DEPARTMENT OF THE AIR FORCE
HEADQUARTERS UNITED STATES AIR FORCE
WASHINGTON, DC
20330-5140

Reply To
Attn of: CEC

Subject: Engineering Technical Letter (ETL) 91-2:
High Altitude Electromagnetic Pulse (HEMP) Hardening in Facilities

TO: SEE DISTRIBUTION LIST

1. Attached for your information and action is the guidance for the planning, programming, designing, constructing and acceptance testing of new or renovations to existing HEMP barriers in facilities.

2. Purpose. This ETL:

a. Supersedes the HEMP portion of ETL 88-7: TEMPEST and High-Altitude Electromagnetic Pulse (HEMP) Protection for Facilities, 24 Aug 88.

b. Implements Air Force Regulation (AFR) 80-38, The Air Force Systems Survivability Program, 29 Sept 89.

c. Establishes guidelines for determining the degree of hardening C4I and other mission critical systems during the planning and programming stages.

d. Provides guidance for developing the Project Requirements and Management Plan (RAMP).

e. Establishes guidelines from planning through acceptance testing of HEMP hardened barriers within facilities.

3. Effective Date: This ETL is effective immediately for projects in the FY92 and subsequent MILCON programs. For projects currently under design authorized by a previous Design Instruction (DI), there is no requirement to modify the ongoing design process.

4. The point of contact is Mr. R.S. Fernandez at DSN 297-4083 or (202) 767-4083.

FOR THE CHIEF OF STAFF

CHARLES L. PEARCE, Colonel, USAF
Director, Military Construction
Office of The Civil Engineer

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ETL 91-2

4 MARCH 1991

ENGINEERING TECHNICAL LETTER

HIGH-ALTITUDE ELECTROMAGNETIC PULSE (HEMP) HARDENING IN FACILITIES

Department of Air Force
United States of America

OFFICE OF THE CIVIL ENGINEER
DIRECTOR OF CONSTRUCTION
REQUIREMENTS AND OVERSIGHT DIVISION

Table of Contents

Appendices

Part 1 - INTRODUCTION

1. Introduction. This ETL provides guidance for planning, programming, designing, constructing, in-progress testing and acceptance testing of electromagnetic barriers in facilities to limit the magnitude of HEMP-induced electrical stresses (currents and voltages) that might reach mission-critical electronic systems and components. The radioactive atmosphere produced by a high altitude nuclear burst is a result of the interaction of radiation (chiefly gamma rays) with the atmosphere at altitudes above 30 kilometers. The radioactive atmosphere then propagates, with little attenuation, to all points within line-of-sight of the burst. The high altitude burst can produce high amplitude HEMP electric and magnetic fields. These fields will create voltages along overhead transmission lines rising to a peak value of about 50 kilovolts per meter within a few nanoseconds and then decaying gradually over a period lasting hundreds of seconds.

Part 2 - General

2. Referenced documentation: Applicable referenced publications are as follows:

a. AFR 57-1, Operational Needs, Requirements, and Concepts (U).

b. AFR 80-38, The Air Force Systems Survivability Program (u).

c. AFR 86-1, Programming Civil Engineering Resources (U)

d. Construction Technical Letter (CTL) 90-1: Management of the MILCON Planning and Execution Process, 6 Mar 90 (U).

e. DNA-EMP-1, Electromagnetic Pulse (EMP) Security Classification Guide, 1 Jul 89 (S).

f. DNA-TR-88-277-VI, High Power Microwave Hardening Technology Review, May 90 (S).

g. DNA-TR-89-134, Piece Part Susceptibility to HPM and FREMP, December 1989 (U)

h. DNA-TR-89-216, EMP Assessment of the Chemical Warfare Directional Detector AN/KAS-1, September 1990 (U)

i. DOD Directive 4640.11, Mandatory Use of Military Telecommunications Standards in the MIL-STD-188 Series, 21 Dec 87 (U).

j. DOD Instruction 4245.5, Acquisition of Nuclear Survivable Systems, 25 Jul 88 (U).

k. DOD Standard 2169A, High Altitude Electromagnetic Pulse Environment (S).

l. Joint Chiefs of Staff Memorandum (JCSM) 2010/635-1, Identification of CE Systems Subject to the DOD Standard for High-Altitude Electromagnetic Pulse Environment, 8 Jun 85 (S)

m. JCSM 238-85, Identification of CE Systems Subject to the DOD Standards for High-Altitude Electromagnetic Pulse Environment, 20 Jun 85 (S)

n. JCSM 27-86, Integrated Tactical Warning and Attack Assessment System Integration, 24 Jan 86 (U)

o. Military Handbook (MIL HDBK) 232, RF Shielded Enclosures for Communications Equipment (U).

p. MIL HDBK 419A, Grounding, Bonding, and Shielding for Electronic Equipments and Facilities (U).

q. Military Standard (MIL STD) 22D, Notice 2, Welded Joint Design (U).

r. MIL STD 188-124B, Grounding, Bonding, and Shielding (U).

s. MIL STD 188-125, High-Altitude Electromagnetic Pulse (HEMP) Protection for Ground-Based C4I Facilities Performing Critical, Time-Urgent Missions (U).

t. MIL STD 220A, Notice 1, Method of Insertion-Loss Measurement, 8 Mar 78 (U).

u. MIL STD 248C, Notice 1, Welding and Brazing Procedure and Performance Qualifications, 23 Jul 84 (U).

v. MIL STD 285, Attenuation Measurements for Enclosures, Electromagnetic Shielding, for Enclosures, Electromagnetic Shielding for Electronic Test Purposes, Method of (U).

w. MIL-STD-461C, Notice 2, Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference (U).

x. USAF Guide Specification for HEMP/TEMPEST Shield Doors, Electrical Filter/ESA Assemblies, and other Shield Penetrations, June 1988 (U).

y. USAF Handbook for the Design and Construction of HEMP-Hardened POL Facilities, Nov 89, Revision 1, Jan 90 (U).

z. USAF Handbook for the Design and Construction of HEMP/TEMPEST Shielded Facilities, Revision 2, Nov 89 (U).

Definitions.

a. Acceptance Test. Final test of RF-tightness of the shield barrier by an independent testing laboratory which is contracted by the government separately from the facility construction contractor. Test will verify that the shield barrier is RF-tight and acceptable. This test will be done after the contractor completes installation of the shield barrier, penetrations (shielded doors, waveguides, power and signal filters, etc.) and all interior finishes.

b. Attenuation. The reduction of signal strength in the electric and magnetic fields by physical barriers. For HEMP hardening ground-based C4I systems and facilities performing critical time-urgent missions, the minimum required attenuation is shown in Appendix 1. Reference MIL STD 188-125 for further details. Unless otherwise stated by the requiring command, equipment of other mission critical systems will be hardened against the damage thresholds of Appendix 2.

c. C4I Facilities. Command, control, communications, computer, and intelligence facilities used for common long-haul/communications systems.

d. Certification. A statement in the Command Submittal DD Form 1391 (Military Construction Project Data) and Project Definition of the "Requirements and Management Plan" (RAMP) narrative: "The requirement for HEMP shielding is approved."

e. Field Design Instruction (DI). An instruction issued by the DM to the Design Agent which indicates the scope of work and the Programmed Amount (PA).

f. Global Shield. A shield enclosing the entire interior of a large or multi-room facility where mission critical equipment must be protected against a HEMP event.

g. Hardening in Facilities. The HEMP barrier in a facility which contains the Hardness Critical Items (HCIS) and Mission Essential Equipment (MEE) which require protection against a HEMP event.

h. Hardness Critical Concept. Drawn from the minutes (U) of the JRSC Survivability Working Group Meeting (#16), 19 Oct 89. it includes a description of the Hardness Critical Areas (HCAs), HCIs and Hardness Critical Processes (HCPs).

i. Hardness Critical Area (HCA). An enclosed volume within which are contained HCIs or where HCPs are carried out. Examples include power systems, antenna subsystems, ventilation penetrations, and ground systems.

j. Hardness Critical Items (HCIs). Those components and/or construction features which singularly and collectively provide specified levels of HEMP protection, such as the RF shield, surge arrestors, RF shielded doors, shield welding, electrical filters, honeycomb waveguides, and waveguides-below-cutoff.

k. Hardness Critical Processes (HCPs). Those installation, retrofit, and/or maintenance procedures which are applied to HCIs to implement HEMP protection characteristics as designed.

l. HEMP. Acronym for "high-altitude electromagnetic pulse." This pulse creates electrical transients which damage electronic equipment unless the equipment is protected.

m. HEMP Manager. The user of the hardened facility at the base level or the requiring command representative who determines whether the equipment or system needs to be HEMP hardened.

n. HEMP POC. The base civil engineer point of contact knowledgeable on HEMP hardening technical requirements.

o. HEMP OPR. The MAJCOM facilities engineer or Design Manager (DM) responsible for the successful design, construction and testing of HEMP barriers in facilities. Reference Appendix 3 for a listing of HEMP shielding contacts.

p. Independent Testing Laboratory. A testing firm separate from the construction contractor contracted by the government, to conduct the acceptance test.

q. In-Progress Tests. Tests performed by the contractor during the installation/welding of the shielding before room finishes are installed. These tests are usually performed when the contractor seeks assurance that the shield joints and penetrations are not leaking RF, and the shielded enclosure or facility is ready for the final acceptance test.

r. Mission Essential Equipment (MEE). Includes all equipment, sensitive and non-sensitive, necessary for survival and success of the mission within the barrier.

s. Non-C4I Facilities. Mission critical facilities other than C4I-type which must be operational after a HEMP event. These vary from command to command and base to base and can be aircraft refueling facilities, hospitals, fire stations (systems), security police systems, airfield lighting systems, etc.

t. Planning Instruction (PI). Authorization issued through the Programming, Design and Construction system (PDC) by HQ USAF/CEC/CEP allowing the Air Force Design Manager (DM) to proceed to 100 percent design at the discretion of the requiring MAJCOM.

u. Project Definition (PD). A package developed by the designer which outlines the design solution for the required facility, within the identified scope and cost limitation of the field DI. A PD package defines the user's needs, provides a link to the Base Comprehensive Plan or Master Site Plan, develops a design analysis package, provides a revised project cost estimate, verifies the construction contracting strategy, and includes a briefing to the user (Reference CTL 90-1 for further details).

v. Project Management Plan (PMP). A plan which outlines the procedures and responsibilities of the project management team and is required for every project designed under the new process. The DM is responsible for development of the PMP. Reference CTL 90-1 for further information.

w. Requirements and Management Plan (RAMP). A set of criteria normally developed by the BCE staff with portions sometimes developed by a design contractor and consists of: project narrative; project management plan; subarea development plan; infrastructure requirements; environmental issues; base design standards; base architectural guide: and project cost estimate.

x. Sensitive Electronic Equipment (SEE). Equipment that can fail due to a HEMP event and must be protected in order to successfully perform the electronic functions) intended.

y. Shielding Effectiveness (SE). The HEMP attenuation (reduction) to be provided by the HEMP barrier. SE is typically designated by db = 100,000/1 with db = to 20 log (Out/In).

z. User. Operator of the equipment inside the HEMP barrier, or tenant organization (MAJCOM) for whom the shield was installed.

aa. Verification Test. Air Force test funded by the user of the HEMP barrier after all the MEE have been installed by the user. This test is required for C4I facilities per MIL STD 188-125 and waivers must be obtained from OSD. However, verification tests for non-C4I, mission critical facilities can be waived by the requiring command.

