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DEPARTMENT OF DEFENSE STANDARD PRACTICE

NUCLEAR COMPATIBILITY CERTIFICATION OF NUCLEAR WEAPON SYSTEMS, SUBSYSTEMS AND SUPPORT EQUIPMENT

AMSC: 9317 **FSG 11GP**

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

FOREWORD

1. This standard is approved for use by the Air Force Nuclear Weapons Center (AFNWC), Department of the Air Force and is available for use by all Departments and Agencies of the Department of Defense.

2. The purpose of this standard is to provide specific requirements for nuclear compatibility certification and information on the nuclear compatibility certification process.

3. This standard is structured and formatted to facilitate tailoring requirements to the specific system needs. Each system program office is encouraged to selectively apply and tailor these requirements during the acquisition process.

4. Comments, suggestions, or questions on this document should be addressed to AFNWC/EN, 1551 Wyoming Blvd SE, Kirtland AFB, NM 87117 or e-mailed to AFNWC.ENWorkflow@kirtland.af.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil.

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1. SCOPE

1.1 General

This document describes standard practices for nuclear compatibility certification of nuclear weapon systems (excluding nuclear facilities). Nuclear weapon system compatibility certification authority is derived from the 1953 Atomic Energy Commission (AEC)/Department of Defense (DoD) Memorandum of Agreement (MOA) and restated within numerous DoD and Air Force (AF) directives.

a. The mission of the Air Force Nuclear Weapons Center (AFNWC) is to ensure safe, secure, reliable nuclear weapon systems are available to support the National Command Structure and the AF war-fighter. By definition, “nuclear surety” encompasses all aspects of nuclear weapon system safety, reliability, and security. A basic pillar supporting the Air Force’s nuclear surety program is the Air Force’s Nuclear Certification Program managed by the AFNWC.

b. The Air Force Nuclear Certification Program, defined in Air Force Instruction (AFI) 63-125, *Nuclear Certification Program,* ensures all procedures, software, personnel, equipment, facilities, and organizations are certified before conducting nuclear operations with nuclear weapons or nuclear weapon systems. Nuclear Certification occurs when a determination is made by the Air Force Nuclear Weapons Center’s Commander that: procedures, software, equipment, and facilities are sufficient to perform nuclear weapon functions, and personnel and organizations are capable of performing assigned nuclear missions. Nuclear Certification is a part of Operational Safety, Suitability & Effectiveness (OSS&E) as directed by AFI 63-1201, *Life Cycle Systems Engineering.*

c. The Air Force Nuclear Certification Process is described in detail in AFI 63-125. Major elements of nuclear certification are: design certification, and operational certification. Components of design certification are: compatibility certification, nuclear safety design certification, safety rules development, and technical order certification. Although all components of design certification are closely related and arguably difficult to totally separate this document will focus on nuclear compatibility certification.

d. The Nuclear Weapon System Compatibility is the capability of two or more nuclear weapon system components of equipment or material to exist or function in the same system or environment without mutual interference. Nuclear weapon system compatibility evaluations are a component of Operational Suitability as established in AFI 63-1201. Nuclear weapon system operational suitability is a measure of the degree to which a nuclear weapon system or end-item can be placed satisfactorily into field use with consideration given to availability, compatibility, transportation, interoperability, and reliability. A successful nuclear weapon system compatibility evaluation (and subsequent Nuclear Compatibility Certification Statement [NCCS]) is a component of the Air Force’s Nuclear Weapon System Certification and Systems Engineering processes.

e. Nuclear safety design certification requirements are closely related to compatibility requirements. They are described in detail in AFMAN 91-118, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems*, and AFMAN 91-119, *Safety Design and Evaluation Criteria for Nuclear Weapon Systems Software*, and are not repeated here.

f. According to DODD 3150.02, section 4.2.8, "Nuclear weapon system safety, security, survivability, and use control are interrelated. Decisions concerning one should not be made without consideration of the effect of those decisions on the others." Survivable nuclear weapons need survivable support equipment. To address the interrelation of survivability with safety and security, AFNWC established the Nuclear Capabilities Analysis (NCA) division, which

provides scientific oversight of the RN part of the CBRN (Chemical, Biological, Radiological, Nuclear) survivability mission. NCA monitors development and modification of nuclear weapons, their components, or subassemblies for compliance with Military Characteristics and Stockpile To Target Sequence survivability requirements.

1.2 Purpose.

This military standard identifies the tasks, analyses and tests that are necessary to assure compatibility between National Nuclear Security Administration (NNSA) developed nuclear weapons and DoD operational nuclear weapon delivery systems and support equipment. Requirements for evaluation and reporting for nuclear compatibility certification are also delineated.

1.3 Applicability.

This document applies to AF nuclear weapon systems. Modified portions of nuclear weapon systems will also comply with this document. This document complements AFI 63-125.

1.3.1 Application and tailoring guidance.

1.3.1.1 Applying requirements.

Requirements described in this military standard are to be applied in Air Force nuclear weapon system procurements, requests for proposals, statements of work and U.S. Government in-house developments requiring nuclear certification programs for the development and sustainment of weapon systems. Although this military standard provides specific nuclear compatibility certification requirements, it may be necessary to tailor this military standard to accommodate unique characteristics of a particular weapon system.

1.3.1.2 Tailoring of requirements.

Requirements are to be tailored by the engineering organization as required by governing documents and as appropriate to particular systems or equipment depending on the program type, magnitude, and funding. In tailoring the requirements, the detail and depth of the effort is defined by the managing engineering organization and incorporated in the appropriate contractual documents. Also, each program will specify which requirements in this military standard are applicable and binding for their specific system design.

1.3.2 Application guidance to the procuring agency.

All proposed tailoring and rationale for modifying requirements of this military standard to address unique aspects of the weapon system must be reviewed and approved by the AFNWC/NCS.

2. APPLICABLE DOCUMENTS

2.1 General.

The documents listed in this section are referenced in sections 3, 4, or 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3, 4, or 5 of this standard, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks.

The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-E-7016	Electric Load and Power Source Capacity, Aircraft, Analysis of
MIL-DTL-38999	Connectors, Electrical, Circular, Miniature, High Density, Quick Disconnect (Bayonet, Threaded, and Breech Coupling), Environmental Resistant, Removable Crimp and Hermetic Solder Contacts, General Specification For

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-962	Defense Standards Format and Content
MIL-STD-963	Data Item Descriptions (DIDs)

(Copies of these documents are available online at https://assist.dla.mil/quicksearch/ or https://assist.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.2.2 Other Government documents, drawings, and publications.

The following other Government documents, drawings, and publications form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE (DoD) DOCUMENTS

DoDD 3150.1	Joint DoD-DoE Nuclear Weapon Life-Cycle Activities
DoDD 3150.2	DoD Nuclear Weapon System Safety Program
DoDD 3200.11	Major Range and Test Facility Base (MRTFB)
DoDD 5000.01	The Defense Acquisition System
DoDI 5030.55	DoD Procedures for Joint DoD-DoE Nuclear Weapons Life Cycle Activities

(Copies of these documents are available on line at http://www.dtic.mil/whs/directives/.)

AIR FORCE INSTRUCTIONS

AFJI 21-301/ AR 25-36/ OPNAVINST 5600.22/ MCO 5215.9/ DLAR 4151.9	Interservicing of Technical Manuals and Related Technology
AFI 10-2607	Air Force Chemical, Biological, Radiological, and Nuclear (CBRN) Survivability

AFI 63-101	Acquisition and Sustainment Life Cycle Management
AFI 63-103	Joint Air Force-National Nuclear Security Administration (AF-NNSA) Nuclear Weapons Life Cycle Management
AFI 63-104	The SEEK EAGLE Program
AFI 63-125	Nuclear Certification Program
AFI 63-1201	Life Cycle Systems Engineering
AFI 91-103	Air Force Nuclear Safety Design Certification Program
AFI 99-103	Capabilities-Based Test and Evaluation
AFPD 10-9	Lead Command Designation and Responsibilities for Weapon Systems
AFPD 63-1/20-1	Integrated Life Cycle Management
AFPD 91-1	Nuclear Weapons and Systems Surety

(Copies of these documents are available on line at http://www.e-publishing.af.mil/.)

AIR FORCE NUCLEAR WEAPONS CENTER

498th NSW OI 99-01	Aircraft Monitor and Control (AMAC) Testing

(Copies of this document are available from the AFNWC/NCSS, Kirtland AFB, NM 87117)

AIRCRAFT MONITOR AND CONTROL (AMAC) PROJECT OFFICERS GROUP (POG) INTERFACE SPECIFICATION STANDARDS

SYS 1001	AMAC POG System 1 Basic Interface Specification
SYS 2001	AMAC POG System 2 Basic Interface Specification

(Copies of AMAC POG Interface Specifications and Standards are available from the AFNWC/NCSS, Kirtland AFB, NM 87117

MEMORANDUMS OF AGREEMENT (MOA)/UNDERSTANDING (MOU)

MOA, 21 March 1953	Atomic Energy Commission (AEC) and the Department of Defense (DoD) for the Development, Production, and Standardization of Atomic Weapons
MOU DE-GM04-94AL94738	NNSA/USAF Joint Testing and Assessment of the Nuclear Weapons Stockpile
MOU DE-GM04-2001AL77133	Agreement on Division of Responsibilities for Aircraft Monitor and Control (AMAC) Systems Design Requirements and Compatibility Testing

(Copies of these documents are available from the AFNWC/NCSS, Kirtland AFB, NM 87117.)

2.3 Order of precedence.

Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence.

Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 Aircraft Monitor and Control (AMAC).

Equipment installed in aircraft to permit nuclear weapon monitoring and control of the following critical functions: (1) safing; (2) pre-arming; (3) arming; and (4) fuzing of nuclear weapons or nuclear weapon systems.

3.2 Aircraft Compatibility Control Drawing (ACCD).

A controlled drawing prepared and maintained by the National Nuclear Security Administration's Sandia National Laboratory (NNSA/SNL); SNL designs and integrates the nuclear weapon's safety and security systems. The ACCD establishes the extent of compatibility and restrictions between a nuclear weapon and an aircraft.

3.3 Arming.

Operations that configure a nuclear weapon or nuclear weapon system so application of a single signal will start the action required for obtaining a nuclear detonation. Arming is a critical function.

3.4 Basic Certification Requirements Plan (BCRP).

The BCRP is a preparatory Certification Requirements Plan document containing nuclear certification tasks (including compatibility certification tasks) and schedules prepared by the AFNWC's certification management organization.

3.5 Certification Requirements Plan (CRP).

A document containing nuclear compatibility certification tasks and schedules submitted by the Single Manager to the AFNWC's nuclear certification organization; the CRP also contains other certification tasks discussed in 1.1c.

3.6 Combat Delivery vehicle.

In the context of this document, a combat delivery vehicle is a human or automated airborne controlled vehicle, with its installed equipment and components, used to deliver a nuclear weapon(s) on a target.

3.7 Compatibility Test Units (CTUs).

CTUs are NNSA/SNL engineering tools that represent electrical and functional characteristics of a war reserve (WR) nuclear weapon. CTUs come in a variety of sizes, shapes, and quality of WR electrical/mechanical components (see A.3.6).

3.8 Critical Nuclear Weapon/Weapon System Functions.

The functions listed in the DoD Nuclear Weapon System Safety Standards are critical to nuclear weapon system safety. The functions which are explicitly stated are:

(1) authorization,

(2) pre-arming,

(3) arming,

(4) nuclear consent,

(5) releasing, and/or

(6) launching of a nuclear weapon.

For missiles with self-contained guidance systems, “targeting” is also a critical function as it pertains to protection of friendly territory.

3.9 Cruise-Combat Electrical Loads.

Cruise-combat is that condition during which the aircraft is performing its combat mission in a combat ready or actual combat condition. The cruise-combat electrical loads are determined by the sum of the power requirements of all electrical systems, including weapons that may be used in this condition. MIL-E-7016 defines cruise-combat electrical loads and provides guidance for analyzing and testing aircraft power systems.

3.10 Data Item Description (DID).

A DID is a standardization document that defines the data content, preparation instructions, format, and intended use of data required of a contractor. DIDs are prepared in accordance with MIL-STD-963.

3.11 Department of Defense (DoD) Standard.

A DoD Standard is used to satisfy primarily multiple, military unique applications. There are five types of DoD Standards: (1) interface standards; (2) design criteria standards; (3) manufacturing process standards; (4) standard practices; and (5) test method standards. Standards are prepared in accordance with MIL-STD-962.

3.12 Department of Energy (DoE).

An agency of the U.S. government created in October 1977 responsible for: (1) long-range, high-risk research and development of energy technology; (2) power marketing at the federal level; (3) the promotion of energy conservation; (4) oversight of the nuclear weapons program; (5) regulatory programs; and (6) the collection and analysis of energy data.

3.13 Design Certification.

Design certification occurs when each of the four design certification components is accomplished for the weapon system. Design Certification components are: (1) Compatibility Certification; (2) Nuclear Safety Certification; (3) Weapon System Safety Rules (WSSRs) approval; and (4) Technical Orders Certification.

3.14 Electrical Interface Control Drawing (EICD).

The EICD documents the physical, electrical power and logical signal circuits in the delivery system between the avionics components at the NNSA/AF interfaces. The EICD includes all types of electrical interfaces in the monitor and control circuits of the nuclear gravity weapon(s) and nuclear weapon system, including man-machine, discrete lines and multiplex data buses.

3.15 Engineering Organization.

The organization that has program management responsibilities for a system’s acquisition, configuration, or modification is called the Engineering Organization. Depending on the scope/intent of the project and the phase of the system (development, acquisition, sustainment, etc.), the Engineering Organization may be a Program Office, the Air Force Life Cycle

Management Center, a specialized organization such as the AFNWC or numerous other agencies.

3.16 Final Design Approval Report (FDAR).

The FDAR is a document prepared by the AMAC designer to demonstrate that the design of the AMAC system will meet the requirements of the nuclear weapon/nuclear weapon delivery vehicle interface specification. The FDAR may also contain a description of an aircraft's cockpit display, aircraft software logic, and the weapon release system.

3.17 Hardware.

Hardware is a generic term dealing with physical items, as distinguished from their capability or function, such as equipment, assemblies, subassemblies, components, and parts. In data automation, hardware is the physical equipment or devices forming a computer and peripheral components.

3.18 Independent Verification and Validation (IV&V).

IV&V is the analysis and test of computer software by an organization that is separate from the development contractor or organization. IV&V is a software evaluation process that includes both analysis and testing and extends throughout program development. "Verification" analyses software requirements, design, and code to detect program deficiencies before they can propagate into later development phases. "Validation" analyses and tests the final program to determine its compliance with requirements.

3.19 Joint Test Assembly (JTA)/Nuclear.

A configuration developed by the Department of Energy (DoE)/NNSA for use in the Joint Flight Test (JFT) program. It includes or combines the Joint Test Subassembly and DoE war reserve nuclear weapon components to approximate the appearance and physical characteristics of the war reserve configuration without the capability to produce a nuclear yield.

3.20 Lead Command.

The Major Command (MAJCOM) that serves as an operators' interface with the Single Manager for a weapon system as defined by AFPD 10-9. This term is not to be confused with that MAJCOM designated by HQ USAF as Office of Primary Responsibility (OPR) for authoring a requirements document (i.e., that MAJCOM would be the Using Command). In most cases, however, the MAJCOM designated by HQ USAF to sponsor a requirement will become the "Lead Command" for a weapon system.

