system of systems matures the Mission Phases and Operational Modes will be defined and particular instants will be called –out. At the present time, “All phases” will be considered due to the “mission phase and operational mode” have not been clearly defined.

An implication is made in the Failure Definition and Scoring Criteria (FDSC) Report Section 5 (27 Jan 2016) that a *k*-of-*n* model is present during operations. This allows the assumption to be made that Maintenance and Operations can be performed concurrently, i.e. that is a part of the system can be taken down to perform a particular type maintenance without taking the entire system off line.

5.2. System Definition and Mission Time

The system definition provides a functional description of the system to be analyzed. Functional narratives must be developed for each mission, mission phase and operational mode, and include statements of mission objectives. The narratives will include system and part descriptions for each mission phase and operational mode, As stated above, “All phases” will be considered due to the “mission phase and operational mode” have not been clearly defined.

A quantitative statement of system function-time requirements will be developed and included in the system definition (when available). Function-time requirements will be developed for items that operate in different operational modes during different mission phases and for items which function only if required. The function-time requirements are developed by Reliability Engineering, Design, and Logistics Engineering using the Operational Mode Summary / Mission Profile (OMS/MP), MIS-PRF-56500E, and other specifications as appropriate.

It is currently assumed that all hardware operates with mission pulse (72 hours) during emplacement as called-out in Section 5 of the FDSC. The mission pulse is used in the calculation of the Failure Mode Criticality Number (C_m).

5.3. Environmental Profiles

The environmental profiles which present the anticipated environmental conditions for each mission and mission phase will be defined. These profiles are developed by Reliability Engineering and Design personnel using the OMS/MP, MIS-PRF-56500E, and other specifications as appropriate. At the present time a system is only being considered in the ground fixed environment. As the system matures a more extensive examination will be performed. CDRL IBCS-A241, contains more information on how environments are incorporated into future analysis.

5.4. Functional Diagrams

A functional block diagram provides a functional flow sequence for the system and each indenture level of analysis and present hardware indenture used for both hardware and functional method FMEA's. MIL-M-24100 procedures and techniques for developing major functional diagrams may be used for guidance in developing functional block diagrams.

At the present time the functional diagrams are being developed to depict the functional flow sequence for the system and each indenture level of analysis and present hardware indenture used for both hardware and functional method.

5.5. Data Sources and Techniques

Design data for these analyses ideally come from approved drawings, although prior to the development of a complete set of such drawings, Engineering Review Board (ERB)-approved sources are also used. Product drawings will be delivered in CDRLs IBCS-A244. IBCS parts are chosen using the Parts, Materials, and Processes Management Plan, 01K698.IBCS.System Engineering & Integration (SE&I)-002, which is a part of CDRL IBCS-A238, the Program Product Assurance Plan.

The initial modelling effort was accomplished by a team of engineers using software created by Diagnostics Support Integrator (DSI) International, Inc. Much of the current FMECA was structured using this information.

The output product yields failure modes for the particular LRU being examined. In many cases, a LRU will have many output ports. An individual port can have numerous failure modes. The preliminary analysis contained in Appendix A and Appendix B shows the failure mode break-down. This information is used to calculate the criticality numbers.

As updated information becomes available it will be incorporated in a timely manner.

At the present time, all failure rate data at an LRU level is provided by the Vendor (COTS). Currently the failure rate data is being updated (10-01-2019). The updated values are reflected in the appropriate Appendixes (more information) of the report (bold font). As vendor data is received it will be incorporated into the report. Also, in the future, IBCS Reliability Engineering hopes to establish a tracking process to monitor LRU revisions and/or ECPs.

6. FMECA Analysis Overview

A FMECA is typically performed using a functional approach, a hardware (and software) approach, or a combination of the two. The functional approach analyzes the effects that a system or sub-system has on a specified mission. This approach is often performed in a top-down manner, and a failure mode description using the functional approach is a functional description of a failure, such as “motor failure”. A hardware approach lists individual hardware items and analyzes their possible failure modes. The hardware approach is normally performed from the bottom up and a failure mode description for this approach is often the identification of a failed part of the item, such as “motor windings are open”. The approach used for a specific FMECA is usually dependent on the amount and type of information available. A functional approach requires knowledge of system functions and theory of operation whereas the hardware approach necessitates the use of detailed design information such as schematics. Often, it is necessary to use both approaches to get the most use of the information available. The IBCS FMECA will use both approaches, but will use the hardware approach when sufficient information is available and appropriate to the goals of the FMECA. The FMECA will be performed at the LRU hardware level due to the two-level maintenance requirement levied on the program. Note that the FMECA is an evolving analysis, starting early in the design phase to maximize the benefits of the analysis. As such, the analysis starts using mostly the functional approach and as more details become available, the analysis transitions to being more of a hardware/software FMECA.

The functional-level approach can be used when the hardware cannot be uniquely identified or may be used early in the program until the design matures, although a hardware FMECA is preferred.

Excluded from this FMECA are GFE and Military Off the-Shelf (MOTS) items. However, if any of the GFE or MOTS items interface with IBCS hardware, a FMECA will be performed for the GFE and MOTS at the interface level looking from the perspective of the IBCS hardware. For GFE, GFE manuals will be used for information on failure detection methods when available.

Software developed on the program will typically be analyzed at the Software Configuration Item (SCI) level by the time of the critical design phase of the program. Software, both program-developed and non-developed, will be analyzed using a functional approach, where the software functional outputs are listed and their failure modes analyzed. The FMECA will consider interfaces between hardware items, between software items, and between hardware and software items. Details of how IBCS software is developed and maintained are found in CDRL IBCS-A220, IBCS Software Development Plan.

The Software FMECA is contained in Appendix C.

6.1. Analysis Approach

When possible, the FMECA utilizes inductive logic in a bottoms-up approach. Beginning at the lowest level (LRU) of the system hierarchy, and from a knowledge of the failure modes of each piece of hardware and software, the analyst traces up through the system hierarchy to determine the effects that each failure mode will have on system performance.

Lower-level FMECA may be required on a case-by-case basis where Category I (per Table 6-1) and single point of failures exist.

Unless otherwise specified, the following discrete steps will be used in performing a FMECA:

1. Define the ground rules and assumptions to be used in the analysis. This step will start with the ground rules and assumptions contained in this report and review them to see if there are any exceptions or additions due to changes or additional information since the release of this report. Any changes to the ground rules and assumptions need to be reflected in this report and approved by the Government. Section 6.2 contains the baseline set of ground rules and assumptions.
2. Construct block diagrams. RBDs which illustrate the operation, interrelationships, and interdependencies of functional entities will be obtained or constructed. The RBDs are illustrated in CDRL IBCS-A241.
3. Complete the combined FMEA and Criticality Analysis (CA) worksheets. (Appendix A through Appendix C)
4. Create a Critical Items List, and Criticality matrix: A Preliminary Analysis presented for every critical LRU in spreadsheet form. The information is present in the appropriate Appendices (Appendix A and Appendix B)
5. Create a summary of conclusions, interpretations, and recommended corrective actions based on the analysis results.
6. Document the analysis and report the results.

The resulting FMECA report contains a summary of the results, data sources, techniques used, system definitions and block diagrams, worksheets, and conclusions and recommendations. Results are provided to IPTs and other program management. Results may also be reported to the program through the SE&I Working Product Integration Team (WIPT), which contains representatives from each Integrated Product Team (IPT). Figure 6-1 summarizes the steps required to perform a FMECA.

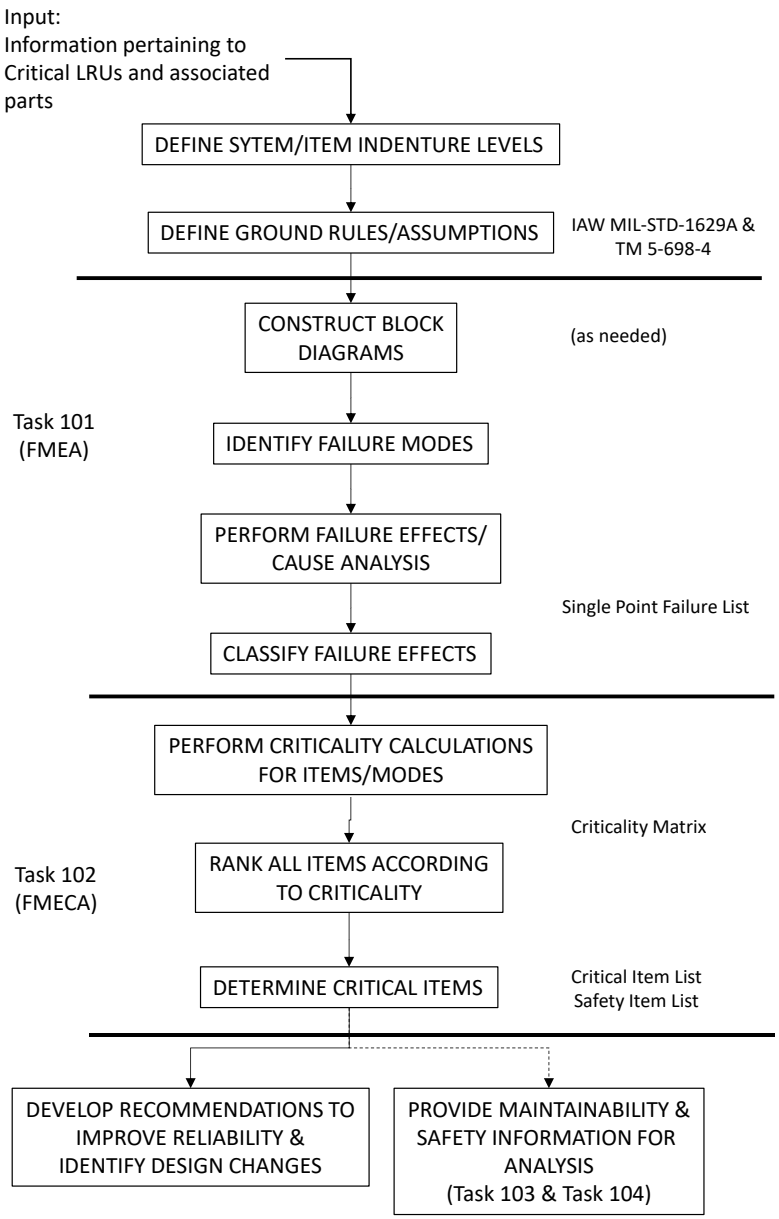


Figure 6-1. FMECA Process Flow

The hardware and software approach was chosen since the hardware/software can be identified from schematics, drawings, and other engineering and design data. This approach is normally utilized in a bottoms-up approach; however, it can be initiated in either direction. Each identified failure mode will be assigned a severity classification which will be utilized during design to establish priorities for corrective actions.

6.2. Ground Rules and Assumption

The ground rules for the IBCS (S-280) FMECA/ Analysis are as follows:

1. Analysis is provided at the EOC and Relay level which is constant with the MTBFc requirements.
2. A failure is defined as an event, or inoperable state, in which any item or part of an item does not, or would not, perform as previously specified.
3. An IBCS mission critical function is defined an IBCS function whose failure results in the loss of the ability to perform Engagement Operations or a severe degradation in that ability.
4. A mission critical failure is a failure of hardware or software resulting in a failure mode that prevents a mission critical function from being performed or that severely degrades the performance of that function.
5. The Two - Level Maintenance program allows the Operator/ Maintainer to remove and replace the faulty component (LRU). Therefore limiting the identification of failure modes and effects to the output of the faulty LRU.
6. For Reliability Engineering, a mission critical part is any hardware or software that has a critical failure mode. These items are identified in the appropriate Appendix of this document
7. All predictions are for a mature system

Failure modes induced by human error are included if the failure mode is considered to be reasonably plausible.

In general, a system can have only one independent failure cause at any given time (i.e., no multiple independent failures occurring at the same time are analyzed). Exceptions are made on a case-by-case basis when additional analysis is needed to fully understand the significance of the failure. The FMECA does consider multiple failure effects, effects at different levels of the system, and the impact of redundancy. Note that a failure effect is different than a failure cause and a given failure effect may result from multiple potential failure causes.

All consumables are present in sufficient quantities unless otherwise stated.

All inputs (including software commands and power) to the item being analyzed are present at nominal values unless otherwise stated.

At this time, failure rate data from field experience is very limited. The most recent fielded findings are found in CDRL IBCS-A241-003.