4. Applications. The emphasis of this ETL is on new construction and alteration of C4I and other mission critical systems to survive a HEMP event.

a. C4I-Type Facilities. The tailored hardening guidelines that are presented here for C4I systems, per MIL STD 188-125, are also applicable to other distributed systems and to the retrofit of existing systems which must continue to operate after a HEMP event.

b. Non-C4I-Type Facilities. The referenced USAF handbook to harden Petroleum, Oil and Lubricants (POL) control systems has been prepared primarily for use by United States Air Force Engineers and Contractors who are responsible for the design and construction of HEMP hardened POL systems, but it can be used as guidance to harden non-C4I mission critical systems. The primary approach to protect these systems is to harden the equipment against the generic solid state damage thresholds presented in Appendix 2.

Part 3 - HEMP HARDENING

5. Implementation - General. A major goal of HEMP protection is to assure that validated requirements are satisfied with the most effective life cycle cost protection per AFR 80-38. Global shielding may not be required if the MEE/SEE are HEMP hardened at the equipment level and are properly integrated. However, for C4I-type facilities, MIL STD 188-125 requires global shielding regardless of the life cycle cost. Hardening non-C4I, mission critical systems do not have to meet the requirements of MIL STD 188-125. Life cycle cost versus risk must be weighed. However, if HEMP hardening of non-C4I systems electronic components is selected versus global shielding, the equipment must be able to withstand damage thresholds per Appendix 2. While C4I-type facilities are shielded from upset, non-C4I mission critical systems should be able to suffer upset and be reset within minutes to continue functioning.

a. C4I-Type Facilities. Hardening of systems in these types of facilities must be done IAW MIL STD 188-125. This is a fixed approach of high first cost, low risk and high life cycle cost. Reference the USAF Handbook for the Design and Construction of HEMP/TEMPEST Shielded Facilities for details.

b. Aircraft Refueling Facilities. Reference the USAF handbook for hardening POL systems.

(1) General. The POL systems have fewer sensitive electronic components and less time sensitive operations. The trade-offs of cost and survivability should be considered.

(2) Microprocessors. The most reasonable and effective protection is to HEMP harden the microprocessors or integrated circuitry associated-with the electrical power and control to avoid the damage levels shown on Appendix 2. The components must be protected if their inoperability will disable the operation of the POL facility.

(3) Motors and Backup Generators. Hardening sensitive electronic components also applies to backup generators which have electronics controls. Motors may be robust and not need protection, but their starting circuits may have solid state components.

(4) Preferred Consideration. The first consideration is to harden the pump control panel which contains microprocessors by installing filters, gaskets and/or waveguides on the cabinets and housings themselves, per the USAF handbook to harden POL systems. This includes hardening SEE associated with the backup generators. This is a high risk but low life cycle cost approach. Reference Appendix 2 for damage levels of components.

(5) Alternate Approach. Another approach is to harden the control room which contains the SEE by installing global shielding. This is the low risk, high first cost and high life cycle cost.

c. Non-C41 Mission Critical Facilities. The approach will be similar to that for POL systems as described in paragraph b above.

(1) Harden equipment which houses sensitive electronic components. This is the low first cost, high risk, but low life cycle cost approach. Reference Appendix 2 for component damage levels.

(2) Install a shield barrier in part of the facility where the SEE is consolidated.

6. Planning Requirements.

a. General. Reference the flow chart of Appendix 4 for HEMP Hardening Planning and Programming. A series of verification and validation steps have been establish to ensure only necessary shielding is installed.

b. Origin of the Requirements.

(1) Joint Chiefs of Staff (JCS). Per JCS direction, "all implementing commands shall harden all Air Force mission critical systems containing electronics to withstand high-altitude electromagnetic pulse (HEMP) effects if they must function during or after a nuclear environment."

(2) Air Staff. (Reference AFR 80-38)

(a) Nuclear Criteria Group (NCG). The Director of Advanced Programs (SAF/AQQ) chairs the NCG which confirms nuclear survivability strategies and establishes nuclear criteria for selected USAF systems with validated survivability requirements. The various nuclear survivability options are developed by the Nuclear Criteria Group Secretariat (NCGS). Members of the NCG are SAF/AQQ, HQ AFSC/XT (Vice Chairperson), SAF/AQS, HQ USAF/IN/CE/SA, HQ AFLC/MM, AFOTEC/CC, Operating Commands, HQ AFWL/CC and system Offices of Primary Responsibility (OPRs). SAF/AQQS manages the procedures for NCG operation, scheduling meetings, development of agendas, and so on.

(b) Nuclear Criteria Group Secretariat (NCGS). The Secretariat is located at the Weapons Lab in Kirtland AFB, NM. it supports the NCG by developing nuclear survivability options, proposed criteria, analysis for each option and a recommendation. Analysis of the options include the effects of technology risk, threat and operational employment on system nuclear survivability and estimated costs for design and construction; hardness maintenance and surveillance throughout the system life cycle

(c) Strategic Division (SAF/AQQS - The SAF OPR for nuclear survivability). Responsible for informing the appropriate Air Staff agency of the criteria determined by the NCG, providing administrative support for the NCG, monitoring the status of nuclear survivability recommendations acted on by the NCG, and keeping records of the requirements. SAF/AQQS accepts requirements and data on survivability strategies and criteria from the commands and provides the information to the NCGS for analysis and review.

(d) Nuclear Survivability Steering Group (NSSG). This group is co-chaired by HQ USAF/LGY and SAF/AQQS and guides the Air Force in management and policy matters for nuclear survivability. Some of the major duties are: establishing and reviewing requirements for nuclear survivability; developing goals for nuclear survivability activities; and establishing and documenting USAF policy/guidance for nuclear survivability. All MAJCOMs are represented in this group.

(3) MAJCOM.

(a) The requiring command will establish HEMP hardening requirements per AFR 57-1.

(b) The requiring MAJCOM HEMP Manager must inform the user at the base level of the hardening required.

(4) Base Level.

(a) HEMP Manager. The user should be involved in the planning, programming, design reviews, site visits and barrier testing from initial request to facility acceptance.

(b) For C4I-type systems, the user will submit an AF Form 332 (BCE Work Request) to identify the requirement to construct a hardened barrier in a new or existing facility. For non-C4I-type systems, the user must consider procuring hardened equipment first or hardening existing equipment per the damage thresholds 6f Appendix 2. If the equipment is real property installed equipment, then the user must submit an AF Form 332 to have the work accomplished by the base civil engineer. The shielded barrier user (HEMP Manager) and the Base HEMP POC should work together to determine the HEMP hardening requirements for the new or renovated system.

(c) Construction Designation Code. A construction code will be established by the Real Property Division (HQ USAF/CER) for the purpose of identifying those facilities or areas within a facility that are HEMP protected.

(d) HEMP hardening requirements must be available at the Pre-Project Definition Conference to avoid delays.

7. Programming Requirements for MILCON Funding.

a. General. Reference Appendix 4 for a planning and programming flow chart.

b. Command Submittal.

(1) The Base or Host MAJCOM HEMP OPRs must include a separate line item entitled "HEMP Hardening" under "Supporting Facilities" in Block 9 of the DD Form 1391.

(2) The following statement shall be included in the DD Form 1391c: "The requirement for HEMP hardening is approved."

(3) The shielding cost estimate must be provided as a cost per square foot of surface area and it includes filters, waveguides, shielded doors, etc., in addition to the metal shield plates.

(4) After the Air Staff Facilities Panel approves the scope of the project, a PI will be issued by HQ USAF/CEC/CEP.

c. Funding. The cost for HEMP shielding will be programmed as follows:

(1) The acquisition cost for C4I facilities shielded per MIL STD 188-125 is estimated to be $60 per Surface Square Foot (SSF) for shielding in new facilities, and $80 ($20 for demolition and $60 for installation of new) per SSF for installing shielding in existing facilities. These cost estimates include a cost of $6.00 to $10.00 per SSF for testing, depending on the size of the building. These costs are for the FY 92 program.

(2) The acquisition cost for non-C4I facilities shielded per USAF handbook to harden POL systems is estimated to be $30 per SSF for shielding in new facilities and $50 per SSF for installing shielding in existing facilities. These estimates include a cost of $6.00 per SSF for testing.

(3) Shielding in new or existing facilities because of a mission change will follow the appropriate funding guidance and thresholds for military construction or minor construction.

(4) Shielding new equipment (non-RPIE) will be user funded.

(5) Hardening existing RPIE SEE. Funding to harden existing equipment will be minor construction funds up to $200K. Above that, funding request will be through the MILCON process. Efforts should be made to replace this equipment with EAID and standardize with logistically supported components through AFLC.

(5) Hardening System Control Rooms in Existing Facilities. It may be more cost effective to harden a room or part of a room than several cabinets or housings which contain microprocessors. Funds for upgrading RPIE will be minor construction up to $200K. Otherwise, the project will have to be programmed for MILCON funding.

(6) Facility Alterations. Shielding which requires a permanent change (removal of existing or construction of new fixed walls, roofs, etc) to an existing facility or a section of that facility because of a mission change will follow the funding guidance and thresholds for military construction or minor construction appropriations.

(7) In-progress and acceptance tests will be funded as part of the construction project. However, the verification test by the Air Force, done after the contractor turns the facility over to the Air Force, is always funded by the user (requiring command).

8. Project Development (MILCON, FY92 and Beyond).

a. Planning Instructions (PIs). PIs issued by the Air Staff on HEMP hardening projects will be designated "Special Interest." This means that HQ USAF/CECE (Formerly AF/LEEDE) and/or HQ ESC/LEEEC should be notified of the pre-design and pre-construction conferences which they may attend.

b. Requirements and Management Plan (RAMP). Reference CTL 90-1, para 4 for details.

c. Field Design Instruction. Include HEMP hardening as a special interest item. Reference CTL 90-1 for further details.

d. Project Management Plan (PMP). The project management team headed by the DM should consist of: the HEMP Manager; the HEMP Base POC; the HEMP OPRs from the host and requiring MAJCOMS: and the Design Agent's (DA's) project officer. Reference CTL 90-1 for further details.

e. Commerce Business Daily (CBD) Announcements. The CBD announcement should include the statement: "HEMP hardening design experience will be a rating factor."

f. Architect-Engineer Firm (A-E) Selection. The DM HEMP OPR should be involved in the selection process. As a minimum, the OPR should act as an advisor to the selection panel.

g. Pre-Project Definition Conference. For facilities or portions of facilities which will contain shielded areas of 1,000 SF or more, the HEMP Base POC, HEMP OPR from the Requiring MAJCOM and DM should attend the conference to ensure the A-E understands the requirements for shielding.