3.21 Lead Project Officer (LPO).

An LPO is the AFNWC Project Officer responsible for coordinating the efforts of other project officers and Project Officers Group (POG) activities relating to nuclear weapon systems projects. Lead Project Officers/Project Officers Groups manage warheads/bombs, weapon systems, and AMAC activities.

3.22 Major Assembly Release (MAR).

The MAR is a statement prepared and signed by Sandia National Laboratory (SNL) and either Los Alamos National Laboratory (LANL) or Lawrence Livermore National Laboratory (LLNL) and approved and transmitted to DoD by DoE. It states that war reserve (WR) weapon material is

satisfactory for release on a designated effective date to the DoD for specified uses that are possibly qualified by exceptions and limitations.

3.23 Major Range and Test Facility Base (MRTFB).

The MRTFBs are a set of “test” installations, facilities, and ranges which are regarded as "national assets." These assets are sized, operated, and maintained primarily for DoD test and evaluation missions. However, the MRTFB facilities and ranges are also available to commercial and other users on a reimbursable basis (see DoDD 3200.11, Enclosure 2, for a complete MRTFB listing).

3.24 Master Nuclear Certification List (MNCL).

A domain controlled web-site data base that identifies equipment (hardware and software) that is nuclear certified per AFI 63-125. The MNCL is the sole authority for determining equipment certification status and is managed by the AFNWC’s certification management organization.

3.25 Mechanical Interface Control Drawing (MICD).

The MICD defines the physical and mechanical interfaces between the aircraft and the nuclear weapon(s). The MICD includes dimensions, clearances, forces, installations, etc. associated with the gravity weapon’s suspension and release equipment (for aircraft, on the wing or in the weapons bay).

3.26 Military Characteristics (MCs).

A Department of Defense document submitted to the National Nuclear Security Administration (NNSA) that specifies performance requirements and physical characteristics for a nuclear warhead, bomb, or basic assembly to be compatible with a specific weapon system or systems.

3.27 National Nuclear Design Laboratories.

The National Nuclear Design Laboratories consist of two nuclear weapon design laboratories (Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico (NM) and Lawrence Livermore National Laboratory (LLNL) in Livermore, California (CA)) and two supporting laboratories (Sandia National Laboratories (SNL) in NM and CA). The design laboratories are responsible for the design of a Nuclear Explosive Package (NEP) whereas SNL is responsible for the design of the NEP’s non-nuclear supporting safety and security systems. SNL/CA supports LLNL; SNL/NM supports LANL. The Nuclear Labs are structured under the National Nuclear Security Administration (NNSA) within the Department of Energy (DoE).

3.28 National Nuclear Security Administration (NNSA).

The National Nuclear Security Administration is part of the United States Department of Energy. NNSA is the DoE agency responsible for improving national security through the military application of nuclear energy. The NNSA is also responsible for maintaining and improving the safety, reliability, and performance of the United States nuclear weapon stockpile, including the ability to design, produce, and test nuclear weapons, in order to meet national security requirements.

3.29 Non-combat Delivery Vehicle.

A vehicle and its installed equipment used to move, load, or ship nuclear weapons.

3.30 Nuclear Certification.

The Air Force Nuclear Certification Program, defined in AFI 63-125, ensures all procedures, software, personnel, equipment, facilities, and organizations are certified before conducting nuclear operations with nuclear weapons or nuclear weapon systems. Nuclear Certification occurs when a determination is made by the Air Force Nuclear Weapons Center's Commander that: (1) procedures, software, equipment, and facilities are sufficient to perform nuclear weapon functions (Design Certification); and (2) personnel and organizations are capable of performing assigned nuclear missions (Operational Certification).

3.31 Nuclear Certification Impact Statement (NCIS).

The document issued by the Single Manager to initiate the nuclear certification process. This statement advises the Air Force Nuclear Weapons Center's Certification Manager and other certification process owners that a new weapon system or a change to an existing weapon system, equipment item, software, or procedure needs to be evaluated. The process owners determine if this change impacts nuclear certification of the system. If nuclear certification is required, the AFNWC's Certification Engineer releases a Basic Certification Requirements Plan.

3.32 Nuclear Certification Summary (NCS).

A document issued by the Air Force Nuclear Weapons Center's Certification Engineer to advise the Single Manager (SM) that all Design Certification and Operational Certification actions prescribed in the Certification Requirements Plan are complete and nuclear certification is granted.

3.33 Nuclear Compatibility Certification.

Nuclear Compatibility Certification is the process of verifying that the equipment item or weapon system meets design and evaluation requirements for the electrical, mechanical, and aerodynamic interfaces between the delivery vehicle or equipment item and the nuclear weapon. Nuclear Compatibility Certification is a joint effort of DoE/NNSA and DoD to integrate a nuclear weapon into a weapon system.

3.34 Nuclear Compatibility Certification Statement (NCCS).

A document issued by the Air Force Nuclear Weapons Center/NCS when all aspects of compatibility certification have been completed. The NCCS documents the nuclear weapon system configuration, carriage/delivery parameters, test information and references pertaining to compatibility of the delivery system with the nuclear weapon(s). Release of the NCCS constitutes nuclear compatibility certification of the delivery system with the specific weapon indicated. The NCCS is broken into seven (7) sections as follows:

Section I: Aircraft System General Information

Section II: Aircraft Monitor and Control (AMAC) System Components

Section III: Suspension and Release Equipment

Section IV: Compatible Weapon/Equipment Configuration

Section V: Carriage and Employment Limitations

Section VI: AMAC Testers

Section VII: Appendix (to include):

Appendix A: Historical AMAC Testing/Aircraft Types, Locations, Dates

Appendix B: Nuclear Certification Documents Reference (Safety and Compatibility)

Appendix C: Nuclear Certified Technical Orders (TOs)

Appendix D: Open Issues and Restrictions

3.35 Nuclear Safety Cross-Check Analysis (NSCCA).

Nuclear critical software evaluation is accomplished by NSCCA or IV&V. The NSCCA (like the IV&V) is performed by an organization technically, managerially, and financially independent of the developer. The purpose of NSCCA is to ensure the program cannot perform in any way that could contribute to a nuclear safety violation. Analysis and testing focus on ensuring that nuclear safety critical functions are performed correctly and that the program does not perform any unintended functions that could violate nuclear safety.

3.36 Nuclear Safety Design Certification Letter.

A letter issued by Air Force Safety Center (AFSEC) to notify the AFNWC's Certification Manager that all nuclear safety design certification actions have been completed.

3.37 Nuclear Surety.

All functions and activities to ensure Air Force nuclear systems are designed, developed, operated, maintained, transported, and controlled to provide maximum safety to the public and operating personnel while protecting the environment and maintaining reliability to support mission accomplishment.

3.38 Nuclear Weapon.

A nuclear weapon is a device in which an explosion results from energy (equivalent to four (4) pounds or greater of TNT) being released by reactions involving atomic nuclei; reactions may be either by fission, fusion, or both.

3.39 Nuclear Weapon System.

A nuclear weapon system includes: (1) a nuclear weapon and a means for delivering it to the target, (2) associated support equipment, (3) facilities, (4) procedures, (5) personnel, and (6) any vehicles peculiar to the system used for weapon transport.

3.40 Operational Certification.

This occurs when the Lead Command/Using Command qualifies its personnel to perform the mission, certifies them in the Personnel Reliability Program (PRP), trains them in nuclear surety and assigns a Ready rating on an Initial Nuclear Surety Inspection (INSI) or a Satisfactory rating for a NSI. Notification of completion of all Operational Certification requirements identified in the Certification Requirements Plan is made to the AFNWC's Certification Management Organization by the MAJCOM via the Operational Certification Letter (or by signing the CRP when no operational certification impacts exist).

3.41 Operational Plan Data Document (OPDD).

The OPDD is a document that describes normal nuclear weapon system operations in the stockpile-to-target sequence. An OPDD is a source document, used to prepare a Technical Nuclear Safety Analysis (TNSA), which relays to the Nuclear Weapons Safety Study Group

(NWSSG) how the operational command will operate and maintain the nuclear weapon system. The operational command prepares the OPDD. If the OPDD is new or requires change to support an NWSSG study or review, the OPDD is prepared in sufficient time to ensure approval and distribution 6 months before the study is scheduled to begin. The OPDD describes:

- The nuclear weapon system's concept of operations.
- General operations commonly performed regardless of geographical location.
- Significant variations of the general operations.
- Normal operations in the stockpile-to-target sequence during peacetime, wartime, and periods of increased hostilities.
- Operations conducted under contingency plans.

3.42 Project Officers Group (POG).

A working-level body that coordinates activities associated with a particular nuclear weapon/nuclear weapon system. The POG provides a forum for the mutual development and transmission of information describing a new weapon/weapon system or sustainment of an existing weapon system. POG members include DoE and the National Laboratories, NNSA, DTRA, Military Services, using commands and others as required. POG members have the authority to carry out assigned responsibilities of their parent organization and act as points of contact for their agencies in coordinating the development/sustainment of nuclear weapons/systems and in assuring compatibility of associated weapon interfaces. POG functions include:

a. Coordinating the research, development, test, and evaluation activities performed by the Services, MAJCOMS, the using command and the DoE on joint DoE-DoD nuclear weapon/weapon system projects.

b. Providing visibility throughout the nuclear community and parent organizations on issues affecting certification, safety, cost, performance, or other significant matters.

c. Making technological trade-off decisions during the program that do not significantly change MCs or acceptability of the weapon, do not exceed program limits set by DoE-DoD, and remain below threshold program guidance issued by the Assistant to the Secretary of Defense (Nuclear, Chemical, and Biological/ATSD(NCB).

3.43 Pre-arming.

Operations that configure a nuclear weapon system so that arming, firing, launching, or releasing will start the sequence necessary to produce a nuclear detonation. Pre-arming is a critical function.

3.44 Release.

Nuclear weapon release is**:** (1) the intentional separation of a free-fall store from its suspension equipment for purposes of employment of the store, or (2) separation of a missile from a carrier aircraft with the intended result being programmed flight to target. Release is a critical function.

3.45 SEEK EAGLE.

The Air Force certification program for determining safe carriage, employment and jettison limits, safe escape, and ballistics accuracy, when applicable, for all stores in specified loading configurations on USAF aircraft. AFI 63-104, The Seek Eagle Program, assures aircraft-to-store compatibility, including safe-escape distances. AFMC has custody of and responsibility for the Nuclear Hardness Data Base System (NHDBS). The NHDBS is the only place in the AF that manages and maintains the set of data upon which safe-escape distances are determined, along with the scientific and analysis expertise to understand, update and operate the system. NHDBS is a sophisticated modeling and simulation tool, combined with delivery system hardness models, and nuclear weapon outputs models. NHDBS is used to determine the safe-distance a delivery system must obtain before detonation of the delivered nuclear weapon.

3.46 Single Manager (SM).

The SM is the primary single interface to the customer for a system or product group. The Single Managers directs one or more programs and is accountable to the Program Executive Officer (PEO) or the Designated Acquisition Commander (DAC). The Single Manager is vested with full authority, responsibility, and resources to execute a program on behalf of the Air Force. The Single Manager is also responsible for life cycle management of the weapon system. (NOTE**:** The definitions of the terms Single Manager (SM), System Program Manager (SPM), System Support Manager (SSM), and Development System Manager (DSM) (see 3.53) are in various stages of transition and are used interchangeably within existing DoD Directives as the term Single Manager is gradually being phased out and being replaced; within this MIL-STD, the term “Single Manager” is used and may be interpreted as an equivalent term for System Program Manager, Product Group Manager, System Support Manager, Development System Manager, Acquisition Program Manager, Project Manager, Weapon System Manager, or any designated person responsible to the customer and industry partners for overarching programmatic issues).

3.47 Software.

A set of computer programs, procedures, roles, data, and associated documentation (including firmware with programs and data) concerned with the operation of a digital processing system; for example, compilers, library routines, manuals, and software design/data flow diagrams.

3.48 Special Weapons Interface Tester (SWIFT).

The Special Weapons Interface Tester (SWIFT) was developed by the AFNWC/NCSS to conduct: (1) AMAC Certification testing, (2) AMAC Surveillance testing, and (3) other AMAC tests investigating abnormal test results or system abnormalities. These tests measure the aircraft/weapons system interface electrical signals on systems with the capability to carry nuclear bombs. The data obtained from these tests is used to certify that the system design meets the requirements of the System 1 Basic Interface Specification SYS1001, System 2 Basic Interface Specification SYS2001, and to ensure the nuclear weapon system continues to meet design interface specifications as the system ages (Surveillance).

3.49 Statement of Compatibility (SOC).

An NNSA letter documenting the nuclear weapon system is compatible with a specific weapon.

3.50 Stockpile-to-Target Sequence (STS).

a. The order of events involved in moving a nuclear weapon from storage and assembling, testing, transporting, and delivering it on the target.

b. A document that defines the logistical and employment concepts and related normal and abnormal environments, including vulnerability criteria, involved in the delivery of a nuclear weapon from the stockpile to the target. It may also define the logistical flow involved in moving nuclear weapons to and from the stockpile for quality assurance testing, modification and retrofit, and the recycling of limited-life components.

3.51 Support Equipment.

Includes all equipment required to prepare, mate/de-mate, and transport the nuclear weapon to a delivery system. Support equipment includes tools; test equipment; automatic test equipment; organizational, field and depot support equipment; and computers with related software.

3.52 Compatibility Certification (CC) Drawing.

A controlled cruise missile drawing prepared and maintained by the National Nuclear Security Administration's Sandia National Laboratory (NNSA/SNL); SNL designs and integrates the nuclear weapon's safety and security systems. The CC establishes the extent of compatibility and restrictions between a nuclear weapon and the cruise missile (air or ground launched). (Note: There is no equivalent document for warheads on ICBMs. The documents that identify warheads with ground launched ICBMs are defined in the system's MCs, MAR, STS, and ICDs.)

3.53 System Program Manager (SPM)/System Support Manager (SSM)/Development System Manager (DSM).

The SPM is the designated individual with responsibility "for" and authority "to" accomplish program objectives for development, production, and sustainment to meet the user's operational needs. For platform/programs in the acquisition phase, the SPM is accountable for cost, schedule, and performance and is the DoDD 5000.01 Program Manager (PM). Depending on the phase of the system (acquisition or sustainment), the SPM will normally reside at an AFLCMC location. If a program is in acquisition, the SPM will be at a Product Center and will be supported by a System Support Manager (SSM**)** normally located at an ALC. If a program is in sustainment, the SPM will normally reside at the appropriate ALC or other sustainment location and will be supported by a Development System Manager (DSM) normally located at a Product Center.

3.54 User.

The unit (squadron, wing, etc.) actually operating a system on a daily basis.

3.55 Using Command.

The Major Command (MAJCOM) operating a system, subsystem or item of equipment. Generally applies to those operational commands or organizations designated by Headquarters, USAF, to conduct or participate in operations or operational testing (e.g., Air Combat Command (ACC), Air Force Global Strike Command (AFGSC), United States Air Force Europe (USAFE)).