Initially the primary source of data is MIL-HDBK-217F. As the systems matures, vendor data and actual field data will be used to supplement the calculated values. At the present time the failure rates for the critical LRUs are being re-evaluated and supplemented by vendor findings

Classification of failures uses the following guidelines:

- The FDSC for Integrated Air and Missile Defense System-of-Systems (IAMD SoS) will be used as a guide in determining failure severity. Also, severity levels will established IAW the reliability block diagrams (as needed) and the defined mission essential functions.
- Severity classification criteria are determined as shown in Tables 6-1 and 6-2. These tables define and describe the different severity classifications that failures of functions can have. The different classifications are used to isolate the different types of failure implications. Table 6-1 addresses the traditional combined safety and reliability failure severity levels. Table 6-2 addresses reliability and the effects of redundancy. The severity classification for safety is not intended to replace traditional safety classifications but rather to supplement safety analyses by adding FMECA-generated potential safety issues. For example, redundancy considerations may reduce the severity classification from Category II to a Category III-2R, meaning that a failure that could have been a critical failure has been mitigated to a marginal failure through the use of redundancy.
- Severity classifications are made on the basis of the worst case potential effects. This guideline helps determine the functional effect of a given failure.

Table 6-1. Reliability Severity Classification Criteria

Severity Classification	Severity Definition	Severity Description
Category I	Catastrophic	A failure which may cause weapon system loss (i.e., aircraft, tank, missile, ship, etc.).
Category II	Critical	A failure which may cause major property damage or major system damage which will result in loss of mission.
Category III	Marginal	A failure which may cause minor property damage or minor system damage which will result in delay or loss of availability or mission degradation.
Category IV	Minor	A failure not serious enough to cause property damage, or system damage, but which will result in unscheduled maintenance or repair.

Due to the configuration flexibility of the IBCS System Table 6-2 was created. The rows labeled Category III-1R and Category III-2R allows for the Severity Classification to be modified when the system is re-configured to incorporate redundancy.

Table 6-2. Reliability Expanded Severity Classification Criteria

Severity Classification	Severity Definition	Severity Description
Category I	Catastrophic	A failure which may cause weapon system loss (i.e., aircraft, tank, missile, ship, etc.).
Category II	Critical	A failure which may cause major property damage or major system damage which will result in loss of mission.
Category III-1R	Marginal – 1R	A failure of a system with redundancy which may cause minor property damage or minor system damage which will result in delay or loss of availability or mission degradation, but if redundancy fails or if all redundant systems fail, may result in a Category I failure.
Category III-2R	Marginal – 2R	A failure of a system with redundancy which may cause minor property damage or minor system damage which will result in delay or loss of availability or mission degradation, but if redundancy fails or if all redundant systems fail, may result in a Category II failure.
Category III	Marginal	A failure which may cause minor property damage or minor system damage which will result in delay or loss of availability or mission degradation.
Category IV	Minor	A failure not serious enough to property damage, or system damage, but which will result in unscheduled maintenance or repair.

Figure 6-2 illustrates the specified configuration of the IBCS System. Redundancy is incorporated at the EOC level, in conjunction with the *k*-of-*n* configuration of the ICE

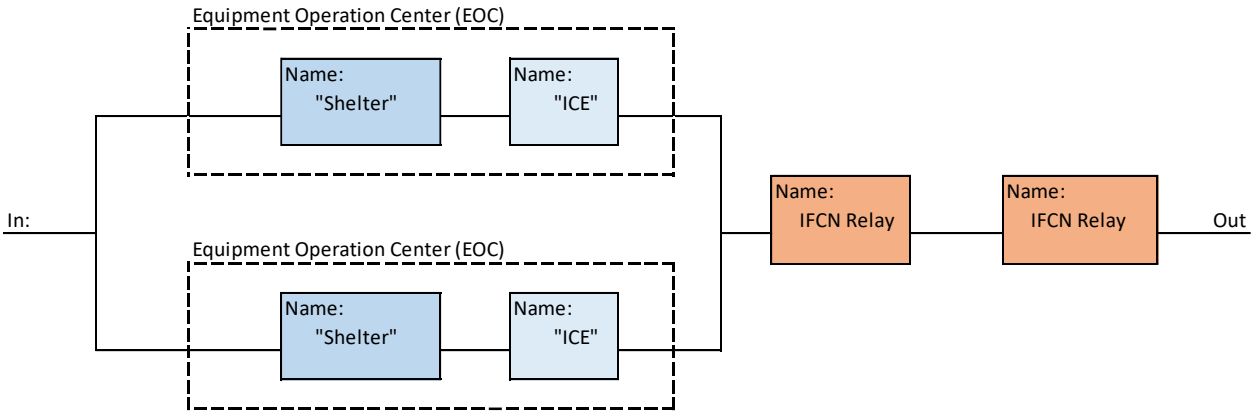


Figure 6-2. Specified Configuration of the IBCS System.

Also, the configuration of the IFCN Relay is multi-functional for more information refer to of Failure Definition and Scoring Criteria (FDSC) Report Section 5 (27 Jan 2016)

Throughout the system, EOC and IFCN Relay, there are many redundant and *k*-of-*n* configuration that allows the reduction of Severity Classification Categories I and II to a less severe Category III (Appropriate Appendix and LRU Spreadsheet).

6.3. Coding System

For consistent identification of system functions and equipment and for tracking failure modes, the FMECA adheres to a system of alpha-numeric identifiers generated earlier by a FMECA software tool, with component name, drawing number, and part number used for consistency. As system maturity is achieved, the hardware/software will be identified by a Work Unit Code (WUC) structure define in MIL-PRF-49506. The FMECA indenture coding system will be consistent with the reliability and functional block diagram numbering system to provide complete visibility of each failure mode and its relationship to the system. When available the Logistic Support Analysis (LSA) Control Number (LCN) is provided. The LCN's are provided in the appropriate Appendixes.

The IBCS FMECA is typically at a higher level than the piece-part level. Since the program uses mostly COTS, MOTS, and Government Off-the-Shelf (GOTS) hardware, a detailed piece-part level approach may not be possible for many items. In the event that further analysis is warranted, FMECA at the piece-part level can be performed on a case-by-case basis, given that sufficient data are available. The IBCS FMECA is performed at the LRU level due to the two-level maintenance requirement. This includes all COTS, MOTS and GOTS products.

Software is included as a part of the same higher-level assembly as the hardware that hosts the software. When appropriate, the software hosted by a given piece of hardware is divided into software modules. These software modules interact with other modules in the same hardware host, and possibly with other modules hosted by other hardware as well. Interactions between hardware and software are also included where appropriate. The Software FMECA Results is referenced as an Appendix to the Hardware FMECA Results.

6.4. FMECA Review and Schedule

The FMECA may require updating due to changes in the design or changes in the FMECA. Updates to the FMECA are scheduled for the same timeframe as the releases of CDRL IBCS-A241, to provide consistent information. More frequent and periodic FMECA status reviews may be required for all Critical Items until they are dispositioned. The FMECA is reviewed by the appropriate organizations and/or IPTs. Updates are subject to the configuration and change management process (CMP) defined in CDRL IBCS-A258, the IBCS CMP.

Prior to the release of the first formal FMECA, draft versions are produced "as needed" to ensure that the analysis provides adequate feedback to the design. These "as needed" draft versions are documented as Inter-Office Correspondences (IOCs) and all IPTs are notified of the updated analysis. These IOCs are logged and maintained with the other SE&I IPT IOCs. Each formal release of the FMECA is documented as a Technical Manual (TM) and is controlled by Program Configuration Management. Each formal release will be posted on NG System Integrated Data Environment (NSIDE).

6.5. FMEA/FMECA Worksheets

The documentation of the FMECA is the next step and is accomplished by completing the columns of the approved FMECA worksheet. The FMECA worksheet will be in spreadsheet or database format for data link and query and will be current and be available on NSIDE for access at any time by the stakeholders. At the present time, the newest version (S-280 incorporation) is not available.

Since this FMECA is performed using the hardware approach, failure modes and effects of the hardware itself must be addressed as a separate item from the function of the hardware.

The worksheet formats, which organize and document the FMECA and other analysis methods contained herein, will be structured in a spreadsheet or database format for quick and easy bottom-up or top-down relational data query for every field. These fields are listed and described below. Figure 6-3 lists the fields and provides a representative example.

The documenting of the FMEA and FMECA is the next step and is accomplished by completing the columns of the approved FMEA/ FMECA worksheet in accordance with MIL-STD 1629A Task 101 and Task 102.

Appendix A contains the information for the IFCN Relay (R001 – R034)
Appendix B-1 contains the information for the “Shelter” Portion of the EOC
Appendix B-1a “Shelter” (E001 – E034)
Appendix B-1b “Shelter” (E043 – E069)
Appendix B-1c “Shelter” (E123 – E157)
Appendix B-2 contains the information for the “ICE” Portion of the EOC

Every LRU has a workbook contained in the appropriate Appendix Directory The Workbook consists of:

- Pivot Table linked to the FMECA worksheet
- Preliminary Analysis worksheet contains:
  Failure mode count and percentage over all the events pertaining to the individual LRU
  A breakdown of failure modes by Severity Categories
  Calculation of C_m by Failure Modes
- Category I and Category II Severity Classifications and mitigating actions
- Worksheet for the LRU Data, this is the FMECA worksheet for the individual LRU

Initial LRU Information:

LRU ID#	Nomenclature	Part Number*	Remarks	Redesign, COTS, or GFE
Rxxx or Exxx		*EOC: ALH-216053-001 Date: 07-16-2019 *Relay: ALH-216053-003 Date: 07-16-2019	Comments/LCN	

Contained in the apprpriate Appendix:
Appendix A: IFCN Relay (Workbooks R001 - R034)
Appendix B1a: "Shelter" (Workbooks E001 - E034)
Appendix B1b: "Shelter" (Workbooks E043 - E069)
Appendix B1c: "Shelter" (Workbooks E123 - E157)
Appendix B2: "ICE"

PRELIMINARY ANALYSIS:

Parent LRU: RXXX-or EXXX – LRU Nomenclature
Component: Component Nomenclature
Mission Phase-Operational Mode: All Phases

$C_r = \sum C_m$
Task 102 (3.2.1.7)

Failure Modes	Ordered Count of Failure Modes	Failure Mode Ratio (α) %
Failure Mode_1	$\sum \text{Failure Mode}_1$	$\sum \text{Failure Mode}_1 / \sum \text{Failure Modes}$
⋮	⋮	⋮
Failure Mode_n	$\sum \text{Failure Mode}_n$	$\sum \text{Failure Mode}_n / \sum \text{Failure Modes}$
Grand Total:	**∑ Failure Modes**	

Severity Classifications	Count of Seveverity Classification
Category I Failure Modes ⋮	**∑Cat. I** Count of Failure Modes
Category II Failure Modes ⋮	**∑Cat. II** Count of Failure Modes
Category III Failure Modes ⋮	**∑Cat. III** Count of Failure Modes
Category IV Failure Modes ⋮	**∑Cat. IV** Count of Failure Modes
Grand Total:	**∑ Failure Modes**

Failure Modes Associated with C_m	Ordered Sum of C_m	Count of Failure Modes Associated with C_m
Failure Mode	C_{m_1}	m_1
⋮	⋮	⋮
Failure Mode	C_{m_n}	m_n
Grnd Total	**$C_r = \sum C_m$** Task 102 (3.2.1.7)	

A Worksheet identifying Category I and Category II Severity Classification and Mitigating Actions for the Individual LRU

FMECA Worksheet for the Individual LRU

Header for all Worksheets:

Parent LRU: RXXX-or EXXX – LRU Nomenclature
Component: Component Nomenclature Task 101 Sec. 5.2
Mission Phase-Operational Mode: All Phases Task 101 Sec. 5.5
FPMH: Failure per Million Hours Source: Mil-Hdbk 217F - Vendor (COTS)
t: 72 hrs. (Mission Profile) Source: FDSC Sec. 5

Worksheet Components:

				*Failure Effect at		
A	**B**	**C**	**D**	**E**	**F**	**G**
Identification Number	**Function**	**Failure Modes Description**	**Failure Cause**	**Local Failure Effects**	**Next Higher Level Failure Effects**	**Major End Item Failure Effect**
	Narrative	Narrative	Narrative	Narrative	Narrative	Narrative
Task 101 & Task 102	Task 101 (5.3) & Task 102	Task 101 (5.4) & Task 102	Task 101 (5.4) & Task 102	Task 101 (5.6.1)	Task 101 (5.6.2)	Task 101 (5.6.3)

		Failure detection method.				Compensating Provisions	
H	**I**	**J**	**K**	**L**	**M**	**N**	**O**
Safety Consideration.	**Safety Impact.**	**Operator Observations.**	**Visual Indications**	**C-Bit Capabilities**	**Severity Classification.**	**Modified Design Provisions**	**Modified Design (Modified β)**
Refer to Sec 6.6.3				**Refer to Sec 6.6.4**	Table 6-1		Table 6.2
		Task 101 (5.7.1)	Task 101 (5.7.2)		Task 101 (5.9)	Task 101 (5.8.1)	Task 101 (5.8.1)

P	**Q**	**R**	**S**	**T**	**U**
Failure Effect Probability	**Modified Failure Effect Probability**	**Failure Mode Ratio**	**Part Failure Rate**	**Failure Mode Crit. #**	**Mod. Failure Mode Crit. #**
(β)	(β_{mod})	(α)	λ_p = FPMH/(1 x 10^6)	$C_m = \beta\alpha\lambda_p t$	$C_{m_{mod}} = \beta_{mod}\alpha\lambda_p t$
Task 102 (3.2.1.2)	Task 102 (3.2.1.2)	Task 102 (3.2.1.3)	Task 102 (3.2.1.4)	Task 102 (3.2.1.6)	Task 102 (3.2.1.6)

Figure 6-3. FMECA Format Worksheet

6.6. FMEA Report

The results of the FMECA and other related analyses will be documented in a report that identifies the level of analysis, summarizes the results, documents the data sources and techniques used in performing the analysis, and includes the system definition narrative, resultant analysis data, and worksheets.