9. Design Requirements.

a. General. Reference Appendix 5 for a design flowchart.

b. Electromagnetic Barrier. Where a barrier is required, it must be configured to achieve the following technical objectives:

(1) Enclose all MEE which can practically be housed inside the barrier.

(2) Minimize the number of shield POEs for interconnections between enclosed equipment and mission critical equipment outside the barrier. Group POEs when possible.

(3) Minimize overall HEMP protection subsystem degradation due to failure of a single HCI. HCIs should be standard, off-the-shelf items. Note: HCIs must be highlighted in the drawings and specifications.

c. C4I-Type Systems. For details, reference the USAF Handbook for the Design and Construction of HEMP/TEMPEST Shielded Facilities. A copy of this handbook can be obtained from HQ ESC/LEEEC or HQ USAF/CECE. Conflicts between the USAF handbook, guide specs or any others should be reported through the DM or host MAJCOM to HQ USAF/CECE for resolution.

d. Non-C4I-Type Systems. These essential systems can be protected per USAF handbook for design and construction of hardened POL systems. A copy of this handbook can be obtained from HQ USAF/CECE. Conflicts in criteria will be handled as described in paragraph (c) above.

e. Levels of Protection.

(1) C4I-Type Systems. C4I facilities shall be tested and meet the shielding effectiveness requirements per Appendix 1.

(2) Non-C4I-Type Systems. A level of protection should be sufficient to prevent the equipment from experiencing the damage threshold of Appendix 2.

f. Shielding Material. The user determines that a shield barrier or global shield is cost effective. The designer will utilize materials of high permeability, such as stainless or galvanized steel plates or sheets. These also are corrosion resistant. Other materials, such as hypernick, mu-metal or permalloy, may be used if cost effective. Metallic foils must not be used for HEMP hardening. Reference the USAF handbook for design and construction of shielded POL facilities for further details. Note: Bolted-type, sandwich panels which have been proven life cycle cost effective may be considered.

g. Fire Alarm Systems.

(1) Global Shields. Filter-protected, communication-type circuits can be used for fire reporting between the shielded facility and base fire department. However, fiber optics systems are preferred and should be used where cost effective.

(2) Alarms for Shielded Areas within Buildings.

(a) Where alarm systems are hard-wired, consider installing an alarm panel inside the shielded area to receive signals from alarm heads within the protected area. This will eliminate the need to penetrate the shield with large numbers of sensor wires, each of which must be filtered.

(b) Run two filtered signal lines or fiber optics cables from the panel in the shielded area to the building fire alarm panel. One line will alert the fire department and occupants in the unshielded portion of the building, while the other will alert the occupants in the shielded area of an alarm outside the shielded area.

(c) The fire alarm equipment must be able to withstand the damage and upset thresholds of Appendix 2.

(3) Sprinkler Piping in Waveguides. Care should be exercised by designers when locating lighting circuits, sprinkler piping, or any conduit/piping systems within waveguide entryways. These systems can negate the effectiveness of the waveguides if piping or conduit are not installed properly. Reference the USAF handbook for Design and Construction of HEMP/TEMPEST Shielded Facilities, page 150 for details.

h. High Voltage Filters. Avoid usage of filters greater than 600V. Step the voltage down if necessary in order to use lower voltage filters. At present, high voltage filters are not reliable and can be safety hazards. Acquire Air Force standard filters with standard voltage and current ratings through AFLC, when possible. If not available, use commercially available filters with standard voltages and current ratings. Recommend using lowest ampacity size possible. Power filters leak reactive current to ground which increases power loss and lowers the power factor.

i. Shield Penetrations. Various items of mechanical equipment are often located outside of the shielded enclosure. Note: Control wiring, pneumatic tubing, refrigerant lines, HVAC ducts and controls, etc., may need to be designed with adequate filtering/waveguides to attenuation RF signals per this ETL. Reference the USAF handbook for HEMP/TEMPEST shielding paragraph VI for details.

j. Shielded Equipment in Shielded Areas. Double filtering has been known to cause problems with Satellite Communications (SATCOM) earth terminal equipment, communication lines and with fire alarm and intrusion detection systems. Caution should be exercised with double filtering.

k. Solid State Systems in Non-C4I-Type Facilities. Sensitive circuit systems such as microprocessor controls in aircraft refueling systems, airfield lighting control systems, standby generator controls, etc, require:

(1) Surge Protection. High speed (nanosecond reaction time) surge protection, such as a surge arrestor, must be placed on the input side of the transformer, if it is to supply power only to the immediate SEE. If the power system lines extend over 100 feet to the facility from the transformer, additional surge protection will be required at the motor control or power distribution center. The feeder must be in rigid conduit. Reference the Guide Specifications for HEMP/TEMPEST Shield Doors, Electrical Filter/ESA Assemblies, and other Shield Penetrations for further details.

(2) Metallic Conduit. All electrical wiring, i.e., between motors, relays display panels, lights, sensors and power connections, shall be shielded by metallic conduit which is electrically continuous and grounded.

(a) Metallic rigid conduit must be used to contain all power and control wires.

(b) All connections of conduit to boxes, conduit bodies, fittings, enclosures and shield shall be circumferentially welded.

(c) The conduit must be grounded to the building ground.

(3) Microprocessor Hardening. All sensitive electronic components, such as the microprocessor in the power control panel, or the power control panel itself shall be electromagnetically shielded against a HEMP event per Appendix 2, or must be placed in a hardened enclosure, whichever is most cost effective.

(4) Shielding. The shield shall consist of: RF-shielded wiring conduit; RF-tight equipment racks using RF gaskets; welded/brazed seals on container seams; surge protection; and filters on electrical lines.

(5) Standby Generator. The generator control panel requires shielding and the protection of electrical wiring. Special attention must be given to the electronic components of the generator, such as the electronic governor.

l. Performance Specifications are Not Acceptable. Each design must be completely detailed to leave no aspect to chance or guess work by the construction contractor. Detailed shop drawings of shielding material/component construction or installation must be reviewed and approved by the Technical Representative for the Contracting Officer (TRCO).

m. Standardize Hardness Critical Items (HCI). Whenever possible obtain standard products from AFLC (SM-ALC) which are stocklisted and logistically supported items of equipment. This includes doors, electrical filters, ventilation filters, latches, surge or transient suppressors, gaskets, etc.

n. Design Checklist. Appendix 6 is provided to assist the designers in preparing the drawings and specifications for the HEMP barrier.

o. Design Classification. The design will be unclassified to allow normal design and construction procedures.

p. Facility Testability.

(1) The HEMP barrier shall be accessible for visual inspection at all point-of-entries (utility penetrations and personnel entryways). At least one side of the shield, preferably the outside of the shield, must be easily accessible to facilitate placing test equipment. Near penetrations, the exterior clearance must be 36 inches wide for safety purposes. This assumes the shielded volume is constructed within a building.

(2) A built-in shield monitoring capability should be installed with the HEMP barrier, and include antenna loops, SELDS drive points (below the floor) or equivalent.

q. Design Reviews. The Base HEMP Manager and POC, host MAJCOM HEMP OPR and DM, and HQ ESC/LEEEC must be included in review at the 60 and 90 percent design review stages. For C4I-type facilities, Technology Integration Group (TIG)/APGD (formerly 1842 EEG) must be included in the review process, and SIO/SYE for integrated TW/AA systems. HQ USAF/CECE must be included in the design reviews of shielded enclosures or facilities which exceed 5,000 SSF scope.

10. Construction Requirements.

a. Preparation for Pre-Construction Conference. A contract which includes shielding requirements can be very complex. Therefore, all government interested parties should meet prior to the Pre-Construction Conference to review the shielding requirements and to resolve any questions.

b. Pre-Construction Conference. For shielding surface areas of 1,000 SSF or more, the user, DM HEMP OPR or OPR's representative should attend the Pre-Construction Conference. For shielded areas greater than 5,000 SSF, the user and the DM HEMP OPR must attend the Conference, and the Base and MAJCOM HEMP OPRs should be invited. The OPRs must ensure that the contractor is aware of the special hardening requirements of the design and is capable of completing them.

c. Welder/Installer Qualifications. An experience clause for the HEMP barrier installer must be included in the design documents. The contractor must submit to the contracting officer certification that workers who are to weld and braze a facility HEMP shield are qualified to MIL STD 248. Welding of thicker sheets should be done in accordance with the general provisions of the American Welding Society Standard DI.1, which describes the procedures for welding carbon and low alloy steel greater than 1/8-inch thick.

(1) If the shield is to be welded, then the welder must be certified according to the applicable requirements of the American Welding Society. Shield welders must be qualified according to the welding procedures and welding operator performance using MIL-STD-248C and shall comply with the Structural Welding Code of the American Welding Society for inert gas shielding metal arc welding. Where both structural integrity and shielding quality are required for a given weldment, both criteria shall be met simultaneously. Where only welded joints are required, the welder qualification shall be based on an acceptable procedural qualification test per MIL-STD-22D.

(2) For soldering (limited to around the door fingerstock and other HCIS), the solderer must show previous experience in at least two successful construction projects.

d. Inspector Qualifications. A HEMP-qualified construction inspector shall inspect the progress of the 100 dB shielding and/or filtering installations. The inspector must be certified as an Electromagnetic Compatibility (EMC) Engineer or Technician by the National Association of Radio and Telecommunications Engineers (NARTE) and be knowledgeable in shielding construction and practices. NARTE can be contacted at P.O. Box 15029, Salem, Oregon 97309, or telephone (503) 581-3336.

e. Extended Warranties. HCIs are normally warranty to sustain their attenuation above the required level, if maintained IAW the manufacturers' instructions. Requiring commands are encouraged to incorporate the maintenance and periodic testing of these components for the warranty period as a portion of the contract. The following HCIs should be considered for extended warranties:

(1) All welds

(2) All power and signal filters

(3) All shielding doors (manufacturer provides maintenance kit including cheese cloth, putty knife, gaskets, finger stock, Allen wrenches, lubricants, etc., with each door)

(4) All honeycomb filters in mechanical systems and plumbing

(5) All waveguides

f. Submittals.

(1) All shielding submittals (shop drawings and literature for doors, filters, etc.) shall be approved by the TRCO prior to installation. Any deviations from the shielding specifications and drawings must be approved by the Contracting Officer (CO).

(2) Shop drawings of the contractor's proposed hardened equipment and components must be reviewed by the TRCO with the assistance of Air Force DM and MAJCOM HEMP OPR. These equipment and components are those boxes, filters, waveguides, i.e., hardness critical items which will be installed between the shielded and non-shielded areas.

(3) The contractor must submit a hardness maintenance/hardness surveillance plan for each HCI to ensure they are properly maintained and can provide life cycle performance. The contractor shall submit a complete parts list, to include manufacturer and part number.

g. Construction Monitoring. The same MAJCOM HEMP OPR responsible for monitoring the design should also be responsible for monitoring the shielding installation during construction. This is to ensure continuance not only of knowledge of critical parts of the design, but also to ensure these are properly installed during the construction. The following is a set of lessons learned during construction inspection.