3.56 Acronyms and abbreviations used in this standard.

ACC Air Combat Command

ACCD Aircraft Compatibility Control Drawing

ACO Allied Command Operations

AEC	Atomic Energy Commission
AF	Air Force
AFGSC	Air Force Global Strike Command
AFI	Air Force Instruction
AFLCMC	Air Force Life Cycle Management Center
AFMC	Air Force Materiel Command
AFNWC	Air Force Nuclear Weapons Center
AFOTEC	Air Force Operational Test & Evaluation Center
AFSEC	Air Force Safety Center
AFSEO	Air Force SEEK EAGLE Office
ALCM	Air Launched Cruise Missile
AMAC	Aircraft Monitor and Control
AMSC	Acquisition Management System Control (number)
ASSIST	Acquisition Streamlining and Standardization Information System
BCRP	Basic Certification Requirements Plan
BDU	Bomb Dummy Unit
CBRN	Chemical, Biological, Radiological, and Nuclear
CC	Compatibility Certification Drawing
CD	Command Disable
CEP	Circular Error Probable
CONOPS	Concept of Operations
CRP	Certification Requirements Plan
CTU	Compatibility Test Unit
DAC	Designated Acquisition Commander
DID	Data Item Description
DJTA	Development Joint Test Assembly
DoD	Department of Defense
DODD	Department of Defense Directive
DODI	Department of Defense Instruction

DoE	Department of Energy
DOF	Degrees of Freedom
DSM	Development System Manager
DTRA	Defense Threat Reduction Agency
ECD	Electrical Compatibility Data
ECM	Electronic Countermeasure
EICD	Electrical Interface Control Drawing
EM	Electromagnetic
FDAR	Final Design Approval Report (synonymous with Final Design Analysis Report)
HOB	Height Of Burst
HQ	Headquarters
NHDBS	Nuclear Hardness Data Base System
ICBM	Intercontinental Ballistic Missile
ICD	Initial Capabilities Document (or Interface Control Document)
IV&V	Independent Verification and Validation
JFT	Joint Flight Test
JTA	Joint Test Assembly
INSI	Initial Nuclear Surety Inspection
LANL	Los Alamos Nuclear Laboratory
LLNL	Lawrence Livermore National Laboratory
LPO	Lead Project Officer
M&S	Modeling and Simulation
MAJCOM	Major Command
MAR	Major Assembly Release
MC	Military Characteristics
MCD	Mechanical Compatibility Data
MICD	Mechanical Interface Control Drawing
MNCL	Master Nuclear Certification List
MOA	Memorandum of Agreement

MOU	Memorandum of Understanding
MRTFB	Major Range and Test Facility Base
NCA	Nuclear Capabilities Analysis
NCIS	Nuclear Certification Impact Statement
NCCS	Nuclear Compatibility Certification Statement
NCM	Nuclear Certification Manager
NCS	Nuclear Certification Summary
NEP	Nuclear Explosive Package
NHDBS	Nuclear Hardness Data Base System
NNSA	National Nuclear Security Administration
NPOM	Nuclear Project Officers Meeting
NSCCA	Nuclear Safety Cross-Check Analysis
NWSDD	Nuclear Weapon System Definition Document
NWSSG	Nuclear Weapons Safety Study Group
OPDD	Operational Plan Data Document
OPR	Office of Primary Responsibility
OSS&E	Operational Safety, Suitability, and Effectiveness
PAL	Permissive Action Link
PDR	Preliminary Design Report
PEO	Program Executive Officer
PLS	Pre-arm Load Simulator
POG	Project Officers Group
RA	Responsible Agency
SA	Supporting Agencies
SETU	Static Ejection Test Unit
SM	Single Manager
SNL	Sandia National Laboratories
SOC	Statement of Compatibility
SPO	System Program Office

SPM	System Program Manager
SSM	System Support Manager
STS	Stockpile-to-Target Sequence
SWIFT	Special Weapon Interface Tester
TNSA	Technical Nuclear Safety Analysis
TO	Technical Order
TOMA	Technical Order Management Authority
USAF	United States Air Force
USAFE	United States Air Force Europe
USG	Unique Signal Generator
VFA	Vibration Fly-Around
VV&A	Verification, Validation, and Accreditation
WR	War Reserve
WSSR	Weapon System Safety Rules

4. NUCLEAR WEAPON SYSTEM COMPATIBILITY CERTIFICATION

4.1 Overview

4.1.1 Nuclear compatibility certification.

Nuclear compatibility certification is the process of verifying that the equipment item or weapon system meets design and evaluation requirements for the electrical, mechanical, and aerodynamic interfaces between the delivery vehicle/aircraft or equipment item and the nuclear weapon. Compatibility Certification is a joint effort of DoE/NNSA and DoD to integrate a nuclear weapon into a weapon system and must be monitored for compliance with the four DoD Safety System Standards throughout the weapon system's life cycle.

4.1.1.1 Nuclear compatibility certification responsibility.

DoE/NNSA is responsible for the nuclear weapon and its associated electrical and mechanical interfaces to the DoD supplied equipment item/nuclear weapon system.

4.1.1.1.1 Nuclear bombs.

For nuclear bombs DoE/NNSA is normally responsible for the bomb design to include the connection to the aircraft as documented in the Aircraft Compatibility Control Drawing (ACCD).

4.1.1.1.2 Nuclear warheads.

For nuclear warheads (both ground and air launched systems), DoE/NNSA is responsible for the warhead design and the electrical/mechanical interfaces with the particular missile as documented in the Compatibility Certification (CC) Drawing for cruise missiles, and in the MCs, STS, and ICDs for ICBM warheads.

4.1.1.2 Nuclear weapon system.

DoD is responsible for the nuclear certification of the nuclear weapon system of which one system component is the DoE produced nuclear weapon.

4.1.1.2.1 Responsibility of Project Officers Group (POG).

Extensive coordination and exchange of information is required to successfully accomplish the integration of the weapon to the weapon system. An important means of coordination and exchange of information is through the nuclear weapon POGs (nuclear warhead/bomb, nuclear weapon system, and AMAC POGs). The nuclear weapon POGs are responsible for assuring that nuclear weapon development is in accordance with both DoE and DoD requirements. Nuclear weapon POGs consist of representatives from various DoD and DoE agencies comprising the nuclear community for a given system.

4.1.2 Nuclear compatibility certification process.

The Nuclear Compatibility Certification process begins with the Nuclear Certification Impact Statement (NCIS) and the subsequent approved Certification Requirements Plan (CRP), identifying Compatibility Certification as a requirement, and includes tasks which lead to the publication of a Major Assembly Release (MAR) for new systems, an Aircraft Compatibility Control Drawing (ACCD) for aircraft systems, and a Compatibility Certification (CC) Drawing for cruise missiles. The MAR is a statement prepared and signed by SNL and either LANL or LLNL, and approved and transmitted to DoD by DOE. It states that war reserve (WR) weapon material is satisfactory for release on a designated effective date to the DoD for specified uses that are possibly qualified by exceptions and limitations. The process concludes with the issuance of a Nuclear Compatibility Certification Statement (NCCS) from the AFNWC/NCS or the ICBM Nuclear Certification Manager (NCM) for ICBM Compatibility Certification. The NCCS indicates all Compatibility Certification actions have been successfully completed. The Nuclear Compatibility Certification Statement provides written assurance of the compatibility of the delivery platform with the bomb or warhead. The NCCS may also include operational restrictions if any are required.

4.2 Primary governing directives.

The Nuclear Weapon System Compatibility Certification Authority is derived from the original 1953 MOA between DoD and the Atomic Energy Commission (AEC) which states that “the determination of MCs, suitability, and acceptability (standardization) is a primary function of DoD”, and flows through numerous subsequent DoD and AF acquisition/sustainment directives. Following is a listing of cornerstone “Compatibility Certification” directives:

MOA, An Agreement between the AEC and the DoD for the Development, Production, and Standardization of Atomic Weapons; 21 March 1953

DoDD 3150.1, Joint DoD-DoE Nuclear Weapon Life-Cycle Activities

DoDD 3150.2, DoD Nuclear Weapon System Safety Program

DoDI 5030.55, DoD Procedures for Joint DoD-DoE Nuclear Weapons Life Cycle Activities

NNSA/USAF MOU DE-GM04-94AL94738, Joint Testing and Assessment of the Nuclear Weapons Stockpile, 16 Feb 2001

AFJI 21-301/AR 25-36/OPNAVINST 5600.22/MCO 5215.9/DLAR 4151.9, Interservicing of Technical Manuals and Related Technology

AFI 63-101, Acquisition and Sustainment Life Cycle Management

AFI 63-103, Joint Air Force-National Nuclear Security Administration (AF-NNSA) Nuclear Weapons Life Cycle Management

AFI 63-104, The SEEK EAGLE Program

AFI 63-125, Nuclear Certification Program

AFI 63-1201, Life Cycle Systems Engineering

AFPD 63-1/20-1, Integrated Life Cycle Management

System 1: Basic Interface Specification Standard No. SYS 1001

System 2: Basic Interface Specification Standard No. SYS 2001

MOU, NO DE-GM04-2001AL77133, Agreement on Division of Responsibilities for Aircraft Monitor and Control (AMAC) Systems Design Requirements and Compatibility Testing, November 14, 2001

Dash 1 Technical Orders Series

(11N) Series Technical Orders

Dash 21 Technical Orders Series

NSW OI 99-01, Aircraft Monitor and Control (AMAC) Testing, 25 February 2010

4.3 Compatibility certification activities/aircraft.

The description below of compatibility activities is general in nature; specific compatibility certification requirements will be contained in the CRP and will be determined by the program's scope and for existing weapon systems undergoing modification, the overall impact on nuclear certification. Cruise Missiles and Ground Launched Missiles (described in 4.4 and 4.5 below) are subject to Compatibility Certification activities similar to those of an aircraft/bomb with the exception that a CC is developed in place of the ACCD for Cruise Missiles, and MCs, STS, and ICDs for Ground Launched Missiles.

a. Develop Six (6) Degrees of Freedom (6 DOF) model of nuclear weapon system and conduct system analysis using computer simulation (Responsible Agency (RA): Sandia National Labs (SNL)/Supporting Agencies (SA): AFNWC.)

b. Wind tunnel tests (RA: Single Manager (SM)/SA: SNL/Contractors/AFNWC).

c. Lug and sway brace loads analysis (RA: SM/SA: Contractors/AFNWC/SNL).

d. Static ejection tests (RA: SM/SA: Contractors/AFNWC/SNL).

e. EM test and analysis (RA: SM/SA: SNL/Contractors/AFNWC).

f. Mechanical fit tests (RA: Program Office/SA: SNL/Contractors/AFNWC).

g. Vibration flight tests and analysis (RA: SM/SA: Contractors/AFNWC/SNL.).

h. Non-Combat Delivery Vehicles tests and analysis of (RA: SM/SA: Contractors/AFNWC/SNL).

i. Weapon separation tests/analysis (RA: SM SA: Contractors/AFNWC/SNL).

j. Develop Mechanical Interface Control Drawing (RA: SM/SA: Contractor/SNL/AFNWC).

k. Develop Preliminary Design Report (PDR) (RA: SM/SA: Contractor/SNL/AFNWC).

l. Develop Final Design Approval Report (FDAR) (RA: SM/SA: Contractor/SNL/AFNWC).

m. Develop Electrical Interface Control Drawing (RA: SM/SA: Contractor/SNL/AFNWC).

n. FDAR analysis (RA: SM/SA: Contractor/SNL/AFNWC).

o. Preliminary weapon/aircraft electrical interface tests (RA: SM/SA: SNL/Contractors/AFMWC).

p. Weapon/aircraft interface and AMAC electrical tests (RA: AFNWC/SA: SNL/Contractors).

q. Full weapon system demonstration/drop test (RA: SM/SA: SNL/AFNWC).

r. Publish ACCD/CC/Statement of Compatibility (RA: DoE/NNSA/SNL).

s. 6 DOF model Verification, Validation, & Accreditation (VV&A) (RA: SNL/SA: AFNWC).

t. Sign/approve/release Nuclear Compatibility Certification Statement (NCCS) (RA: AFNWC).

4.3.1 Nuclear weapon system compatibility certification activities.

Following is an expanded description of each nuclear weapon system compatibility certification activity:

4.3.1.1 Six (6) Degrees of Freedom (6 DOF) system analysis.

Modern day high-speed computers, combined with proven Modeling and Simulation (M&S) techniques, allow very complex system interactions to be accurately represented throughout the range of expected operations. Common techniques consider six-degrees of freedom (6 DOF) models that are analyzed through finite-element/matrix analysis. The 6 DOF model/analysis allow potential critical operations to be identified and aids in the development of follow-on wind tunnel and separation test planning

4.3.1.2 Wind tunnel tests.

Wind tunnel tests are normally performed to obtain: (1) store loads data; and (2) separation data prior to conducting flight tests. The USAF is interested in obtaining data associated with loads imposed on the aircraft by the store while SNL is most interested in information about the loads imposed on the bombs/warheads. The key to successful wind tunnel testing is to get involved early in an aircraft development program when the aircraft contractor is conducting wind tunnel testing for conventional stores. At this point the costs are minimal and the facilities and test hardware are available. The wind tunnel tests are generally performed in DoD facilities with the DoD paying for tests involving new aircraft and the DoE paying for tests on new bombs.

4.3.1.3 Lug and sway brace loads analysis.

The purpose of the lug and sway brace analysis program is to determine the mechanical loads imposed on weapon lugs and on the weapon case where the lugs attach and where the bomb rack sway braces make contact during carriage. The loads are determined for the full flight envelope of the aircraft. The flight envelope is a definition of mach number or speed versus altitude requirements for the aircraft. The bomb is designed to a set of requirements based on aircraft type called out in the original Military Characteristics (MCs) and this analysis verifies that the aircraft being added to the requirements (if that is the case) does not impose higher loads on the lugs and on the weapon case. Although it is possible to directly measure these loads by

using instrumented bomb test units, this has been found to be prohibitively expensive and so other means of producing the required data have been developed. Bomb case loads for external carriage are generally predicted (using 6 DOF M&S) based on the aerodynamic characteristics which have been measured in wind tunnel tests and the performance characteristics of the aircraft.

4.3.1.4 Static ejection tests.

Static ejection tests are run for initial compatibility and whenever questions arise about the magnitude of shock spectra that will be imposed on bomb components during ejection. A newly designed or redesigned rack will undergo static ejection testing. When an ejector cartridge's performance is changed, the modified cartridge will require static ejection testing. Static ejection tests can also be used to help determine the bomb pitch and ejection velocity that will occur during weapon release. The test configuration generally consists of a DoD supplied rack mounted on a relatively rigid beam with the SNL-supplied Static Ejection Test Unit (SETU). The SETU is a specially designed test unit containing components that have been instrumented to measure the shock spectra; data is collected for later analysis. The unit is ejected off the rack and the acceleration data spectra are recorded. A video of the test is usually recorded using a high speed camera to record pitch angle and velocity information. The tests may be run at a contractor facility or at a DoD engineering facility. These tests may also be run with the rack mounted on a real aircraft in order to get real-world (less severe) results.