As the system of systems matures, interim reports will be available at each major program milestone to provide information and to highlight the Category I and Category II failure modes. These failure modes are reported in the appropriate appendices of the report. FMECA reports are part of the entrance/exit criteria for each of the major program milestone gates.

6.6.1. Critical Items List

All Category I and Category II items are listed in the Preliminary Analysis Section of the associated LRU contained in Appendix A and Appendix B. Also, contained in Appendix A and Appendix B is a list of Severity Classifications I and II and how they can be mitigated by having the redundancy design in the system. Note, in most cases redundant switching is present so the Severity Classifications I and II can be reduced to a Marginal Severity Classifications (III-R1 or III-R2).

This information is used to calculate the criticality number for failure mode (C_m). As the product matures a more extensive analysis will be performed which may assist in eliminating the given problem. More detail is shown in Section 6.6.4.

6.6.2. Safety Impact

An overview of possible safety issues are presented in the section. Also, the spreadsheet contained in the appropriate Appendix may contain additional information.

IFCN Critical LRUs
R001-HRFU Antenna
HNR SYSTEM E2-8WCH, A404

Function:	**ID# 0086** Heater
Safety Impact:	Safety related – Failure mode (Jacket rupture) may create an unsafe situation. Institute appropriate controls.
Safety Impact Message:	Transmission Hardware Malfunction: Possible Hazardous Radiation Leak

R002-Harris BPU

Function: **ID# 0156** 1) Interface between BPU (J7) and Front Panel Connector (J7) - Hail (pins 11 through 22)
ID# 0185 2) Local Reset/Silent Watch Disable Switch (S2)

Safety Impact: Safety related – Failure mode (Short) may create an unsafe situation. Institute appropriate controls.

Safety Impact Message: Transmission Hardware Malfunction: Possible Hazardous Radiation Leak

R003- KG250X
HAIPE, AltaSec KG250X, Ruggedized

Function: External Battery

Safety Impact: **ID# 231** 1) Safety related (Leaking)– No Impact to operation
ID# 232 2) Safety related – Failure mode (Shorted) may create an unsafe situation. Institute appropriate controls.

Safety Impact Message: Battery Malfunction: Possible Hazardous Material Leak

EOC Critical LRUs

E048-HRFU Antenna
HNR SYSTEM E2-8WCH, A404

Function: **ID# 1052** Heater

Safety Impact: Safety related – Failure mode (Jacket rupture) may create an unsafe situation. Institute appropriate controls.

Safety Impact Message: Transmission Hardware Malfunction: Possible Hazardous Radiation Leak

E049- Harris BPU

Function: **ID# 1118** 1) Interface between BPU (J6) and HRFU (J1)
ID# 1133 2) Interface between BPU (J7) and - Hail (pins 11 through 22)
ID# 1155 3) Local Reset/Silent Watch Disable Switch (S2)

Safety Impact: Safety related – Failure mode (Short) may create an unsafe situation. Institute appropriate controls.

Safety Impact Message: Transmission Hardware Malfunction: Possible Hazardous Radiation Leak

E050-KG-250X

Function: **ID# 1201 & ID# 1202** 1/2AA-Size Battery

Safety Impact: Safety related – Failure mode may create an unsafe situation. Institute appropriate controls.

Safety Impact Message: Battery Malfunction: Possible Hazardous Material Leak

E123-TMSS ECU (Series Portion)

Function:	**ID# 3669** 1) Quench Valve (QV) used to allow cool refrigerant from condenser to mix with the hot gas bypass valve to maintain the superheat value. **ID# 3687** 2) Hot Gas Bypass Valve (HGBV) used to keep the pressure from dropping to low, on the suction side, and requiring long compression cycles to bring the pressure back up, on the discharge side. **ID# 3690** 3) Thermal Expansion Valve and Distributor (TEV/D) allows fluid to enter the evaporator at a controlled pressure. **ID# 3697** 4) Solenoid Valve (SV) is opened and closed by the temperature controller allowing fluid to enter the evaporator
Safety Impact:	Safety related – Slight
Safety Impact Message:	ECU Malfunction: Possible Hazardous Material Leak

E143-01-ICE UPS PowerGrid-800

Function:	**ID# 4593** Overheated Interchangeable Battery Modules (Shorted). **ID# 4596** 1 of 2 Battery Modules are required for spurious power conditions.
Safety Impact:	Slight Risk
Safety Impact Message:	Potential thermal/fire hazard

E145-01-ICE Table - 1 – Power Raceway

Function:	**ID# 4725 and ID# 4766:** Malfunction GFCI Switch
Safety Impact:	Slight Risk
Safety Impact Message:	Potential for electrical shock hazard

E146-01-ICE Table - 2 – Power Raceway

Function:	**ID# 4920 and ID# 4961:** Malfunction GFCI Switch
Safety Impact:	Slight Risk
Safety Impact Message:	Potential for electrical shock hazard

E147-01-ICE Table - 3 – Power Raceway

Function:	**ID# 5115 and ID# 5156:** Malfunction GFCI Switch
Safety Impact:	Slight Risk
Safety Impact Message:	Potential for electrical shock hazard

E148-01-ICE Table - 4 – Power Raceway

Function:	**ID# 5310 and ID# 5546:** Malfunction GFCI Switch
Safety Impact:	Slight Risk
Safety Impact Message:	Potential for electrical shock hazard

E149-01-ICE Table - 5 – Power Raceway

Function: **ID# 5505 and ID# 5351:** Malfunction GFCI Switch
Safety Impact: Slight Risk
Safety Impact Message: Potential for electrical shock hazard

EOC Non-Critical LRUs

E005 - Blower Assembly

Function: The vent fan draws outside filtered air into the shelter through the blower door at a rate of 60 Cubic Feet Per Minute (CFM). Note that the shelter is not typically occupied.
Safety Impact: Extremely Remote.
1) Shelter is not typically occupied,
2) LED light on PDP provides indication of Vent Fan Operation,
3) CO Monitor provides annunciation of high CO levels, 4) TM provides check of Vent Fan before each field installation
Safety Impact Message: Ventilation Hardware Malfunction: Possible Hazardous Carbon Monoxide Concentration

E047-CO Monitor and Sonar alert

Function: Carbon Monoxide (CO) Monitor
Safety Impact: Extremely Remote.
1) Shelter not typically occupied,
2) Requires Loss of fresh air (LED provides indication of Fan Operation),
3) TM PMCS of Vent Fan/Monitor for each field installation,
4) LED on Monitor provides indication of Monitor operation
Safety Impact Message: Ventilation Hardware Malfunction: Possible Hazardous Carbon Monoxide Concentration

E129-01 SATCOM Radio (Left)
E129-02 SATCOM Radio (Right)
E130-01 LOS Radio (Left)
E130-02 LOS Radio (Right)

Function: B1 Battery, (Lithium – HUB) used to back up memory by A3 Red/Black Digital Control PWB and A4 Sierra II Crypto PWB when 28 VDC power is not available
Safety Impact: Remote. Safety Exposure Duration reduced to 72 hours based on BIT.
Safety Impact Message: Battery Malfunction: Possible Hazardous Material Leak

E140-01 JTT Radio
JTT RECEIVER-TRANSMITTER, A430

Function: Batteries provide power to maintain crypto-keys when primary power is unavailable
Safety Impact: Remote. Safety Exposure reduced to 168 hours - Verify that PMCS calls out weekly inspection
Safety Impact Message: Potential thermal shock hazard

6.6.3. Continuous Built – In Test (C-BIT)

At the present time the functionality of C-BIT is limited to the LRUs identified in the following table. The Table 6.3 indicates if the LRU is connected to the network and if the LRU has C-BIT capabilities (can the LRU be identified). The future C-BIT will incorporate internal probing of designated LRUs. At the present time C-BIT is limited due to lack of funding.

For further information refer to CDRL IBCS-A306-001, Maintainability Test Plan.

Table 6-3 Current Status of C-BIT

Nomenclature or Description	LRU ID	Network Connectivity	C-BIT Capabilities to the LRU (Current C-BIT Ping)
MEI: V2 Relay			
HRFU	R001	No	No
BPU & BPU Router	R002	Yes	Yes
KG250X	R003	Yes	Yes
IGRM	R004	Yes	No
SCIM	R005	No	No
Timing Unit	R006	Yes	Yes
Relay Network Switch-18 Port	R007	Yes	Yes
Media Converter Chassis	R008	No	No
PFPU Assembly	R009	Yes	Yes
ECU Assembly	R011	No	No
PDU	R015	No	No
10/100TX to 100FX Media Converter	R016-R025	Yes	No
PFPU Solid State Drive 1	R029	No	No
PFPU Solid State Drive 2	R030	No	No
Relay Black Router- Unclassified	R031	Yes	Yes
10/100TX to 100FX Media Converter	R032, R033	Yes	No
Media Converters DC-DC Power Supply	R034	No	No
MEI: EOC			
DC Power Supply, Rack 1	E001	No	No
ECU Blower	E005	No	No
ADSI	E013	Yes	Yes
KVM Switch	E029	No	No
Server Interface Module (KVM Switches)	E030	No	No

Nomenclature or Description	LRU ID	Network Connectivity	C-BIT Capabilities to the LRU (Current C-BIT Ping)
Server Stack - VM1-VM4, Server 5 & 7	E031	Yes	Yes
Server Stack - VM1-VM4, Server 5 & 7	E032	Yes	Yes
Server Stack - VM1-VM4, Server 5 & 7	E033	Yes	Yes
Server Stack - VM1-VM4, Server 5 & 7	E034	Yes	Yes
eMCSU, TOCNET MCSU	E035	Yes	Yes
Network Mgt Computer, Rack 3	E040	Yes	Yes
CISCO-Classified Firewall	E043	Yes	Yes
CISCO-Unclassified Firewall	E044	Yes	Yes
HRFU	E048	No	No
BPU & BPU Router	E049	Yes	Yes
KG-250X (Classified Side Only)	E050	Yes	Yes
IGRM	E051	Yes	Yes
SCIM	E052	No	No
Timing Unit, Rack 1	E053	Yes	Yes
48 Port Classified Ethernet Switch	E059	Yes	Yes
48 Port Classified Ethernet Switch	E060	Yes	Yes
Classified Isolation Router	E061	Yes	Yes
Classified Router	E062	Yes	Yes
Unclassified Isolation Router	E063	Yes	Yes
Unclassified Router	E064	Yes	Yes
PLTC Red Switch, C3850	E067	Yes	Yes
Monitor	E082-E091	No	No
ECU - Environmental Control Unit	E123	Yes	No
PEV	E150	No	No
Server Stack - VM1-VM4, Server 5 & 7	E153	Yes	Yes
Server Stack - VM1-VM4, Server 5 & 7	E155	Yes	Yes
UPS #1, Shelter	E156	Yes	Yes

MEI	# of LRUs	LRUs with Network Connectivity	LRUs % Network Connectivity	LRUs Networked Connectivity w/CBIT Capabilities (	LRUs with % CBIT Ping Capability: Fault Detection	LRUs % CBIT Capable: Fault Isolation Manual Troubleshooting
"Shelter":	69	20	28.99%	19	27.54%	27.54%
ICE:	38	1	2.63%	1	2.63%	2.63%
IFCN Relay:	27	20	74.07%	6	22.22%	22.22%
Total (IBCS):	134	41	30.60%	26	19.40%	19.40%

The IBCS System equipment design incorporates Built-In-Test (BIT) and Built-In-Test Equipment (BITE) to aid the Operator and Maintainer in the detection/isolation of System Faults. BIT for fault detection runs automatically in the background during normal operations and is under control of BIT Manager SW.