(1) All penetrations (waveguides, welded pipes, and pipes between buildings) into the HEMP barrier shall be tested and visually inspected for corrosion and workmanship before finishes are installed.

(2) Properly fabricated and installed honeycomb waveguides for ventilation ducts can be trouble-free. An example of a better method is an array of one foot long metal pipes less than 1/2-inch diameter which are bonded together and which can also act as a waveguide for non-conductive materials to provide attenuation per MIL STD 188-125. For further details, reference page 118, paragraph 5 of the USAF handbook to design and construct HEMP/TEMPEST shielded facilities.

(3) Installers will not install conductive material (wiring, sprinkler pipes, ducting, etc.) through waveguide penetrations because this will negate the frequency effectiveness of waveguides.

(4) Installation of shielded doors will be done by the manufacturer of the door or his representative. After acceptance testing, the building contractor should protect doors and finger stocks by constructing a temporary protective structure around the shielded doors, while he continues to install the facility cosmetics. The doors will be protected in-place and blocked open. Ramps will be placed over the thresholds. This is to ensure that the doors are not damaged by traffic during installation of interior finishes.

h. Job Site Visits. The host and operating command HEMP OPRs or their representatives must visit the construction job site at the 35 percent and 65 percent (as a minimum) of HEMP shielding construction to ensure the facility's operating command is aware of the progress and intricacies of the construction. When the shielded facility has a shielded area 5,000 SSF or greater, the CM should also invite HQ USAF/CECE and AFESC/DEMM to participate in the job site visits.

i. Conflicts and Discrepancies. HEMP hardening discrepancies, deficiencies, and conflicts that occur during construction must be documented by the CM and resolved by the contracting officer in coordination with the CM and the MAJCOM HEMP OPP. Copies of these documents, along with the OPR's resolutions and recommendations must be provided to HQ USAF/CECE.

11. Testing Requirements.

a. General. Shield testing has three main objectives: ensure good mechanical and electrical joints, detect problems early so they can be corrected with minimum cost, and demonstrate spec compliance by the contractor. Reference Appendix 8 for contractor test plan and results approval flow chart (Appendix 7).

b. Security Classification. The results of a HEMP in-progress or acceptance test, whether pass or fail, are not classified. This assumes the facility is not in operation. For C4I-type or non-C4I-type facilities, results of a verification test which indicate the facility has passed or failed the verification test shall be classified and marked as to the same level of classification as the mission within the facility. This assumes the facility is in operation. Reference DNA's EMP Security Classification Guide.

c. In-Progress Test by the Contractor. For shielded enclosures or facilities with 5,000 SSF minimum shielded surface area, the contractor should perform in-progress tests of seam, joint, and corner shield welds, door frame and honeycomb waveguides, panel frame welds to the primary shield, piping and conduit welds, and other welds in the shielding and points of entry to assure himself that the expensive acceptance test will probably pass. For facilities with less than 5,000 SSF of shield area, greater emphasis must be given to in-factory testing of components and good quality assurance.

(1) One hundred percent of the shield welds or soldered (primarily around doors and HCI penetrations) joints will be tested for RF radiation leaks as described below. The most common tests are non-destructive. The contractor can use the Shielded Enclosure Leak Detection System (SELDS) test or the dye penetrant test, or both.

(a) For welded steel, the dye penetrant procedure is the preferred mechanical test technique.

(b) The shielded enclosure leak detection system (SELDS) testing evaluates the electromagnetic properties of the shield. This method, with recognition of its limitations, is also suitable for in-progress testing of incomplete shields. Reference the USAF Handbook for Design and Construction of HEMP/TEMPEST Shielded Facilities for further details. Appendix 9 lists several testers which have been used in the past.

(2) SELDS testing entails direct-driving the shield with an RF current, usually around 100 kHz. Joints are swept with a hand-held ferrite probe that will detect RF energy leaking through the joints, either by direct diffusion or via. small holes. Although the SELDS test has limitations, it

is effective during in-progress testing. Reference the USAF Handbook for the Design and Construction of HEMP/TEMPEST Shielded Facilities for details.

(3) The independent testing laboratory's acceptance test plan must be approved prior to use by TIG/APGD, Scott AFB, IL for C4I facilities or HQ ESC/LEEEC, San Antonio, TX for non-C4I-type facilities. Reference Appendix 8 for the minimum information required in a test plan. A minimum of 30 days may be required for review of this plan. So, the proposed test plan must be submitted by the TRCO for review in a timely manner.

d. In-Factory Shielding Effectiveness Tests.

(1) Doors. Each RF shielded door will have a certificate of compliance from the factory per MIL STD 188-125.

(2) Honeycomb Waveguide Panels. One sample of each type of construction to be installed in the facility or enclosure shall be tested prior to installation per MIL STD 188-125 and MIL STD 285.

(3) Filter/Surge Arrester Assembly. At least one of each type of filter and surge arrester to be installed shall be tested per MIL STD 188-125 and MIL STD 220A.

(4) RF Shielded Enclosure. A representative sample of RF filter enclosures, pull boxes and junction boxes in the shielding and penetration protection subsystem shall be tested at the factory to ensure compliance with shielding effectiveness performance requirements, per MIL STD 188-125 and MIL STD 285 modified (Appendix I).

(5) Test data will be submitted to the contracting officer for approval prior to user equipment delivery to the site.

e. Acceptance Test - By Contract.

(1) General. The government will contract with an independent testing laboratory to perform this test. This laboratory will not be affiliated with the construction contractor, his subcontractors, or the shield manufacturer. The independent lab shall perform an RF-tightness acceptance test after the building contractor completes installation of the shield, penetrations and/or filters, and any interior finishes. Correct timing for testing is when the building or room(s) is RF-tight, all shielded doors are in place (including associated fingerstock and gasketing), all electrical/ electronic lines have filters in place, and cosmetics, such as sheetrock, paneling, are installed to conceal welded or soldered joints, and before MEE are installed.

(2) Purpose. This shield effectiveness test will inform the contractor and the Air Force whether the shield installation is acceptable. As a minimum, a probe must be made for RF leaks at the shield joints, shielded doors, signal and power lines and other types of penetrations. The test can consist of a SELDS or equivalent test, and H-field and plane wave CW tests per MIL STD 188-125 and MIL STD 285. Reference the USAF Handbook for Design and Construction of HEMP/TEMPEST Shielded Facilities for more details. Methodology and procedures for setting up equipment are per MIL STD 285.

(3) Test Time. This test may range from only one to two weeks for small rooms to several months for large facilities. The government may save time by fielding several independent testing teams. At some locations, this test may have to be done at night, or weekends to avoid RF interference with other systems in the area.

(4) The building contractor must provide support to the independent testing team. Generally, the testing team only tests. The contractor is responsible for correcting any deficiencies. The contractor will have personnel available to immediately correct minor deficiencies uncovered by testing.

(5) Acceptance Test Plan Approval. Before the independent testing lab can use its test plan, it must be submitted for approval to the mLIG/APGD for C4I-type facilities, or HQ ESC/LEEEC for all other types of facilities. This review could require a minimum of 30 days and must be submitted in a timely fashion by the CM to HQ ESC or TIC. Appendix 7 provides a listing of minimum information required in a test plan.

(6) Qualified Independent Testing Laboratory. Qualified means the testing firm has the expertise to perform shield testing per MIL STD 188-125 and has a good track record (successfully tested four or five facilities with shielding surfaces of 1,000 SSF or greater) of testing shielded facilities or enclosures.

(7) Air Force Test Monitor.

(a) An Air Force HEMP OPR or his representative must be present during at least part of independent lab's testing to ensure it is being done according to the test plan. To effectively serve as the Air Force's representative during the acceptance test, the monitoring Air Force agency must be included in the review cycle for the test plan.

(b) The 1839th EIG/EIX can be contacted through the EID/EIW to serve as the Air Force representative to monitor the independent testing lab's test. It is possible that a private consultant may have to be hired by the operating command to perform this work if the workload at 1839th does not permit them to be the Air Force representative.

(c) The monitoring team must work closely with the contracting officer or his representative in the testing of the independent testing laboratory and correction of deficiencies by the building contractor.

(d) The testing contractor shall maintain appropriate records to ensure that all welds are checked and results recorded. All unsatisfactory welds shall be repaired by the building contractor and retested. Records shall be available for review by responsible Air Force offices. After the acceptance test, these records must be turned over to the user or operating command.

(8) Independent Lab Test Result Approval. The test results must be submitted to TIC for C4I-type facilities or HQ ESC/LEEEC for all others to review within 30 days after the test is performed. Copies of the test results will also be provided to the construction contractor, user or operating command, and the MAJCOM HEMP Manager.

(9) Test Failure.

(a) General. If the test indicates a shielding failure, then the building contractor will be responsible for making appropriate repairs to the shield, and/or filtering components, and must pay for related retest.

(b) Cost for Retest. The building contractor payment for retesting by the independent testing laboratory will be based on the number of points that failed divided by the total number of points tested. This fraction will then be multiplied times the total cost for testing the entire facility.

(c) Time to Repair. Time allowances for time to repair of shielding deficiencies by the contractor must be included in the facility construction contract. The building contractor should be charged for delays beyond the allowed time for repairs. Historical information at the 1839th EIG/EIEE indicates that repairs can take from a few minutes (replace filters, door gaskets, etc.) to a few hours (removing finishes and re-welding) to one year (replacement of shielded door because it was the wrong type).

f. Verification Test (After Construction Completion) - By Air Force.

(1) General. For non-C4I-type facilities, the verification test is not required if no new penetrations are made after the equipment is installed and ready to run. However, for C4I-type facilities, the verification test is required per MIL STD 188-125. This test will be funded by the user.

The test occurs after the Air Force has accepted the shielded enclosure or facility from the building contractor. The user(s) or operating command(s) will contact EID/EIW (DSN 884-9386) at Tinker AFB to schedule testing of any additional penetrations and associated filters, waveguides, etc. EID tasks the 1839th EIG/EIX (DSN 868-3920) at Keesler AFB to perform the tests. If the 1839th cannot perform the test, then the user or operating command may have to contract with a private laboratory to perform this test.

g. Life-Cycle HEMP Hardening - For Warranty Considerations.

(1) Post Occupancy Testing. The user(s) will be responsible for HEMP surveillance of the shielding to ensure the integrity of the shield. Verification testing as described above will be funded by the user at least once every three years or whenever any structural change (alteration, addition, penetration, etc.) is made to the shielded enclosure or facility. The user should schedule more frequent testing every three months using RF illumination testing. While this test is not a comprehensive test, it does indicate where shielding is leaking and needs repair and/or comprehensive testing after the repair. Usual shielding leakage often occurs around the doors, penetrations and along the corners of the shield sheets, or plates, and at the actual weld. AFLC is in the process of becoming the support agency for Air Force hardness maintenance/hardness surveillance initiatives for all HEMP barriers.

(2) Test Plan. The user must develop a verification test plan with the assistance of HQ ESC/LEEEC or TIC (for C4I-type facilities) for periodic testing of critical facilities after beneficial occupancy of the facility.