4.3.1.5 Electromagnetic (EM) test and analysis.

Modern military aircraft are exposed to a very complex electromagnetic environment. Onboard sources include UHF, VHF, and EHF communication transmitters, radars, and electronic warfare equipment such as Electronic Counter-Measures (ECM) pods. The aircraft may also be exposed to significant EM fields due to external sources such as radars and communication transmitters both on the ground and on nearby aircraft. In general, nuclear weapons are designed to be safe and reliable when exposed to a set of EM environments that are specified in the Stockpile-to-Target Sequence (STS). These environments include the EM exposure that a bomb will see when carried on the aircraft specified in the MCs. When a new aircraft is designed that has a requirement to carry nuclear weapons, the EM environments at weapon carriage points must be determined to verify that they are below the STS limits. Aircraft with an established nuclear weapon capability may have new equipment added to its store list and this new equipment may change the expected EM environments at nuclear weapon carriage locations. Again, the EM exposure that the weapons will see must be determined. Predictions of the electromagnetic fields expected at nuclear weapon locations due to radiators on new aircraft or new radiators on existing aircraft are usually generated by the DoD (by either a contractor or by a DoD engineering laboratory) based on radiator design parameters such as the peak and average power, antenna gain, and physical proximity to weapon locations. SNL engineers may also perform some worst case calculations based on these same parameters. If the field strength predictions are remotely close to the weapon design limits, a test will be conducted on the aircraft to determine the actual field strength.

4.3.1.6 Survivability analyses and test.

Nuclear survivability requirements are included in the STS for nuclear weapons. Nuclear weapons and their delivery aircraft are designed to be safe and reliable when exposed to the set of nuclear effects environments specified in the STS. Support equipment may experience nuclear effects environments on the ground, which is one phase in the STS. If support equipment is not survivable, nuclear weapons cannot be employed in their prescribed manner. Nuclear environments are typically specified for different operational employment phases of the weapon's life cycle. These environments include thermal, overpressure, gust, and ionizing

radiation exposure that a bomb will see when on the ground and when carried on the aircraft. When a new aircraft has a requirement to carry nuclear weapons, nuclear environments must be analyzed in accordance with the aircraft's operational processes and procedures to verify that nuclear effects environments are below the weapon's STS limits. Aircraft with established nuclear weapon capability may have new equipment added to its store list. This new equipment must be assessed to assure that it meets or exceeds survivability levels. Predictions of the nuclear effects environments expected on new or existing aircraft are usually generated by the DoD (by either a contractor or by AFNWC/NCA) based on parameters such as the number, types, yields, height of bursts (HOBs), and CEPs of weapons expected to detonate near the Air Force Base under attack. SNL engineers may also perform some worst case calculations based on these same parameters. If nuclear effects environment predictions are more than 25% of the inherent survivability design limits of nuclear compatible equipment, testing of the equipment should be conducted to determine the design has margin.

4.3.1.7 Mechanical fit tests.

Mechanical fit tests are performed to verify the information given in the MICDs. SNL supplied CTUs are loaded on operational aircraft and measurements are made of the spaces and dimensions that are critical to bomb/aircraft compatibility. These dimensions are compared with those given in the MICDs. The mechanical fit tests are usually performed at the same time as the five-aircraft AMAC electrical interface tests to get a measure of variability; preliminary fit tests are performed earlier to uncover incompatibilities in time for them to be corrected.

4.3.1.8 Vibration Fly-Around (VFA) tests and analysis.

The purpose of the VFA tests and analyses is to determine the vibration environment imposed on components inside the bombs when carried on the aircraft. The aircraft with the VFA test unit loaded in the configurations of concern, is flown at various mach number-altitude points within the desired flight envelope that, by analysis, have been determined to provide the worst-case vibration environments to the weapon. The vibration spectra obtained from this flight testing must be lower than the spectra for which the weapon components were originally designed in order for the aircraft to be judged as compatible with a particular bomb. The VFA test units are supplied by SNL. They may use either air-to-ground telemetry or an onboard recorder to acquire data. The VFA test units duplicate the War Reserve (WR) mass properties and will have the real components or mass mockups of the components of concern installed. The components of concern are instrumented with accelerometers. The aircraft are supplied and operated by the DoD; the tests are staged out of a DoD test base and flown over a DoD or DoE test range.

4.3.1.9 Non-combat delivery vehicle test and analysis.

Non-Combat vehicles are tested to verify that the vehicle does not allow environmental inputs (e.g. for example, shock or vibration) into the weapon that may be detrimental to the weapon's nuclear surety. The tests will use representative test assets of sufficient high fidelity to ensure capturing realistic environmental data. The mechanical compatibility test shall also include monitoring and analysis of static and dynamic inputs to the weapon produced and transferred by the Non-Combat Delivery Vehicles. Some common environments per the STS are transportation loads and mate and de-mate loads.

4.3.1.10 Weapon separation tests and analysis.

The purpose of this work is to assure the safe release of weapons from aircraft throughout the flight envelope as described in the Concept of Operations (CONOPs). The test units are generally Bomb Dummy Units (BDUs) supplied by the DoD, but may be weapon development units supplied by SNL. The data acquired in the weapon separation tests is usually in the form

of video taken from the release aircraft or from a chase aircraft. The USAF may also perform some computer analysis on the video to determine trajectory, orientation, and other important parameters. This data is used by the USAF to verify safety, accuracy, and other information. The video and computer-generated data are supplied to SNL for their analysis. SNL engineers use this information to verify that the bomb is released from the aircraft with the proper aerodynamic parameters. In a retarded drop, the weapon must not pitch or yaw beyond certain limits so that the parachute will operate correctly. Tests are also conducted at the extremes of the flight envelope to verify repeatable ballistics for freefall units or proper decelerations to operate weapon Environmental Sensing Devices.

4.3.1.11 Develop Mechanical Interface Control Drawing (MICD).

MICDs document the physical configuration of an aircraft loaded with bombs. The drawings are generally produced by a DoD contractor or by the USAF. The MICD is signed by the originator, the USAF contracting office, and SNL. The signatures are an indication that the drawing is complete and that it fully depicts the aircraft and the installation of nuclear bombs. Revisions to the MICD are submitted to the USAF for review and approval. The MICD consists of at least the following:

a. Signature block for responsible agency representatives.

b. The aircraft external configuration.

c. The aircraft pylons with bombs installed configuration.

d. The aircraft weapons bay with bombs installed configuration.

e. Ejector rack, pullout cables, and other details.

f. References to drawings to include the aircraft, the ejector rack, the appropriate bombs, and other items such as ECM pods, fuel tanks, and missiles.

4.3.1.12 Develop Preliminary Design Report (PDR).

In the early stages of a new aircraft design, a PDR is produced and reviewed in order to aid the designer in producing a certifiable AMAC design and supporting the preliminary AMAC test. The PDR consists of a report of hardware and software information which must describe and define the design concept to the extent that the components, as well as the operational capability of the system, are clearly understood. The PDR is prepared and presented by the AMAC designer to SNL and DoD (AFNWC/NCS) at a time sufficiently in advance of final design submittal as to allow for design changes. Any changes occurring after PDR must be concurred by all concerned prior to inclusion in the Final Design Approval Report (FDAR).

4.3.1.13 Develop Final Design Approval Report (FDAR).

The FDAR is a document required by all Aircraft Monitor and Control (AMAC) specifications that documents the AMAC design and ensures the AMAC system meets the AMAC specifications. It contains an electrical analysis of the AMAC system, including power supply characteristics, switching logic, monitoring circuitry logic, individual component characteristics and digital or analog control logic. In the case of an aircraft with an integrated AMAC, such as the F-16, it also contains a description of the software used to control the weapon interface. An FDAR shows a comparison of conservative design results obtained from analysis versus AMAC specification requirements. The FDAR is prepared by the designer of the AMAC system. The completed FDAR is reviewed and approved by SNL and the DoD (AFNWC/NCS).

4.3.1.14 Develop Electrical Interface Control Drawing (EICD).

The EICD is a signature-controlled drawing set detailing the aircraft/nuclear interface and associated electrical systems. The FDAR is part of the EICD; the EICD must be provided to the using agency in the same time frame as the FDAR. Revisions to the EICD are submitted to DoD and SNL for review and approval. The EICD is signed by the originator, the USAF contracting office, and SNL. The items listed below are included in the EICD. Release system information is to be included as required by the using agency. The EICD consists of at least the following:

a. Signature Block for responsible agency representative.

b. System Block Diagram of the aircraft AMAC and release electrical systems.

c. Aircraft AMAC system schematic.

d. Aircraft release system schematic.

e. Aircraft AMAC and release component descriptions.

f. Aircraft AMAC and release power source descriptions.

g. List of drawings that define the nuclear weapons, ancillary test equipment, and training devices appropriate to the aircraft.

h. FDAR (provided separately).

4.3.1.15 FDAR analysis.

The FDAR is reviewed by the DoD and by SNL (Aircraft Compatibility Department) for completeness and accuracy to determine whether or not the aircraft meets the appropriate interface specification. The FDAR is formally approved by SNL and the DoD. The FDAR and EICD are the prime source documents used in the preparation of a test plan for the AMAC certification tests discussed below. The analyses in the FDAR for interface voltage levels are worst case; thus, it is expected that actual measurements will yield less severe results.

4.3.1.16 Preliminary weapon/aircraft electrical interface tests.

Preliminary aircraft/weapon electrical interface tests are not a requirement for the release of an ACCD but they are generally run as part of a nuclear compatibility certification program for a new aircraft or for an aircraft undergoing significant modifications. The purpose of these tests is to verify that the design at a given point in time will lead to the system meeting nuclear compatibility certification requirements. The PDR supports a preliminary AMAC test. The five-aircraft AMAC tests, described in the next section, are run for the purpose of verifying that operational aircraft actually meet their nuclear compatibility certification requirements. It is a good engineering practice to test the aircraft AMAC system as early as possible when developing a new weapon delivery system or performing a major upgrade. The preliminary AMAC tests may be run on laboratory hardware before full aircraft hardware is available or they may be run on test aircraft that are being used to evaluate the new design, or both.

4.3.1.17 Weapon/aircraft interface and AMAC electrical tests.

The purpose of the AMAC electrical interface testing is to ascertain compliance of the aircraft AMAC system with the required AMAC specification and to establish that the aircraft is indeed electrically compatible with the required set of nuclear weapons. The electrical interface tests are typically some of the last tests to be run in an AMAC certification program. The tests are

performed on up to five production aircraft that have been prepared according to USAF Technical Orders (TOs). The number five was chosen, based on experience and the hyper-geometric mathematical probability model (see Appendix A), to provide the necessary statistical confidence to detect variability between aircraft and to make the test program tractable. The AMAC electrical testing is divided into two parts: ground and air. The ground tests are, in turn, divided into AMAC specification compliance tests and electrical functional tests. The air tests consist of only electrical functional tests. The AMAC specification compliance tests checks the ability of the AMAC system to provide the electrical interface required by the appropriate AMAC specification. Maximum and minimum electrical loads are applied to the interface, and the resulting interface voltages/currents are measured. The PAL, USG, and CD (if capable) signals are evaluated for load-handling capability and for the proper number of pulses for timing, pulse amplitudes, rise and fall times, and noise. The functional tests are used to evaluate the ability of the aircraft AMAC system to properly pre-arm and safe nuclear bombs. Compatibility Test Units (CTUs), which are virtually identical to WR bombs (except for a dummy warhead), are connected to the aircraft AMAC through an electrical breakout box which allows for the measurement of the voltages and currents on all lines used to monitor and control the nuclear bomb. The interface measurement instrumentation also has the capability to monitor transients and noise. The aircraft AMAC system is then used to pre-arm and safe the CTU (including PAL, USG, and CD operations), and the electrical signals transmitted between the aircraft and the bombs are recorded. The ground tests described above are initially done on five aircraft. For the AMAC specification compliance tests, the aircraft engines are running and the AMAC system is powered by aircraft power since interface voltage levels under load are critical. For the functional electrical interface tests, the AMAC may be powered by either aircraft power or by auxiliary power carts, since functionality and sequencing are the important parameters. Functional compatibility tests are also run on aircraft in flight. A battery-powered data acquisition system mounted in specially designed CTUs is used to record electrical data transmitted between the aircraft and the bomb. The data is read out and analyzed after the flight is completed. One in-flight functional interface test is done for each bomb type to be evaluated.

4.3.1.18 Full weapon system drop test.

The purpose of this test is to exercise the whole weapon system from beginning to end. SNL and the DoE provide a bomb test unit that, as nearly as possible, duplicates the features of a real WR bomb. The test units are transferred to the DoD/USAF who then handle the weapon as if it were real. It is necessary to use operational aircraft, maintenance crews, weapon loading crews, flight crews, and Technical Orders. The USAF crews are given the task of delivering the test unit to a target. The target is typically an instrumented test range, such as Tonopah Test Range, where the delivery parameters of the weapon can be measured as the weapon separates from the aircraft and falls to the target. This is the only test that evaluates the entire system.

4.3.1.19 Publish Aircraft Compatibility Control Drawing (ACCD)/Statement of Compatibility (SOC).

The Statement of Compatibility is issued by SNL ensuring the ACCD will be updated. The ACCD is a document that is referenced by the Major Assembly Release (MAR) for each nuclear gravity bomb. The ACCD contains a listing of the nuclear weapon's capable aircraft documenting conditions and restrictions for loading, carriage, and delivery. The ACCD documents that SNL and NNSA are satisfied that carriage and release of the bomb on that aircraft will not affect the assigned reliability numbers; i.e., the aircraft meets all the electrical and mechanical requirements to carry the bomb, and the environments that the bomb will experience while on the aircraft are within those described in the current bomb STS. The MAR

is an NNSA statement that WR weapon material is satisfactory for release to the Department of Defense (DoD) for specified capabilities and uses. It is prepared by SNL and the appropriate physics laboratory (either Los Alamos National Laboratory or Lawrence Livermore National Laboratory) and approved by DoE. The MAR may be qualified by limitations and exceptions. The MAR is published by NNSA and distributed to the DoD in a joint service technical manual.

4.3.1.20 Verification, Validation & Accreditation (VV&A) of the 6 DOF Model

Throughout the process of the nuclear weapon system's compatibility certification, actual test results will be compared to Modeling and Simulation (M&S) results that may result in changes to assumptions and techniques employed to ensure the model accurately represents the system throughout the spectrum of expected operations. The VV&A process ensures: (1) Verification that the computer simulation/programming yields expected results, (2) Validation that the model adequately represents the actual system, and (3) Accreditation that the user has a high confidence in using the model results. Once the 6 DOF model has undergone the VV&A process, the model may be used in lieu of actual wind tunnel and separation tests to conduct post-compatibility certification system analyses.

4.3.1.21 Nuclear Compatibility Certification Statement (NCCS).

The NCCS is issued by the AFNWC's Nuclear Systems Division (AFNWC/NCS) when all aspects of the nuclear weapon system's compatibility certification have been completed. The NCCS documents the nuclear weapon system configuration, carriage/delivery parameters, test information and references pertaining to compatibility of the delivery system with the nuclear weapon(s). Release of the NCCS constitutes nuclear compatibility certification of the delivery system with the specific weapon indicated; the NCCS is forwarded to the AFNWC/NCS's certification organization as part of the overall nuclear certification package.

4.4 Compatibility certification activities/air-launched cruise missile.

For air launched cruise missiles carried on aircraft, the certification tasks are similar to aircraft certification tasks described in the previous section; a CC is required for air-launched cruise missiles since the warhead interface is with the missile. Interface Control Drawings (ICD) are developed, or updated, to define electrical and mechanical design requirements between the delivery platform (missile) and the warhead. An ICD is also developed to define the electrical and mechanical design requirements between the aircraft and the missile. Interface requirements must be established early in the program so that DoE requirements are reflected throughout the weapon system. It is important to note that changes to the aircraft/missile interface do not necessarily affect the MAR/CC. However, changes to the warhead/missile interface directly impact the MAR/CC. (Note: There are no EICD/MICD requirements for cruise missiles. Interface definition is handled by the ICDs with certification compliance documented in the CC.)