The Power-on BIT Test (PBIT) is performed automatically upon initial power-up or reset of a LRU or COTS/GFE assembly. Used for Fault Detection (FD) and Fault Isolation (FI) and reported to the system BIT manager via SW.

Some faults will require other methods for fault detection and isolation (e.g. manual troubleshooting) to isolate to a specific LRU. All available fault codes will be reported on the CWMI based on the results of the diagnostic reasoned. These fault codes are identified in the IETM (e.g., Fault Code Work Package) to provide the operator/maintainer the required link to facilitate troubleshooting and/or repair. Manual troubleshooting procedures for any missing capability have been developed to link a detected fault to the required IETM troubleshooting work package.

For information pertaining to IBCS Fault Detection and Fault Isolation refer to CDRL IBCS-A241-003. At the present time FD/FI information is very tentative at best.

6.6.4. Criticality Matrix

The initial C_m and criticality number for the LRU, C_r, are shown in the Preliminary Analysis Section contained in Appendix A and Appendix B for each critical LRU.

The value of the failure mode criticality number (C_m) is calculated and listed on the worksheet. C_m is the portion of the criticality number for the LRU due to one of its failure modes under a particular severity classification. For a particular severity classification, the C_m for a failure mode is calculated using the following formula:

$$C_m = \beta\alpha\lambda_p t$$

where:

C_m: Criticality number for failure mode.

β: The failure effect probability (β) values are the conditional probability that the failure effect will result in the identified criticality classification, given that the failure mode occurs. The β values represent the analyst's judgment as to the probability that the loss will occur. The chart below is a combination of Table 6-1, Table 6-2 and the quantified guidance provided in Sec 3.2.1.2 provided in MIL-STD-1629A:

Severity Classification	Severity Definition	Failure Effect	β values
Category I	Catastrophic	Actual 1oss	= 1.00
Category II	Critical	Probable loss	= 0.50
Category III-1R	Marginal-1R	Possible loss	= 0.05
Category III-2R	Marginal-2R	Possible loss	= 0.05
Category III	Marginal	Possible loss	= 0.05
Category IV	No Effect	No effect	= 0.00

Due to the flexibility of the IBCS system various configurations are applicable The LRU FMECA Worksheets identifies β and a modified β_{mod} when a redundancy condition exists.

α: Failure mode ratio The ratio of particular failure modes to the total number of failure mode occurrences pertaining to a particular LRU.

λ_p: LRU failure rate (FPMH/1,000,000 hours)

t: Duration of a mission pule, 72 hours

The second criticality number calculation is for the LRU under analysis. Criticality numbers (C_r) for the LRUs of the system shall be calculated and listed on the worksheet. A criticality number for an LRU is the number of system failures of a specific type expected due to the LRU's failure modes. The specific type of system failure is expressed by the severity classification for the LRU's failure modes. For a particular severity classification, the C_r for an LRU is the sum of the failure mode criticality numbers, C_m. Therefore, C_r, the criticality number is calculated using the following formula:

$$C_r = \sum_{n=1}^{j} (\beta \alpha \lambda_p t)_n \quad \text{or} \quad C_{r_{mod}} = \sum_{n=1}^{j} (\beta_{mod} \alpha \lambda_p t)_n \qquad n = 1,2,3, \dots, j$$

where:

C_r: Criticality number for the LRU.

$C_{r_{mod}}$: Modified Criticality number for the LRU.

n: The failure modes in the LRUs that fall under a particular criticality classification.

j: Last failure mode in the item under the criticality classification.

A Criticality Matrix for each critical LRU will be developed in the future. The Criticality Matrix summarizes the results of the criticality analysis. The criticality matrix has severity classification on the abscissa, and on the ordinate axis, the criticality numbers of the associated LRU will be shown. A dashed diagonal line is used to show the direction of increasing criticality.

6.7. A Brief Example

Appendix A contains the information for the IFCN Relay
Appendix B-1 contains the information for the "Shelter" Portion of the EOC
Appendix B-2 contains the information for the "ICE" Portion of the EOC

Every LRU has a Directory contained in the LRU Directory is series of Workbooks:

- Pivot Table linked to the FMECA worksheet
- Preliminary Analysis worksheet contains:
  - Failure mode count and percentage over all the events pertaining to the individual LRU
  - A breakdown of failure modes by Severity Categories
  - Calculation of C_m by Failure Modes
- Category I and Category II Severity Classifications
- Worksheet for the LRU Data, this is the FMECA worksheet for the individual LRU

Walk-through of the BPU so as to trace the failure modes to the Criticality Analysis:

First, the system was defined, then the system indenture levels defined- LRU level. Next, the BPU Failure effects are evaluated per the severity classifications developed.

BPU Failure modes are considered with respect to historical IBCS system data and engineering judgment of relevant potential failure modes. A criticality ranking of the BPU based on Criticality Mode, C_m, was completed to determine the most critical failure modes and a basis for providing design improvement recommendations. BPU Failure Modes are ranked per the Quantitative Criticality Analysis per *MIL-STD-1629A: Procedures for Performing a Failure Mode Effects and Criticality Analysis.*

The BPU criticality analysis takes into account the probability of failure for the BPU and the portion of the failure likelihood that can be attributed to a particular failure mode as follows:

The initial C_m and criticality number for the LRU (C_r) are shown in the Preliminary Analysis Section contained in Appendix A and Appendix B.

The value of the failure mode criticality number (C_m) is calculated and listed on the worksheet. C_m is the portion of the criticality number for the LRU due to one of its failure modes under a particular severity classification. For a particular severity classification, the C_m for a failure mode is calculated using the following formula:

$$C_m = \beta\alpha\lambda_p t$$

where:

C_m: Criticality number for failure mode. (Column S of LRU Data Worksheet)

β: The failure effect probability (β) values are the conditional probability that the failure effect will result in the identified criticality classification, given that the failure mode occurs. The β values represent the analyst's judgment as to the probability that the loss will occur. The chart below is a combination of Table 6-1, Table 6-2 and the quantified guidance provided in Sec 3.2.1.2 provided in MIL-STD-1629A:

Severity Classification	Severity Definition	Failure Effect	β values
Category I	Catastrophic	Actual 1oss	= 1.00
Category II	Critical	Probable loss	= 0.50
Category III-1R	Marginal-1R	Possible loss	= 0.05
Category III-2R	Marginal-2R	Possible loss	= 0.05
Category III	Marginal	Possible loss	= 0.05
Category IV	No Effect	No effect	= 0.00

Due to the flexibility of the IBCS system various configurations are applicable The LRU FMECA Worksheets identifies β and a modified β_{mod} when a redundancy condition exists. (Column O of LRU Data Worksheet)

α: Failure mode ratio The ratio of particular failure modes to the total number of failure mode occurrences. (Column Q of LRU Data Worksheet)

λ_p: LRU failure rate (FPMH/1,000,000 hours) (Column R of LRU Data Worksheet)

t: Duration of a mission pule, 72 hours

The second criticality number calculation is for the LRU under analysis. Criticality numbers (C_r) for the LRUs of the system shall be calculated and listed on the worksheet. A criticality number for an LRU is the number of system failures of a specific type expected due to the LRU's failure modes. The specific type of system failure is expressed by the severity classification for the LRU's failure modes. For a particular severity classification, the C_r for an LRU is the sum of the failure mode criticality numbers, C_m. Therefore, C_r, the criticality number is calculated using the following formula:

$$C_r = \sum_{n=1}^{j} (\beta \alpha \lambda_p t)_n \quad \text{or} \quad C_{r_{mod}} = \sum_{n=1}^{j} (\beta_{mod} \alpha \lambda_p t)_n \qquad n = 1,2,3, \ldots, j$$

where:

C_r: Criticality number for the LRU. (Contained in the Preliminary Analysis Sheet of the appropriate LRU Directory)

$C_{r_{mod}}$: Modified Criticality number for the LRU. (Is the LRU Redundant)

n: The failure modes in the LRUs that fall under a particular criticality classification.

j: Last failure mode in the item under the criticality classification.

The Criticality Mode, C_m, for each LRU Failure Mode is calculated. The Criticality Modes for all the LRU Failure Modes are then ranked so as to identify the Priority Failure Modes that need to be addressed by the Design Team and Management

7. Summary and Conclusion

In conclusion, the system consisting of the EOC and IFCN Relay can be configured many ways to fit a defined profile for a SoS.

At the present time taking advantage of the inherent designs features incorporated into the system the EOC Mean Time Between Failure (MTBF) will be met.

The *k*-of-*n* configuration of the ICE components, as a static failure rate adjustment of 50%, which approximates a 4-of-10 ICE configuration which yields an EOC MTBF of 955.67 hours. The specification states a MTBF for the EOC of not less than 893 hours.

The ePFPU, a component of the IFCN Relay MEI, is currently in a re-design mode by the vendor (Boeing). The latest correspondence (19 June, 2019) reported the Failures per Millions Hours (FPMH) of approximately 546 failures. This is approximately 65% of the current Failure Rate (FR) for the IFCN Relay MEI.

If during the re-design the FPMH of the ePFPU could be reduced by 50% (≈ 273 FPMH), the recalculated FPMH of the IFCN Relay MEI is 560.91 FPMH, which equivalent to a MTBF of 1,782.81 hours. The specification states a MTBF for the IFCN Relay of not less than 1,735 hours.

		EOC	IFCN Relay	Overall
MTBF	Spec Requirement:	Greater than or equal to 893 hours	Greater than or equal to 1,732 hours	Greater than or equal to 560 hours
	Approx. calculated MTBF:	≈ 956 hours	≈ 1,783 hours	≈ 622 hours

Throughout the system, EOC and IFCN Relay, there are many redundant and *k*-of-*n* configuration that allows the reduction of Severity Classification Categories I and II to a less severe Category III (Appropriate Appendix and LRU Spreadsheet).

On-going work:

Reflect ongoing BIT and C-BIT Capabilities to be incorporated in the FMECA Spreadsheets to assist in fault diagnosis. This can be accomplished by linking FMECA Spreadsheet information to the appropriate fault code by way of the severity classification.

The interconnection/relationship between the EOC and IFCN Relay

8. Abbreviations and Acronyms

(U) The following abbreviations and acronyms are used in this document.

Term	Abbreviations & Acronym
1PPS	1 Pulse Per Second
AIAMD	Army Integrated Air and Missile Defense
AMD	Air and Missile Defense
ASoS	AIAMD System of System
BIT	Built In Test
BN	Battalion
BPU	Baseband Processing Unit
BTRY	Battery
C4ISR	Command, Control, Communications, Computer, Intelligence, Surveillance, and Reconnaissance
CAGE	Commercial and Government Entity
C-BIT	Continuous Built-In Test
CDRL	Contract Data Requirements List
CIL	Critical Items List
C_m	Criticality number for failure mode
CMDS	Cruise Missile Defense System
CMP	Configuration Management Plan
COTS	Commercial Off The Self
CP	Command Post
CPCI	Compact Peripheral Component Interconnect
CPCS	Command Post Communication System
CPP	Command Post Platform
C_r	Criticality number for the item (LRU)
CROP	Container Roll-On/Off Platform
CSM	Common Software Module
DCR	Document Change Request
ECU	Environmental Control Unit
EMI	Electromagnetic Interference
EOC	Engagement Operations Center
ePFPU	Enhanced Plug and Fight Processing Unit
FDSC	Failure Definition and Scoring Criteria
FMEA	Failure Mode and Effects Analysis
FMECA	Failure Mode, Effects and Criticality Analysis
FMTV	Family of Mobile Tactical Vehicles
FPMH	Failures per Million Hours
FY	Fiscal Year

Term	Abbreviations & Acronym
Gb	Gigabit
GFE	Government Furnished Equipment
GOTS	Government Off The Self
GPS	Global Positioning System
HAIPE	High Assurance Internet Protocol Encryptor
HDT	Highband Digital Transceiver
HNR	Highband Networking Radio
HRFU	Highband Networking Waveform RF Unit
IAMD	Integrated Air and Missile Defense
IBCS	IAMD Battle Command System
IFCN	Integrated Fire Control Network
IFF	Identification Friend or Foe (IFF)
IGRM	Initialization and GPS Receiver Module
IOC	Inter-Office Correspondence
IPT	Integrated Product Team
JCR	Joint Capabilities Release
LAN	Local Area Network
LCN	Logistic Support Analysis Control Number
LINK	Launcher Integration Network Kit
LOS	Line-Of-Sight
LRU	Line Replaceable Unit
LSA	Logistic Support Analysis
LTPO	Lower Tier Project Office
MC	Mission Command
MCSU	Micro Control Switching Unit
MEI	Major End Item
MOTS	Military Off The Self
NAS	Network Attached Storage
NDI	Non-Developed Item
NSIDE	NG System Integrated Data Environment
OMS/MP	Operational Mode Summary / Mission Profile
P&F	Plug and Fight
PFPU	Plug and Fight Processing Unit
PLT	Platoon
PO	Project Office
PPAP	Program Product Assurance Plan
RAM	Reliability Availability, and Maintainability
RBD	Reliability Block Diagram
RCM	Reliability Centered Maintenance

Term	Abbreviations & Acronym
RF	Radio Frequency
SAASM	Selective Availability Anti-Spoofing Module
SBC	Single Board Computers
SCI	Software Configuration Item
SCIM	Status Coordinate Input Module
SE&I	System Engineering and Integration
SEP	Signal Entry Panel
SICPS	Standardized Integrated Command Post System
SoS	System of Systems
STAT	Small Tactical Air Beam Tent
SWFMECA	Software Failure Mode, Effects and Criticality Analysis
TF	Task Force
TFOCA	Tactical Fiber Optic Assembly
TIP	Tent Interface Panel
TM	Technical Manual
TMSS	Trailer Mounting Support System
TMT	Tactical Mast Trailer
TOCNET	Tactical Operations Center Network
UPS	Uninterruptable Power Supply
VPX	Voice Protocol Exchange
WIN-T	Warfighter Information Network – Tactical
WIPT	Working Integrated Product Team
WUC	Work Unit Code

Appendix A. IFCN Relay

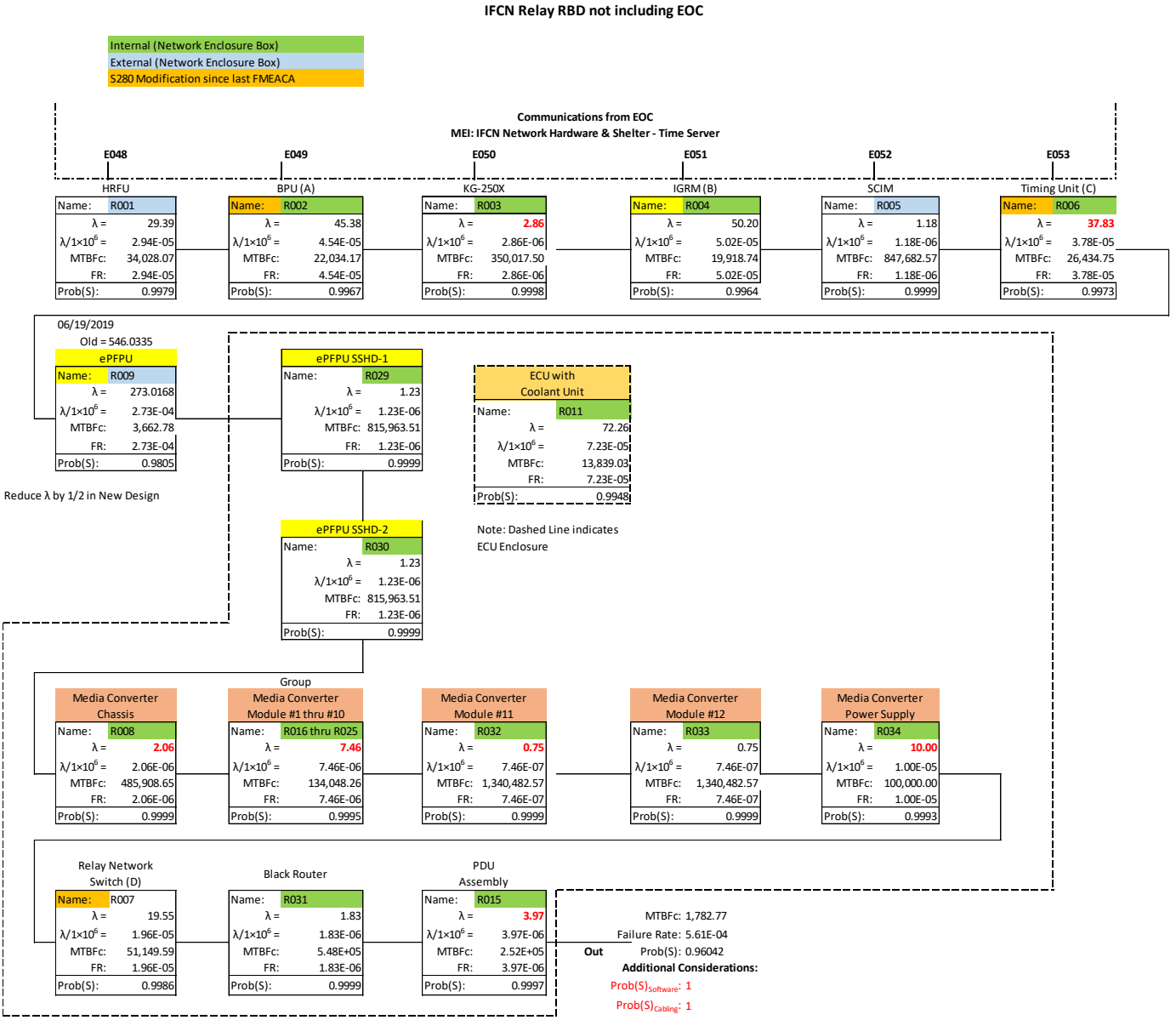
The following list presents a simple description or comment about the LRU contained in the IFCN Relay MEI:

LRU ID#	Nomenclature	Part Number	Brief Description of LRU /Comment	Redesign COTS/ GFE
R001	HNR Antenna (HRFU)	ALH-215818-001	Interface to BPU HRFU Antenna (same as P&F Kit). LCN: BAAAM	COTS
R002	Broadband Processing Unit (BPU)	3158010-104	BPU - Primary interface to IFCN. Physically located in the Network Enclosure Assembly (ALH-215749-001). LCN: AAAAAADACAAAEAB	COTS
R003	HAIPE KG250X Ruggedized Network Encryptor (KG-250X)	1101000	Encryption Device. Physically located in the Network Enclosure Assembly (ALH-215749-001). LCN: BAAAIAAAGAUAA	GFE
R004	Initialization Receiver Module - No SAAM (IGRM)	ALH-215992-001	Provides the GPS location information to the BPU. Forwards the Timing Unit 1PPS timing signal to the BPU. Provides BPU Status for display on the SCIM. Loads/zeroize the BPU Crypto Keys. Physically located in the Network Enclosure Assembly (ALH-215749-001) LCN: N/A	COTS
R005	Status & Coordinate Input Module (SCIM)	ALH-212853-001	Used as a backup for GPS (to input location) and display the failure messages. Physically located in the Network Enclosure Assembly. LCN: AAAAAADACAAAEAG	COTS
R006	Spectracom Securesync Timing Unit DC Power (Timing Unit)	1200-437	Provides GPS referenced NTP server timing system, also, provides backup during GPS denied environments. Made up of a Spectracomm Secursync Timing Unit and separate add-on cards physically installed inside the timing unit. This Timing Unit is physically located in the Network Enclosure Assembly (ALH-215749-001). LCN: AAAAAADACAAAPAJ	COTS
R007	Parvus Duranet 18-Port Switch (Relay Network Switch)	NET-3000-13	Physically located in the Network Enclosure Assembly. LCN: BAAAIAAAKAB	COTS
R008	Media Converter Chassis	1026-1W-KNG	This is a rack mounted chassis that contains 10 individual Media Converter Module LRUs. The Media Converter Chassis consists of a physical mother board for the Media Converter Modules and a common power	COTS

LRU ID#	Nomenclature	Part Number	Brief Description of LRU /Comment	Redesign COTS/ GFE
			supply the power Media Converter modules #1 thru #10. Physically located in the Network Enclosure Assembly LCN: BAAAIAAAJAJ.	
R009	Plug & Fight Process Unit (PFPU) Assembly	ALH-213591-001	Refer to Sec. 4.4 Redesign of ePFPU by Boeing LCN: BAAADAAAA	REDESIGN
R011	Environmental Control Unit (ECU) Assembly	ALH-211155-003	Provides heating and cooling for the Relay Network Enclosure Assembly. LCN: BAAAIAAAAAAABAF	COTS
R015	Power Distribution Unit (PDU) Assembly	1101-1101	Power Distribution Unit (PDU) Assembly. Contains circuit breakers to the various Relay LRUs. Physically located in the Network Enclosure Assembly (ALH-215749-001). LCN: N/A	COTS
R016	10/100TX to 100FX Media Converter Module #1	1119-0-W-KNG	Media Converter module used to interface with the Platform A-Kit. Physically located in one of the slot of the Media Converter Chassis. Interface with Sensor-Data LCN: AAAAAADACACAPAC	COTS
R017	10/100TX to 100FX Media Converter Module #2	1119-0-W-KNG	Media Converter module used to interface with the Platform A-Kit. Physically located in one of the slot of the Media Converter Chassis. Interface with Sensor-Voice LCN: AAAAAADACACAPAC	COTS
R018	10/100TX to 100FX Media Converter Module #3	1119-0-W-KNG	Media Converter module used to interface with the Platform A-Kit. Physically located in one of the slot of the Media Converter Chassis. Interface with Launcher #1-Data #1 LCN: AAAAAADACACAPAC	COTS
R019	10/100TX to 100FX Media Converter Module #4	1119-0-W-KNG	Media Converter module used to interface with the Platform A-Kit. Physically located in one of the slot of the Media Converter Chassis. Interface with Launcher #1-Data #2	COTS
R020	10/100TX to 100FX Media Converter Module #5	1119-0-W-KNG	Media Converter module used to interface with the Platform A-Kit. Physically located in one of the slot of the Media Converter Chassis. Interface with Launcher #2-Data #1 LCN: AAAAAADACACAPAC	COTS
R021	10/100TX to 100FX Media Converter Module #6	1119-0-W-KNG	Media Converter module used to interface with the Platform A-Kit. Physically located in one of the slot of the Media Converter Chassis. Interface with Launcher #2-Data #2 LCN: AAAAAADACACAPAC	COTS
R022	10/100TX to 100FX Media Converter Module #7	1119-0-W-KNG	Media Converter module used to interface with the Platform A-Kit. Physically located	COTS

LRU ID#	Nomenclature	Part Number	Brief Description of LRU /Comment	Redesign COTS/ GFE
			in one of the slot of the Media Converter Chassis. Interface with Launcher #3-Data #1 LCN: AAAAAADACACAPAC	
R023	10/100TX to 100FX Media Converter Module #8	1119-0-W-KNG	Media Converter module used to interface with the Platform A-Kit. Physically located in one of the slot of the Media Converter Chassis. Interface with Launcher #3-Data #2 LCN: AAAAAADACACAPAC	COTS
R024	10/100TX to 100FX Media Converter Module #9	1119-0-W-KNG	Media Converter module used to interface with the Platform A-Kit. Physically located in one of the slot of the Media Converter Chassis. Interface with Launcher #4-Data #1 LCN: AAAAAADACACAPAC	COTS
R025	10/100TX to 100FX Media Converter Module #10	1119-0-W-KNG	Media Converter module used to interface with the Platform A-Kit. Physically located in one of the slot of the Media Converter Chassis. Interface with Launcher #5-Data #1 LCN: AAAAAADACACAPAC	COTS
R029	PFPU SSHD-1	532079-00	This item is physically installed on the PFPU LRU. Provides interface to the IFCN Relay Assembly LCN: BAAADAAAAAA	COTS
R030	PFPU SSHD-2	532079-10	This item is physically installed on the PFPU LRU. Provides interface to the IFCN Relay Assembly LCN:BAAADAAAAAB	COTS
R031	TCS Tactical Router, MIL SPEC (Relay Black Router)	40-2796-01	Provides communication between the Media Converters (#11 and #12) and KG-250X (Unclassified) LCN: BAAAIAAAPAW	COTS
R032	10/100TX to 100FX Media Converter Module #11	1119-0-W-KNG	Provides the Alternate Media #1 interface. LCN: AAAAAADACACAPAC	COTS
R033	10/100TX to 100FX Media Converter Module #12	1119-0-W-KNG	Provides the Alternate Media #2 interface. LCN: AAAAAADACACAPAC	COTS
R034	DC-DC Power Supply Media Converter Power Supply	MIL-VIC-15-5V	Provides 5VDC power to Media Converter Module #11 & #12 (Alternate Media interface). LCN: BAAAIAAAPAM	COTS

The updated failure rates are shown in red.
The RBD for the IFCN Relay and associated information:



MEI: IFCN Relay

Note: Bold type indicates an update to the FPMH from the vendor (Oct. 1, 2019)

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
R001	IFCN HRFU Installation	**29.388**	ALH-215818-001	**3.76E-03**	**6.97E-04**	COTS
R002	BPU	**45.384**	3158010-104	**1.25E-02**	**2.62E-03**	COTS
R003	HAIPE KG250X Ruggedized Network Encryptor	**2.857**	1101000	**7.54E-04**	**6.15E-05**	COTs
R004	IGRM	50.204	ALH-215992-001	3.41E-02	4.79E-03	C0TS
R005	SCIM	1.180	1200-437	2.08E-04	2.15E-05	COTS
R006	Timing Unit	**37.828**	ALH-210931	**1.49E-02**	**1. 03E-03**	COTS
R007	Relay Network Switch (PARVUS DURANET 18-Port Switch)	19.550	NET-3000-13	1.87E-02	9.38E-04	COTS
R008	Media Converter Chassis	**2.057**	1026-1-W-KING	**6.81E-04**	**6.74E-05**	COTS
R009	PFPU Assembly	**546.034**	ALH-213591-001			New Design
R011	ECU Assembly	72.259	ALH-211155-003	6.79E-04		COTS
R015	PDU Assembly	**3.971**	1101-1101	**1.31E-03**	**1.09E-04**	COTS
R016	10/100TX TO 100 FX Media Converter Module #1	**0.746**	1119-0-W-KNG	**2.69E-04**	**2.69E-05**	COTS
R017	10/100TX TO 100 FX Media Converter Module #2	**0.746**	1119-0-W-KNG	**2.69E-04**	**2.69E-05**	COTS
R018	10/100TX TO 100 FX Media Converter Module #3	**0.746**	1119-0-W-KNG	**2.69E-04**	**2.69E-05**	COTS
R019	10/100TX TO 100 FX Media Converter Module #4	**0.746**	1119-0-W-KNG	**2.69E-04**	**2.69E-05**	COTS
R020	10/100TX TO 100 FX Media Converter Module #5	**0.746**	1119-0-W-KNG	**2.69E-04**	**2.69E-05**	COTS
R021	10/100TX TO 100 FX Media Converter Module #6	**0.746**	1119-0-W-KNG	**2.69E-04**	**2.69E-05**	COTS
R022	10/100TX TO 100 FX Media Converter Module #7	**0.746**	1119-0-W-KNG	**2.69E-04**	**2.69E-05**	COTS
R023	10/100TX TO 100 FX Media Converter Module #8	**0.746**	1119-0-W-KNG	**2.69E-04**	**2.69E-05**	COTS
R024	10/100TX TO 100 FX Media Converter Module #9	**0.746**	1119-0-W-KNG	**2.69E-04**	**2.69E-05**	COTS
R025	10/100TX TO 100 FX Media Converter Module #10	**0.746**	1119-0-W-KNG	**2.69E-04**	**2.69E-05**	COTS
R029	PFPU SSHD-1	1.226	532079-00	3.42E-04	2.80E-05	COTS
R030	PFPU SSHD-2	1.226	532079-10	2.83E-04	2.33E-05	COTS
R031	TCS TACTICAL ROUTER, MIL SPEC	1.825	40-2796-01	7.70E-04	3.85E-05	COTS

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
R032	10/100TX TO 100 FX Media Converter Module #11	**0.746**	1119-0-W-KNG	**8.60E-05**	**4.30E-06**	COTS
R033	10/100TX TO 100 FX Media Converter Module #12	**0.746**	1119-0-W-KNG	**1.88E-04**	**9.39E-06**	COTS
R034	DC-DC Power Supply	**10.000**	MIL-VIC-15-5V	**7.20E-04**	**3.60E-05**	COTS

Appendix A: "Relay" Available https://eide.myngc.com/sites/NSIDE/WIP/SitePages/Home.aspx?RootFolder

Appendix B. EOC (Engagement Operation Center)

The EOC is separated into two sections:

1.) "Shelter"
2.) "ICBS Collaborative Environment (ICE)"

Appendix B.1: "Shelter"

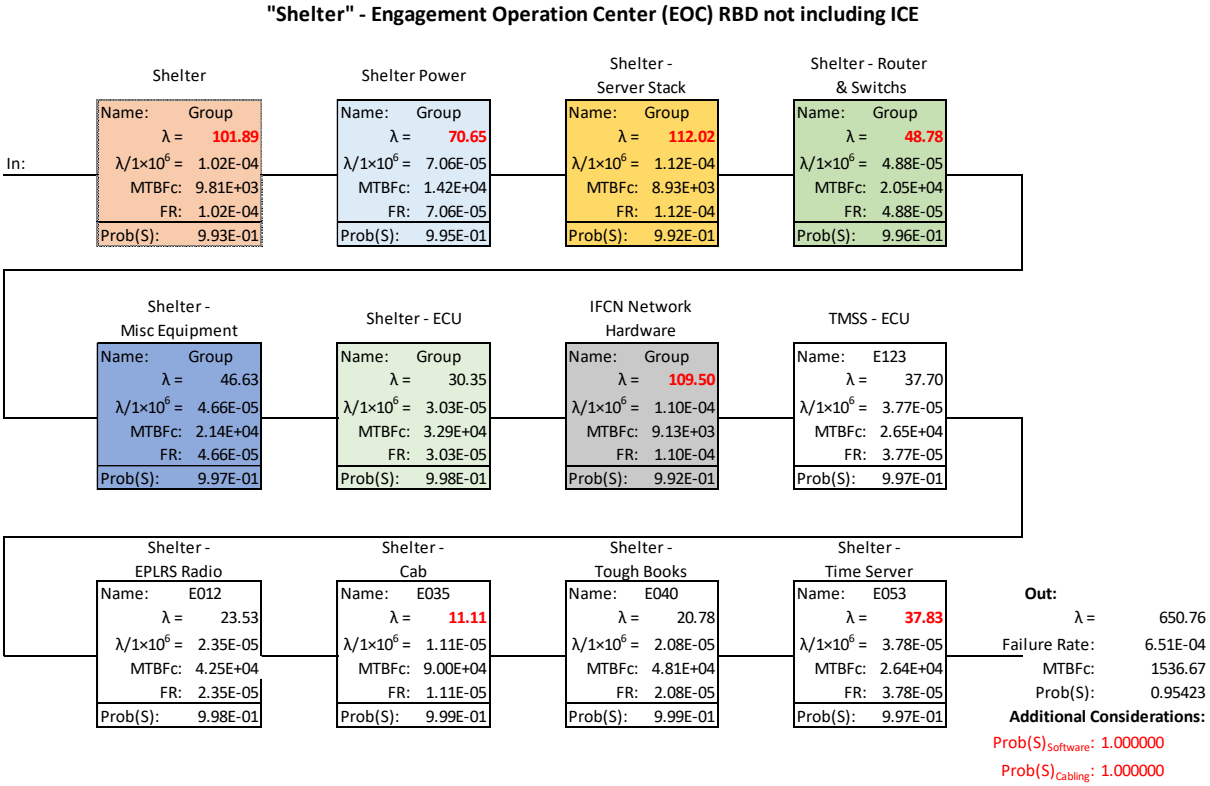
The following list presents a simple description or comment about the LRU contained in the EOC – "Shelter" Portion separated into MEI:

LRU ID#	Nomenclature	Part Number	Brief Description of LRU /Comment	COTS/ GFE
MEI: Shelter				
E068	Media Convertor-02	119-0-W-KNG	Interface to the Alternate Media (direct connection to an 2nd EOC). LCN: AAAAAADACACAPAC	COTS
E069	Media Convertor - 03	119-0-W-KNG	Interface to the ICE SLTC. LCN: AAAAAADACACAPAC	COTS
E151	Media Convertor - 04	1119-0-W-KNG	Connected to the Red Isolation Router and the external WIN-T/SIPRNET Transit Case. This LRU serves no function without WIN-T. LCN: AAAAADACACAPAC	COTS
E152	Media Convertor - 05	1119-0-W-KNG	Connected to the Black Isolation Router and the external WIN-T/NIPRNET Transit Case. This LRU serves no function without WIN-T. LCN: AAAAADACACAPAC	COTS
E153	Shelter RS-112 Server-05	CMS-00500	This RS-112 Server LRU provides C2 Software functions. LCN: AAAAAADACADAHAA	COTS
E154	Shelter RS-112 Server-06	CMS-00500	This RS-112 Server LRU provides C2 Software functions. LCN: AAAAAADACADAHAA	COTS
E155	Shelter RS-112 Server-07	CMS-00500	This RS-112 Server LRU provides B-Side Software functions. LCN: AAAAAADACADAHAA	COTS
E156	Shelter UPS	PG3000-UPS-RSD	This Uninterruptable Power Supply (UPS) is used to power the three added RS-112 Servers per the MOD-7 Design change. LCN: N/A	COTS
E157	Shelter KVM Switch-02	B072-016-1	This is KVM Switch LRU in the Shelter is used to communicate with the added RS-112 Servers. LCN: N/A	COTS
MEI: Shelter - Power				
E001	Shelter 28VDC Power Supply #1	MIL-PWR H-1	28VDC Power Supply #1 to the Shelter LCN: N/A	COTS

LRU ID#	Nomenclature	Part Number	Brief Description of LRU /Comment	COTS/ GFE
E002	Power Inverter-1000W	IPS1K-20-110-NG1	Provides 120 VAC and acts as an UPS. Converts +28 VDC from the 28V PS and vehicle battery. Output is connected to CB18 & 19 and from there to receptacles on racks 1 to 6. LCN: N/A	COTS
E144	RWS Backup Batteries	ALH-102947-001	Backup Batteries - Modeled as a group of 2 (should be replaced as a group). MTBF Is for random failure (not wear out).	COTS
E150	Power Entry Vault (PEV)	ALH-215099-001	The Power Entry Vault (PEV) provides power to the Shelter hardware. LCN: AAAAAADAAABAHAA	COTS
MEI: Shelter - Server Stack				
E029	Shelter KVM Switch-01	B072-016-1	8 port KVM Switch for Shelter RS-112 Servers -01 thru -06 and the ADSI LRUs. LCN: N/A	COTS
E030	KVM Console	90-2722-012-B	Shelter KVM for Server Stack and ADSI. LCN: AAAAAADABF8	COTS
E031	Shelter RS-112 Server-01	CMS-00500	1 of 4 Primary Shelter Servers. LCN: AAAAAADACACAPAC	COTS
E032	Shelter RS-112 Server-02	CMS-00500	2 of 4 Primary Shelter Servers. LCN: AAAAAADACACAPAC	COTS
E033	Shelter RS-112 Server-03	CMS-00500	3 of 4 Primary Shelter Servers. This is the server that will host the Diagnostics Software. LCN: AAAAAADACACAPAC	COTS
E034	Shelter RS-112 Server-04	CMS-00500	4 of 4 Primary Shelter Servers. LCN: AAAAAADACACAPAC	COTS
MEI: Shelter - Routers & Switches				
E059	Shelter Switch-01	WS-C3850-48P-E	1 of 2 RED Switches in the Shelter. LCN: N/A	COTS
E060	Shelter Switch-02	WS-C3850-48P-E	2 of 2 RED Switches in the Shelter. LCN: N/A	COTS
E061	Isolation Router (Red)	ALH-215606-001	Provides the interface to WIN-T/SIPRNET. This LRU serves no function without WIN-T. LCN: AAAAAADACADAYAS	COTS
E062	Shelter Router (Red)	ISR4321-AXV/K9	Shelter Red Router. Interface to the CDS LRU. LCN: N/A	COTS
E063	Isolation Router (Black)	ISR4321-AXV/K9	Provides the interface to WIN-T/NIPRNET. This LRU serves no function without WIN-T. LCN: N/A	COTS
E064	Shelter Router (Black)	ALH-215291-001	Shelter Black Router. Interface to the CDS LRU. LCN: AAAAAADACACAGAC	COTS
MEI: Shelter - Misc Equipment				
E013	ADSI - Air Defense Systems Integrator	3UIAMD-NN-NF	ADSI: Air Defense System Integrator. Communication between the LOS Radio and the Ethernet Switch LCN: N/A	COTS

LRU ID#	Nomenclature	Part Number	Brief Description of LRU /Comment	COTS/ GFE
E043	Firewall-Red	ASA5508-K9	Red Side Firewall providing connectivity to external data (WIN-T/SIPR,). , LCN: N/A	COTS
E044	Firewall-Black	ASA5508-K9	Black Side Firewall providing connectivity to external data (WIN-T/NIPR). LCN: N/A	COTS
MEI: Shelter - ECU				
E006	Shelter ECU-Assembly, CONDENSER	ALH-209336-001	ECU CONDENSER	COTS
E007	Shelter ECU Assembly, EVAPORATOR	ALH-209382-001	ECU EVAPORATOR	COTS
MEI: IFCN Network HW				
E048	HNR ANTENNA (HRFU)	ALH-213929-003	Interface to BPU LCN: AAAAAAB	COTS
E049	BPU	3158010-104	Primary interface to IFCN LCN: N/A	COTS
E050	KG-250X	1101000	Encryption Device. LCN: BAAAIAAAGAUAA	GFE
E051	IGRM LRU	ALH-215456-001	Interprets and forwards GPS signal to BPU and determines when GPS is down and switches to SCIM input. LCN: AAAAAADAF	COTS
E052	SCIM	ALH-212863-001	Used as a backup for GPS (to input location) and display the failure messages. LCN:AAAAAADACAAAEAG	COTS
MEI: TMSS				
E123	Environmental Control Unit,	T256250	Provides Environmental Control For The Ice LCN: AAAAAADAEABAAAA:	GFE
MEI: Shelter - Cab				
E035	EMCSU	5459100-001	Part of the TOCNET System	COTS
MEI: Shelter-Tough Books				
E040	NMC, Panasonic Toughbook	02-2855479-3	NMC = Net Management Computer	COTS
MEI: Shelter - Time Server				
E053	Time Server	ALH-215144-005 ALH-210931-007	Provides GPS referenced NTP Server Timing System. Also provides backup during GPS denied environments. LCN: AAAAAADACAAAPAJ	COTS

The updated failure rates are shown in red.
The RBD for the "Shelter" Portion of the EOC and associated information:



Note: Bold type indicates an update to the FPMH from the vendor (Oct. 1, 2019)
The "Shelter" MEIs are separated into the proper LRU groups:

MEI: Shelter

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
E068	10/100TX to 100FX MEDIA CONVERTOR-02 (Alt Media)	**0.746**	1119-0-WKNG	**2.15E-05**	**3.36E-06**	COTS
E069	10/100TX to 100FX MEDIA CONVERTOR-03 (ICE)	**0.746**	1119-0-WKNG	**2.15E-05**	**3.36E-06**	COTS
E151	10/100TX to 100FX MEDIA CONVERTOR-04 (RED)	**0.746**	1119-0-WKNG	**2.15E-05**	**3.36E-06**	COTS
E152	10/100TX to 100FX MEDIA CONVERTOR-05 (BLACK)	**0.746**	1119-0-WKNG	**2.15E-05**	**3.36E-06**	COTS
E153	Shelter RS-112 Server-05	**25.594**	CMS-00500	**2.73E-03**	**3.54E-04**	COTS
E154	Shelter RS-112 Server-06	**25.594**	CMS-00500	**2.73E-03**	**3.54E-04**	COTS
E155	Shelter RS-112 Server-07	**25.594**	CMS-00500	**2.73E-03**	**3.54E-04**	COTS
E156	Shelter UPS	**18.182**	PG3000-UPS-RSD	**2.59E-03**	**2.60E-04**	COTS

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
E157	Shelter KVM Switch-02	**3.937**	B072-016-1	**8.59E-05**	**6.35E-05**	COTS

MEI: Shelter-Power

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
E001	Shelter 28VDC Power Supply #1	**1.916**	NG2602	2.29E-04	2.27E-05	COTS
E002	Power Inverter-1000W	1.420	IPS1K-20-110-NG1	9.61E-03	4.81E-04	COTS
E144	RWS Backup Batteries	3.113	ALH-102947-001	3.36E-05	3.36E-05	COTS
E150	S-280 Power Entry Vault (PEV) Assembly	56.113	ALH-215099-001	1.33E-01	1.25E-02	COTS

MEI: Shelter-Server Stack

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS / GFE
E029	Shelter KVM Switch-01	**3.937**	B072-016-1	**1.55E-04**	**1.31E-04**	COTS
E030	KVM Console	**5.708**	90-2722-012-B	**9.42E-04**	**1.34E-04**	COTS
E031	Shelter RS-112 Server-01	**25.594**	CMS-00500	**2.67E-03**	**1.06E-04**	COTS
E032	Shelter RS-112 Server-02	**25.594**	CMS-00500	**2.67E-03**	**1.06E-04**	COTS
E033	Shelter RS-112 Server-03	**25.594**	CMS-00500	**2.72E-03**	**1.37E-04**	COTS
E034	Shelter RS-112 Server-04	**25.594**	CMS-00500	**2.72E-03**	**1.37E-04**	COTS

MEI: Shelter-Routers & Switches

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
E059	Shelter Switch-01	**4.149**	WS-C3850-48P-E	**6.25E-04**	**5.35E-04**	COTS
E060	Shelter Switch-02	**4.149**	WS-C3850-48P-E	**3.09E-03**	**6.42E-04**	COTS
E061	Isolation Router (Red)	9.258	ALH-215606-001	1.14E-04	1.14E-04	COTS
E062	Shelter Router (Red)	10.903	ISR4321-AXV/K9	2.29E-03	1.60E-04	COTS
E063	Isolation Router (Black)	9.258	ISR4321-AXV/K9	1.30E-04	1.30E-04	COTS
E064	Shelter Router (Black)	11.066	ALH-215291-001	3.27E-03	2.45E-04	COTS

MEI: Shelter-Misc Equipment

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
E013	ADSI - Air Defense Systems Integrator	28.571	3UIAMD-NN-NF	1.12E-02	7.98E-04	COTS
E043	Firewall-Red (CISCO-ASA 5508-X with Fire Power Services)	9.029	ASA5508-K9	1.25E-03	1.43E-04	COTS
E044	Firewall-Black (CISCO-ASA 5508-X with Fire Power Services)	9.029	ASA5508-K9	5.88E-04	8.61E-05	COTS

MEI: Shelter-ECU

LRU ID#	Nomenclature	FPMH	Part Number	Cm	Mod Cm	COTS/ GFE
E006	Shelter ECU- Assembly, Condenser	18.850	ALH-210761-001			COTS
E007	Shelter ECU-Assembly, Evaporator	11.499	ALH-210653-11			COTS

MEI: IFCN Network HW

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/GFE
E048	HNR ANTENNA (HRFU)	**29.388**	ALH-213929-003	**3.85E-03**	**6.97E-04**	COTS
E049	BPU	**35.945**	3158010-104	**1.04E-02**	**1.02E-03**	COTS
E050	KG-250X	**2.857**	1101000	5.96E-04	7.52E-05	COTS
E051	IGRM LRU	40.435	ALH-215456-001			COTS
E052	SCIM	0.875	AHL-212863-001	1.05E-04	9.77E-06	COTS

MEI: TMSS

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/GFE
E123	Environmental Control Unit	37.700	T256250	5.71E-03	8.49E-04	GFE

MEI: Shelter-EPLRS Radio

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
E012	TacLink-3100	23.529	902928-801			COTS

MEI: Shelter-Cab

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/GFE
E035	EMCSU	**11.111**	5459100-001			COTS

MEI: Shelter-Tough Books

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/GFE
E040	NMC, Panasonic Toughbook	20.775	02-2855479-3			COTS

MEI: Shelter Time Server

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/GFE
E053	Time Server **(I)**	**37.829**	ALH-210931-007	**1.75E-02**	**1.03E-03**	COTS

Appendix B.1: "Shelter" https://eide.myngc.com/sites/NSIDE/WIP/SitePages/Home.aspx?RootFolder

Appendix B.2: "ICE"

The following list presents a simple description or comment about the LRU contained in the EOC – "ICE" Portion separated into MEI:

LRU ID#	Nomenclature	Part Number	Brief Description of LRU /Comment	COTS/ GFE
MEI: ICE Workstation Assembly				
E082	ICE Workstation Laptop #1	CMS-00597	ICE Workstation Laptop Computer (failure rate does not include the workstation battery).	COTS
E083	ICE Workstation Laptop #2	CMS-00597	ICE Workstation Laptop Computer (failure rate does not include the workstation battery).	COTS
E084	ICE Workstation Laptop #3	CMS-00597	ICE Workstation Laptop Computer (failure rate does not include the workstation battery).	COTS
E085	ICE Workstation Laptop #4	CMS-00597	ICE Workstation Laptop Computer (failure rate does not include the workstation battery).	COTS
E086	ICE Workstation Laptop #5	CMS-00597	ICE Workstation Laptop Computer (failure rate does not include the workstation battery).	COTS
E087	ICE Workstation Laptop #6	CMS-00597	ICE Workstation Laptop Computer (failure rate does not include the workstation battery).	COTS
E088	ICE Workstation Laptop #7	CMS-00597	ICE Workstation Laptop Computer (failure rate does not include the workstation battery).	COTS
E089	ICE Workstation Laptop #8	CMS-00597	ICE Workstation Laptop Computer (failure rate does not include the workstation battery).	COTS
E090	ICE Workstation Laptop #9	CMS-00597	ICE Workstation Laptop Computer (failure rate does not include the workstation battery).	COTS
E091	ICE Workstation Laptop #10	CMS-00597	ICE Workstation Laptop Computer (failure rate does not include the workstation battery).	COTS
E092	ICE Display #1	ALH-215604-001	Display for the ICE Workstation Laptop	COTS
E093	ICE Display #2	ALH-215604-001	Display for the ICE Workstation Laptop	COTS
E094	ICE Display #3	ALH-215604-001	Display for the ICE Workstation Laptop	COTS
E095	ICE Display #4	ALH-215604-001	Display for the ICE Workstation Laptop	COTS
E096	ICE Display #5	ALH-215604-001	Display for the ICE Workstation Laptop	COTS
E097	ICE Display #6	ALH-215604-001	Display for the ICE Workstation Laptop	COTS
E098	ICE Display #7	ALH-215604-001	Display for the ICE Workstation Laptop	COTS
E099	ICE Display #8	ALH-215604-001	Display for the ICE Workstation Laptop	COTS
E100	ICE Display #9	ALH-215604-001	Display for the ICE Workstation Laptop	COTS
E101	ICE Display #10	ALH-215604-001	Display for the ICE Workstation Laptop	COTS
E102	ICE Video Extender Transmitter #1	P580-015	Provides ICE Workstation #1 video to the ICE Display #1 and to external overhead projectors and Audio to the ICE per the PLTC Nexia and VGA-Audio Receiver Module #1.	COTS
E103	ICE Video Extender Transmitter #2	P580-015	Provides ICE Workstation #2 video to the ICE Display #2 and to external overhead projectors and Audio to the ICE per the PLTC Nexia and VGA-Audio Receiver Module #2.	COTS
E104	ICE Video Extender Transmitter #3	P580-015	Provides ICE Workstation #3 video to the ICE Display #3 and to external overhead projectors and	COTS

LRU ID#	Nomenclature	Part Number	Brief Description of LRU /Comment	COTS/ GFE
			Audio to the ICE per the PLTC Nexia and VGA-Audio Receiver Module #3.	
E105	ICE Video Extender Transmitter #4	P580-015	Provides ICE Workstation #4 video to the ICE Display #4 and to external overhead projectors and Audio to the ICE per the PLTC Nexia and VGA-Audio Receiver Module #4.	COTS
E106	ICE Video Extender Transmitter #5	P580-015	Provides ICE Workstation #5 video to the ICE Display #5 and to external overhead projectors and Audio to the ICE per the PLTC Nexia and VGA-Audio Receiver Module #5.	COTS
E107	ICE Video Extender Transmitter #6	P580-015	Provides ICE Workstation #6 video to the ICE Display #6 and to external overhead projectors and Audio to the ICE per the PLTC Nexia and VGA-Audio Receiver Module #6.	COTS
E108	ICE Video Extender Transmitter #7	P580-015	Provides ICE Workstation #7 video to the ICE Display #7 and to external overhead projectors and Audio to the ICE per the PLTC Nexia and VGA-Audio Receiver Module #7.	COTS
E109	ICE Video Extender Transmitter #8	P580-015	Provides ICE Workstation #8 video to the ICE Display #8 and to external overhead projectors and Audio to the ICE per the PLTC Nexia and VGA-Audio Receiver Module #8.	COTS
E110	ICE Video Extender Transmitter #9	P580-015	Provides ICE Workstation #9 video to the ICE Display #9. The video and Audio functions are not sent to the ICE PLTC for Workstation #9.	COTS
E111	ICE Video Extender Transmitter #10	P580-015	Provides ICE Workstation #10 video to the ICE Display #10. The video and Audio functions are not sent to the ICE PLTC for Workstation #10.	COTS
MEI: ICE Power				
E122	EMI Tent PDU	ALH-215087-001	Takes 208VAC 3-phase power from the TMSS Generator or facility power and provides six 120VAC GFCI Outlets to power the ICE HW LRUs.	GFE
E143	ICE UPS	ALH-214912-001	Uninterruptable Power Supply (UPS).	COTS
MEI: ICE Workstation Transit Case				
E145	Wkstn Transit Case-1 and Work Table	ALH-215524-001 BP300A000	Provides power/interface for ICE Wkstns #1 & #2.	COTS
E146	Wkstn Transit Case-2 and Work Table	ALH-215524-001 BP300A000	Provides power/interface for ICE Wkstns #3 & #4.	COTS
E147	Wkstn Transit Case-3 and Work Table	ALH-215524-001 BP300A000	Provides power/interface for ICE Wkstns #5 & #6.	COTS
E148	Wkstn Transit Case-4 and Work Table	ALH-215524-001 BP300A000	Provides power/interface for ICE Wkstns #7 & #8.	COTS
E149	Wkstn Transit Case-5 and Work Table	ALH-215524-001 BP300A000	Provides power/interface for ICE Wkstns #9 & #10.	COTS
MEI: ICE				
E067	ETHERNET Switch, PLTC	ALH-215087-001	PLTC = Primary LAN Transit Case (located in the ICE)	COTS

The RBD for the "ICE" Portion of the EOC and associated information:

The "ICE" Portion of the EOC is a basic *k*-of-*n* reliability configuration, shown below is the static "RBD" representing a 4-of-10 component configuration. Note updated failure rates are shown in red.

IBCS Colaborative Environment (ICE) RBD
Complete Redesign (λs from Old Design) [07/14/2019]

t = 72.00 Hours
MTBFc 10,904.10 Hours

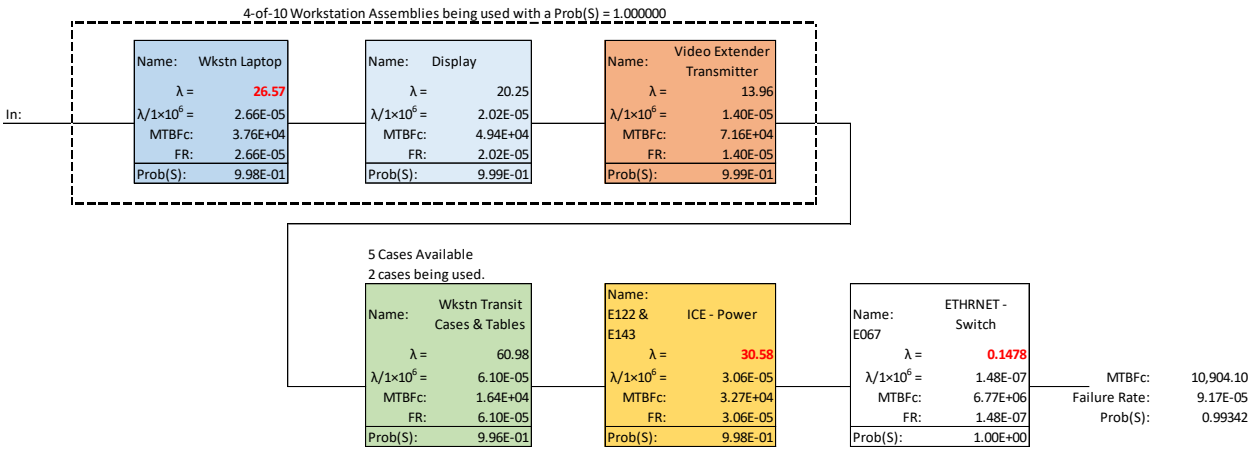
Probability of Success at a 72 Hour using 4 Wkstn Assemblies and 2 Transit Cases is 0.9934

ICE Configurations Available =	10	
ICE Configurations Required =	4	
Pr(Workstation Assembly Baseline Model Mission Success) =	0.9956	Pr(1 Workstation Assembly Model with MTBFc = 16451.62 hrs. and Mission Pulse of 72.0 hrs.)
Pr(Mission Success of Workstation Transit Cases) =	0.9978	Pr(1 Workstation Transit Case with MTBFc = 32799.36 hrs. and Mission Pulse of 72.0 hrs.)
Pr(Mission Success of Workstation Assemblies) =	1.00000	Pr(4-out-of-10)
Pr(Mission Success of Workstation Transit Cases) =	0.99406	Pr(2-out-of-5)
Pr(Mission Success of ICE Power) =	0.99780	Static
Pr(Mission Success of the ETHRNET - Switch) =	0.99999	Static
Pr(Mission Success of the MEI =	0.99187	

The Probability of Success at 72 Hours is 0.99187 for theShelter Portion of the EOC with the additional considerations
The difference is a decrease of -0.00155 for the Probability of Success for theICE Portion of the EOC
The difference is a decrease of 0.00 hours for the MTBFc of theICE Portion of the EOC

Additional Considerations:

$Prob(S)_{Software}$: 1.000000
$Prob(S)_{Cabling}$: 1.000000
MTBFc: 10904.103
Failure Rate: 9.17E-05
Prob(S): 0.99342



Note: Bold type indicates an update to the FPMH from the vendor (Oct. 1, 2019)
The "ICE" MEIs are separated into the proper LRU groups:

MEI: ICE-Workstation Assembly

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
E082	ICE Workstation Laptop #1	**26.575**	CMS-00597	**6.71E-04**	**6.71E-04**	COTS
E083	ICE Workstation Laptop #2	**26.575**	CMS-00597	**6.71E-04**	**6.71E-04**	COTS
E084	ICE Workstation Laptop #3	**26.575**	CMS-00597	**6.71E-04**	**6.71E-04**	COTS
E085	ICE Workstation Laptop #4	**26.575**	CMS-00597	**6.71E-04**	**6.71E-04**	COTS
E086	ICE Workstation Laptop #5	**26.575**	CMS-00597	**6.71E-04**	**6.71E-04**	COTS
E087	ICE Workstation Laptop #6	**26.575**	CMS-00597	**6.71E-04**	**6.71E-04**	COTS
E088	ICE Workstation Laptop #7	**26.575**	CMS-00597	**6.71E-04**	**6.71E-04**	COTS
E089	ICE Workstation Laptop #8	**26.575**	CMS-00597	**6.71E-04**	**6.71E-04**	COTS
E090	ICE Workstation Laptop #9	**26.575**	CMS-00597	**6.71E-04**	**6.71E-04**	COTS
E091	ICE Workstation Laptop #10	**26.575**	CMS-00597	**6.71E-04**	**6.71E-04**	COTS

MEI: ICE-Workstation Assembly

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/GFE
E092	ICE Display #1	20.470	ALH-215604-001	7.29E-06	7.29E-06	COTS
E093	ICE Display #2	20.470	ALH-215604-001	7.29E-06	7.29E-06	COTS
E094	ICE Display #3	20.470	ALH-215604-001	7.29E-06	7.29E-06	COTS
E095	ICE Display #4	20.470	ALH-215604-001	7.29E-06	7.29E-06	COTS
E096	ICE Display #5	20.470	ALH-215604-001	7.29E-06	7.29E-06	COTS
E097	ICE Display #6	20.470	ALH-215604-001	7.29E-06	7.29E-06	COTS
E098	ICE Display #7	20.470	ALH-215604-001	7.29E-06	7.29E-06	COTS
E099	ICE Display #8	20.470	ALH-215604-001	7.29E-06	7.29E-06	COTS
E100	ICE Display #9	20.470	ALH-215604-001	7.29E-06	7.29E-06	COTS
E101	ICE Display #10	20.470	ALH-215604-001	7.29E-06	7.29E-06	COTS

MEI: ICE-Workstation Assembly

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
E102	ICE Video Extender Transmitter #1	13.963	P580-015	4.35E-04	4.35E-04	COTS
E103	ICE Video Extender Transmitter #2	13.963	P580-015	4.35E-04	4.35E-04	COTS
E104	ICE Video Extender Transmitter #3	13.963	P580-015	4.35E-04	4.35E-04	COTS
E105	ICE Video Extender Transmitter #4	13.963	P580-015	4.35E-04	4.35E-04	COTS
E106	ICE Video Extender Transmitter #5	13.963	P580-015	4.35E-04	4.35E-04	COTS
E107	ICE Video Extender Transmitter #6	13.963	P580-015	4.35E-04	4.35E-04	COTS
E108	ICE Video Extender Transmitter #7	13.963	P580-015	4.35E-04	4.35E-04	COTS

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
E109	ICE Video Extender Transmitter #8	13.963	P580-015	4.35E-04	4.35E-04	COTS
E110	ICE Video Extender Transmitter #9	13.963	P580-015	4.35E-04	4.35E-04	COTS
E111	ICE Video Extender Transmitter #10	13.963	P580-015	4.35E-04	4.35E-04	COTS

MEI: ICE Workstation Transit Case

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/ GFE
E145	Wkstn Transit Case-1 and Work Table	**30.488**	ALH-215524-001 BP300A000	**1.22E-03**	**1.16E-03**	COTS
E146	Wkstn Transit Case-2 and Work Table	**30.488**	ALH-215524-001 BP300A000	**1.22E-03**	**1.16E-03**	COTS
E147	Wkstn Transit Case-3 and Work Table	**30.488**	ALH-215524-001 BP300A000	**1.22E-03**	**1.16E-03**	COTS
E148	Wkstn Transit Case-4 and Work Table	**30.488**	ALH-215524-001 BP300A000	**1.22E-03**	**1.16E-03**	COTS
E149	Wkstn Transit Case-5 and Work Table	**30.488**	ALH-215524-001 BP300A000	**1.22E-03**	**1.16E-03**	COTS

MEI: ICE-Power

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/GFE
E122	EMI Tent PDU	7.074	AHL-215087-001	1.44E-03	2.29E-04	GFE
E143	ICE - Power (UPS)	**23.510**	ALH-214912-001	**6.02E-03**	**8.78E-04**	COTS

MEI: ICE

LRU ID#	Nomenclature	FPMH	Part Number	C_m	Mod C_m	COTS/GFE
E067	ETHERNET SWITCH, PLTC	**0.1478**	ALH-215087-001	**1.70E-05**	**3.58E-06**	COTS

Appendix B.2: "ICE"
https://eide.myngc.com/sites/NSIDE/WIP/SitePages/Home.aspx?RootFolder

Appendix C. Link to SWFMECA

Analysis Decisions:

- Primary emphasis has been put on v4.5ER2 requirements and capabilities.
- Requirements have been analyzed based on an DOORS SRS extraction dated 13 May 2019.
- All SRS Requirements have been assessed to the point of Fault Mode identifications. Some requirements have undergone additional analysis.
- Requirements were assessed in this order:
    - v4.5ER2 requirements were assessed first.
    - Non v4.5ER2 requirements were then assessed per their SRS ID number.
- Use cases were assessed in order of their location within the A015 documentation.
    - Each use case warranted an initial assessment. If deemed pertinent to system reliability, it was reviewed and assessed.
    - Only those use cases that were of the most interest and within the range analyzed received write-ups.
- The Software FMEA Document consists of these tabs:
    - Observations – These are a list of general observations and potential mitigations recognized through the analysis.
    - General Failure Modes – This is a general list of failure modes that will be identified on the system. Included in this list is an estimation of the worst case result of the given failure mode.
    - Functional Requirement FMEA – This provides an assessment of individual SRS Requirements.
    - Use Cases – Check List of Use Cases to be assessed. Items not selected imply that a detailed assessment was not performed. This does not imply an assessment was not performed as all requirements received an initial review.
    - Use Case Assessment – Evaluation of individual use cases.
    - Code FMEA – Placeholder for performing code based FMEA activity.
    - 4.5 ER2 – This is requirements analysis done specifically targeting v4.5ER2 activities.
    - TM_UC_Analysis/MC_UC_Analysis are worksheets intended to detail analysis of several specific use cases.
    - ET/SS/TM/MC/MS/IF/UI are all analysis of specific software components.

SWFMEA RESULTS.xlsx