(a) Monthly Tests. This plan will consist of frequent visual inspections for shield cracks, corrosion along the shield, dirty fingerstock, and shield door malfunctions.

(b) Tri-Monthly Tests. This includes SELDS testing or using the built-in shield monitoring capability to identify leakage along shield welded joints and around the shielded doors.

(c) Three-Year Tests. These tests will be duplicates of the verification tests.

(3) Shielded Enclosure Test Set Included in the Construction Contract. If the facility does not have a built-in shield monitoring system, then the contractor will turn over to the government a SELDS-type tester similar to those described in Appendix 9. This tester should be the type used during the In-Progress testing. The tester will be maintained and operated by the user.

(4) Correction of Deficiencies. The test team will not have the capability to correct any deficiencies. The user must have a readily available construction team to correct any deficiencies. Otherwise, the testing team will be forced to make repeated trips to retest the facility or room after the deficiencies have been corrected.

(5) Unlimited Access to the Facility. The test team (government or private contractor) must have unlimited access to the shielded facility or room. Therefore its personnel must have adequate security clearances. The mission of the facility may have to be curtailed. Personnel door usage will be very limited or even impossible during the testing.

(6) Testing Support. The test team (1839th or other government testing agency) may need such things as scaffolding, and removal of any building cosmetics to access the shield or penetrations and communications through shielded walls. If a private test firm performs the testing, it will provide its own supporting equipment. Removal and replacement of the building cosmetics is the responsibility of the user.

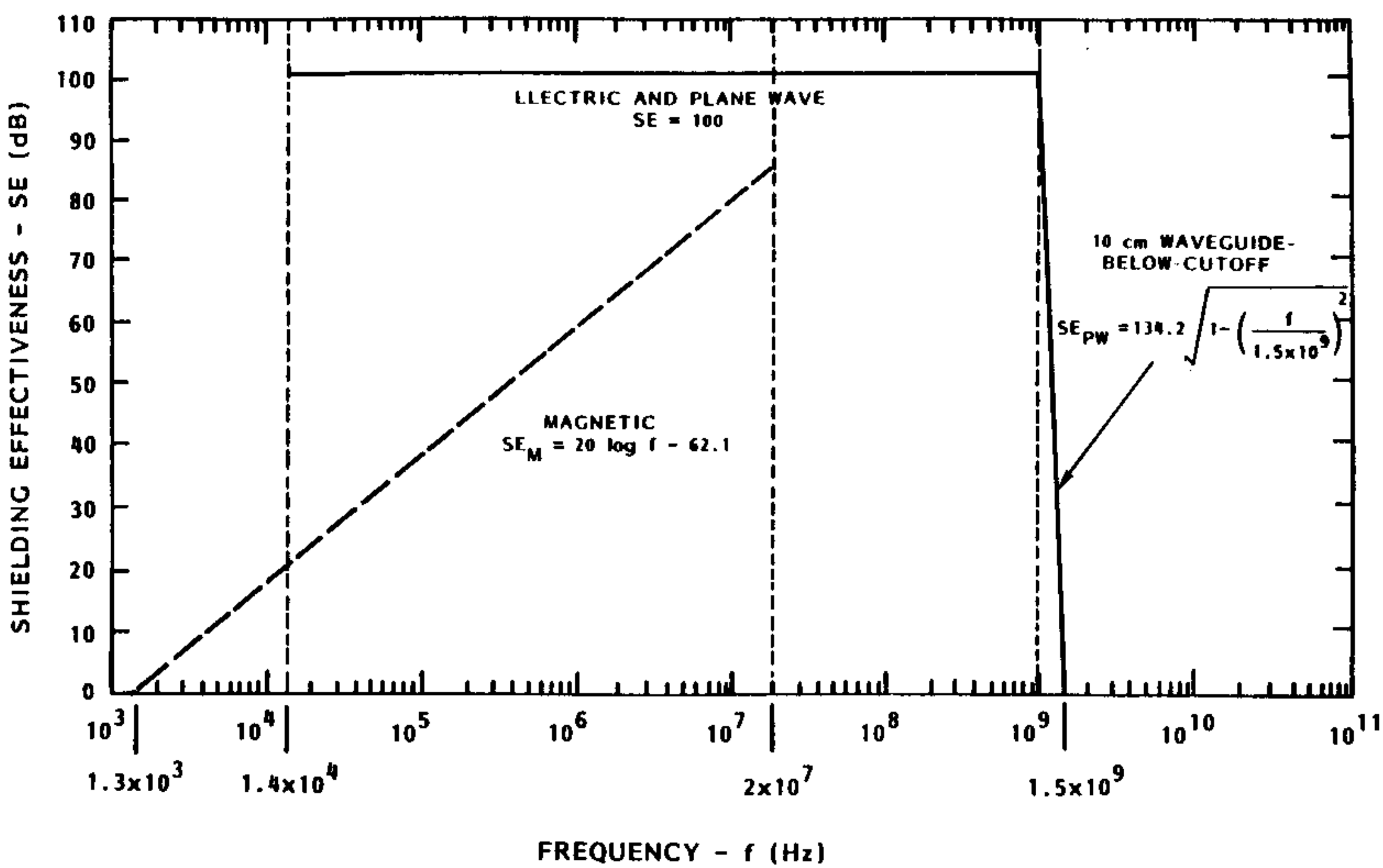

FIGURE 1. Minimum HEMP shielding effectiveness requirements

APPENDIX 2

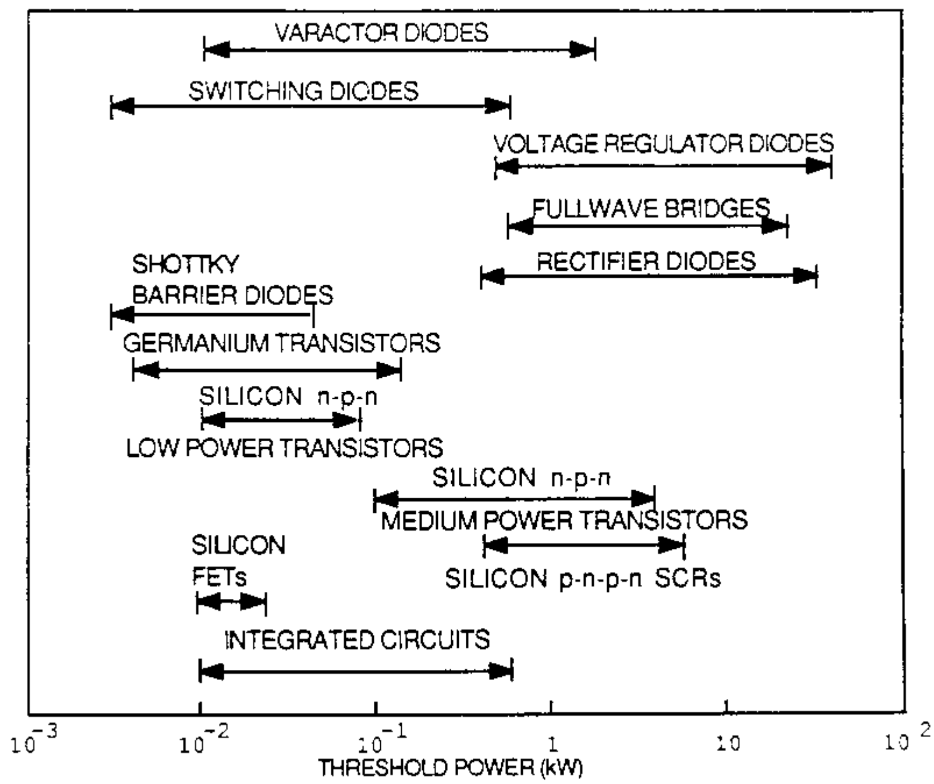

Figure 1. **Permanent damage power–threshold ranges (for a 1 µsecond pulse) for several device categories.**