4.5 Compatibility certification activities/ground launched missile.

A MC for a ground launched missile warhead is a DoD prepared document submitted to the NNSA that specifies performance requirements and physical characteristics for a nuclear warhead to be compatible with a specific weapon system or systems. A STS is the DoD document that defines the logistical and employment concepts and related normal and abnormal environments, including vulnerability criteria, involved in the delivery of a nuclear weapon from the stockpile to the target. It may also define the logistical flow involved in moving nuclear weapons to and from the stockpile for quality assurance testing, modification and retrofit, and the recycling of limited-life components. Interface Control Drawings (ICDs) are developed or updated, as appropriate, by the DoD to define electrical and mechanical

requirements between the delivery platform (missile) and the warhead. ICD interface requirements must be defined jointly by DoD and NNSA early in the program and updated as appropriate so that DoE interface requirements are reflected throughout the weapon system. A MAR for a ground launched missile is a NNSA approved statement that war reserve (WR) weapon material is satisfactory for release on a designated effective date to the DoD for specified uses which are qualified by exceptions and limitations. The MAR identifies the applicable requirements documents (MCs and STS) and interface control documents (ICDs). The MAR is prepared by Sandia National Laboratories and approved by NNSA, Sandia National Laboratories and either Los Alamos National Laboratory or Lawrence Livermore National Laboratory. Issuance of the MAR indicates the completion of the missile/warhead compatibility analysis and documentation required for nuclear certification. It must be emphasized that changes to the warhead/missile interface can directly impact the MC, STS, ICDs and MAR. Issuance of the STS and MC by the DoD, the MAR by DoE/NNSA, as well as the jointly defined NNSA/DoD ICDs, culminates the missile/warhead compatibility analysis and documentation required for nuclear certification.

4.6 Primary participants/roles.

The Compatibility Certification process requires significant involvement throughout the development community. Participants include, but are not limited to: (1) the Single Manage; (2) AFNWC/NCS or the ICBM NCM; (3) Sandia National Laboratories (SNL); (4) the lead and using MAJCOMs, and when needed; (5) the Air Force SEEK EAGLE Office (AFSEO) and a variety of test and evaluation organizations including contractors.

4.6.1 Single manager or nuclear certification manager.

To obtain Compatibility Certification for gravity weapon systems, the Single Manager or Nuclear Certification Manager generates the required Compatibility Certification documents such as the Nuclear Certification Impact Statement, Electrical Interface Control Drawing (EICD), Mechanical Interface Control Drawing (MICD), Preliminary Design Report (PDR), Final Design Approval Report (FDAR), and appropriate technical orders as specified in the Certification Requirements Plan. For cruise missile and ICBM systems, the Single Manager is responsible for updating appropriate interface documents.

4.6.2 AFNWC/NCS or ICBM NCM.

If the Certification Requirements Plan identifies requirements for testing and analysis to complete the Compatibility Certification process, then the AFNWC/NCS (for aircraft systems) or the ICBM NCM (for ICBM systems) will coordinate the necessary testing, demonstration and analysis with the appropriate test organizations, and the National Nuclear Security Administration, as needed. The AFNWC/NCS issues or updates the Nuclear Compatibility Certification Statement for aircraft systems and the ICBM NCM is responsible for the compatibility certification of ICBM systems. For aircraft systems, the AFNWC/NCS and SNL will determine the AMAC testing necessary for each aircraft nuclear weapon system. The AFNWC/NCS will conduct and direct testing as required. The results of AMAC testing are maintained in a database. These results are published in a test report following each test and used as source data justifying nuclear compatibility certification. The AFNWC/NCS provides AMAC test results to the system's Single Manager and briefs these results at the weapon delivery system's Nuclear Project Officers Meeting (NPOM).

4.6.3 Sandia National Laboratories (SNL).

The aircraft compatibility department at Sandia National Laboratories (SNL) has the responsibility to assure that the aircraft/missiles that have been designed to carry and release

nuclear weapons are indeed compatible with the nuclear bombs/warheads. SNL personnel work with the Air Force and their contractors to ensure that electrical, mechanical, and aerodynamic compatibility certification requirements are fully understood, and are full participants in conducting required compatibility certification testing, demonstrations, and analyses. At the conclusion of an aircraft/missile compatibility certification program, SNL updates the Aircraft Compatibility Control Drawing (ACCD) for aircraft or the Compatibility Certification (CC) Drawing for cruise missiles for inclusion into the Major Assembly Release (MAR).

4.6.4 Lead/using MAJCOM.

The Lead Command is the MAJCOM that serves as the operators' interface with the Single Manager for a weapon system (i.e., Air Combat Command for the B-2 and F-15). The Using Commands are the MAJCOMs that operate the weapon system, subsystem or equipment item (i.e., USAFE for F-16s and F-15s). HQ USAF designates operational commands or organizations authorized to conduct or participate in operations or operational testing. In addition to all other testing and analysis, the responsible MAJCOM determines if a system requires further testing of the release interface with the weapon delivery vehicle. If flight clearance or safe separation test and analysis are required, the MAJCOM conducts tests and submits test data to the Air Force SEEK EAGLE Office (AFSEO) and the appropriate System Program Office.

4.6.5 Air Force SEEK EAGLE Office (AFSEO).

The Air Force SEEK EAGLE certification program determines safe upload and download procedures, flight limits for safe carriage, employment, jettison, safe escape, and ballistic accuracy for all nuclear weapons and for associated suspension equipment, tanks, and pods carried internally or externally on the aircraft. The AFSEO will initiate updates to appropriate aircraft technical orders and flight manuals as a result of their activities. Recertification is required for any change which alters the aerodynamic characteristics of the aircraft or store, and ejection characteristics of the suspension equipment.

4.6.6 Test Squadrons.

Various flight test and evaluation organizations including the 49th Test & Evaluation Squadron, 72nd Test Squadron, 576th Flight Test Squadron, and the Air Force Operational Test and Evaluation Center (AFOTEC) provide additional assistance to the AFSEO when operational testing aboard an aircraft platform (such as AMAC testing, follow-on VFA testing, etc.) is required.

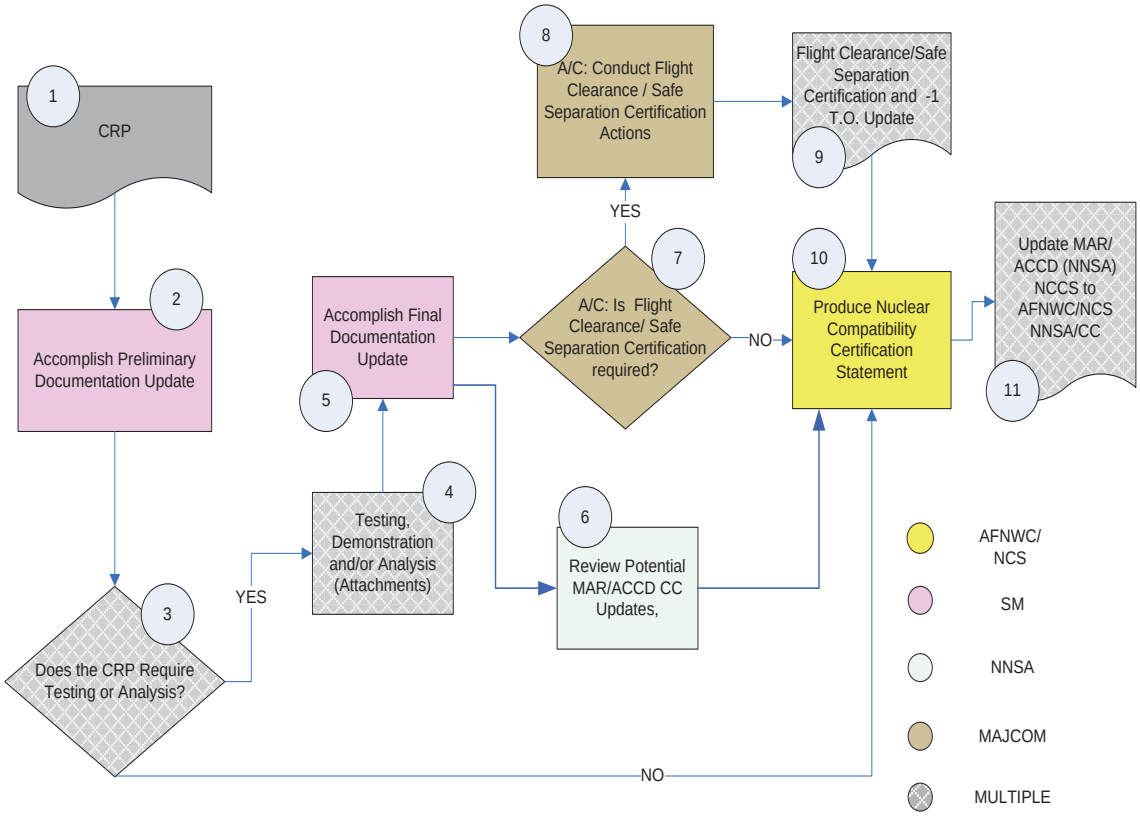

FIGURE 1. Aircraft compatibility certification process.

4.7 Nuclear compatibility certification process.

The Compatibility Certification process for aircraft, gravity weapons, air-launched cruise missiles, ground-launched missiles, and ICBM weapon systems is initiated by a Nuclear Certification Impact Statement followed by a Basic Certification Requirements Plan (BCRP) that is coordinated through the process owners. The simple flow chart above illustrates the process. The coordinated BCRP becomes a Certification Requirements Plan (CRP/FIGURE B-1, Block 1) that addresses the required compatibility certification actions to include testing, demonstrations and/or analysis (all actions required for the AFNWC/NCS or the ICBM NCM to issue the Nuclear Compatibility Certification Statement (NCCS)). The CRP is coordinated with the process owners and action agencies for final signature as an acknowledgement that all agree with the CRP activities and schedule. To obtain gravity weapon compatibility certification, the Single Manager is required to generate compatibility certification documents such as the Electrical Interface Control Drawing (EICD), Mechanical Interface Control Drawing (MICD), and a Final Design Approval Report (FDAR) as specified in the Certification Requirements Plan (FIGURE 1, Block 2). For ICBM systems, the ICBM NCM is responsible for generation of the required documents.

4.7.1 Aircraft/Air Launched Cruise Missile Systems Compatibility Certification.

The AFNWC/NCS will review the compatibility certification documentation and coordinate necessary testing , demonstration or analysis identified in the Certification Requirements Plan (FIGURE 1, Block 3) with the Single Manager (reference Appendix B). If no additional testing,

demonstration or analysis is required, then the AFNWC/NCS will issue the Nuclear Compatibility Certification Statement (FIGURE 1, Blocks 10 and 11). If testing is required to satisfy certification requirements, the AFNWC/NCS will coordinate required tests and analysis with the appropriate test organizations (e.g., 49th Test & Evaluation Squadron, Air Force SEEK EAGLE Office (AFSEO), etc.) and the DoE National Nuclear Security Agency (NNSA) as required (FIGURE 1, Block 4). If the results meet the standards and specifications, the Single Manager updates all the appropriate engineering documents and technical data (FIGURE 1, Block 5). The approval package provides the complete design analysis of all circuits, components, etc., needed to demonstrate compliance with the appropriate design criteria.

a. The AFNWC/NCS interfaces and coordinates with DoE/NNSA (via Sandia National Laboratory) through the weapons system POG to obtain or update the Major Assembly Release (MAR) and/or Aircraft Compatibility Control Drawing (ACCD) and/or CC Drawing as appropriate. DoE/NNSA will document the initial release or update to the nuclear weapon MAR, CC Drawing, and ACCD, as appropriate (FIGURE 1, Block 6).

b. The MAJCOM reviews the CRP for requirements to test and/or analyze the need for a Flight and or Safe Separation Clearance test. If further testing is required the MAJCOM will coordinate with the Air Force SEEK EAGLE Office/Aircraft System Program Office (SPO) to provide the appropriate flight clearance and safe separation certification (FIGURE 1, Blocks 7 and 8).

c. Once the required tests and analyses have been completed, and the results comply with the standards and specifications, the Air Force SEEK EAGLE Office submits a Clearance/Safe Separation Certification letter to the Single Manager. The Single Manager updates the appropriate -1 Technical Orders with flight clearance and safe separation certification results. The Air Force SEEK EAGLE Office or applicable aircraft Single Manager will also initiate updates to other appropriate aircraft technical orders and flight manuals (FIGURE 1, Block 9).

d. Upon completion of all actions identified in the CRP for compatibility certification, the AFNWC/NCSS will provide the Nuclear Compatibility Certification Statement to the AFNWC/NCS (FIGURE 1, Blocks 10 and 11).

4.7.2 ICBM Compatibility Certification.

Compatibility Certification for ICBMs is similar to that for aircraft systems as it certifies the equipment item or weapon system meets mechanical and electrical compatibility requirements between the delivery vehicle and the nuclear weapon. ICBM Compatibility Certification is the responsibility of the ICBM NCM in coordination with Air Force Global Strike Command (AFGSC). Interface and coordination with Weapons Systems Division and DoE/NNSA is required to obtain the MAR, if necessary (FIGURE 1, Block 6). Any special testing or analysis necessary to complete the compatibility certification will be identified in the Certification Requirements Plan. After all compatibility certification requirements have been met, the ICBM NCM, in coordination with AFGSC, will issue the Nuclear Compatibility Certification Statement and provide it to the AFNWC/NCS.

5. EVALUATION REQUIREMENTS

5.1 Scope.

If a determination is made that a nuclear system requires nuclear compatibility certification, analysis and/or testing must be accomplished to evaluate and establish the system's nuclear compatibility certification (reference Appendix B). The responsible agency to ensure these

requirements are met is the system procurement/development organization that has program management responsibility; the responsible organization will designate a Single Manager to manage and overlook the nuclear compatibility certification process. The standard practices leading to a nuclear weapon system's nuclear compatibility certification are described in Section 4 and Appendixes A, B, and C.

5.2. Nuclear weapon system compatibility certification requirements.

This section lists specific requirements for tasks, analyses, and tests (identified in the Certification Requirements Plan (CRP)) necessary to show compatibility between the DoD developed nuclear weapon system and the NNSA developed nuclear weapons which it employs. The result of these tasks will be: (1) a Major Assembly Release (MAR) for bombs and warheads, (2) an Aircraft Compatibility Control Drawing (ACCD) for bombs, (3) a Compatibility Certification (CC) Drawing for cruise missile warheads, (4) a Statement of Compatibility (SOC), (5) a Nuclear Compatibility Certification Statement (NCCS), and (6) a Nuclear Certification Summary (NCS). The MAR, ACCD, CC, and SOC are DoE/NNSA generated documents; the NCCS and NCS are DoD/AF generated documents.

5.2.1 Aircraft with gravity weapons.

5.2.1.1 Aircraft Monitor and Control (AMAC) system.

The AMAC system will be analyzed and tested to ensure it meets the design and nuclear safety requirements. The results of these analyses and tests will be documented in two design reports: the AMAC Preliminary Design Report (PDR) and the Final Design Approval Report (FDAR). The specifics of these reports are contained in 6.5.1.

5.2.1.2 Electrical Interface Control Drawing (EICD).

The EICD (aka Electrical Compatibility Data) will be prepared to identify AMAC system configurations, interfaces, component locations, and other pertinent data (see 6.5.2).