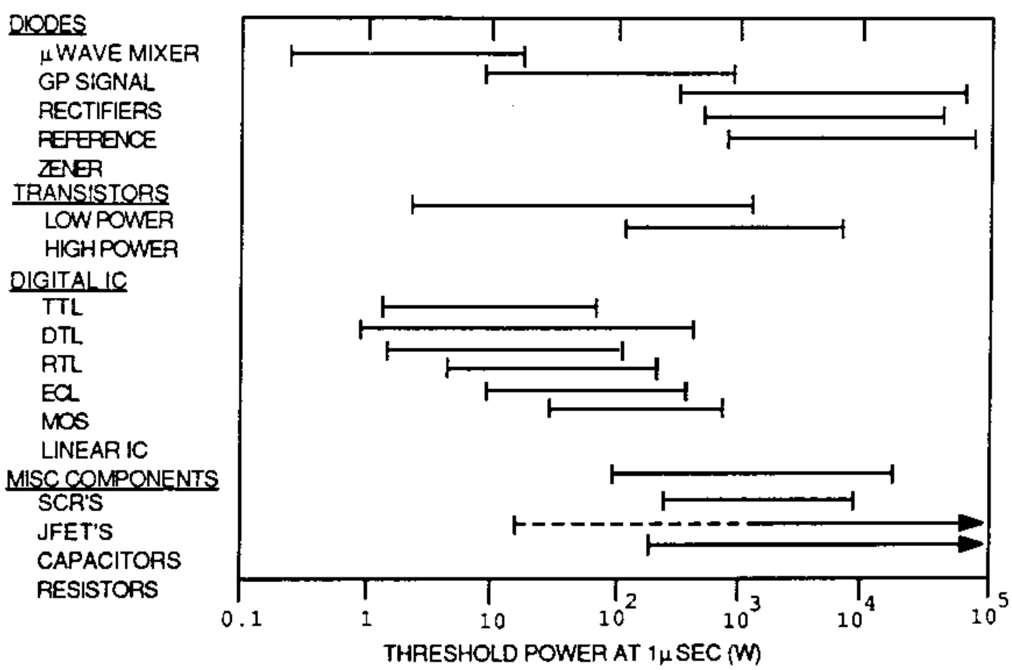

Figure 2. **Damage thresholds for a 1 µsecond pulse.**

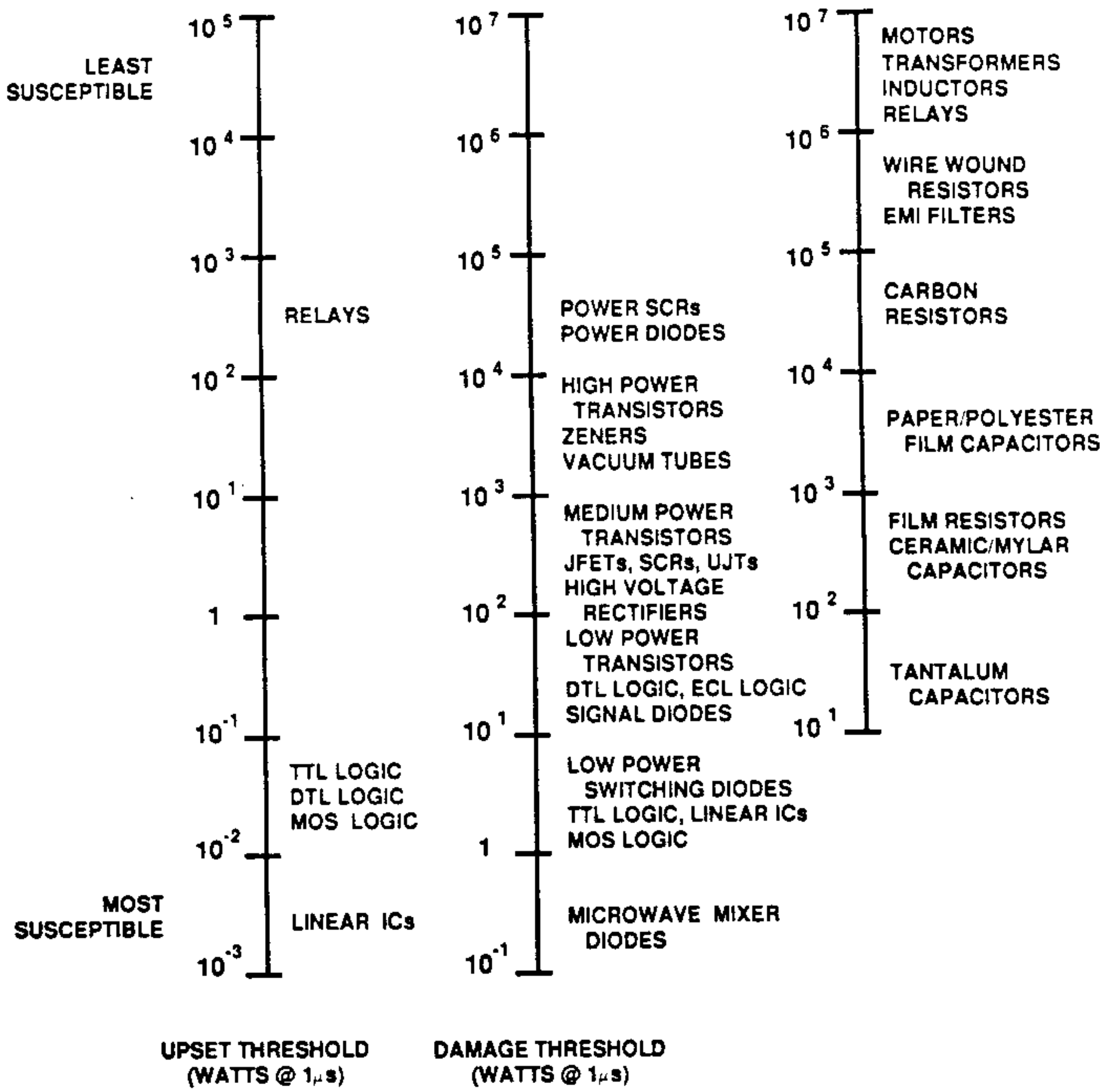

Figure 3. EMP Generic Device Damage and Upset Thresholds.

APPENDIX 3

AIR FORCE
HEMP HARDENING MAJCOM/AFRCE CONTACTS
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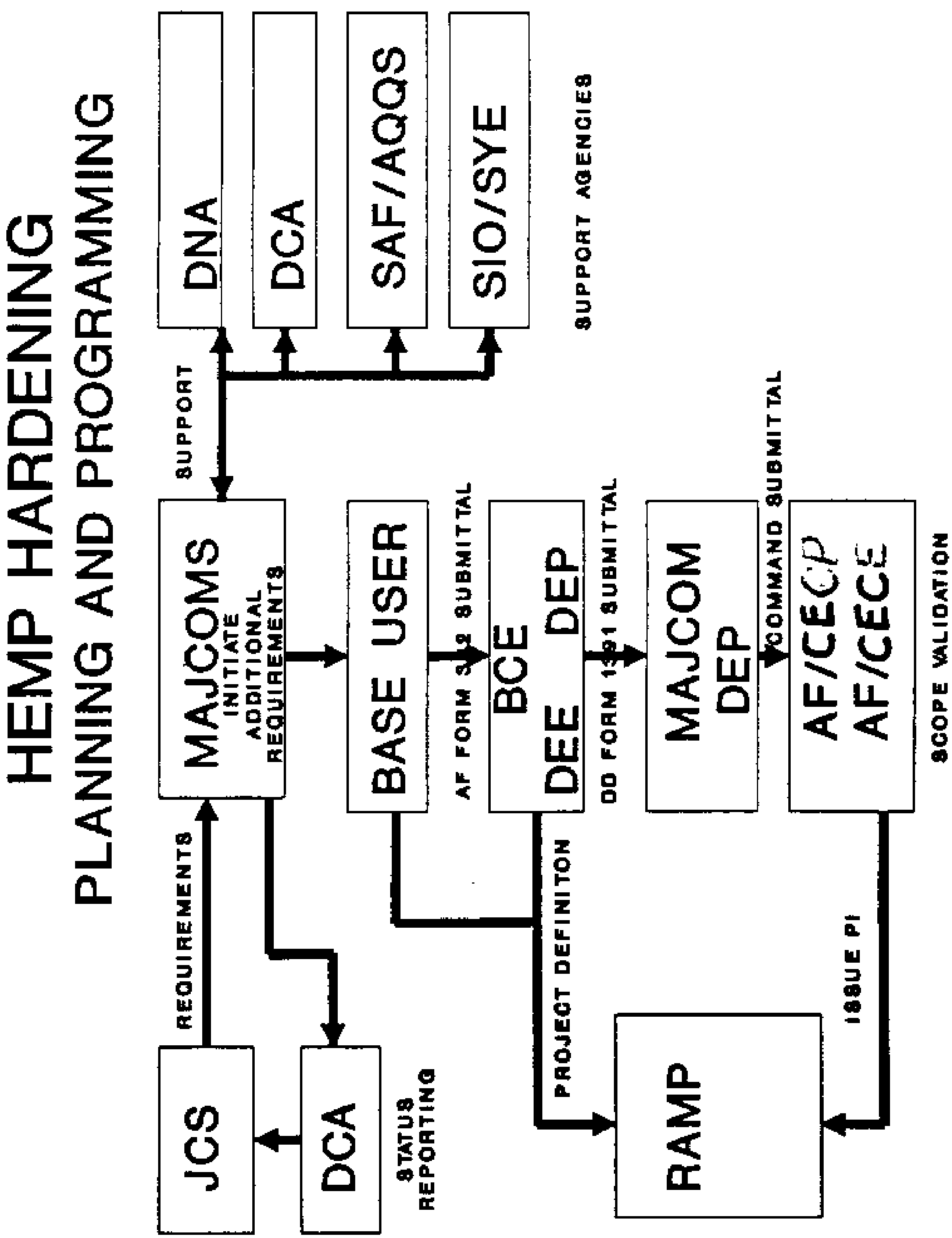
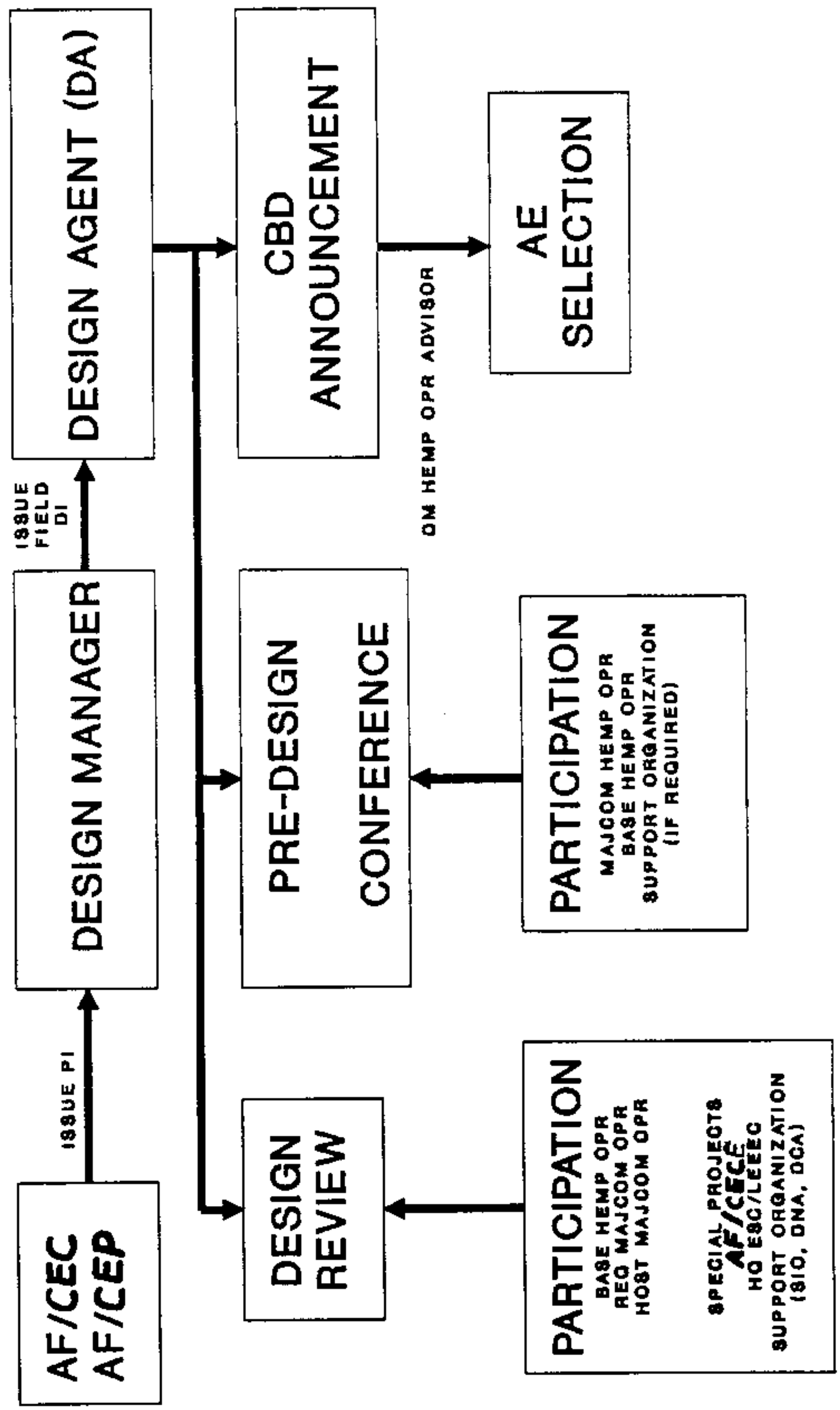
ORGANIZATION	NAME	PHONE NUMBER
AAC/DEE	Mr Alan Quesnel	DSN 371-552-5187
TIG/APGC	Mr. Harlen Mayberry	DSN 576-6121
TIG/APGC	Mr. Charles Ondrej	DSN 576-6121
TIG/APGD	Mr. McKinnon	DSN 576-3197
AFLC/DEE	Mr. Richard Winters	DSN 787-4563
AFLC/SCZPS	Mr. Hank Miller	DSN 787-7333
AFRCE-ER	Mr. Gary Lowe	(404) 331-6566
AFRCE-CR	Mr. Cleo Walton	(214) 653-3327
AFRCE-WR	Mr. Nick DiMario	(415) 556-8326
AFRCE-BMS/DEEC	Mr. Eugene Shonka	DSN 876-5615
AFRES/DEE	Mr. Bud Garner	DSN 468-5755
AFRES/DEM	Mr. J. Hugh Maddox	DSN 468-2903
ATC/DEE	Mr. A.G. Pinson	DSN 487-2786
ANGSC/DEE	Mr. Fred MacDonald	DSN 858-2461
AFSC/DEE	Mr. Jerry Lohsl	DSN 858-6017
MAC/DEM	Mr. Sam Sivewright	DSN 576-3067
MAC/DEEE	Mr. Rodney Hartleib	DSN 576-5895
SAC/DEER	Mr. George Sachs	DSN 271-4442
SAC/DEMU	Mr. Mark Bulechek	DSN 271-5917
AFSPACECOM/DEES	Mr. Fred Loudon	DSN 692-5030
AFSPACECOM/LKNIP	Maj Faudree	DSN 692-5286
SIO/SYE	Mr. Richard Cullen	DSN 692-5714
PACAF/DEE	Mr. Andy Hirano	DSN 449-5120
TAC/DESU	Mr. Calvin Poole	DSN 574-3237
USAFA/DEE	Mr. Ken Walters	DSN 259-3460
USAFE/DEE	Mr. Romel Madlangbayan	DSN 480-6795/6
USAFE/DER	Mr. Don Castamore	DSN 232-4251
USAFE/DER	Mr. Joe Nicks	DSN 230-4249
AFFTC/DEEE	Mr. Ron Smoldt	DSN 527-8307
SSD/DEE	Mr. Peter Campbell	DSN 833-0932
AU/DEED	Mr. Michael Allen	DSN 875-6908
ESD/DEE	Mr. Charles Wire	DSN 478-8604
EID/EISS	Mr. Robert Vaughan	DSN 884-9387
1839th EIG/EIX	Mr. Hugh Hanna	DSN 597-3920
TIG/APGD	Mr. John Zych or Mr Robert Carson	DSN 576-2661
AFIT/DET	Capt Brad Beer or Capt Marc Richard	DSN 785-4552
ASD/DEE	Mr. Andrew Ernest	DSN 785-5368
HQ ESC/LEEE	Mr. Joel Edwards	DSN 945-2831
AFESC/DEMM	Mr. David Conkling	DSN 523-6358
AFESC/RDC	Mr. Tom Hardy	DSN 523-6315
AF/CECE	Mr. Refugio Fernandez	DSN 297-4083
AF/CECP	Mr. Art Markowitz	DSN 227-1235
HQ DNA/RAEE	LTC Clinton Gordon	DSN 221-1158
SAF/AQQS	Lt. Col. Charles Martin	DSN 223-6303
WL/NTN	Col John Justice	DSN 244-0671

APPENDIX 4


HEMP HARDENING
PLANNING AND PROGRAMMING
DNA
DCA
SAF/AQQS
SIO/SYE
SUPPORT AGENCIES
SUPPORT
MAJCOMS
INITIATE
ADDITIONAL
REQUIREMENTS
BASE USER
AF FORM 3 2 SUBMITTAL
BCE
DEE DEP
DD FORM 1 91 SUBMITTAL
MAJCOM
DEP
COMMAND SUBMITTAL
AF/CECP
AF/CECE
SCOPE VALIDATION
REQUIREMENTS
JCS
DCA
STATUS
REPORTING
PROJECT DEFINITON
RAMP
ISSUE PI

APPENDIX 5

HEMP HARDENING
DESIGN FLOWCHART



APPENDIX 6

DESIGNER'S CHECKLIST FOR THE RF SHIELD

1. Designer

a. Overview

(1) Show shielding envelope by distinctive markings on the building floor plan and elevation cross-section drawings.

(2) Ensure that the design approach is constructible and maintainable.

b. Drawings

(1) Provide wall, floor and ceiling sections through each unique shield feature:

(a) Seams between adjacent sheets
(b) Wall-floor joints
(c) Wall-ceiling joints
(d) Wall-wall joints
(e) Wall-wall-floor and -ceiling intersections
(f) Anchoring details
(g) Treatment of interior columns
(h) Shield and false ceiling suspensions
(i) Expansion joints
(j) Other

(2) Specify type and thickness of shield materials.

(3) Specify methods of welding and type of welding materials.

(4) Specify methods for protecting shield materials (emphasis on gaskets and associated sealer materials) from weather and unfavorable environmental factors.

c. Specifications

(1) State shield performance requirements explicitly.

(2) Include materials certifications (Emphasis on anti-corrosive charateristics).

(3) Include shop drawing requirements.

(4) Include welder qualification and certification.

(5) Specify maintenance procedure requirements.

(6) Include quality assurance for:

(a) In-progress weld testing
(b) Complete shield test
(c) Acceptance shielding effectiveness measurements

(7) Determine if a shielding construction or quality assurance specialist will be required by specifications

(8) Extended warranties (optional)

2. Mechanical

a. Overview

(1) Identify all shield penetrations and ensure that each one is properly protected. Group penetrations wherever possible.

(2) Minimize penetrations by combining functions or making other design changes.

(3) Implement the utility entrance vault concept to the maximum practical extent.

(4) Ensure that penetration protection designs are constructible and maintainable.

(5) Provide physical security for mechanical penetration protection devices (PPDS) as required for HEMP protection.

b. Drawings

(1) Include a complete schedule of shield penetrations.

(2) Provide detailed drawings which show EM isolation- critical features of the design for each unique shield penetration:

(a) Shielded joints

(b) Floor drains and other piping or waveguide sleeve penetrations

(c) Ventilation honeycomb panels

(d) Lengths and diameters for waveguides

(5) Ensure that penetrations between conditioned and unconditioned spaces are sealed to prevent development of moisture in sensitive electronics components due to large temperature differences between conditioned and unconditioned spaces.

c. Specifications

(1) Explicitly define performance requirements for each type of PPD.

(2) Include maintenance procedure requirements.

(3) Specify replacement parts requirements.

(4) Include quality assurance test requirements for:

(a) 110 dB or 60 dB (minimum) shield doors

(b) Honeycomb panels

(d) In-progress inspections of PPD installation welds

(5) Address evaluation of PPDs during final shield acceptance testing.

(6) HM/HS plan for each HCI

(7) Waveguide entryway preferred for main personnel entryway.

(8) Include a filter ahead of HVAC waveguides-beyond-cutoff

3. Electrical

a. Overview

(1) Identify all shield electrical penetrations and ensure that each one is properly protected.

(2) Minimize penetrations by combining functions or making other design changes.

(3) Design to avoid use of fortuitous conductors.

(4) Ensure that penetration protection designs are constructible and accessible for maintenance and inspection.

(5) Ensure that PPDs are protected from the elements and provided with environmental control (especially large power filters).

(6) Implement the utility entrance vault concept to maximum extent.

b. Drawings

(1) Include a complete schedule of shield electrical penetrations.

(2) Provide detailed drawings which show EM isolation critical features of the design for each unique type of electrical penetration:

(a) Power filters
(b) Signal line filters
(c) RF filters
(d) Grounding interface with shield
(e) Door interlock and alarm circuits
(f) High current surge arrestors

(3) Call out where RF gaskets will be used.

(4) Indicate split filter box covers.

(5) Indicate "clean" and "dirty" sides of filter enclosures.

(6) Show exact electrical surge arrestor (ESA) installation details.

(7) Define shield door interlock and alarm circuits.

c. Specifications

(1) Explicitly define performance requirements for each type of PPD.

(2) Define maintenance requirements.

(3) List recommended replacement parts.

(4) Specify quality assurance test requirements:

(a) Filters
(b) ESAs
(c) Enclosures
(d) Factory quality control tests

(5) Include evaluation of PPDs during final acceptance testing.

4. Special Cases

a. Overview

(1) Determine all electrical/electronic equipment and controls tobe placed outside the shield.

(2) Analyze these special cases to determine if supplementary measures are required. Define the tailoring approach, and derive performance criteria.

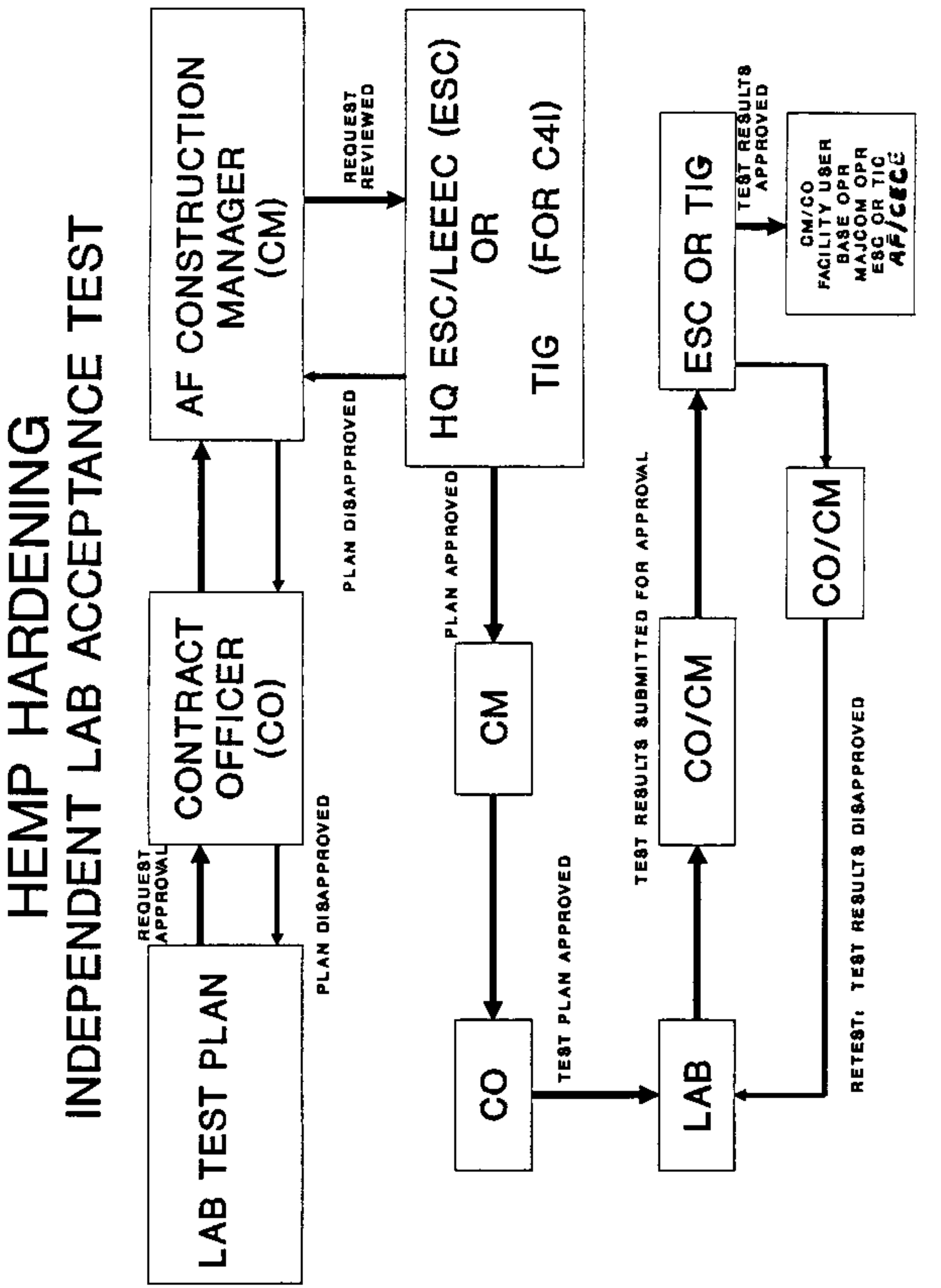
b. Drawings. Define the additional protective features in sufficient detail to ensure that the delivered facility satisfies the Government requirements.

c. Specifications

(1) Specify the 100 dB protection actions required by the contractor,including quantitative performance criteria.

(2) Include quality control testing provisions appropriate to the particular tailored protective design in specification. articles.

APPENDIX 7


HEMP HARDENING
INDEPENDENT LAB ACCEPTANCE TEST
LAB TEST PLAN
REQUEST APPROVAL
CONTRACT OFFICER (CO)
PLAN DISAPPROVED
AF CONSTRUCTION MANAGER (CM)
PLAN DISAPPROVED
REQUEST REVIEWED
HQ ESC/LEEEC (ESC) OR TIG (FOR C4I)
PLAN APPROVED
CM
CO
TEST PLAN APPROVED
LAB
CO/CM
TEST RESULTS SUBMITTED FOR APPROVAL
ESC OR TIG
TEST RESULTS APPROVED
CM/CO FACILITY USER BASE OPR MAJCOM OPR ESC OR TIC AF/CECE
CO/CM
RETEST; TEST RESULTS DISAPPROVED

APPENDIX 8

HEMP HARDENING TEST PLAN REQUIREMENTS

1. FACILITY IDENTIFICATION:

   A. CATEGORY CODE
   B. PROJECT PDC NO.
   C. PROJECT TITLE
   D. TOTAL SCOPE (SF)
   E. SCOPE OF PROTECTED AREA (SF)
   F. TYPE OF PROTECTION REQUIRED

2. APPLICABLE SPECIFICATIONS AND DOCUMENTS

3. PERFORMANCE REQUIREMENTS (FREQUENCIES, FIELD, & SHIELDING EFFECTIVENESS)

   A. HIGH FREQUENCY (E-FIELD & PLANE WAVE) TEST AREA AND ANTENNA LOCATION IDENTIFICATION
   B. LOW FREQUENCY (H-FIELD) TEST AREA AND TRANSMITTING ANTENNA LOCATION IDENTIFICATION

4. DETAIL TEST PROCEDURE

   A. DESCRIPTION OF TEST METHODOLOGY
   B. ARRANGEMENTS OF TEST EQUIPMENT
   C. PRECAUTIONS

5. TEST POINTS

   A. PERIMETER OF DOORS
   B. FILTER AREAS
   C. ALL PENETRATIONS
   D. WALL SEAMS

6. TEST EQUIPMENT USED (DESCRIPTION, MODEL NO. AND MANUFACTURER)

7. INDICATE ANY DEVIATIONS FROM REQUIRED PROCEDURES

8. IDENTIFY THE SECURITY CLASSIFICATION OF THESE RESULTS

APPENDIX 9

SHIELDED ENCLOSURE TESTERS

Listed below are five testers which are currently available. These or similar are the type that are recommended for used in periodic checks of shielded rooms or facilities. The testers must have an operating frequency of up to 450 MHz and a dynamic range of 110 DB. Cost is approximately $5,000 or less per set.

Manufacturer	Description	Model No.
Retlit Incorporated	Shielded Enclosure Test Set	TS45U
Euroshield	RF Leak Detector	4F-130
Keene Corporation, Ray Proof Div	Shielding Integrity Monitoring System	SIMS II
Eaton Corporation, Electronic Instrumentation Division	Shielded Integrity Leak Detection System	Eaton 3500
Lindgen RF Enclosures, Incorporated	RF Shielding Integrity Monitor	

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ENGINEERING TECHNICAL LETTERS (ETL)

SECTION A - CURRENT ETLs

ETL Number	Title	Date Issued
82-2	Energy efficient Equipment	10 Nov 82
83-1	Design of Control Systems for HVAC	16 Feb 83
	Change No. 1 to ETL 83-1, U.S. Air Force Standardized Heating, Ventilating & Air Conditioning (HVAC) Control Systems	22 Jul 87
83-3	Interior Wiring Systems, AFM 88-15 Para 7-3	2 Mar 83
83-4	EMCS Data Transmission Media (DTM) Considerations	3 Apr 83
83-7	Plumbing, AFM 88-8, Chapter 4	30 Aug 83
83-8	Use of Air-to-Air Unitary Heat Pumps	15 Sep 83
83-9	Insulation	14 Nov 83
84-2	Computer Energy Analysis	27 Mar 84
	Change I Ref: HQ USAF/LEEEU Msg 031600Z MAY 84	1 Jun 84
84-7	MCP Energy Conservation Investment Program (ECIP)	13 Jun 84
84-10	Air Force Building Construction and the Use of Termiticides	1 Aug 84
86-2	Energy Management and Control Systems (EMCS)	5 Feb 86
86-4	Paints and Protective Coatings	12 May 86
86-5	Fuels Use Criteria for Air Force Construction	22 May 86
86-8	Aqueous Film Forming Foam Waste Discharge Retention and Disposal	4 Jun 86
86-9	Lodging Facility Design Guide	4 Jun 86
86-10	Antiterrorism Planning and Design Guidance	13 Jun 86
86-14	Solar Applications	15 Oct 86
86-16	Direct Digital Control Heating Ventilation and Air Conditioning Systems	9 Dec 86
87-1	Lead Ban Requirements of Drinking Water	15 Jan 87
87-2	Volatile Organic Compounds	4 Mar 87
87-4	Energy Budget Figures (EBFS) for Facilities in the Military Construction Program	13 Mar 87
87-5	Utility Meters in New and Renovated Facilities	13 Jul 87
87-9	Prewiring	21 Oct 87

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ENGINEERING TECHNICAL LETTERS (ETL)

SECTION A - CURRENT ETLs

ETL Number	Title	Date Issued
88-2	Photovoltaic Applications	21 Jan 88
88-3	Design Standards for Critical Facilities	15 Jun 88
88-4	Reliability & Maintainability (R&M) Design Checklist	24 Jun 88
88-5	Cathodic Protection	2 Aug 88
88-6	Heat Distribution Systems Outside of Buildings	1 Aug 88
88-8	Cholorfluorocarbon (CFC) Limitation in Heating, Ventilating and Air-Conditioning (HVAC) Systems	4 Oct 88
88-9	Radon Reduction in New Facility Construction	7 Oct 88
88-10	Prewired Workstations Guide Specification	29 Dec 88
89-2	Standard Guidelines for Submission of Facility Operating and Maintenance Manuals	23 May 89
89-3	Facility Fire Protection Criteria for Electronic Equipment Installations	9 Jun 89
89-4	Systems Furniture Guide Specification	6 Jul 89
89-5	Not Used	
89-6	Power Conditioning and Continuation Interfacing Equipment (PCCIE) in the Military Construction Program (MCP)	7 Sep 89
89-7	Design of Air Force Courtrooms	29 Sep 89
90-1	Built-Up Roof (BUR) Repair/Replacement Guide Specification	23 Jan 90
90-2	General Policy for Prewired Workstations and Systems Furniture	26 Jan 90
90-3	TEMPEST Protection for Facilities Change I Ref: HQ USAF/LEEDE Ltr dated 20 April 90, Same Subject	20 Apr 90
90-4	1990 Energy Prices and Discount Factors for Life-Cycle Cost Analysis	24 May 90
90-5	Fuel and Lube Oil Bulk Storage Capacity for Emergency Generators	26 Jul 90
90-6	Electrical System Grounding, Static Grounding and Lightning Protection	3 Oct 90
90-7	Air Force Interior Design Policy	12 Oct 90
90-8	Guide Specifications for Ethylene Propylene Diene Mononer (EPDM) Roofing	17 Oct 90
90-9	Fire Protection Engineering Criteria for Aircraft Maintenance, Servicing, & Storage Facilities	2 Nov 90
90-10	Commissioning of Heating, Ventilating and Air-Conditioning (HVAC) Systems Guide Specification	17 Oct 90

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ENGINEERING TECHNICAL LETTERS (ETL)

SECTION A - CURRENT ETLs

ETL Number	Title	Date Issued
91-1	Fire Protection Engineering Criteria Testing Halon Fire Suppression Systems	2 Jan 91
91-2	High Altitude Electromagnetic Pulse (HEMP) Hardening in Facilities	4 Mar 91

SECTION B - OBSOLETE ETLs

No.	Date	Status
82-1	10 Nov 82	Superseded by ETL 83-10, 86-1, 87-4
82-3	10 Nov 82	Superseded by ETL 83-5, 84-2
82-4	10 Nov 82	Superseded by ETL 84-7
82-5	10 Nov 82	Superseded by ETL 84-1, 86-13, 86-14
82-6	30 Dec 82	Cancelled
82-7	30 Nov 82	Cancelled
83-2	16 Feb 83	Superseded by ETL 84-3
83-6	24 May 83	Cancelled
84-3	21 Mar 84	Cancelled
84-4	10 Apr 84	Superseded by ETL 86-7, 86-15, 87-5
84-5	7 May 84	Superseded by ETL 84-8, 86-11, 86-18, 88-6
84-6	Not Issued	Cancelled/Not Used
84-9	5 Jul 84	Superseded by ETL 88-7
86-3	21 Feb 86	Superseded by ETL 86-4
86-6	3 Jun 86	Superseded by ETL 86-11, 86-18, 88-6
86-7	3 Jun 86	Superseded by ETL 86-15
86-12	3 Jul 86	Superseded by ETL 90-2
86-13	15 Aug 86	Superseded by ETL 86-14
86-15	13 Nov 86	Superseded by ETL 87-5
86-17	17 Dec 86	Superseded by ETL 89-6
86-18	18 Dec 86	Superseded by ETL 88-6
87-3	12 Mar 87	Superseded by ETL 87-6, ETL 88-5
87-6	21 Aug 87	Superseded by ETL 88-5
87-7	14 Oct 87	Superseded by ETL 89-1
Chg 1	30 Dec 87	Superseded by ETL 90-1
88-1	5 Jan 88	Superseded by ETL 89-2
88-7	24 Aug 88	Superseded by ETL 90-3 & ETL 91-2
89-1	6 Feb 89	Superseded by ETL 90-4