5.2.1.3 Mechanical Interface Control Drawing (MICD).

The MICD (aka Mechanical Compatibility Data) will be prepared to define the mechanical aspects of the weapons suspension and release system, including electrical connectors as appropriate and in compliance with MIL-DTL-38999, and clearances during carriage and release (see 6.5.3).

5.2.1.4 Structural loads analyses and test (see 4.3.1.3).

Joint analyses/tests will be conducted by the weapon system contractor and Sandia National Laboratories (SNL). The analyses/tests will determine the distribution of forces and pressures on the weapon(s) and aircraft to determine if the aircraft can safely carry the nuclear weapon(s) and if the structural capability of the weapon could be exceeded. The analyses/tests will include ground and flight environments as specified in the Stockpile-to-Target Sequence (STS) document and the Military Characteristics (MC). Limitations will be identified and provided for inclusion in the applicable DoE compatibility document.

5.2.1.5 Ejection characteristics (see 4.3.1.4).

Ejection characteristic (static drops) tests to assure proper weapon release, ejection velocity, separation, adequate fall-angle clearances, ejection forces, and proper lanyard retention under static-level flight conditions prior to in-flight separation tests will be conducted. Test parameters and instrumentation will be jointly determined by the system program office (SPO), DoE laboratories, AFNWC/NCS, and contractors. Production or equivalent hardware is required.

5.2.1.6 Environmental fly-around and data (see 4.3.1.8).

Support for environmental fly-around tests will be provided. These tests will be conducted by the appropriate Air Force test organization and will provide the basic data to demonstrate the warhead compatibility with the carriage/launch environments (thermal, vibration, and acoustic) for all aircraft weapon carriage locations. Vibration analyses will be conducted to identify the important frequencies and modes for the various arrangements of weapons on the launcher or pylon. Ground vibration tests of selected configurations may be performed to substantiate the vibration analysis results. In-flight measurements of the thermal, vibration, and acoustic environments will be made for selected configurations and flight conditions. Vibration of the weapon bay doors will be measured to demonstrate that the weapon bay door motion is not such that it could cause less than the required weapon-to-door clearance for ejection. Tests will be conducted with a vibrational fly-around assembly to simulate the structure and dynamic response of the actual warhead/bomb. Other environmental data will be gathered by sensors in the weapon bays or external pylons.

5.2.1.7 Separation tests (in-flight) (see 4.3.1.10).

Separation tests to assure compatibility of the aircraft with required nuclear weapons will be conducted. The tests will verify proper separation within the aircraft flight envelope to determine the nuclear weapon launch or delivery envelope. Detailed requirements and instrumentation will be jointly determined by the SPO, DoE laboratories, AFNWC/NCS, and contractors. The flight parameters of the drop tests will include all of the aircraft flight envelope with conditions tailored to the expected carrier flight and delivery envelopes. The number of tests required will be a function of the completeness of the 6 DOF model dynamic analysis and wind tunnel testing. Tests will at least verify the results predicted by wind tunnel tests and analytical modes in the extremes of the flight envelope.

5.2.1.8 Mechanical fit and electrical function tests (see 4.3.1.7, 4.3.1.16, 4.3.1.17).

The following tests will be performed by AFNWC/NCS and the DoE laboratories. MICDs and EICDs will be delivered in sufficient time to support these tests.

a. A mechanical fit test will be performed for all configurations of the aircraft and for applicable transportation equipment. The test will include uploading and downloading (mating/de-mating) of compatibility test unit(s) at all stations using production or production-equivalent hardware and appropriate support equipment.

b. An electrical function test will be performed to verify compliance with the applicable portion of the AMAC POG System 1 or System 2 interface specification/standard and interoperability with other nuclear weapons carried on the aircraft. The test will include a flight test to verify the interface during flight conditions.

5.2.1.9 ACCD (see 4.3.1.19).

The ACCD is a control drawing prepared and maintained by SNL which establishes the extent of compatibility and restrictions between a nuclear bomb and an aircraft. It is released after the compatibility tasks defined in the CRP have been successfully completed. A similar document, the Compatibility Certification (CC) Drawing is used for cruise missile warheads. The ACCD and CC are maintained by SNL.

5.2.1.10 MAR.

The compatibility analyses and tests between aircraft/missile/warhead/bomb culminate in the issuance by the DoE of a compatibility statement contained in a document called the Major

Assembly Release (MAR). The MAR, or an assurance of a MAR, ACCD, CC, or SOC, is required prior to issuing a Nuclear Compatibility Certification Statement.

5.2.2 Air-launched cruise missiles

5.2.2.1 AMAC system.

The AMAC system will be analyzed and tested to ensure it meets the interface requirements. The results of these analyses and tests will be documented in the AMAC FDAR.

5.2.2.2 Mechanical Interface Control Drawing (MICD).

There is no MICD requirement for cruise missiles. Interface definition is handled by the ICDs with certification compliance documented in the CC.

5.2.2.3 Electrical Interface Control Drawing (EICD).

There is no EICD requirement for cruise missiles. Interface definition is handled by the ICDs with certification compliance documented in the CC.

5.2.2.4 Structural loads analyses and tests.

Joint analyses/tests will be conducted by the missile contractor against requirements specified by the Air Force in cooperation with the DoE and their prime contractors. The analyses/tests will determine the distribution of forces and pressures transmitted to the warhead to determine if the warhead environments are within design limits. The analyses/tests will include ground and flight environments as specified in the STS and MCs. Limitations will be identified and provided for inclusion in the MAR.

5.2.2.5 Environmental fly-around and data.

Support for environmental fly-around tests will be provided. These tests will be conducted by the appropriate Air Force flight test organization and will provide the basic data to demonstrate the warhead compatibility with the carriage/launch environments (thermal, vibration, and acoustic) for aircraft weapon carriage locations. Vibration analyses will be conducted to identify the important frequencies and modes transmitted to the warhead during aircraft carriage and during missile flight. Ground vibration tests of selected configurations may be performed to substantiate the vibration analysis results. In-flight measurements of the thermal, vibration, and acoustic environments will be made for selected carriage locations and flight conditions. Tests will be conducted with special instrumented warheads provided by the DoE through the Air Force.

5.2.2.6 Ejection characteristics.

Ejection characteristic (static drops) tests to assure proper weapon release, ejection velocity, separation, adequate fall-angle clearances, ejection forces and proper lanyard retention under static-level flight conditions prior to in-flight separation tests will be conducted. Test parameters and instrumentation will be jointly determined by the SPO, DoE laboratories, AFNWC/NCS, and contractors. Production or equivalent hardware is required.

5.2.2.7 Separation tests (in-flight).

Separation tests to assure compatibility of the aircraft with the cruise missile will be conducted. The tests will verify proper separation within the aircraft flight envelope to determine the nuclear weapon launch or delivery envelope. Detailed requirements and instrumentation will be jointly determined by the SPO, DoE laboratories, AFNWC/NCS, and contractors. The flight parameters of the drop tests will include specified portions of the aircraft flight envelope with

conditions tailored to the expected carrier flight and delivery envelopes. The number of tests required will be a function of the completeness of the dynamic analysis and wind tunnel testing. Tests will at least verify the results predicted by wind tunnel tests and analytical modes in the extremes of the flight envelope.

5.2.2.8 Mechanical fit and electrical function tests.

The following tests will be performed by AFNWC/NCS and the DoE laboratories. ICDs will be delivered in sufficient time to support these tests.

a. A mechanical fit test will be performed for all configurations of the aircraft with the missile, for the missile with the warhead, and for applicable transportation equipment. The tests will include uploading and downloading (mating/de-mating) of compatibility test unit(s) using production or production-equivalent hardware and appropriate support equipment.

b. An electrical function test will be performed to verify compliance with the applicable portion of the Interface Control Drawing between aircraft, missile, and/or warhead. The interoperability with other nuclear weapons will be verified. A flight test will be included to verify the AMAC system operation during flight conditions.

5.2.2.9 Time line integration tests.

Tests will be conducted to determine if all functions occurring at the missile-to-warhead interface occur in the sequence and time lines as called for in the EICD. This will be a quantitative as well as qualitative test.

5.2.2.10 Major Assembly Release (MAR).

The compatibility analyses and tests between aircraft/missile/warhead culminate in the issuance by the DoE of a compatibility statement contained in a document called the MAR. The MAR, or the assurance of a MAR, is required prior to mating/uploading nuclear weapons.

5.2.2.11 Compatibility Certification (CC).

The CC is a control drawing prepared and maintained by SNL which establishes the extent of compatibility and restrictions between a nuclear warhead on a cruise missile and an aircraft. It is released after the compatibility tasks defined in the CRP have been successfully completed. The CC is maintained by SNL.

5.2.3 Ground-launched missiles

The compatibility analyses and tests (described above) between missile/warhead/launcher culminate in the issuance by the DoE of a compatibility statement in a document called the MAR. The MAR, or an assurance of an MAR, is required prior to mating nuclear warheads with the reentry vehicle or missile.

5.2.4 Non-combat delivery vehicles.

The AFNWC or the SPO will provide a production equivalent Non-Combat Delivery vehicle (e.g. for example, a bomb trailer), and specify an environment (e.g. for example, a set of road courses based on the actual environment) the weapon and trailer will encounter. DoE laboratories will provide an instrumented weapon shape with the proper mechanical properties and instrumentation to capture vibration and shock data, or any other data deemed necessary to satisfy compatibility. Test parameters and instrumentation will be jointly determined by the SPO, DoE laboratories, AFNWC/NCS, and contractors. The analyses/tests will include ground

environments as specified in the STS and MCs. Limitations will be identified and provided for inclusion in the MAR.

5.3 Basis and documentation.

The analyses of the weapon system shall be based on the system, subsystem, and end item specifications and qualified system operating parameters. The supporting analyses are required for, and shall be documented in, the appropriate engineering reports (mechanical, electrical, and aerodynamics).

5.4 Guidelines for analyses and tests.

The data from analyses and tests of systems, subsystems, components, and equipment are necessary to evaluate nuclear compatibility. Qualitative and quantitative analyses and tests provide a basis for the nuclear compatibility evaluations. Analyses and tests must be compatible with the concepts used within the system, such as information control, energy control, etc.

5.5 Use of specifications and standards.

When military specifications or standards exist that satisfy nuclear compatibility certification requirements, the analysis and test requirements may be met by showing those specifications or standards have been met.

5.6 Tailoring of tests.

When operational needs differ significantly from the test requirements of a military specification or standard, the test requirements shall be changed to reflect operational requirements.

5.7 Non-specialized support equipment.

Non-specialized equipment (aircraft tie-downs, trailers, general “dual use” support equipment, etc.) shall be evaluated for nuclear compatibility adequacy according to the appropriate standards, specifications, and designated tests.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory.)

6.1 Intended use.

This document is intended for use in the procurement or modification of Air Force nuclear weapon systems, subsystems and support equipment.

6.2 Acquisition requirements.

Acquisition documents should specify the following:

a. Title, number, and date of this standard.

6.3 Associated Data Item Descriptions (DIDs).

This standard has been assigned an Acquisition Management Systems Control (AMSC) number authorizing it as the source document for the following DIDs. When it is necessary to obtain the data, the applicable DIDs must be listed on the Contract Data Requirements List (CDRL) (DD Form 1423).

DID Number	DID Title
DI-NUOR-80156	Nuclear Survivability Program Plan
DI-NUOR-80926	Nuclear Survivability Assurance Plan
DI-NUOR-80927	Nuclear Survivability Design Parameters Report
DI-NUOR-80928	Nuclear Survivability Test Plan
DI-NUOR-80929	Nuclear Survivability Test Report
DI-NUOR-81405	Aircraft Nuclear Safety Analysis Report (NSAR)
DI-NUOR-81407	Aircraft Mechanical Interface Control Drawing (MICD)
DI-NUOR-81408	Aircraft Monitor and Control (AMAC) Preliminary Design Report (PDR) and Final Design Approval Report (FDAR)
DI-NUOR-81409	Certification Requirements Plan (CRP)
DI-NUOR-81410	Aircraft Electrical Interface Control Drawing (EICD)
DI-NUOR-81411	Engineering Evaluation Report (EER)
DI-NUOR-81413	Aircraft Nuclear Weapon System Definition Document (NWSDD)
DI-NUOR-81888	Nuclear Certification Impact Statement (NCIS)

The above DIDs were current as of the date of this standard. The ASSIST database should be researched at https://assist.dla.mil/quicksearch/ to ensure only current and approved DIDs are cited on the DD Form 1423.

6.4 Subject term (key word) listing.

Aircraft-weapons compatibility
Ground/Air-Launched Missile systems
Critical components
Critical functions
Design
Ejection characteristics
Evaluation
Gravity weapons
Mechanical fit
Missile systems
Safety
Security
Structural loads
Surety

6.5 Nuclear Compatibility Certification Reports.

6.5.1 Aircraft Monitor and Control (AMAC) Design Approval Report (DAR).

This report defines and analyzes the aircraft system which controls the interface between the aircraft and the nuclear weapon. It should be submitted in two parts as described below. DI-NUOR-81408, Aircraft Monitor and Control (AMAC) Preliminary Design Report (PDR) and Final Design Approval Report (FDAR), applies to these requirements. Deliverable data identified on the DD Form 1423 should be prepared in accordance with instructions specified in this DID and prepared to include the following:

6.5.1.1 Preliminary Design Approval Report.

This report should describe in as much detail as possible the design details of the proposed AMAC system, which consists of the electrical controls and avionics required to monitor, safe, or pre-arm a nuclear weapon prior to release. It should be submitted as soon as the design baseline of the AMAC system has been established. Normally, this should be in conjunction with the weapon system preliminary design review.

6.5.1.2 Final Design Approval Report.

This report should include a complete design analysis detailing all the circuits and components employed, and an analysis showing compliance with the applicable nuclear weapons requirements. All electrical analyses should be based on worst expected conditions of aircraft direct current loads, power input conditions, and temperature conditions. The complete power distribution analysis should be performed using only the main alternating current generator(s). All constraints used in the analyses should be substantiated in the report by cross-referencing applicable test reports, specification sheets, and military standard drawings. The design should represent the production design to be deployed, and no changes can be made to the nuclear interface defined in this report unless a revised AMAC report first provides a second review and is approved in writing by the authorized agencies (Single Manager and the AFNWC's Certification Manager). In order to support the ACCD release, the FDAR should be completed and submitted to the Single Manager at least 270 days prior to the nuclear certification need date.

6.5.2 Aircraft Electrical Interface Control Drawing (EICD).

The EICD should define the physical, electrical power, and logical signal interfaces between the avionics components at the DoE/Air Force interfaces. They should cover all types of electrical interfaces in the monitor and control circuits of nuclear weapons, whether discrete lines or multiplex data buses. DI-NUOR-81410, Aircraft EICD, applies to these requirements. Deliverable data identified on the DD Form 1423 should be prepared in accordance with the instructions specified in this DID.

6.5.3 Aircraft Mechanical Interface Control Drawing (MICD).

The MICD should define the physical and mechanical interfaces between the aircraft and nuclear weapons. They should cover dimensions, clearances, forces, installations, etc., associated with the weapons and suspension and release equipment. DI-NUOR-81407, Aircraft MICD, applies to these requirements. Deliverable data identified on the DD Form 1423 should be prepared in accordance with the instructions specified in this DID.

6.5.4 Aircraft Nuclear Weapon System Definition Document (NWSDD).

The nuclear weapon system definition document should define the nuclear configuration of the aircraft's avionics and nuclear weapon delivery systems. The nuclear configuration should be defined by the hardware and software components of the aircraft's avionics system and nuclear weapon delivery system. The NWSDD identifies the nuclear weapon system configuration. DI-NUOR-81413, Aircraft NWSDD, applies to these requirements. Deliverable data identified on the DD Form 1423 should be prepared in accordance with the instructions specified in this DID.

6.6 Changes from previous issue.

Marginal notations are not used in this revision to identify changes with respect to the previous issue due to the extent of changes.

APPENDIX A

Aircraft Monitor and Control (AMAC) Testing

A.1 SCOPE

A.1.1 Scope.

Aircraft Monitor and Control (AMAC) testing demonstrates compliance of the nuclear weapon/nuclear weapon system interface with the specifications of the Aircraft Monitor and Control (AMAC) Specification Standard No. SYS 1001: System 1 Basic Interface Specification and SYS 2001: System 2 Basic Interface Specification. System 1 is an analog interface used on existing systems; System 2 is a digital interface specification.

AMAC certification testing is designed to meet DoE and DoD requirements. Testing is conducted jointly to: (1) eliminate duplication of effort, (2) maximize resources, (3) reduce cost, and (4) minimize operational impact. The AMAC POG has developed and maintains a System 1 test requirements document (SYS 1300-02) that reflects this philosophy.

498 NSW OI 99-01, Aircraft Monitor and Control (AMAC) Testing, 1 April 2011, directs the methodology used for conducting Aircraft Monitor and Control (AMAC) tests on USAF and Host Nation aircraft which are certified to carry nuclear weapons for nuclear strike missions. AFI 63-1201, Life Cycle Systems Engineering, directs that the preservation of the Operational Safety, Suitability, and Effectiveness (OSS&E) design baseline of aircraft systems shall be maintained. To maintain the OSS&E baseline for the nuclear command and control system (AMAC system) on board nuclear weapon delivery systems, the Air Force Nuclear Weapons Center has developed System 1 AMAC test procedures to measure the AMAC system performance characteristics in operational aircraft for nuclear bomb release, thus ensuring the design baseline is preserved throughout the weapon system life cycle. AMAC tests cover three categories: (1) AMAC certification tests; (2) AMAC surveillance tests; and (3) other AMAC tests investigating abnormal test results or system anomalies. Additionally, NSWOI 99-01 prescribes the methodology used for aircraft selection, data acquisition during tests, post-test data analysis, and reporting/notification to stakeholders. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

A.2 APPLICABLE DOCUMENTS

a. Aircraft Monitor and Control Project Officer's Group (AMAC POG) Charter, undated

b. Specification Standard No. SYS 1300 System 1 AMAC Test Requirements

c. GM-86 Air Frame to W80 Warhead ICD, ICD D232-98101, Boeing Aerospace Company

d. Memorandum of Understanding (MOU) Number DE-GM04-2001AL77133, *Agreement on Division of Responsibilities for Aircraft Monitor and Control Systems Design Requirements and Compatibility Testing,* 14 Nov 2001

(Copies of these documents are available from the AFNWC/NCSS, Kirtland AFB, NM 87117.)

Any conflict between the requirements specified and the design capabilities of an aircraft/system under test will be resolved through reference to the System 1 or System 2 Specifications to which the aircraft system was built. This resolution will be documented by the AFNWC/NCS and Sandia National Labs (SNL) engineers involved and presented to the AMAC Project Officers Group (POG) for final approval.

A.3 DEFINITIONS

A.3.1 In-service periodic tests.

Periodic Serviceability electrical testing is conducted at the System 1 interface connector to assure that the aircraft is capable of MONITORING, SAFING and PREARMING the weapon. Organizational Level maintenance crews perform these checks on aircraft on a nominal 180-day cycle and a 24-month cycle for rotary launchers and pylons.

A.3.2 AMAC surveillance tests.

Surveillance tests are those tests conducted by the Department of Defense (DoD/AFNWC/NCS) for the purpose of determining the AMAC system compliance with the System 1 specification requirements over the life of the aircraft; the data obtained is empirical in nature. These tests are normally conducted once per year on each type of aircraft (see A.4.1).

A.3.3 AMAC certification tests.

These joint SNL/AFNWC/NCS electrical nuclear certification tests are used to determine design compliance of a sample of two to five (2-5) new or significantly modified aircraft. The exact number of aircraft tested is determined using the hyper-geometric mathematical probability model in accordance with the methodology described in NSWOI 99-1. AMAC certification tests consist of:

a. System 1 verification tests of the interface under worst-case aircraft load conditions, including multiple station loading.

b. Functional evaluation of a complete system on the ground using Compatibility Test Units (CTUs).

c. Functional evaluation of a complete system in flight using CTUs.

On new aircraft or on aircraft that has had major software and hardware changes to its AMAC system, a Full Weapon System Demonstration (FWSD) using a Development Joint Test Assembly (DJTA) may be required.

AMAC testing will be completed on every new weapon system or when there has been a major modification to the AMAC system. Both ground and flight tests will be performed for new systems. Modifications to the AMAC system will require testing using all or a subset of required AMAC tests. After initial nuclear certification, the DoD and NNSA (Sandia National Labs) will jointly make the determination of whether a modification is major or minor. As a minimum, ground tests will be performed for systems with major and minor modifications. Flight tests will be done for modified systems, as necessary, to ensure that the AMAC system functions correctly in a normal flight environment.

A.3.4 AMAC periodic tests.

The purpose of these tests is to verify that no degradation to the AMAC system has occurred that would jeopardize the aircraft's capability as stated in the Aircraft Compatibility Control Drawings (ACCDs) due to modification or aging, and to assure that the reliability numbers published by DoE are supportable. These tests are conducted on AMAC systems that have not been modified or tested for an extended period. During this period, there could have been many conventional changes to the aircraft that, at first inspection, did not affect the nuclear system; these tests are used to confirm that no change has occurred. Periodic AMAC tests are typically conducted every five years (up to a maximum of ten years) to determine if the aircraft/bomb weapon system continues to meet the System 1 Specification and perform AMAC

functions, with war reserve equivalent test units, as designed. The exact number of aircraft tested is determined using the hyper-geometric mathematical probability model in accordance with the methodology described in NSWOI 99-1.

A.3.5 Air vehicle (cruise missile) to warhead testing.

Functionality and compatibility between the W80-1 and its delivery vehicle is based on tests of the interface. The criteria for validation of the Aircraft/Missile/Warhead are based on the W80-1-to-Air Launched Cruise Missile (ALCM) Interface Control Drawing and the Sandia W80-1 Compatibility Certification (CC) Drawing. These tests are performed with the required number of missile configurations (i.e., 20 missile PREARM test in the case of the B-52) with Sandia supplied W80-1 CTUs and warhead PREARM Load Simulators. Tests are also conducted to certify: (1) combined missile and gravity bomb configurations, and (2) interoperability between cruise missiles and gravity weapon configurations. Currently the B-52H aircraft is the only nuclear certified platform that can operate both cruise missiles and gravity bombs.

A.3.6 Compatibility test units.

Compatibility test units (CTUs) are Sandia Aircraft Compatibility Department engineering tools that represent electrical and functional characteristics of a war reserve (WR) special weapon. The CTUs and associated test devices come in a variety of sizes, shapes and quality of WR electrical components.

A.3.6.1 CTU-1.

The CTU-1 is a classified unit that is electrically and mechanically equal to an actual WR weapon. The CTU-1 is designed to have the same weight, size, shape, moments of inertia, center of gravity, and paint scheme. The CTU-1 does not have a physics package. This item has been replaced with a mass mockup. The CTU-1 contains classified items (not all visible) and is certified to fly on its associated platforms. The CTU-1 contains WR major components that have been accepted within the Department of Energy quality process. The CTU-1 has identical electrical loads as a WR weapon and will function with AMAC signals accordingly. CTU-1 hazards are documented in Joint Nuclear Weapons Publications System (JNWPS) 20-11 section 2-5. The CTU-1 offers the highest quality of WR facsimiles and is the ideal tool when conducting system integration tests using production aircraft and weapon equipment.

A.3.6.2 CTU-2.

The CTU-2 is similar to the CTU-1 except some of the WR Military Characteristics (MCs) are electrically simulated (for example, the Use Control devices are electrically simulated). The CTU-2 is certified for flight on its associated aircraft. The CTU-2 is an unclassified shape that can be used in special situations where classified items are prohibited (i.e., NATO flights). The CTU-2 does not contain explosives or hazards. The CTU-2 has a high degree of electrical accuracy but is slightly less than that of a CTU-1.

A.3.6.3 CTU-3.

The CTU-3 has the same quality of WR electrical major components as the CTU-1 but is not flight certified (cylinder shape). The CTU-3 is classified. This unit is primarily used at aircraft manufactures' facilities during the development of new AMAC systems.

A.3.6.4 CTU-4.

The CTU-4 has some WR components and some simulated components. The WR components do not have the same quality (pedigree) as the WR components found in the CTU-1, CTU-2, or CTU-3. The CTU-4 is an unclassified tool that is packaged in a suitcase for portable use. This unit provides good weapon functionality and electrical loads but it is not ideal. The CTU-4 is used during preliminary AMAC tests, lab tests, and on AMAC systems that have minor nuclear software changes.

A.3.6.5 W80-1 PREARM load simulator (PLS).

A W80-1 PREARM load simulator (PLS) is unclassified and is used in place of a W80 warhead on ALCMs to simulate the electrical load and functional portions of the warhead during pre-launch operations. The PLS is flight certified. These units, used in conjunction with the W80-1 CTU-1, allow test engineers to conduct a 20 missile PREARM test on the B-52H aircraft. Its small size (2 x 6 in) allows it to be used with USAF training/ferry payloads when flight or ground tests are required.

A.3.6.6 Development joint test assembly (DJTA).

This is a test unit that is used in a full system demonstration drop test in order to exercise the end-to-end DoD Command and Control system and aircraft functions such as mission planning, PAL, weapon loading, and delivery to the target. SNL and the NNSA provide a bomb test unit that, as nearly as possible, duplicates the features of a WR bomb. It is not necessarily pulled directly from the stockpile. DJTAs are also used for other types of testing.

A.4 Surveillance testing.

The AFNWC/NCS has implemented and manages a “Surveillance Test Program”. Surveillance testing is a quantitative assessment of the Aircraft Monitor and Control (AMAC) system in nuclear capable aircraft; the major test objective is to acquire engineering measurements of aircraft-weapon interface signals. The engineering parameters measured during surveillance testing are compared with design specifications and monitored over time for performance degradation that may impact the system’s Nuclear Compatibility Certification. Surveillance testing provides direct System 1 (System 2 in the future) specification comparisons, isolation tests, DC voltage measurements, continuity measurements, time critical measurements, and open circuit, short circuit, and load current tests. Surveillance testing is conducted using the AFNWC/NCS developed Special Weapons Interface Tester (SWIFT). Surveillance testing directly supports Operational-Suitability as established in AFI 63-1201.

A.4.1 Surveillance tests methodology.

The purpose of AMAC surveillance testing for each weapon system is to monitor changes in the baseline for each system that would indicate a design issue created by aging, aircraft modification, or a combination thereof. The required test sample size for each weapon system shall meet a statistical confidence of 90 percent probability that a defect which appears in no more than ten percent of the interfaces will be detected over a two-year period. A hyper-geometric mathematical-probability model determines the number of an aircraft type to be tested based on the number of stations in the fleet that are available to a specific weapon system. To achieve the necessary statistical confidence, the hyper-geometric probability model prescribes the following sample sizes based on the number of stations in the fleet available to that type of aircraft:

a. F-15E: 22 stations required; five aircraft over a two-year moving window if five stations remain certified on the aircraft, eight aircraft over a two-year moving window if certified stations are reduced to three per aircraft.

b. F-16C/D: 22 stations required; 11 aircraft over a two-year moving window

c. B-2A: 21 stations required; two aircraft over a two-year moving window. This is based on eight stations per RLA (Rotary Launcher Assembly), and the number of RLAs at the B-2A home station.

d. B-52H: 22 stations required for gravity bombs; three aircraft over a two-year moving window. NOTE: Surveillance testing is not currently conducted on cruise missiles since they are not governed by System 1 Specification. SNL conducts a functional check of AMAC signals between the aircraft and cruise missile with nominal electrical current loads, but does not measure the signals at the W80-1 to ALCM interface. The AMAC POG is investigating the proper test protocol to measure the physical signals at the DOD/DoE interface.

e. F-16 MLU: (Belgium and Netherlands) 21 stations required; 11 aircraft over a two-year moving window.

f. PA-200: (Germany and Italy) 21 stations required; 11 aircraft over a two-year moving window.

APPENDIX B

CERTIFICATION REQUIREMENTS PLAN (CRP) DEVELOPMENT PROCESS

B.1 SCOPE.

B.1.1 Scope.

As discussed in Section 1, the major elements of nuclear weapon system Nuclear Certification are: design certification, and operational certification. Components of design certification are: compatibility certification (the focus of this MIL-STD), nuclear safety design certification, weapon system safety rules (WSSR) development, and Technical Order (TO) certification.

The certification process is initiated by the Nuclear Certification Impact Statement (NCIS) followed by (if required) the development of the Basic Certification Requirements Plan (BCRP); once coordinated and signed by the process owners, the BCRP is presented to the Single Manager. The Single Manager (SM) will develop the Certification Requirements Plan (CRP) using the BCRP as a baseline; the SM is responsible for the CRP's execution. The CRP process, discussed below, is outlined on FIGURE B-1. This Appendix is a mandatory part of the standard. The information contained herein is intended for compliance.

B.2 APPLICABLE DOCUMENTS

AIR FORCE INSTRUCTIONS

AFI91-107	Design, Evaluation, Troubleshooting, and Maintenance Criteria for Nuclear Weapon Systems

AIR FORCE MANUALS

AFMAN91-118	Safety Design and Evaluation Criteria for Nuclear Weapon Systems
AFMAN91-119	Safety Design and Evaluation Criteria for Nuclear Weapon Systems Software

(Copies of these documents are available on line at http://www.e-publishing.af.mil/.)

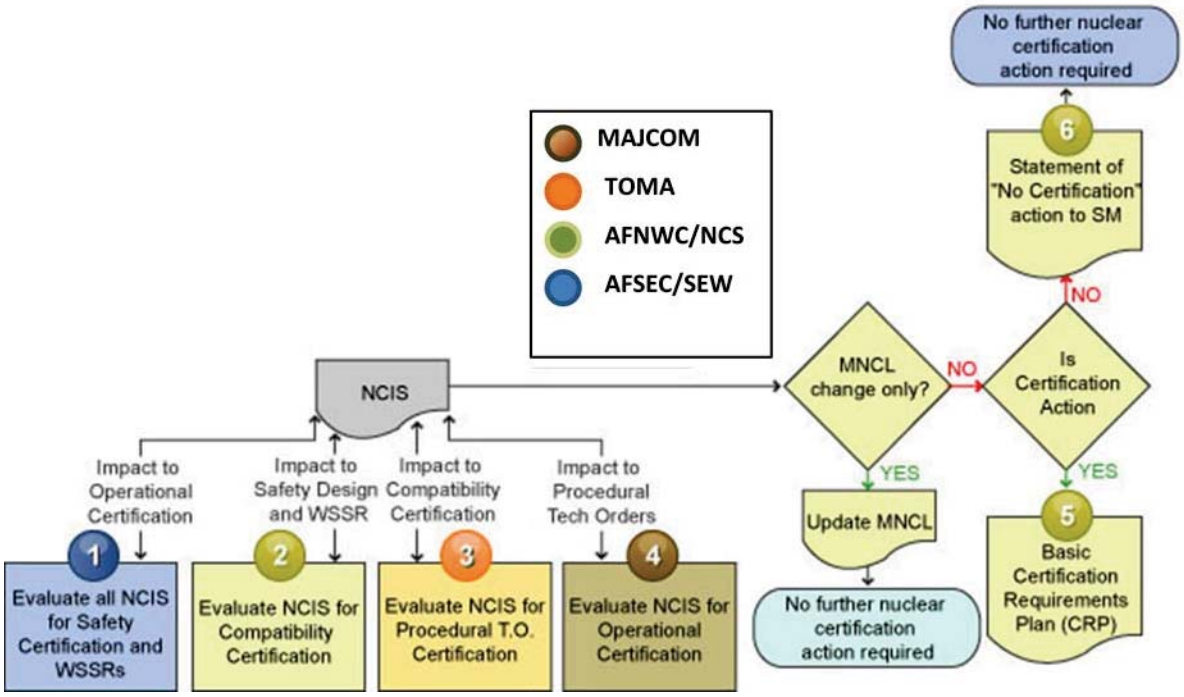

FIGURE B-1. Certification requirements plan development.

B.2 Nuclear certification impact statement (NCIS).

The NCIS is a document issued by the Single Manager to initiate the nuclear certification process. This statement advises the Air Force Nuclear Weapons Center's Certification Organization and other certification process owners that a new weapon system or a change to an existing weapon system, equipment item, software, or procedure needs to be evaluated. The process owners determine if this change impacts nuclear certification of the system. If nuclear certification is required, the AFNWC's Certification Organization manages the development of a Basic Certification Requirements Plan.

B.3 Basic certification requirements plan (BCRP).

The purpose of the BCRP is to: ensure proper nuclear certification planning is accomplished, and define the approach for obtaining nuclear certification of hardware/software and procedures used within a nuclear weapon system. The BCRP is the single document, communicated to the Single Manager which embodies all of the requirements identified by the process owners necessary to achieve a certified nuclear weapons system:

a. The BCRP describes basic actions necessary to evaluate new requirements or modifications for nuclear certification.

b. Identifies which certification processes must be accomplished, their general requirements, and responsibilities of each identified process owner.

c. The BCRP contains an appendix for each component of design certification, including compatibility certification, delineating the tasks necessary to accomplish

nuclear certification. If no certification tasks are required for the component being considered, the applicable appendix is marked as “Not Applicable”. The BCRP also contains a separate appendix describing tasks required for operational certification; if none are required, the appendix is marked as “Not Applicable”.

d. Identifies the documentation needed to support the certification evaluations. These might include a Nuclear Safety Analysis Report (NSAR), Final Design Approval Report (FDAR), Electrical Interface Control Drawing (EICD), Mechanical Interface Control Drawing (MICD), and the list goes on.

e. Contains a draft schedule identifying major certification and program milestones.

f. The Basic Certification Requirements Plan may also contain:

(1) A draft allocation matrix that maps all applicable AFI 91-107 directed requirements to the equipment or system components.

(2) Recommended approaches for operationally certifying and decertifying potential critical components.

(3) Other pertinent information that will help the Single Manager plan for and obtain nuclear weapon system certification

B.4 CRP process.

After reviewing the Nuclear Certification Impact Statement and determining the certification actions required, the AFNWC/NCS Certification Organization will develop the Basic Certification Requirements Plan if nuclear certification is required, or issue a letter stating nuclear certification is not required (FIGURE B-1, Block 6). If a BCRP is required, actions of process owners are as follows:

a. The AFNWC/NCS Certification Organization will incorporate specific certification requirements identified by the process owners into the BCRP following their review of the Nuclear Certification Impact Statement. All processes are reviewed even if they *are not* identified as impacts in the Nuclear Certification Impact Statement.

b. The Air Force Safety Center’s Weapons Safety Division (AFSEC/SEW) will identify:

(1) Nuclear Safety Design Certification requirements based on the system’s development efforts (see FIGURE B-1, Block 1)

(2) Impacts to nuclear safety design requirements outlined in AFI 91-103, *Air Force Nuclear Safety Design Certification Program.*

(3) Impacts to AFI 91-107, AFMAN 91-118, and/or AFMAN 91-119.

(4) Impacts to: (1) directed criteria and/or degradations to existing nuclear weapon system safety features, (2) the Nuclear Safety Compliance Matrix, and (3) the Weapon System Safety Rules (WSSR) established by the Nuclear Weapons System Safety Group.

c. The AFNWC/NCS and the ICBM NCM (for ICBM related efforts) will provide compatibility certification requirements inputs (see FIGURE B-1, Block 2) based on impacts to the ACCD/MAR.

(1) The appropriate Technical Order Management Authority (TOMA) (e.g., Nuclear Weapons Logistics Division (AFNWC/NCLS), Program

Office/Contractor, or ICBM/NCM) will identify Technical Orders or other technical publications that will require nuclear certification (FIGURE B-1, Block 3).

(2) The AFNWC/NCLS is responsible for procedures which involve nuclear weapon loading, weapons delivery and aircraft operations, handling, movement, restraint configuration, loading, unloading, testing and delivery.

(3) The ICBM/NCM is responsible for ICBM related technical data related to OPCERT/DECERT procedures, missile maintenance, etc.

(4) The appropriate Program Office's TOMA is responsible for nuclear related procedures not identified above.

d. The Lead/Using Command (MAJCOM) will:

(1) Review the Nuclear Certification Impact Statement to determine if there is any impact on the Operational Certification (see FIGURE B-1, Block 4) components that would necessitate the need to engage the operational element of the nuclear certification process.

(2) Determine which elements, if any, of the Operational Certification process need to be accomplished based on the complexity of the development effort. The MAJCOM should examine the impact the modification or new development has on personnel task qualification training, Personnel Reliability Program (PRP), and nuclear surety training requirements to determine if the development and deployment of the modification or new system requires conducting an Initial Nuclear Surety Inspection before the unit can assume its operational tasking. This latter determination should be made in coordination with the Air Force Safety Center.

e. Generally, the Operational Certification process would be required when:

(1) A new nuclear mission (e.g., new delivery system or nuclear weapon) is being assumed by an already nuclear certified unit.

(2) A non-nuclear certified unit assumes or resumes a nuclear mission.

(3) New or significantly modified maintenance or operational procedures, maintenance facility, or item of support equipment is introduced to an already nuclear certified unit.

(4) Certifying of a unit assigned a contingency mission that is now required to be operationally nuclear certified.

f. Operational Certification would normally not be required when the proposed action does not affect the current operational certification status of the operating units (i.e., no new training requirement or need to conduct an Initial Nuclear Surety Inspection).

g. If the MAJCOM determines that Operational Certification is not necessary, the MAJCOM will submit written notification to the AFNWC/NCS Certification Organization that Operational Certification is not impacted following the MAJCOM review of the NCIS.

h. The AFNWC/NCS Certification Organization will coordinate the Basic Certification Requirements Plan among all the process owners to ensure the plan and its appendices accurately capture the process owner requirements. Once the process owners have coordinated on the BCRP, it will be forwarded to the Single Manager.

i. The SM uses the Basic CRP to develop the draft Certification Requirements Plan (CRP) which details the program office's processes, activities, responsibilities, tasks and schedules that will be accomplished to demonstrate compliance with the certification requirements identified by the various certification process owners in the Basic CRP. The SM returns the completed draft version of the CRP to the AFNWC/NCS Certification Organization for review and approval. The AFNWC/NCS Certification Organization will distribute the draft plan to the process owners for their final review and coordination. Issues will be resolved and a finalized CRP will be approved by the process owners and the AFNWC/NCS Certification Organization.

j. The SM's draft Certification Requirements Plan (CRP) cover page will be marked as shown below to indicate the draft status of the plan. This step in the process may require producing one or more iterations of the draft CRP. If necessary, iterations of the draft CRP will be identified by the date.

CERTIFICATION REQUIREMENTS PLAN
CONTROL NUMBER: AFNWCYearMoXXX
Draft ("Date")

k. When all coordination is complete and process owner signatures are obtained, the AFNWC/NCS Certification Organization will approve (sign) the CRP and return it to the Single Manager for execution. A copy of the CRP will be sent to all appropriate process owners. The approved Certification Requirements Plan cover page will be marked as indicated below.

CERTIFICATION REQUIREMENTS PLAN
CONTROL NUMBER: AFNWCYearMoXXX
Original ("Date")

APPENDIX C

SUPPLEMENTAL INFORMATION FOR USE WITH MIL-STD-1822

C.1 SCOPE

C.1.1 Scope.

This appendix contains general information on surety design and evaluation, and describes reports which may be required under the weapon system contract. This Appendix is not a mandatory part of the standard. The information contained herein is intended for guidance only.

C.2 APPLICABLE DOCUMENTS

Documents mentioned or referenced in the text of this standard are listed in section 2. Section B.4 is a bibliography of other documents which may be needed during the nuclear compatibility certification process.

C.3 TECHNICAL WORKING GROUPS SUPPORT

C.3.1 Project Officers Group (POG) or Nuclear Surety Working Group (NSWG) support

C.3.1.1 Technical support.

Agencies participating in weapon system development relative to the monitor and control of the nuclear weapon should participate in either the weapon system POG (for aircraft systems) or the NSWG (for ground-launched missile systems) to resolve surety, compatibility, support equipment, TO, and facility issues.

C.3.1.2 Coordination.

The weapon system developing organization should (through the POG or NSWG) establish, encourage, and maintain open communications between all agencies on nuclear compatibility certification issues.

C.4 BIBLIOGRAPHY OF RELATED DESIGN DOCUMENTS

C.4.1 Government documents.

C.4.1.1 Military specifications, standards, and handbooks.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-W-5088	Wiring, Aerospace Vehicle (Inactive for New Design)
MIL-T-7743	Testing, Store Suspension and Release Equipment, General Specification For
MIL-S-8512	Support Equipment, Aeronautical, Special, General Specification for the Design of
MIL-I-8671	Installation of Droppable Stores and Associated Release Systems
MIL-DTL-9977	Manuals, Technical and Checklists: Munitions/Weapons Loading Procedures, Nonnuclear and Nuclear and Packages, Standard Data: Munitions Loading Procedures, Nonnuclear

MIL-T-21868	Trucks, Lift, Fork, Diesel; Shipboard, General Specification For
MIL-C-25200	Cable Assemblies, Special Weapons, Electrical, General Requirements For (Cancelled)
MIL-M-25802	Manual, Technical: Loading and Transport of Nuclear Weapon Cargo in Cargo Aircraft; Preparation Of (Cancelled)
MIL-DTL-25959	Tie Down, Tensioners, Cargo, Aircraft
MIL-PRF-27260	Tie Down, Cargo, Aircraft, CGU-1/B
MIL-PRF-28800	Test Equipment for Use with Electrical and Electronic Equipment, General Specification For
MIL-S-45152	Semitrailers, Lowbed: Commercial (Inactive for New Design)

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-209	Lifting and Tie-Down Provisions
MIL-STD-461	Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment
MIL-STD-464	Electrical Environment Effects Requirements
MIL-STD-498	Software Development and documentation
MIL-STD-648	Specialized Shipping containers
MIL-STD-704	Aircraft Electrical Power Characteristics
MIL-STD-810	Environmental engineering Considerations and Laboratory Tests
MIL-STD-1289	Airborne Stores, Ground Fit and Compatibility Requirements
MIL-STD-1366	Transportability Criteria
MIL-STD-1553	Digital Time Division Command/Response Multiplex Data Bus
MIL-STD-1760	Interface Standard for Aircraft/Store Electrical Interconnection System
MIL-STD-1773	Fiber Optic Mechanization of an Aircraft Internal Time Division Command/Response Multiples Data Bus
MIL-STD-1791	Designing for Internal Aerial Delivery in Fixed Wing Aircraft
MIL-STD-1795	Lightning Protection of Aerospace Vehicles and Hardware
MIL-STD-1818	Electromagnetic Effects Requirements for Systems
MIL-STD-2088	Bomb Rack Unit (BRU), Aircraft, General Design Criteria for
MIL-STD-2169	High-Altitude Electromagnetic Pulse (HEMP) Environment (U)
MIL-STD-8591	Airborne Stores, Suspension Equipment and Aircraft-Store Interface (Carriage Phase)
MIL-STD-38784	Standard Practice for Manuals, Technical: General Style and Format Requirements

DEPARTMENT OF DEFENSE HANDBOOKS

MIL-HDBK-244	Guide to Aircraft/Stores Compatibility

MIL-HDBK-454	General Guidelines For Electronic Equipment
MIL-HDBK-1763	Aircraft/Store Compatibility: System Engineering Data Requirements and Test Procedures
MIL-HDBK-1784	Mobility, Towed and Manually Propelled Support Equipment
AFNWCH63-100	Aircraft Nuclear Compatibility Certification Handbook

(Copies of these documents are available online at https://assist.dla.mil/quicksearch/ or https://assist.dla.mil or from the Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094. Copies of MIL-STD-2169 are available from the Defense Threat Reduction Agency, 8725 John J. Kingman Rd., Stop 6201, Ft. Belvoir VA 22060.)

C.4.1.2 Other Government documents.

AIR FORCE INSTRUCTIONS

AFI 91-101	**AIR FORCE NUCLEAR WEAPONS SURETY PROGRAM**

(Copies of this document are available on line at http://www.e-publishing.af.mil/.)

JOINT CHIEFS OF STAFF PUBLICATIONS

JCS Pub I	DoD Dictionary of Military and Associated Terms

(Copies of some JCS publications are available from the Air Force Publications Distribution Center, 2800 Eastern Boulevard, Baltimore, MD 21220; phone (410) 687-3330/DSN 584-4529.)

C.4.2 Non-Government publications.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME Y14.24	Types and Applications of Engineering Drawings (DoD Adopted)
ASME Y14.34	Associated Lists Engineering Drawing and Related Documentation Practices (DoD Adopted)
ASME Y14.35M	Revision of Engineering Drawings and Associated Documents (DoD Adopted)
ASME Y14.38	Abbreviations and Acronyms for Use on Drawings and Related Documents (DoD Adopted)
ASME Y14.100	Engineering Drawing Practices (DoD Adopted)

(Copies of these documents are available online at www.asme.org or from ASME, Three Park Ave., New York NY 10016-5990.)

IPC – ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES

IPC-2221	Generic Standard on Printed Board Design (DoD Adopted)
IPC-2222	Section Design Standard for Rigid Organic Printed Boards

(Copies of these documents are available online at www.ipc.org or from IPC – Association Connecting Electronics Industries, 3000 Lakeside Dr., Suite 309S, Bannockburn IL 60015.)

SAE INTERNATIONAL

SAE AS50881	Wiring Aerospace Vehicle (DoD Adopted)

(Copies of this document are available on line at www.sae.org or from SAE International, 400 Commonwealth Dr., Warrendale, PA 15096-0001.)

CONCLUDING MATERIAL

Custodian:
Air Force -27

Review activity:
Air Force - 11

Preparing activity:
Air Force - 27

Agent: Air Force 11

Project 11GP-2012-001

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil.