

CNSSAM TEMPEST/1-13
17 January 2014



**(U) RED/BLACK
Installation Guidance**

This document prescribes guidance to be used by a CTTA to determine the required standards for their department or agency.



(U) FOREWORD

1. (U) Committee on National Security Systems Advisory Memorandum (CNSSAM) TEMPEST/01-13, RED/BLACK Installation Guidance, provides criteria for the installation of electronic equipment, cabling, and facility support for the processing of secure information. This publication supersedes NSTISSAM TEMPEST/ 2-95 and the TEMPEST/2-95 Addendum of February 2000.

2. (U) TEMPEST security is a function of the TEMPEST characteristics of the processing equipment, the way the equipment is installed, the electromagnetic and physical characteristics of the facility, and the geographical environment of the facility location.

3. (U) The guidance identified herein will be considered by a Certified TEMPEST Technical Authority (CTTA) as part of the potential solution for facilities, system, and equipment that have been identified as requiring TEMPEST countermeasures. Only those specific criteria identified by the CTTA will be implemented. When this document is implemented by direction or instruction, U.S. Government Agencies and Departments should contact their CTTA to obtain the applicable installation criteria. When implemented by contract, U.S. Government contractors should contact their appropriate government Contracting Office Technical Representative (COTR) for the applicable CTTA requirements.

4. (U) Committee on National Security Systems (CNSS) Representatives may obtain additional copies of this policy from the address below. U.S. Government contractors should contact their appropriate government Contracting Officer regarding further distribution and dissemination of this document.

FOR THE NATIONAL MANAGER

/s/

DEBORA A. PLUNKETT

CNSS Secretariat (IE32)
National Security Agency * 9800 Savage Road * Suite 6716 * Ft Meade MD 20755-6716
cnss@nsa.gov

(U) TABLE OF CONTENTS

SECTION 1 – (U) INTRODUCTION 1

 1.1. (U) General 1

 1.2. (U) Scope 1

 1.3. (U) Policy 1

 1.4. (U) Applicability 1

 1.5. (U) References 1

 1.5.1. (U) Committee on National Systems Security (CNSS) 1

 1.5.2. (U) Intelligence Community Standard (ICS) 2

 1.5.3. (U) National Telecommunications Security Working Group (NTSWG) 2

 1.5.4. (U) Other Government Publications 2

SECTION 2 – (U) DEFINITIONS AND ABBREVIATIONS 3

 2.1. (U) Definitions 3

SECTION 3 – (U) GENERAL REQUIREMENTS 6

 3.1. (U) Introduction 6

 3.2. (U) Protected Distribution System 6

 3.3. (U) Cable Identification 6

 3.4. (U) Electrical Isolation 7

 3.5. (U) Commercial Cable TV (CATV) and Satellite TV Isolation 8

 3.6. (U) RF Transmitter Separation 8

 3.6.1. (U) Stationary Transmitters 8

 3.6.2. (U) Non-Stationary Transmitters 8

 3.6.3. (U) Special Use Transmitters 8

 3.6.4. (U) Remote Radio Head 9

 3.7. (U) RED Equipment and BLACK Wireline Physical Separation 9

 3.8. (U) RED Wireline and BLACK Wireline Physical Separation 9

 3.9. (U) Distribution and Patching Systems 10

 3.10. (U) Communications Security (COMSEC) Equipment 10

 3.11. (U) TEMPEST Certified Equipment 10

 3.12. (U) Fortuitous Conductors 11

 3.13. (U) Shielded Cable 11

 3.14. (U) Grounding 11

SECTION 4 – (U) FACILITIES 12

 4.1. (U) Introduction 12

 4.2. (U) Design Philosophy 12

 4.3. (U) Applicability 12

 4.4. (U) RED/BLACK Requirements Matrix 12

 4.5. (U) Level I RED/BLACK Requirement 14

 4.5.1. (U) Physical Separation 14

 4.5.2. (U) Cables 14

 4.5.3. (U) Electrical Isolation 14

 4.5.4. (U) Power 14

 4.6. (U) Level II RED/BLACK Requirement 15

 4.6.1. (U) Physical Separation 15

4.6.2. (U) Cables	15
4.6.3. (U) Electrical Isolation.....	15
4.6.4. (U) Power.....	15
4.7. (U) Level III RED/BLACK Requirement.....	16
4.7.1. (U) Physical Separation	16
4.7.2. (U) Cables	16
4.7.3. (U) Electrical Isolation.....	16
4.7.4. (U) Power.....	16
SECTION 5 – (U) AIRCRAFT	18
5.1. (U) Introduction	18
5.2. (U) Physical Separation	18
5.3. (U) Cables	19
5.4. (U) Electrical Isolation.....	19
5.5. (U) Power.....	19
5.6. (U) Grounding and Bonding	19
SECTION 6 – (U) SHIPS	20
6.1. (U) Introduction	20
6.2. (U) Physical Separation	20
6.3. (U) Cables	21
6.4. (U) Electrical Isolation.....	21
6.5. (U) Power.....	21
6.6. (U) Grounding and Bonding	21
SECTION 7 – (U) TRANSPORTABLES	22
7.1. (U) Introduction	22
7.2. (U) Physical Separation	22
7.3. (U) Cables	22
7.4. (U) Electrical Isolation.....	23
7.5. (U) Power.....	23
7.6. (U) Grounding and Bonding	23
SECTION 8 – (U) SPECIAL CATEGORY FACILITIES	24
8.1. (U) Introduction	24
8.2. (U) Cables	24
8.3. (U) Distribution and Patching Systems.....	24
8.4. (U) Multiple Circuit Equipment.....	24
8.5. (U) Power.....	25
SECTION 9 – (U) GENERAL GUIDANCE.....	26
9.1. (U) Introduction	26
9.2. (U) TEMPEST Basics.....	26
9.3. (U) RED/BLACK Basics	26
9.4. (U) Signal Cables	27
9.5. (U) Signal Distribution	28
9.6. (U) Signal Line Isolators and Filters.....	29
9.7. (U) Power Distribution	33
9.8. (U) Grounding System.....	35
9.9. (U) Administrative Support Equipment.....	36
9.10. (U) Other Considerations	38

(U) Tables

Table 1 – (U//FOUO) Cable Color Scheme 7
Table 2 – (U//FOUO) Electrical Isolation Level..... 7
Table 3 – (U//FOUO) RF Transmitter Separation Requirements 9
Table 4 – (U//FOUO) RED/BLACK Requirements Level Matrix 13
Table 5 – (U//FOUO) Summary of Facility RED/BLACK Isolation Requirements 17
Table 6 – (U//FOUO) Special Category Electrical Isolation Level 25

SECTION 1 – (U) INTRODUCTION

1.1. (U) General

(U) This section contains introductory, applicability, and administrative information associated with this document.

1.2. (U) Scope

(U) This document defines the guidance for the design of facilities and the installation of equipment and systems that receive, transmit, route, switch, manipulate, graph, store, archive, calculate, generate, print, scan, or in any other manner process or transfer National Security Information (NSI). This guidance is part of the potential solution for facilities, systems and equipment identified as requiring TEMPEST countermeasures. Additional TEMPEST countermeasures, including facility and/or equipment shielding may also be a part of a potential solution, but is beyond the scope of this document.

1.3. (U) Policy

(U) The *National Policy on the Control of Compromising Emanations* (CNSSP 300) and its implementing instructions, *TEMPEST Countermeasures for Facilities* (CNSSI 7000), and *NONSTOP Countermeasures* (NSTISSI 7001), establish the policy that certain systems and facilities that process NSI must be reviewed by a Certified TEMPEST Technical Authority (CTTA). If such a review is required and the review determines that TEMPEST countermeasures are required, the CTTA will consider a variety of methods that can be applied to the system/facility to achieve TEMPEST security. The RED/BLACK guidance contained in this document will be considered by the CTTA along with other countermeasures, such as TEMPEST suppressed equipment, filtering, and shielding, to determine the most cost-effective countermeasures to achieve TEMPEST security. Only those specific criteria identified by the CTTA will be implemented. The authority to issue this Advisory Memorandum derives from National Security Directive 42, which outlines the roles and responsibilities for securing national security systems, consistent with applicable law, E.O. 12333, as amended, and other Presidential directives. Nothing in this Advisory Memorandum shall alter or supersede the authorities of the Director of National Intelligence.

1.4. (U) Applicability

(U) The guidance contained herein, when specified by a CTTA, is applicable to U.S. Government departments, agencies, and contractors. When this document is to be specified by U.S. Government contract, either in part or in its entirety, the Government Contract Officer will contact the CTTA for applicable requirements.

1.5. (U) References

(U) The following references contain information that supplements the requirements contained herein. The most current edition of any of these documents should be used.

1.5.1. (U) Committee on National Systems Security (CNSS)

CNSSP No. 300	(U) National Policy on Control of Compromising Emanations (U)
CNSSI No. 7000	(U) TEMPEST Countermeasures for Facilities (C)
NSTISSI No. 7001	(U) NONSTOP Countermeasures (S)

CNSSI No. 7003	(U) Protected Distribution Systems (U)
NSTISSAM TEMPEST/1-92	(U) Compromising Emanations Laboratory Test Requirements, Electromagnetics (C)
NSTISSAM TEMPEST/1-93	(U) Compromising Emanations Field Test Requirements, Electromagnetics (C)
CNSSAM TEMPEST/01-02	(U) NONSTOP Evaluation Standard (C)
NTISSI No. 4002	(U) Classification Guide for COMSEC Information (S)
CNSSI No. 4009	(U) National Information Assurance (IA) Glossary (U)

1.5.2. (U) Intelligence Community Standard (ICS)

ICD 705	(U) Sensitive Compartmented Information Facilities
ICS 705-1	(U) Physical and Technical Security Standards For Sensitive Compartmented Information Facilities (U)
ICS 705-2	(U) Standards for the Accreditation and Reciprocal Use of Sensitive Compartmented Information Facilities (U)
IC Tech Spec for ICD/ICS 705	(U) Technical Specifications for Construction and Management of Sensitive Compartmented Information Facilities (U)

1.5.3. (U) National Telecommunications Security Working Group (NTSWG)

TSG STANDARD 1	(U) Introduction to Telephone Security (U)
TSG STANDARD 2	(U) TSG Guidelines for Computerized Telephone Systems,
CNSSI No. 5000	(U) Guidelines for Voice Over Internet Protocol (VoIP) Computer Telephony (U)
CNSSI No. 5006	(U) National Instruction for Approved Telephone Equipment (U)

1.5.4. (U) Other Government Publications

MIL-HDBK-232	(U) RED/BLACK Engineering-Installation Guidelines
MIL-HDBK-411	(U) Power and the Environment for Sensitive DoD Electronic Equipment
MIL-HDBK-419	(U) Grounding, Bonding, and Shielding for Electronic Equipment and Facilities (U)
MIL_PRF-15733	(U) General Specification for Filters and Capacitors, Radio Frequency Interference
FED-STD-1037	(U) Glossary of Telecommunications Terms (U)
MIL-STD-220	(U) Method of Insertion Loss Measurement
MIL-STD-188-124	(U) Grounding, Bonding, and Shielding for Common Long-Haul/Tactical Communication systems, including Ground Based Communication Electronics Facilities and Equipment (U)
MIL-STD-1310	(U) Shipboard Bonding, Grounding, and Other Techniques for Electromagnetic Compatibility and Safety. (U)

SECTION 2 – (U) DEFINITIONS AND ABBREVIATIONS

2.1. (U) Definitions

(U) For the purposes of this document, the following definitions are provided. Some have been repeated from CNSSI No. 4009 for the convenience of the reader.

(U) **BLACK.** Designation applied to information systems, and to associated areas, circuits, components, and equipment, in which national security information is encrypted or is not processed.

(U) **BLACK Line.** An optical fiber or a metallic wire that carries a BLACK signal or that originates/terminates in a BLACK equipment or system.

(U) **BLACK Optical Fiber Line.** An optical fiber that carries a BLACK signal or that originates/terminates in a BLACK equipment or system.

(U) **BLACK Signal.** Any signal (e.g., control signal or enciphered signal) which would not divulge national security information if intercepted.

(U) **BLACK Wireline.** A metallic wire that carries a BLACK signal or that originates/terminates in a BLACK equipment or system.

(U) **Certified TEMPEST Technical Authority (CTTA).** An experienced, technically qualified U.S. Government employee who has met established certification requirements in accordance with CNSS approved criteria and has been appointed by a U.S. Government department or agency to fulfill CTTA responsibilities.

(U) **Collateral.** All national security information classified under the provisions of an executive order, for which special community systems of compartmentation [e.g.; non-Special Compartmented Information (non-SCI), General Service Classified Information (GENSER)] are not formally established.

(U) **Commercial-off-the-Shelf (COTS).** Commercially manufactured equipment that have no TEMPEST countermeasures intentionally built into them.

(U) **Compromising Emanations (CE).** Unintentional signals that, if intercepted and analyzed, would disclose the information transmitted, received, handled, or otherwise processed by telecommunications or automated information systems equipment.

(U) **Direct BLACK Wireline.** A BLACK metallic wireline that directly leaves the inspectable space in a continuous electrical path with no signal interruption or isolation. Continuous wirelines may be patched or spliced. Examples of wirelines that directly leave the inspectable space are analog telephone lines, commercial television cables, and alarm lines. Wirelines that do not directly leave the inspectable space are wirelines that pass through a digital switch or converter that reestablishes the signal level or reformats the signaling. Examples of BLACK wirelines that do not directly leave the inspectable space are telephone lines that connect to digital telephone switches, Ethernet lines that connect to digital network routers, and alarm lines that connect to an alarm panel.

(U) High-Power Transmitter. For the purposes of determining separation between RED equipment/lines and RF transmitters, high-power is that which exceeds 100 mWatt (20 dBm) Emitted Isotropic Radiated Power (EIRP). Also refer to the Low-Power Transmitter definition.

(U) Inspectable Space. The three dimensional space surrounding equipment that processes classified and/or sensitive information within which TEMPEST exploitation is not considered practical or where legal authority to identify and remove a potential TEMPEST exploitation exists and is exercised. CTTAs have the authority to define the inspectable space.

(U) Low-Power Transmitter. For the purposes of determining separation between RED equipment/lines and RF transmitters, low-power is that which is less than or equal to 100 mWatt (20 dBm) EIRP. Examples of low-power transmitters are wireless devices for local communication that do not need a Federal Communications Commission (FCC) license, such as some IEEE 802.11X network access points, and portable (but not cellular) telephones.

(U) Meter. A measurement distance under the metric system. For the purposes of meeting the installation requirements herein, the following are considered equivalent between the metric and U.S. system: 1 Meter and 39 inches; 50 cm and 19 inches; 30 cm and 12 inches; 15 cm and 6 inches; and 5 cm and 2 inches.

(U) National Security Information (NSI). Information that has been determined pursuant to Executive Order 13526 or any predecessor order to require protection against unauthorized disclosure and is marked to indicate its classified status when in documentary form.

(U) Protected Distribution System (PDS). Wire line or fiber optic system that includes adequate safeguards and/or countermeasures (e.g., acoustic, electric, electromagnetic, and physical) to permit its use for the transmission of unencrypted information through an area of lesser classification or control.

(U) RED. Designation applied to an IS, and associated areas, circuits, components, and equipment in which unencrypted national security information is being processed.

(U) RED/BLACK Concept. Separation of electrical and electronic circuits, components, equipment, and systems that handle national security information (RED), in electrical form, from those that handle non-national security information (BLACK) in the same form.

(U) RED Equipment. A term applied to equipment that processes unencrypted NSI that requires protection during electrical/electronic processing.

(U) RED Optical Fiber Line. An optical fiber that carries a RED signal or that originates/terminates in a RED equipment or system.

(U) RED Line. An optical fiber or a metallic wire that carries a RED signal or that originates/terminates in a RED equipment or system.

(U) RED Signal. Any electronic emission (e.g., plain text, key, key stream, subkey stream, initial fill, or control signal) that would divulge national security information if recovered.

(U) RED Wireline. A metallic wire that carries a RED signal or that originates/terminates in a RED equipment or system.

(U) Signaling Rate. The signaling rate of a digital signal is defined as the reciprocal of the bit width (1/bit width). The Signaling rate is used to determine the frequency range of electrical isolation.

(U) Special Category. Sensitive Compartmented Information (SCI), Special Access Program (SAP) information, or other compartmented information.

(U) Special Access Program (SAP). A program established for a specific class of classified information that imposes safeguarding and access requirements that exceed those normally required for information at the same classification level.

(U) TEMPEST Certified Equipment or System. Equipment or systems that have been certified to meet the applicable level of NSTISSAM TEMPEST/1-92 or previous editions. Typically categorized as Level I for the highest containment of classified signals; Level II for the moderate containment of classified signals; and Level III for the least containment of classified signals.

SECTION 3 – (U) GENERAL REQUIREMENTS

3.1. (U) Introduction

(U) When specified by a CTTA, the RED/BLACK installation guidance of SECTION 4 shall be used for facilities that are permanent structures and for temporary facilities (such as shelters, trailers, or tents) that are stationary in one location for greater than 90 days. The following paragraphs in this section provide additional guidance and amplifying information that is applicable for all installations. Mobile platforms, such as aircraft, ships, and transportables, shall follow the RED/BLACK installation guidance of SECTIONS 5, 6 and 7, respectively. Facilities and mobile platforms that process Special Category information, such as Sensitive Compartmented Information Facilities (SCIFs) and Special Access Program Facilities (SAPFs) shall follow the guidance of SECTION 8.

(U) Except as delineated in SECTION 8, RED to RED isolation is not required between classification levels or compartments of U.S. NSI, such as between Collateral Secret, Top Secret, and Special Category. RED wirelines that carry information for foreign release and that is distributed to U.S. spaces shared with foreign nationals shall be considered BLACK for separation purposes.

(U) The separation requirements between RED equipment/wirelines and BLACK wirelines delineated herein are dependent on whether the BLACK lines directly leave the inspectable space or are electrically isolated before they leave the inspectable space. A BLACK metallic wireline that directly leaves the inspectable space provides a continuous electrical path with no signal interruption or isolation. Continuous wirelines may be patched or spliced. Examples of wirelines that directly leave the inspectable space are analog telephone lines, commercial television cables, and alarm lines. Wirelines that do not directly leave the inspectable space are wirelines that pass through a digital switch or converter that reestablishes the signal level or reformats the signaling. Examples of BLACK wirelines that do not directly leave the inspectable space are telephone lines that connect to digital telephone switches, Ethernet lines that connect to digital network routers, and alarm lines that connect to an alarm panel.

3.2. (U) Protected Distribution System

(U) RED fiber or wirelines that traverse an area that is controlled to a lower level of classification or access control shall be installed in a Protected Distribution System (PDS) in accordance with CNSSI No. 7003. BLACK wirelines shall not be installed in the PDS unless authorized by a CTTA.

3.3. (U) Cable Identification

(U) Cables carrying NSI shall have a prominently displayed distinguishing label, marking, or color that indicates the classification level and/or compartmentalization of the data. The cable identification shall be located at both ends and at sufficient intervals as determined by the CTTA or the entire cable may be the distinguishing color. Table 1 provides a recommended cable color scheme.

Table 1 – (U//FOUO) Cable Color Scheme

CLASSIFICATION LEVEL	CABLE COLOR
Unclassified	Green
Collateral Confidential	Blue
Collateral Secret	Red
Collateral Top Secret	Orange
Special Category	Yellow

3.4. (U) Electrical Isolation

(U) In addition to the physical separation between RED equipment/lines and BLACK equipment/lines, electrical separation must be provided between RED and BLACK circuits within the same equipment. Examples are equipment and systems that process both RED and BLACK information, such as KVM switches, secure voice switches, Video Teleconferencing (VTC) switches, video matrix switches, cross domain firewalls/guards, and encryption devices. Table 2 provides the isolation level and the minimum frequency range for the isolation that is required for the type of signaling. The isolation is defined as the ratio of the RED signal level on a RED line to the level of the same RED signal on a BLACK line.

(U) Equipment that processes both RED and BLACK information may also require certification for other information assurance disciplines. Electrical isolation does not imply TEMPEST certification nor other information assurance certification and vice-versa.

Table 2 – (U//FOUO) Electrical Isolation Level

RED SIGNAL TYPE	ISOLATION LEVEL	FREQUENCY RANGE
Analog Voice	100 dB	100 Hz to 5 KHz
Analog signaling, including analog video	80 dB	Lowest signaling rate to maximum signaling rate
Digital Signaling	60 dB	Lowest signaling rate to 10 times the maximum signaling rate

(U//FOUO) Note: the analog voice signaling rate may be reduced to 3 KHz for systems where the analog signal is filtered with a cut-off frequency below 5 KHz for digital conversion.

3.5. (U) Commercial Cable TV (CATV) and Satellite TV Isolation

(U) CATV and satellite television cables that traverse spaces processing NSI shall be isolated before the cables leave the inspectable space. For SCIFs and SAPFs, the isolation shall be at the inside boundary of the SCIF or SAPF. The isolation may be achieved by converting the CATV or satellite television wireline cable to fiber optic cable and then back to wireline; or the isolation may be achieved with the combination of a 12 dB minimum gain one-way Radio Frequency (RF) amplifier and a 12 dB minimum loss RF attenuator inline with the cable. Isolation is not required for receive-only systems that are entirely contained within inspectable space, such as satellite television systems with antennas located inside the inspectable space. Receive-only systems do not transmit account or channel authorization requests back to the service provider. CATV and satellite television cables that connect to audio/visual systems that also display NSI must meet SECTION 3.4 or will require additional isolation specified by a CTTA.

3.6. (U) RF Transmitter Separation

(U) For the purposes of separation between RED equipment/lines and RF transmitters, two transmitter power levels are defined: (1) high transmitter power is that which exceeds 100 mWatt (20 dBm) EIRP; and (2) low transmitter power is that which is less than or equal to 100 mWatt (20 dBm) EIRP. Examples of low-power transmitters are wireless devices for local communication that do not need a Federal Communications Commission (FCC) license, such as some IEEE 802.11X network access points, and portable (but not cellular) telephones. The RED/BLACK installation guidance provided herein reduces the TEMPEST vulnerabilities associated with RF transmitters. However, the installation of wireless devices and RF transmitters in spaces that process NSI presents other information assurance vulnerabilities and requires additional approval from the cognizant accrediting authority. Bluetooth, IEEE802.11X and other standards for emerging wireless technologies may increase the power levels and become high power transmitters in future operating modes.

3.6.1. (U) Stationary Transmitters

(U) A separation distance of 3 meters shall be provided between RED equipment and stationary (i.e., docked or permanently installed) high-power RF transmitters. A separation distance of 1 meter shall be provided between RED equipment and stationary low-power RF transmitters.

3.6.2. (U) Non-Stationary Transmitters

(U) A separation distance of 1 meter shall be provided between RED equipment and non-stationary (i.e., hand held and not docked) high-power RF transmitters, such as mobile cellular telephones. There is no separation distance between RED equipment and non-stationary low-power RF transmitters, such as Bluetooth devices. There are no separation requirements for non-stationary transmitter devices while they are in transit (i.e., being carried through a space).

3.6.3. (U) Special Use Transmitters

(U) Consult a CTTA for the separation requirements for passive and active Radio Frequency Identification (RF ID) tags, proximity badges, and other RF radio query-response devices. Unless otherwise directed, the RF device readers are considered RF transmitters for separation purposes. Guidance for the installation of wireless repeaters, wireless fire alarm, and wireless intrusion detection systems should be provided by a CTTA.

3.6.4. (U) Remote Radio Head

(U) Generally, a remote radio head describes an operator radio control panel that connects to a remote radio transceiver via electrical or wireless interface. This remote radio head requires only standard RED/BLACK separation and not the 3 or 1 meter separation required for radios.

Table 3 – (U//FOUO) RF Transmitter Separation Requirements

TRANSMITTER TYPE	SEPARATION FROM RED EQUIPMENT
Stationary (docked or permanently installed) high-power RF transmitters	3 meters
Stationary (docked or permanently installed) low-power RF transmitters	1 meter
Mobile (hand held and not docked) high-power RF transmitters	1 meter
Radio transmitters that are carried through a space	None
RF ID, proximity badges and other query response RF devices	Consult CTTA

3.7. (U) RED Equipment and BLACK Wireline Physical Separation

(U) The physical separation distance between RED equipment and BLACK wirelines is provided in SECTIONS 4 through 8. The separation is applicable to BLACK wirelines that connect to RF transmitters or that directly leave the inspectable space, such as telephone lines, alarm lines, and unclassified network data lines. These lines may be exposed or hidden in adjacent walls. In some cases, a reduced separation is allowed if the wirelines are connected to outside of the inspectable space through BLACK switching equipment (e.g., network switches, network routers, or telephone switches) that is contained within the inspectable space.

(U) The BLACK wireline separation is not applicable to the following:

- (1) (U) Fiber optic lines that do not have a metallic strengthener or armor in the fiber cable; or
- (2) (U) Wirelines that are fiber optically isolated or filtered before leaving the inspectable space.

3.8. (U) RED Wireline and BLACK Wireline Physical Separation

(U) The physical separation distance between RED wirelines and BLACK wirelines is provided in SECTIONS 4 through 8. Unless specifically excepted herein or excepted by a CTTA, RED, and BLACK wirelines shall be installed in separate distribution systems or pathways.

(U) The BLACK wireline separation is not applicable to the following:

- (1) (U) BLACK fiber optic lines that do not have a metallic strengthener or armor in the fiber cable;
- or
- (2) (U) BLACK wirelines that are fiber optically isolated or filtered before leaving the inspectable space.

(U) RED fiber lines may be installed in the same distribution system as BLACK fiber lines provided that the BLACK fiber lines are in a separate cable or fiber tube for identification. If authorized by a CTTA, RED and BLACK fiber lines may be in the same fiber bundle provided the fibers have an opaque sheath and a cable identification scheme.

3.9. (U) Distribution and Patching Systems

(U) RED and BLACK distribution panels shall be separate units and shall be separated by a minimum of 5 cm. If the RED distribution panel contains active electronic components (such as a network switch), then the separation distances for RED equipment and BLACK wirelines delineated in SECTIONS 4 through 8 shall be used. A separate distribution panel shall be provided for each classification level of NSI and for each compartment of Special Category of NSI.

(U) The distribution panels shall have a distinguishing label, marking, or color that indicates the classification level and/or compartmentalization of the data and that matches the cable identification scheme. If available, a system of keyed or mutually exclusive jacks and connectors should be used for different classification levels, unclassified levels, and compartments of data.

(U) RED and BLACK wall jacks for patching to equipment, such as network drops, shall be in separate outlet boxes. RED and BLACK wall jacks connecting to wirelines shall be separated by 5 cm. The wall jacks shall provide the same distinguishing label, marking, or color scheme that is used for cables. If available, a system of keyed or mutually exclusive jacks and connectors should be used for different classification levels, unclassified levels, and compartments of data. Except as delineated in SECTION 8, RED to RED separation is not required in the RED wall jacks between classification levels or compartments of NSI, such as between Collateral Secret and Special Category Top Secret.

3.10. (U) Communications Security (COMSEC) Equipment

(U) The RED plain text cable and BLACK cipher text cables connected to COMSEC equipment shall be separated as soon as feasible. When COMSEC equipment is installed in a RED rack cabinet, the BLACK cipher text cable shall be shielded if it cannot meet the separation requirements from RED equipment as specified herein. When the COMSEC equipment is a Level 1 TEMPEST certified equipment, it may be installed in a BLACK rack without additional separation requirements. When COMSEC equipment is not a Level 1 TEMPEST certified equipment, then it shall be treated as RED equipment for installation purposes. Note that NSA "Type 1" certification does not guarantee Level 1 TEMPEST certification.

3.11. (U) TEMPEST Certified Equipment

(U) When a separation distance is required between RED equipment and BLACK equipment/lines, and the RED equipment is Level 1 TEMPEST Certified, the separation distance may be reduced using the following criteria: (1) 1 meter separation distances may be reduced to 30 cm; (2) 50 cm separation distances may be reduced to 15 cm; and 30 cm separation distances may be reduced to 10 cm. The reduction in the separation distances does not apply to RF transmitters or BLACK lines to RF

transmitters. If required by the manufacturer's installation specification or compliance with TEMPEST certification, then optical or shielded wire cables shall be connected to TEMPEST certified equipment.

3.12. (U) Fortuitous Conductors

(U) As an additional TEMPEST countermeasures requirement, a CTTA may require the isolation of fortuitous conductors that traverse a space that processes NSI. If required by a CTTA, then all pipes, conduits, ducts, and other metallic distribution systems that leave the inspectable space shall be grounded or isolated at the inside boundary of the inspectable space. Non-conductive sections shall be inserted in each fortuitous conductor, or each conductor shall be grounded. The ground must be contained within the inspectable space. Unused wireline cables that leave the inspectable space shall be removed or shortened to be contained within the inspectable space. Fortuitous conductors may also have a requirement for a non-conductive section for acoustic isolation.

3.13. (U) Shielded Cable

(U) When shielded cable is required, the wireline pairs or wireline bundles shall be individually shielded or shall have a minimum of one overall shield, and the cable shall have an outside non-conductive sheath. Screened cable is another term used for a cable with one overall shield. The shield shall be a non-ferrous metallic foil shield with an uninsulated and tinned drain wire or shall be a braided metallic shield with a minimum of 85 percent coverage. Except for coaxial cables, the shield shall not be used as a signal return or a signal carrying conductor.

(U) Unless grounding at only one end of the cable is required for system operation (i.e., to prevent ground loops), the cable shields shall be grounded at both ends. The overall shield should have 360-degree termination with a metal connector. If an equipment jack does not allow the use of a connector with a direct bond to the cable shield, the shield may be grounded to the equipment with a "pigtail" that is as short as feasible, but no greater than 2.5 cm. The pigtail shall not be secured to the connector using screws that compress a cable strain relief clamp.

(U) Metallic distribution, such as conduit or enclosed cable tray, may be used for shielding in lieu of cabling shields when it is difficult to use shielded cable. All metallic distribution shall be electrically continuous and installed in accordance with the National Electric Code. Electrical Metallic Tubing (EMT) used in lieu of shielded cable shall utilize compression fittings.

3.14. (U) Grounding

(U) A separate RED and BLACK grounding system is desirable but is not required for TEMPEST unless directed by a CTTA. When power filters or signal filters are required-, or when a ground is required for fortuitous conductors, a grounding system is required. The facility grounding system may be used provided that the grounding system is a multi-point equipotential plane or that the grounding system is single point ground that is contained within the inspectable space. Consult a CTTA for guidance on grounding. All grounding shall be installed in accordance with the National Electric Code.

SECTION 4 – (U) FACILITIES

4.1. (U) Introduction

(U) Facilities are permanent structures or are temporary structures (such as shelters, trailers, or tents) that are stationary in one location for greater than 90 days. The guidance of this section provides countermeasures to isolate RED signals from BLACK signal paths that leave the inspectable space. The inspectable space is defined by the cognizant CTTA for the facility.

4.2. (U) Design Philosophy

(U) The RED/BLACK facility design philosophy is to provide sufficient attenuation or isolation between RED equipment/lines and BLACK equipment/lines that leave the inspectable space. The level of attenuation or isolation is dependent on the size of the inspectable space. For simplification, the sizes of inspectable space are categorized by three distances: (1) less than 20 meters; (2) greater than or equal to 20 meters but less than 100 meters; and (3) equal to or greater than 100 meters. Three levels of RED/BLACK isolation requirements are defined, which approximately correspond to the three size categories of the inspectable space. The requirement levels are Level I, Level II, and Level III. Level I is the most stringent and Level III is the least stringent.

4.3. (U) Applicability

(U) When a CTTA has determined that a facility has a RED/BLACK TEMPEST countermeasures requirement, the RED/BLACK installation guidance of this section shall be used. The CTTA will determine the applicable RED/BLACK requirements level from Table 4. The inspectable space distance is defined by the CTTA. A summary of the RED/BLACK separation requirements is provided in Table 5.

4.4. (U) RED/BLACK Requirements Matrix

(U) The RED/BLACK Requirements Matrix, Table 4, is used to select the minimum requirements level. The first column corresponds to whether the facility is located within the U.S. (or its trusts and territories), or whether the facility is located outside the U.S. The second column corresponds to the highest classification level of NSI processed in the facility. The third column is the size of the inspectable space. The fourth column is the RED/BLACK minimum requirements level that should be used.

(U) The RED/BLACK requirements levels (e.g., I, II, III) correspond to the level of protection need to contain compromising emanations within the inspectable space. The levels are based upon the installation of Commercial-Off-The-Shelf (COTS) equipment within a standard commercially built office building. As a part of risk management, the requirements level is less stringent for lower classification levels of information processed within the U.S., and is more stringent for higher classification levels of information processed outside the U.S. The CTTA may specify a RED/BLACK requirements level that is more or less stringent based on the details of a specific site.

Table 4 – (U//FOUO) RED/BLACK Requirements Level Matrix

LOCATION	CLASSIFICATION LEVEL	INSPECTABLE SPACE (IS)	LEVEL
Within the US	Collateral Secret and below	< 20 meters	II
Within the US	Collateral Secret and below	≥ 20 meters but < 100 meters	III
Within the US	Collateral Secret and below	≥ 100 meters	III
Within the US	Special Category and Top Secret	< 20 meters	I
Within the US	Special Category and Top Secret	≥ 20 meters but < 100 meters	II
Within the US	Special Category and Top Secret	≥ 100 meters	III
Outside the US	Collateral Secret and below	< 20 meters	I
Outside the US	Collateral Secret and below	≥ 20 meters but < 100 meters	II
Outside the US	Collateral Secret and below	≥ 100 meters	III
Outside the US	Special Category and Top Secret	< 20 meters	I
Outside the US	Special Category and Top Secret	≥ 20 meters but < 100 meters	I
Outside the US	Special Category and Top Secret	≥ 100 meters	II

(U) Note: Consult CTTA or CNSSI No. 7000 for more information on determining the location and classification criteria.

(U) Note: Consult CTTA for site specific requirements at locations outside the US.

4.5. (U) Level I RED/BLACK Requirement

4.5.1. (U) Physical Separation

(U) A separation distance of 1 meter shall be provided between RED Equipment and:

- (1) (U) BLACK wirelines that directly leave the inspectable space; and
- (2) (U) BLACK wirelines that connect to RF transmitters; and
- (3) (U) BLACK equipment with lines that leave the inspectable space; and
- (4) (U) BLACK equipment with lines that connect to RF transmitters.

(U) A separation distance of 50 cm shall be provided between RED Equipment and BLACK wirelines that connect to outside the inspectable space through a digital switch (, a computerized telephone switch or network router) that is contained within the inspectable space.

(U) Unless separated by metal distribution system such as conduit or enclosed cable tray, a separation distance of 5 cm (15 cm for parallel cable lengths over 30m) shall be provided between RED wirelines and:

- (1) (U) BLACK wirelines that leave the inspectable space; and
- (2) (U) BLACK wirelines that connect to RF transmitters.

(U) RED equipment shall be separated from RF transmitters in accordance with SECTION 3.6.

4.5.2. (U) Cables

(U) RED wirelines shall have a minimum of one overall metallic shield.

(U) RED lines shall have a distinguishing label or color coding that identifies the classification level of the NSI conveyed. Suggested color coding schemes can be found in Table 1.

(U) RF wirelines (such as RF antenna, CATV, and satellite television cables) that leave the inspectable space shall be isolated in accordance with SECTION 3.5.

4.5.3. (U) Electrical Isolation

(U) BLACK lines connected to RED equipment (such as KVM, VTC, secure voice, or video matrix switches) shall be electrically isolated from RED signals. The level of isolation is provided in Table 2.

4.5.4. (U) Power

(U) The requirement for RED power shall be determined by a CTTA. If power filters are required, the filter attenuation shall be 100 dB over the frequency range of 14 KHz to 1 GHz.

(U) RF transmitters shall not be powered from the same circuit as RED equipment. The RF transmitter power should be from a separate circuit breaker in a power distribution panel or from a separate AC-DC-AC direct conversion Uninterruptible Power Supply (UPS) than RED equipment. The use of an UPS does not negate CTTA requirements for facility BLACK power isolation.

4.6. (U) Level II RED/BLACK Requirement

4.6.1. (U) Physical Separation

(U) A separation distance of 1 meter shall be provided between RED equipment and:

- (1) (U) BLACK wirelines that connect to RF transmitters and
- (2) (U) BLACK equipment with lines that connect to RF transmitters

(U) A separation distance of 50 cm shall be provided between RED Equipment and BLACK wirelines that directly leave the inspectable space.

(U) A separation distance of 15 cm shall be provided between RED Equipment and BLACK wirelines that connect to outside the inspectable space through a digital switch (such as a computerized telephone switch, or network router) that is contained within the inspectable space.

(U) Unless separated by a metal distribution system such as conduit or enclosed cable tray, a separation distance of 5 cm (15 cm for parallel cable lengths over 30m) shall be provided between RED wirelines and:

- (1) (U) BLACK wirelines that leave the inspectable space; and
- (2) (U) BLACK wirelines that connect to RF transmitters.

(U) RED equipment shall be separated from RF transmitters in accordance with SECTION 3.6.

4.6.2. (U) Cables

(U) RED lines shall have a distinguishing label or color coding that identifies the classification level of the NSI conveyed. Suggested color coding schemes can be found in Table 1.

(U) RF wirelines (such as RF antenna, CATV, and satellite television cables) that leave the inspectable space shall be isolated in accordance with SECTION 3.5.

4.6.3. (U) Electrical Isolation

(U) BLACK lines connected to RED equipment (such as KVM, VTC, secure voice, or video matrix switches) shall be electrically isolated from RED signals. The level of isolation is provided in Table 2

4.6.4. (U) Power

(U) The requirement for RED power shall be determined by a CTTA. If power filters are required, the level of attenuation will be determined by the CTTA.

(U) RF transmitters shall not be powered from the same circuit as RED equipment. The RF transmitter power should be from a separate circuit breaker in a power distribution panel or from a separate AC-DC-AC direct conversion UPS than RED equipment. The use of an UPS does not negate CTTA requirements for facility BLACK power isolation.

4.7. (U) Level III RED/BLACK Requirement

4.7.1. (U) Physical Separation

(U) A separation distance of 1 meter shall be provided between RED equipment and:

- (1) (U) BLACK wirelines that connect to RF transmitters; and
- (2) (U) BLACK equipment with lines that connect to RF transmitters.

(U) A separation distance of 30 cm shall be provided between RED Equipment and BLACK wirelines that directly leave the inspectable space.

(U) A separation distance of 5 cm shall be provided between RED Equipment and BLACK wirelines that connect to outside the inspectable space through a digital switch (such as a computerized telephone switch or network router) that is contained within the inspectable space.

(U) Unless separated by a metal distribution system such as conduit or enclosed cable tray, a separation distance of 5 cm (15 cm for parallel cable lengths over 30 meters) shall be provided between RED wirelines and:

- (1) (U) BLACK wirelines that directly leave the inspectable space; and
- (2) (U) BLACK wirelines that connect to RF transmitters.

(U) RED equipment shall be separated from RF transmitters in accordance with SECTION 3.6.

4.7.2. (U) Cables

(U) RED lines shall have a distinguishing label or color coding that identifies the classification level of the NSI conveyed. Suggested color coding schemes can be found in Table 1.

(U) RF wirelines (such as RF antenna, CATV, and satellite television cables) that leave the inspectable space shall be isolated in accordance with SECTION 3.5.

4.7.3. (U) Electrical Isolation

(U) BLACK lines connected to RED equipment (such as KVM, VTC, secure voice, or video matrix switches) shall be electrically isolated from RED signals. The level of isolation is provided in Table 2

4.7.4. (U) Power

(U) The requirement for RED power shall be determined by a CTTA.

(U) RF transmitters shall not be powered from the same circuit as RED equipment. The RF transmitter power should be from a separate circuit breaker in a power distribution panel or from a separate AC-DC-AC direct conversion UPS than RED equipment. The use of an UPS does not negate CTTA requirements for facility BLACK power isolation.

Table 5 – (U//FOUO) Summary of Facility RED/BLACK Isolation Requirements

REQUIREMENT	LEVEL I	LEVEL II	LEVEL III
RED Equipment to BLACK wirelines that connect to a transmitter	1 m	1 m	1 m
RED Equipment to BLACK wirelines that directly leave IS	1 m	50 cm	30 cm
RED Equipment to BLACK Equipment with lines that leave IS	1 m	none	none
RED Equipment to BLACK wirelines that leave IS through digital switch	50 cm	15 cm	5 cm
RED Equipment to BLACK Equipment with lines that connect to RF transmitter	50 cm	50 cm	50 cm
RED wirelines to BLACK wirelines that leave the IS or connect to RF transmitters (Note 1)	5 cm / 15 cm	5 cm / 15 cm	5 cm / 15 cm
RED wire lines are shielded	Yes	none	none
RED lines have distinguishing marking or color coding for identification	Yes	Yes	Yes
RF wirelines such as CATV and satellite television isolated within the IS	Yes	Yes	Yes
Electrical Isolation between BLACK lines connected to RED Equipment	Yes	Yes	Yes
CTTA determines requirement for RED Power (See Note 2)	CTTA or 100 dB	CTTA	CTTA
RF transmitters not powered on same circuit as RED equipment	Yes	Yes	Yes

(U) Notes:

- (1) (U) The separation distance increased from 5 cm to 15 cm for parallel runs over 30 meters.
- (2) (U) Consult CTTA for RED power requirement.
- (3) (U) For Level 1 TEMPEST certified RED equipment, the separation distance may be reduced in accordance with SECTION 3.11.
- (4) (U) The information provided by the table is not all-inclusive, refer to SECTION 3 for additional requirements for facilities and to SECTIONS 5 through 8 for other installation types.

SECTION 5 – (U) AIRCRAFT

5.1. (U) Introduction

(U) This section provides the RED/BLACK installation guidance for fixed wing, rotary wing, manned, and unmanned air vehicles. The intent is to isolate RED signals from BLACK signal paths that leave the air vehicle during ground operations or while airborne. The application of the RED/BLACK countermeasures must consider weight, size, power consumption, cooling requirements and available space. When the TEMPEST countermeasures described below significantly impact cost or performance, a CTTA may consider other TEMPEST countermeasures, including instrumented TEMPEST tests, to mitigate and evaluate vulnerabilities. Aircraft that process special category information shall also follow the additional guidelines of SECTION 8.

5.2. (U) Physical Separation

(U) A separation distance of 1 meter shall be provided between RED equipment and BLACK wirelines that connect to RF transmitters.

(U) When NSI is processed during ground operations, a separation distance of 30 cm shall be provided between RED Equipment and BLACK wirelines that leave the inspectable space through external connections (e.g., umbilical cable). The inspectable space is defined by the CTTA based on the operations plan and location(s) of the air vehicle(s).

(U) A separation distance of 5 cm shall be provided between RED wirelines and BLACK wirelines that connect to RF transmitters or leave the air vehicle, except when RED and BLACK wirelines pass through the same bulkhead opening.

(U) A separation distance of 1 meter shall be provided between RED equipment and RF transmitters.

(U) The separation requirements of this section may be met by a metallic barrier separating the RED equipment from the BLACK equipment and wirelines (i.e., the RED equipment is located in a separate space). This allows RF transmitter installation in adjacent spaces.

(U) Equipment racks containing RED equipment may be installed adjacent to equipment racks containing BLACK equipment and BLACK wirelines if metal side panels are installed on the racks. The side panels must extend to all sides of the rack and be bonded to the rack frame. BLACK signal wirelines that are connected to an RF transmitter or that directly leave the inspectable space (i.e., a shore tie) must be wholly contained within the rack or shall be shielded.

(U) If space limitations require the installation of RED and BLACK equipment in the same equipment rack, the RED and BLACK equipment and wirelines shall be separated by a full width and depth metallic barrier (such as a shelf or drawer) that is bonded to the rack, and separated by a distance of 30 centimeters. RED and BLACK wirelines shall be shielded.

(U) If the separation requirements between RED equipment/wirelines and BLACK wirelines cannot be met due to space limitations, then as much separation as feasible shall be provided, and the BLACK wirelines shall be shielded.

5.3. (U) Cables

(U) RED wirelines shall have a minimum of one overall metallic shield.

(U) RED lines shall have a distinguishing label or color coding that identifies the classification level of the NSI conveyed.

5.4. (U) Electrical Isolation

(U) BLACK lines connected to RED equipment (such as KVM, VTC, secure voice, or video matrix switches) shall be electrically isolated from RED signals. The level of isolation is provided in Table 2. When feasible, RED and BLACK cables should use separate equipment connectors.

(U) The electrical isolation requirement for secure voice systems shall be applied to the system as a whole, including the Intercommunication Systems (ICS), headsets/handsets, and any wiring between the system components. Additional shielding or isolation techniques may be required for audio cables that contain BLACK send (microphone) audio and receive RED audio in the same cable.

5.5. (U) Power

(U) When separate power sources are available, such as power converters or UPS, RF transmitters should be powered from separate power sources than RED equipment.

5.6. (U) Grounding and Bonding

(U) The grounding onboard an air vehicle is based on airframe structure and materials, electromagnetic interference, static discharge, TEMPEST and other considerations. When feasible, RED equipment shall be bonded to the air vehicle ground system, either directly through the equipment chassis or through a bond strap with a 5 to 1 length-to-width ratio. Cable shields shall be grounded to the equipment as described in SECTION 3.13.

SECTION 6 – (U) SHIPS

6.1. (U) Introduction

(U) This section provides the RED/BLACK installation guidance for shipboard and submarine systems. The intent is to isolate RED signals from BLACK signal paths that leave the hull of the ship, which is considered the inspectable space. Due to the limited space onboard ship and the metal structure of ships, the shipboard requirements are different than facility requirements.

6.2. (U) Physical Separation

(U) A separation distance of 1 meter shall be provided between RED Equipment and:

- (1) (U) Unshielded BLACK wirelines that are connected to an RF transmitter; and
- (2) (U) Unshielded BLACK wirelines that directly leave the inspectable space (e.g., a shore tie); and
- (3) (U) BLACK equipment having a nonmetallic enclosure and signal wirelines that are connected to an RF transmitter or that directly leave the inspectable space (e.g., a shore tie).
- (4) (U) RF transmitters that are contained in their original metallic enclosure.

(U) A separation distance of 30 cm shall be provided between RED equipment and BLACK wirelines that connect to a shore tie through a digital switch (such as a computerized telephone switch or network router) that is contained within the inspectable space.

(U) A separation distance of 3 meters shall be provided between RED equipment and stationary (i.e., docked or permanently installed) high-power RF transmitters. Refer to SECTION 3.6 for definitions for transmitter power levels. The separation distance may be reduced to 1 meter if there is a metallic barrier between the RED and BLACK equipment that extends beyond the extent of either equipment.

(U) A separation distance of 1 meter shall be provided between RED Equipment and:

- (1) (U) Stationary (i.e., docked or permanently installed) low-power RF transmitters.
- (2) (U) Mobile (i.e., hand held and not docked) RF transmitters, such as mobile cellular telephones.

(U) The separation requirements of this section may be met by a full length metallic wall separating the RED equipment from the BLACK equipment and wirelines (i.e., the RED equipment is located in a separate room). This allows RF transmitter installation in adjacent rooms.

(U) Equipment racks containing RED equipment may be installed adjacent to equipment racks containing BLACK equipment and BLACK wirelines if metal side panels are installed on the racks. The side panels must extend to all sides of the rack and be bonded to the rack frame. BLACK signal wirelines that are connected to an RF transmitter or that directly leave the inspectable space (i.e., a shore tie) must be wholly contained within the rack or shall be shielded.

(U) If space limitations require the installation of RED and BLACK equipment in the same equipment rack, the RED and BLACK equipment and wirelines shall be separated by a full width and depth ferrous metallic barrier (such as a shelf or drawer) that is bonded to the rack, and separated by a distance of 30 centimeters. RED and BLACK wirelines shall be shielded.

6.3. (U) Cables

(U) RED wirelines shall have a minimum of one overall metallic shield.

(U) RED lines shall have a distinguishing label or color coding that identifies the classification level of the NSI conveyed.

(U) Due to the limited cable paths onboard ships, RED and BLACK cables may be routed in the same distribution system.

6.4. (U) Electrical Isolation

(U) BLACK lines connected to RED equipment (such as KVM, VTC, secure voice, or video matrix switches) shall be electrically isolated from RED signals. The level of isolation is provided in Table 2. When feasible, RED and BLACK cables should use separate equipment connectors.

6.5. (U) Power

(U) RF transmitters shall not be powered from the same circuit as RED equipment. The RF transmitter power should be from a separate circuit breaker in a power distribution panel or from a separate AC-DC-AC direct conversion UPS than RED equipment.

6.6. (U) Grounding and Bonding

(U) Grounding and Bonding shall be performed in accordance with the recommendations of Military Standard (MIL-STD) 1310 for all RED equipment and wirelines. RED equipment and wirelines shall use the same installation criteria as required for electromagnetic compatibility. (Currently MIL-STD 1310 does not require grounding for TEMPEST purposes.) Cable shields shall be grounded to the equipment as described in SECTION 3.13.

SECTION 7 – (U) TRANSPORTABLES

7.1. (U) Introduction

(U) This section provides the RED/BLACK installation guidance for transportable platforms, such as vehicles, vans, and trailers. The platforms may be tactical, mobile, and/or stationary for less than 90 days. Platforms that are stationary for longer than 90 days shall use the guidance for facilities. Transportables that process special category information shall also follow the additional guidelines of SECTION 8.

7.2. (U) Physical Separation

(U) A separation distance of 1 meter shall be provided between RED equipment and BLACK wirelines that connect to RF transmitters.

(U) A separation distance of 1 meter shall be provided between RED Equipment and the BLACK wirelines that leave the inspectable space through external connections, such as telephone or network lines. The inspectable space is defined by the CTTA based on the operations plan and location(s) of the transportable.

(U) A separation distance of 1 meter shall be provided between RED equipment and RF transmitters.

(U) The separation requirements of this section may be met by a metallic barrier separating the RED equipment from the BLACK equipment and wirelines (i.e., the RED equipment is located in a separate space). This allows RF transmitter installation in adjacent spaces.

(U) Equipment racks containing RED equipment may be installed adjacent to equipment racks containing BLACK equipment and BLACK wirelines if metal side panels are installed on the racks. The side panels must extend to all sides of the rack and be bonded to the rack frame. BLACK signal wirelines that are connected to an RF transmitter or that directly leave the inspectable space must be wholly contained within the rack or shall be shielded.

(U) If space limitations require the installation of RED and BLACK equipment in the same equipment rack, the RED and BLACK equipment and wirelines shall be separated by a full width and depth metallic barrier (such as a shelf or drawer) that is bonded to the rack. RED and BLACK wirelines shall be shielded.

(U) If the separation requirements between RED equipment/wirelines and BLACK wirelines cannot be met due to space limitations, then as much separation as feasible shall be provided, and the BLACK wirelines shall be shielded.

7.3. (U) Cables

(U) RED wirelines shall have a minimum of one overall metallic shield.

(U) RED lines shall have a distinguishing label or color coding that identifies the classification level of the NSI conveyed.

7.4. (U) Electrical Isolation

(U) BLACK lines connected to RED equipment (such as KVM, VTC, secure voice, or video matrix switches) shall be electrically isolated from RED signals. The level of isolation is provided in Table 2. When feasible, RED and BLACK cables should use separate equipment connectors.

(U) The electrical isolation requirement for secure voice systems shall be applied to the system as a whole, including the ICS, headsets/handsets, and any wiring between the system components. Additional shielding or isolation techniques may be required for audio cables that contain BLACK send (microphone) audio and receive RED audio in the same cable.

7.5. (U) Power

(U) If operating from a generator that is dedicated for U.S. usage and contained within the inspectable space, filtered power is not required. If connected to external power, a CTTA shall determine the requirements for power filters.

(U) When separate power sources are available, such as power converters or UPS, RF transmitters should be powered from separate power sources than RED equipment.

7.6. (U) Grounding and Bonding

(U) When feasible, RED equipment shall be bonded to the transportable ground system, either directly through the equipment chassis or through a bond strap with a 5 to 1 length-to-width ratio. Cable shields shall be grounded to the equipment as described in SECTION 3.13.

SECTION 8 – (U) SPECIAL CATEGORY FACILITIES

8.1. (U) Introduction

(U) This section describes additional requirements for spaces that process special category information. These requirements are in addition to the requirements provided in SECTIONS 3 through 7. The intent is to prevent the inadvertent or unauthorized access to special category information by non-special category cleared personnel.

8.2. (U) Cables

(U) RED wirelines carrying special category information shall have a minimum of one overall metallic shield. RED wirelines carrying collateral information are not required to be shielded unless otherwise required in SECTIONS 4 through 7.

(U) RED lines carrying special category information shall be contained within the special category spaces (e.g., SCIF or SAPF) unless installed in a PDS. Separate, dedicated termination boxes must be used for special category circuits. Access to all points with signal connection breakouts of the special category circuits must be restricted to appropriately cleared personnel. Access points containing special category and non-special category circuits that do not have breakouts of the special category circuits can be serviced by non-special category personnel if escorted by appropriately cleared personnel. These requirements apply both within special category areas and for shared PDS outside the special category areas.

8.3. (U) Distribution and Patching Systems

(U) Separate, dedicated distribution frames and patch panels shall be used for special category circuits. It is recommended that patch panels for special category and non-special category circuits use mutually exclusive jacks and connectors to prevent cross-connection. At a minimum, a method must be employed to preclude inadvertent cross-connects.

8.4. (U) Multiple Circuit Equipment

(U) Multiplexers, video switches, audio switches and other multiple circuit equipment that have been approved by the cognizant accrediting authority may be used to process both special category and non-special category information provided that the equipment meets the electrical isolation requirement of Table 6. The isolation is defined as the ratio of the special category RED signal level on a port to the level of the same RED signal on any other RED port.

Table 6 – (U//FOUO) Special Category Electrical Isolation Level

RED SIGNAL TYPE	ISOLATION LEVEL	FREQUENCY RANGE
Analog Voice	65 dB	100 Hz to 5 kHz
Analog signaling, including analog video	60 dB	Lowest signaling rate to maximum signaling rate
Digital Signaling	30 dB	Lowest signaling rate to 10 times the maximum signaling rate

(U//FOUO) Note: the analog voice signaling rate may be reduced to 3 kHz for systems where the analog signal is filtered with a cut-off frequency below 5kHz for digital conversion.

8.5. (U) Power

(U) A CTTA shall determine if there are additional requirements for power and telephone filters.

SECTION 9 – (U) GENERAL GUIDANCE

9.1. (U) Introduction

(U) This section briefly describes the TEMPEST phenomena and general RED/BLACK design. When RED/BLACK separation and/or isolation is required by SECTIONS 3 through 8, the information in this section may be considered in the design of a RED/BLACK installation.

9.2. (U) TEMPEST Basics

(U) TEMPEST is an unclassified short name referring to investigations and studies of Compromising Emanations (CE). CE are defined as unintentional data related or intelligence bearing signals, which if intercepted and analyzed, disclose the NSI transmitted, received, handled, or otherwise processed by any information processing equipment. These intercepted signals need not be of great magnitude to compromise the NSI. Receiving intercept instruments can make use of even a small amount of energy.

(U) When equipment processes NSI, the possibility exists that CE can be generated. Time and frequency characteristics of these emanations are normally unknown. However, the mechanisms of NSI emanation introduction into an escape medium, characteristics of various equipment under test, and experience allow estimation of their characteristics. In practice the more common types of CE are attenuated RED baseband signals, spurious carriers modulated by RED baseband signals, and impulsive emanations.

(U) To determine the extent of CE and the necessary countermeasures to apply, equipment must be considered individually and as components of a system. Any circuit processing NSI can be a source of CE. A system could emit signals beyond the defined boundaries, even when all equipment and components comprising the system individually meet TEMPEST standards. This could occur because of the interrelationship of components, equipment interface characteristics, lengths, locations and shielding of interconnecting signal and control lines and methods of grounding each unit within the system. There are two basic sources of CE:

(U) Functional Sources. Functional sources are those designed for the specific purpose of generating electromagnetic energy. Examples are switching transistors, oscillators, signal generators, synchronizers, line drivers and line relays.

(U) Incidental Sources. Incidental sources are those NOT designed for the specific purpose of generating electromagnetic energy, but can generate energy incidental to normal operations. These sources of CE can include all electromechanical and electronic equipment and systems used to process NSI (e.g., communications equipment, recording and duplicating equipment, automatic data processing equipment, and their installations).

9.3. (U) RED/BLACK Basics

(U) The RED/BLACK concept, by definition, establishes areas for placement of equipment processing NSI (RED) that are separate and unique from areas with equipment processing non-NSI (BLACK). The concept is composed of two parts: physical separation and electrical separation.

(U) Physical Separation. All equipment, wirelines, components, and systems that process NSI are considered RED. All equipment, wirelines, components, and systems that process encrypted NSI and non-NSI are considered Black. The RED/BLACK concept is to establish minimum guidance for physical separation to decrease the probability that electromagnetic emissions from RED devices might couple to BLACK systems.

(U) Electrical Separation. Electrical separation ensures that every signal conductor from a RED device is routed only to another RED device, or is encrypted before connection with a BLACK device. Electrical separation addresses signal distribution, power distribution, and grounding. Switches and/or other devices used to interface between RED and BLACK circuits/equipment should provide port-to-port isolation as applicable.

(U) Facility Considerations. The most cost-effective application of RED/BLACK countermeasures will vary depending on characteristics of the facility and the equipment operated within the facility. The first step in the selection of proper RED/BLACK controls for the facility is the identification of the geographic location, level and type of classified data processed, and the inspectable space. The RED/BLACK installation requirements are a function of these variables.

(U) Physical Security Considerations. Physical security is a key element in deciding what RED/BLACK countermeasures will be adopted and is an important part of the necessary safeguards for equipment and systems that process NSI. The user is responsible for adopting the requisite physical security standards and procedures according to current directives. Physical security should be addressed at the beginning of any new facility or renovation project. Security officials, the CTTA, and/or others responsible for building construction or modification should be involved during the planning stages of a project.

9.4. (U) Signal Cables

(U) Installations can use shielded metallic cables and nonmetallic optical fiber cables to interconnect signals and to meet RED/BLACK separation recommendations.

(U) Shielded Metallic Cables. Selection of metallic cable types varies according to equipment design. Jacketed multi-conductor twisted pair cables consist of insulated, shielded pairs, or a bundle of twisted pairs contained within a single shield. Each shield (of a twisted pair or bundle of twisted pairs) should include an uninsulated and tinned drain wire. This drain wire should have a lay such that it will contact the shield throughout its length. To reduce radiation of CE, metallic cables should have a minimum of one overall braided metallic shield, with the shield terminated at both ends to the grounding network. The shield should not be used as a signal return path. A drain wire is not required in braided copper or outside-plant-type aluminum foil shielded telephone cable.

(U) Cable Characteristics. Cables should have an overall shield composed of 85 to 90 percent tinned copper braid coverage. Consider the following when selecting cables; voltage breakdown, insulation type, jacket material and color. Effective shielding for a cable is achieved by using proper cable shield termination. Crosstalk can appear on adjacent pairs.

(U) Shield Termination. Both ends of the overall shield should have 360-degree termination. Shields for twisted pairs and bundles of twisted pairs are normally terminated at both ends. Designers and installers must be aware that terminating cable shields at both ends can cause signal ground loop problems resulting in TEMPEST emanations or safety concerns. In these cases, the designers and installers should consider terminating the cable shield at one end only, or replacing the cable with a nonmetallic optical fiber cable.

Long pigtail and long ground wire shield termination drastically reduce shielding effectiveness and in certain frequency ranges can completely nullify the inherent shielding capability of a cable. If pigtail termination is required, the pigtail should be as short as possible and should be bonded to a low impedance radio frequency ground such as ground, plate, chassis or wide ground bus. A long slender ground wire is not an effective RF ground and can instead be an effective antenna.

(U) Optical Fiber Cables. A fiber optics system converts an electrical signal to an optical signal, transmits the signal through an optical fiber, and converts the signal to an electrical signal at the receive end of the fiber. Although optical converters can create TEMPEST emanations from the electrical portion of their circuitry, optical systems have several advantages over metallic signal cables when used to transmit RED information:

- (U) Because optical fibers are nonmetallic, they do not conduct or radiate radio frequency interference (RFI). Optical fibers are virtually unaffected by electromagnetic fields (i.e., electromagnetic interference (EMI) or RFI), effectively eliminating cable crosstalk.
- (U) Because there are no cable grounds, systems are not subject to ground loops.
- (U) Optical fiber cable systems are not subject to the transmission of common mode signals.
- (U) Optical fiber cable systems are not damaged from lightning strikes through the optical fiber cable, although the cable can be severed.

(U) Applications of Optical Fiber Cable Systems. Optical fiber cable systems can be used in RED and BLACK distribution systems to prevent the unintended transmission of TEMPEST signals outside the inspectable space. While optical fiber cables used for this purpose will not radiate CE, the cables are still vulnerable to tampering, requiring appropriate physical security as with any RED cable. See MIL-STD-188-111 for interoperability and performance standards of optical fiber cable systems for military application.

(U) Multifiber Cables. Multifiber cables within the same conductive shielding (cladding) should be restricted to either RED or BLACK information to preclude compromise through misconnections. Separate RED and BLACK dielectric multifiber cables can be routed in a common RED distribution system provided the end equipment are managed to preclude misconnections. All optical fiber cables should be clearly marked, labeled, or tagged as RED or BLACK according to purpose to maintain complete accountability. Unused optical fiber cables should be marked as such.

(U) Cable Strength Members or Shielding. A strength member included in some multifiber cables can be made of steel or other metal. Such a metal component in the cable could be a fortuitous conductor. Therefore, treat RED optical fiber cables with metal strength members and/or conductive shielding (cladding) the same as metal lines. They should not traverse BLACK areas unless installed in an approved protected distribution System.

9.5. (U) Signal Distribution

(U) A signal distribution system provides for the routing of BLACK or RED cables and consists of wireways and interconnect facilities. The typical encrypted communications system requires an interconnect medium to connect the terminal equipment to the encryption device, the encryption device to the modulator-demodulator (modem), and the modem to the line or carrier equipment. This medium is usually a technical control or patch and test facility containing patching and distribution equipment. The signal distribution design should:

- (U) Provide an orderly scheme to route signal cables among and between equipment by using good engineering practices.
- (U) Provide accountability for all signal cables with sound administrative and operational accounting.
- (U) Prevent RED cables from becoming intermixed or inadvertently coupled to any BLACK cables by selection of cables, wireways, interconnect facilities, and isolation techniques.

(U) Wireways. Wireways provide convenient methods to control the routing of signal cables to prevent mixing cables by controlling access to the route. Properly installed wireways can also aid in shielding cables contained therein and thereby reducing electromagnetic radiation. RED and BLACK cables should use separate wireways with physical separations. Many signal lines that egress the inspectable space are contained in a pipe, conduit, duct, or other conductive material. This outer physical layer can become a fortuitous conductor and could require isolation. A CTTA will determine if isolation is required for the best location for the break and the length of pipe.

(U) Patching Equipment. Patching equipment is usually a series of jack fields wired in the normal through configuration. This permits equipment to be connected through all elements to the line or carrier equipment. Patch cords enable use of spare equipment or cable pairs when performing routine maintenance or eliminate downtime due to equipment or wiring malfunctions. Install separate RED and BLACK Jack fields to maintain the separation recommendation. The Jack fields should have incompatible connectors to prevent inadvertent RED to BLACK patching. Separate the cabinets or racks from RED and BLACK equipment according to the separation recommendation.

(U) Distribution Equipment (Wire Closets). Wire closets typically are equipment cabinets or rooms designed for hardwired interconnect of cables between equipment. Distribution equipment must be designed with separate RED and BLACK connector blocks to prevent improper connection of RED and BLACK lines. Separation of the connection components and the associated signal line distribution should be according to the separation recommendation.

(U) Protected Distribution Systems (PDS). A signal distribution system containing unencrypted NSI, which enters an area of lesser classification, an unclassified area or uncontrolled (public) area must be protected according to the requirements of the current PDS standard.

9.6. (U) Signal Line Isolators and Filters

(U) Signal Line Isolation. BLACK lines and other electrically conductive materials that egress the inspectable space are potential carriers of CE that can inadvertently couple to the lines. An extensive variety and quantity of BLACK lines and other conductive materials can cross the boundary of the inspectable space of a facility. Various signal line isolation techniques can be used to protect the signal line, the distribution system or other fortuitous conductors from conducting compromising signals beyond secure areas. Before employing these isolation methods, the facility and equipment should be evaluated to determine if the minimum separation recommendations can be met. Consider signal line isolation only if the minimum separation recommendations cannot be met.

(U) Assessing the Need for Signal Isolation. When the minimum separation recommendations cannot be met, there are many factors that combine to determine if a specific facility and equipment complement should use signal line isolation techniques. The CTTA should decide whether compromising signals are detectable on the signal lines in areas where unauthorized personnel could exploit them with little chance of being discovered. Without knowledge of the results of an instrumented TEMPEST test at the site, there

will usually be insufficient information to make this decision. Experienced TEMPEST personnel can decide based on known factors that can include equipment TEMPEST characteristics, cable shielding, equipment separation distances from the potential conductors, physical access controls to the distribution of the conductors, the security classification of the NSI processed, and the relative threat of exploitation based on the geographic location of the facility. To ensure that the facility is adequately protected for future equipment configurations, consider the frequency of changing, adding and relocating equipment. At a specific facility some conductors require isolation while others do not, based on equipment layout, signal line distribution and other factors. Isolation of conductors may not be possible for reasons like life, safety or prohibitive cost. When conflicts occur, consult the cognizant CTTA to develop the best approach.

(U) Passive Signal Line Filters. Passive filters are installed on signal lines to block signals outside a specified frequency range. Lowpass filters are used to pass the intended baseband signal and greatly attenuate all higher frequency signals. Bandpass filters, which suppress signals above and below a specified frequency range, and highpass filters, which pass signals above specified frequency, are also available for special requirements. Filters are available with different signal cutoff frequencies to meet the requirements of a variety of signaling rates. Previously, telephone line filters were required to pass only the analog voice signals. To avoid signal degradation or stoppage in digital data transmission on telephone networks, select telephone line filters compatible with the format and speed of the intended signal.

(U) Lowpass Filters. For most effective performance, signal line filter design should meet the specific requirements for their particular application; however, an existing filter design that approximates the desired characteristics can be more economical. Two types of signals require filtering: analog signals (i.e., voice or the tone output of modems), and digital signals (i.e., mark/space square waves). Filter behavior and performance for each of these types of signals are considered separately.

(U) Analog Signal Line Filters. Analog signal line filters are usually designed to match a balanced 600 ohm signal pair (two 300 ohm filters). These filters can introduce moderate phase and amplitude perturbations in the 1500 Hz to 3300 Hz portion of the passband, even when employed in an impedance matched system. If there is an impedance mismatch to the filter, these perturbations will increase approximately in proportion to the extent of the mismatch. Modems can tolerate a minimum of phase and amplitude distortion introduced by signal line filters. For applications of this type, the options are to use a simple filter designed to introduce minimal phase and amplitude distortion in the frequency band of the modem (0 to 3300 Hz) or to design an expensive, multi-element, compensated filter.

(U) Inductive-Capacitive (LC) Signal Line Filters tend to "ring" when the input signal is a square wave. Using these filters to remove undesired frequency components from digital signals generate stringent design problems. The best square wave performance can be obtained from an LC filter that is both driven and terminated in its characteristic impedance. Some ringing will occur, and there will be 6 dB attenuation of the signaling voltage (i.e., +6 volts to the filter driver will produce + 3 volts out to the line). This degree of signal attenuation is usually not acceptable in a digital system. Two alternate approaches are available to provide minimum desired signal attenuation, with only a moderate increase in ringing. First, a filter driven with a matched source impedance can be terminated in a high impedance (x10 or higher) without appreciable signal attenuation and with only a moderate increase in ringing. Second, when an inductance input type filter is employed, a low impedance device can be used if the filter is terminated in its characteristic impedance. In general, a filter terminated in its characteristic impedance can be used at a bit rate approaching 1/3 the filter cutoff frequency. If the impedance is substantially mismatched, excessive ringing will occur and the bit rate that can be passed is drastically reduced.

(U) Digital Signal Line Filters. Filters driven directly from keying contacts must have inductive inputs or there will be excessive contact arcing resulting in rapid contact deterioration. Ringing will be moderate if the filter is terminated in its characteristic impedance. Without proper termination, the filtered signal will have excessive ringing that severely limits the usable bit rate. Filter designs developed to solve specific problems are necessarily expensive. Changing the signal patch to provide a balanced signal pair matching the characteristic impedance of a filter is usually impossible. Most signal line filters are designed for balanced 600 ohm transmission line systems and are available as either dual 300 ohm or 300 ohm units intended to be used in pairs. They have also been designed primarily for analog signals in the 0 to 3 kHz frequency range. Unfortunately, these filters have been employed in many digital applications for which they were not designed. Most digital systems do not employ balanced transmission techniques in that one lead of a transmission pair is driven at -6 volts for space bits, and 0 volts for mark bits. Also, the input impedance of low level digital devices usually is at least 6,000 ohms and can be as high as 100,000 ohms, while the output driving impedance of digital drivers can be only a few ohms. This suggests that 300 ohm analog filters will give unsatisfactory performances in most digital circuits. If filtering is necessary for specific digital applications, special filter designs should be developed that are tailored to the specific problem. An alternative is to change the signaling path to a transmission link using a balanced signal pair with matched source and sink impedance. A standard filter can then be inserted in the transmission line. This alternative is particularly attractive from an engineering viewpoint when the signaling path leaves the inspectable space for a long run.

(U) Active Signal Line Filters. Active filters are frequency selective devices that employ electronic impedance, current, and voltage moving elements, requiring the application of power to use their filtering properties. As opposed to passive filters, active filters are essentially one-way devices that use impedance mismatch as the primary basis for filtering action. Note also that the phase delay, passband, and stop band characteristics of active filters can be widely divergent from those of standard passive filters. Active filters are more readily adaptable to digital applications than are passive filters and can be specifically designed to process analog signals with a minimum of distortion.

(U) Active linear filters normally consist of linear amplifiers that incorporate frequency selective resistance-capacitance (RC) networks, either as negative feedback elements or in line filter elements, or both. Filters of this type can be configured to be lowpass, bandpass, highpass, or band rejection types. A well-designed active filter provides a greater degree of attenuation of unwanted signals at a higher cost. The small size and versatile characteristics can justify the added cost. Active filters are currently being produced in modular form to produce chips that offer a greater variety of filtering characteristics.

(U) Saturated Amplifiers. One type of active filter for digital signals is a combination of saturated input and output amplifiers coupled by means of a single RC network. If an active feed through capacitor is employed between the input and the output compartments, independent power supply provided, and adequate shielding designed into the enclosure, attenuation of transverse mode unwanted signals of at least 100 dB can be obtained. Saturated amplifiers should not be used by themselves because they do not provide common mode isolation. The provision of an optical path instead of a conducted or capacitive penetration of the RED/BLACK shield adds minimum complexity and enhances security.

(U) Isolators. The common characteristic of isolators is that they can provide DC and ground system isolation between input and output circuits, thus reducing the possibility of signal conducting ground loops. Isolators also offer design possibilities for non-low level signals in and low level signals out, or vice versa, polar-to-neutral-to-polar conversion, and independent dc levels for input and output circuits. To obtain these characteristics, separate power sources are necessary for input and output circuits.

Isolators can be subdivided into the following functional types: magnetic-, acoustic-, and photon-coupled devices.

(U) Magnetic-coupled Isolators, such as a conventional electromechanical relay, provide DC isolation, but is limited to low baud rates, and unless it is of a very special shielded design, provide only meager higher frequency attenuation. Another form of magnetic-coupled isolator is the transformer-coupled type that employs a modulated oscillator in the input operating at a frequency at least ten times the highest baud rate, while the output is equipped with either a suitable phase, frequency shift, or amplitude detector. Effective passive filtering of the input and output signal lines is essential to prevent the modulated high frequency signal from coupling out of the isolator onto the input and output lines. Transformer-coupled isolators have not been highly successful as digital devices, but as analog devices, transformer coupling is used extensively to provide dc isolation between equipment and balanced input and output lines.

(U) Acoustic-coupled isolators are similar to transformer-coupled isolators in that both employ a modulated oscillator and suitable detecting devices. In the acoustical device, the oscillator drives a transducer, which in turn excites a receiving transducer through some non-conducting medium. The problems encountered with this type isolator are similar to those of the magnetic-coupled type. Very few applications of this type device have been achieved.

(U) Photon-coupled (optical) isolators are available in many different configurations. These range from integrated circuit components (containing a light source and detector and providing only DC and very low frequency isolation) to isolators that employ optical coupling through a waveguide (capable of providing more than 120 dB of both common mode and transverse mode isolation from DC through 10 GHz). This definition applies to both forward and backward (output-input) isolation. Common mode signal isolation is the degree of signal attenuation in decibels between the shorted input and the shorted output of the isolation device when the signal source is between the shorted input of the isolation device and ground reference. The measuring equipment is connected between the shorted output and the ground reference. Photon-coupled isolators are available for both digital and analog signal applications. High rate digital signaling speeds and high analog bandwidths can be provided. Photon-coupled isolators use lightwave technologies to couple signals between two points via use of an optical fiber cable. When the optical fiber cable is installed in a waveguide beyond cutoff, the isolator is ideal for use in shielded installations where conducting penetrations are kept at a minimum. Four types of isolators are identified by intended application.

- (U) Digital signals without retiming input (regeneration)
- (U) Digital signals with retiming input (regeneration)
- (U) Analog signals (audio, video, RF modem, wideband, etc.)
- (U) Telephone circuits (duplex, incoming, supervisory signals)

(U) Signal Line Isolators. Isolators can provide more than 120 dB isolation (0 to 100Hz) for lines passing through any equipment or equipment area interface requiring protection. The reason for this stringent requirement is to prevent a conductive or capacitive path for compromising information from the RED equipment area to the BLACK equipment area and the uncontrolled area. Take notice that one line filter cannot perform the function of an isolator, since a conductive path is always present within the passband of the filter. The use of filters is not recommended because ground current loops are generated by the low impedance to ground that the filter inherently has at frequencies above its cutoff frequency. The ground currents present the possibility of compromise.

(U) Analog photon-coupled signal line isolators provide attenuation of the unwanted signals equal to digital isolation in the "backward" direction. In the forward direction, they provide common mode isolation equal to digital isolators but do not provide transverse mode isolation within the bandwidth of the signal being transmitted. The analog photon-coupled signal line isolators are equal to the best active or passive filters.

(U) A photon-coupled signal line isolator allows the input and output modules to be shielded by a ground plane connected only by a nonconductive optical path through a waveguide penetration. A ground plane can be a shielded room wall, conduit box, or equipment housing. This arrangement assures a high level of signal isolation at all signal rates.

(U) Advantages of Photon-coupled Isolators. The advantages of using photon-coupled isolators are: (1) elimination of the electrically conductive path of undesired signals between the input and output modules; (2) attenuation of common mode signals by use of waveguides operating below cutoff as attenuators; (3) elimination of undesired transverse mode signals by filtering, pulse reshaping, or pulse regeneration. The isolators are usually mounted inside an RFI cabinet or on the wall of a shielded room. The penetration of the shield is in the form of a waveguide tube through which the optical path passes. The dimensions of the waveguide tube are normally chosen to prevent the passing of RF energy below the frequency rating of the shield.

9.7. (U) Power Distribution

(U) The power distribution scheme must be protected from exploitation of CE that might be developed in the system. The scheme must conform to the life and safety provisions of the Occupational Safety and Health Act (OSHA), the National Electrical Code (NEC), and local building codes. The following paragraphs address the proper design of a power distribution scheme that will satisfy RED/BLACK recommendations.

(U) The Power Requirement. The power requirements of a facility can be divided into two groups; power for the mission equipment (technical) and power for the supporting services (non-technical). Supporting services include lighting, heating, ventilating, air conditioning, etc. By providing a separate service feeder dedicated to the sensitive equipment and controlling its distribution, the opportunity for unauthorized detection of compromising signals on those lines is reduced. Powerline conduction occurs when plain text information is transferred onto the powerline by RED equipment, or radiated through free space and coupled onto the powerlines. If a facility is processing NSI, power is sometimes divided into RED and BLACK power. RED power provides isolation for those non-TEMPEST approved equipment processing NSI. BLACK power is provided for equipment processing non-NSI because power isolation is not required. This separation prevents conducted emissions from RED equipment being coupled through BLACK equipment to BLACK lines that might egress the inspectable space. Adequate internal filtering permits use of BLACK power for Level I TEMPEST compliant equipment and systems. In addition to separate distribution facilities, the measures outlined in the subsequent paragraphs for containment and suppression of conducted emissions apply to RED power.

(U) RED power distribution must be designed such that neither BLACK equipment nor utility equipment is connected to it. The design and installation of power systems require judicious selection of the primary and auxiliary power sources, UPS, or other power conditioning equipment, secondary substations, protective measures, and the distribution system to attain the maximum overall system performance with the most cost-effective design.

(U) Power Conditioning/Isolation. Facilities using sensitive solid-state equipment often include devices to condition the electrical power by removing or suppressing harmonic distortion, surges, sags, spikes, and electrical noise. Chiefly, powerline filters, isolation (Faraday shielded) transformers, UPS, and power regulators are used.

(U) Powerline Filters. The passive LC filter has long been used to remove unwanted RFI from conductors of all types. Such filtering has been in general use to prevent RFI from interfering with equipment operations. The TEMPEST program employs filters to prevent RFI generated in equipment from escaping as conducted CE. When applied to the treatment of powerlines, two schools of thought exist: bulk filtering for the entire facility, and filtering only equipment as required. Bulk filtering is expensive and generally less effective than filtering at the equipment. Filtering at the component and/or cabinet level is a more practical and economical approach for isolating RED electromagnetic environments from BLACK electromagnetic environments. Vendors' catalogs typically provide detailed information for available filters. If the appropriate filter is not available but is required for secure equipment operation, the following information should be provided to the filter manufacturer for custom design of a filter:

- (U) Operating line voltage
- (U) Operating frequency
- (U) Source impedance
- (U) Load impedance
- (U) Load current
- (U) Desired bandpass frequency
- (U) Acceptable insertion loss

(U) Powerline filters are not considered an assured method of adequately suppressing CE. Custom designing powerline filters for each equipment is a preferred method of preventing conducted CE from being introduced on powerlines. The required insertion loss can be more readily attained with equipment filters because saturation of inductors is a lesser problem due to lower current and because impedance mismatch can be minimized due to known characteristics.

(U) Isolation Transformers. Isolation transformers are principally used to break ground loops to reduce common mode and differential mode noise. An isolation transformer equipped with triple Faraday shields is very effective in reducing conducted emission in both the power mains and the branch feeds. The transformer can be 1:1 ratio or step-down. Its installation in the facility should be as close to the load equipment as possible, preferably in the same room. It should also be installed per NEC as a separately derived system and, as such, establishes a new fault protection subsystem. It should not be tied to the green wire serving the power main side, as this defeats the intent of both the NEC for protection and the use of this type of transformer to break ground loops. Further, some isolation transformers can be designed with the ground and neutral conductors being common to the primary and secondary windings. This reduces the isolation effectiveness of the transformer.

(U) Uninterruptible Power Supplies and Power Regulators. Many installations using computer or process control equipment employ UPS and voltage regulators as a method of providing glitch free power. Certain aspects of UPS aid in containment of conducted emissions as discussed in the following paragraphs.

(U) Solid-state UPS (SSUPS) have demonstrated isolation of conducted emissions by the nature of its operation. SSUPS takes the incoming AC power through a DC converter or rectifier. The filtering section

of the rectifier should attenuate conducted emissions. The DC voltage is supplied to an inverter section that synthesizes a sine wave that is filtered to reduce the probability of a conducted emission feeding back to the power mains. For most security processing applications, an SSUPS can be powered from either RED or BLACK power.

(U) Rotating UPS is constructed as a motor generator or a no-break generator using an inertia flywheel. Its basic principles of operation provide a degree of isolation between power mains and loads. The typical structure is an ac synchronous motor driving a generator. Such systems offer high immunity of the load from line disturbance. Some configurations do not provide isolation for conducted emissions. This is particularly true if the ac motor is mounted on a common shaft with the generator and in a common housing. If the motor and generator shafts and housings are electrically separated and capacitively decoupled, the emissions can be contained. Systems employing dc motors offer some isolation regardless of the configuration. Better isolation can be achieved if the housings are electrically and capacitively decoupled. In such systems, conducted emissions are suppressed in the dc power supply driving the motor and in the battery system.

9.8. (U) Grounding System

(U) The grounding scheme in a facility is composed of an earth electrode subsystem, lightning protection subsystem, fault protection subsystem, and signal reference subsystem. The signal reference subsystem is either a single point grounding design or a multiple point equipotential ground plane design, and it is of particular interest for control of TEMPEST emanations. Each grounding subsystem has a separate and distinct function as described in MIL-HDBK-419, or equivalent. Standards for grounding and bonding are provided in MIL-STD-188-124, or equivalent. Guidance on the construction of an equipotential grid can be found in MIL-HDBK-419, Volume II, or equivalent. Pertinent aspects of the single point and equipotential grounding methods are described here to highlight the security ramifications of each method.

(U) Equipotential Plane. An equipotential ground plane is a mass, or masses of conducting material that, when bonded together, offers negligible impedance to current flow. In any electrical circuit, it is essential to provide a low impedance path for signals to return from the load back to the generator. Noise in a signal line can often be attributed to the noise signal and current finding a lower impedance return than the intended path, where filters are employed in circuit design, unwanted signals are removed from the lines and shunted to another conductor. Any signal shunted to the ground system might circulate through multiple branches of the ground system to return to the source. Due to uncontrolled conductor lengths and impedance mismatches, such signals could be radiated from the conductors. Guidance on the construction of an equipotential grid can be found in MIL-HDBK-419, Volume II, or equivalent. All equipment signal ground terminals are bonded to the grid with leads as short as possible, but should not exceed 1/20 of the wavelength for the highest frequency of interest.

(U) Single Point Ground. Sometimes a single-point ground can be the only viable solution for a signal grounding scheme. From the TEMPEST viewpoint, a single point ground can satisfy the grounding requirement at facilities where: (1) no station ground meeting the criteria of MIL-HDBK-419, Volume II, or equivalent, exists, (2) station ground exists, but is not accessible, and (3) it is neither cost-effective nor practical to construct an equipotential grounding system.

(U) Fault Protection Ground. The National Electrical Code (NEC) requires equipping electrical power installations with a fault protection grounding subsystem. Its purpose is to establish a common reference and to provide an uninterrupted current path from the powered equipment back to the first service

disconnect or transformer. When a fault occurs in the equipment, the grounding conductor will cause a circuit breaker to trip and reduce the hazard to personnel. Use of metallic conduits and wireways as a fault return path is not recommended for data processing and communications equipment. The probable electrical discontinuity at conduit or wireway joints can cause a high impedance that will generate noise. Each equipment that is hardwired to the power source or each power outlet servicing equipment should be connected to a dedicated, contiguous green wire protective ground extending to the service disconnect. The protective grounding subsystem is unacceptable as a signal reference ground for the following reasons. First, the NEC does not intend the green wire system to carry current except during a fault. Second, there is no control over the distribution of signals. Third, the power distribution system is susceptible to noise that can disrupt signal circuits.

(U) Isolated Ground. Although not specifically intended for TEMPEST treatment, an isolated ground power distribution scheme can enhance line isolation concepts. To minimize mutual inductive coupling, the power cable is not run in conduit. This distribution scheme consists of isolated ground outlets, an isolated power distribution panel, and an insulated grounding conductor. The isolated ground outlet is designed with no electrical bond between the grounding terminal and the frame of the outlet. This prevents automatic coupling of the ground to the conduit, which would destroy the isolated ground. The ground conductor should be connected between the grounding terminal on the outlet and the grounding bus in the power distribution panel. The grounding and neutral bus bars should be insulated, isolating them from the distribution panel, conduit, and each other at this point. The grounding conductor is then connected from the ground bus to the grounding point of the facility main power switch gear. At this point it becomes common to the neutral conductor and other grounding conductors used throughout the facility. Only operational equipment should be connected to the power panel. Uprights, air handling systems, utility devices, and housekeeping equipment should be connected to a separate panel since they can induce unwanted noise into the system. Use of an isolated ground power distribution scheme will effectively isolate TEMPEST equipment from other electrical devices in the facility, but is not intended to replace other required powerline isolation devices.

9.9. (U) Administrative Support Equipment

(U) Any facility processing NSI will likely contain electronic administrative support systems not directly associated with the classified processing. This can include administrative telephones, paging systems, alarm detection systems, building utilities, radio and television receivers, and miscellaneous unclassified computer and communications equipment such as facsimiles, television monitors, video cassette recorders, portable computers, modems, and local area network components. If not installed according to RED/BLACK criteria, these systems can provide a conductive path for TEMPEST emanations to escape the facility. These components are sometimes personally owned and are often portable, which increases the likelihood they can be incorrectly installed in a secure facility. Administrative controls are recommended to establish local procedures to control the location and use of administrative support equipment within a secure facility.

(U) Telephone Systems. Administrative telephone systems are a potential source for fortuitous conduction of CE due to their proximity to building maintenance areas and their signal line distribution outside the facility. Additional protection is recommended when commercial telephones are located in a RED electromagnetic environment. The most effective protection is provided by telephone line optical isolators that use waveguide below cutoff. The use of these devices or telephone filters must be approved by the CTTA. These devices should be considered only when installing, replacing or retrofitting telephone systems.

(U) TEMPEST Protective Measures. For the purposes of meeting RED/BLACK installation guidance, the administrative telephone system and its associated wiring are BLACK. The telephone system cabling should be routed in a separate distribution system. If filters or isolators are required and approved by the CTTA, the lines should be filtered or isolated where they egress the inspectable space or facility. Locating the filters or isolators at the controlled space is not recommended because the equipment TEMPEST zone may extend beyond the controlled space. In addition, fewer filters or isolators will be necessary if the trunk lines rather than the individual phone lines are filtered or isolated.

(U) On-hook Security. Telephone systems can exhibit insecurities even when the telephone instruments are on-hook. This happens when RED audio or acoustic signals impinge on microphonic components in the telephone. Refer to the National Telephone Security Working Group (NTSWG) publications for guidance to prevent on-hook security problems.

(U) Paging, Intercom, and Public Address Systems. In addition to being a possible fortuitous conductor of TEMPEST emanations, the speakers in paging, intercom, and public address systems can act as microphones and retransmit classified audio discussions out of the controlled area via the signal line distribution. This microphonic problem could also allow audio from higher classified areas to be heard from speakers in lesser classified areas. Ideally, such systems should not be used. Where deemed vital, the following precautions should be taken in full or in part to lessen the risk of the system becoming an escape medium for NSI.

- (U) Systems should be totally contained within the inspectable space.
- (U) Voice frequency, lowpass filters should be installed on all cables if they are not totally contained within the inspectable space. This protects against TEMPEST signals on the cables but does not protect against voice modulation of the speakers.
- (U) Equipment should meet the separation recommendations.
- (U) Amplifiers should be considered for speakers in higher classified areas to provide reverse isolation to prevent audio from being heard in lesser classified areas.

(U) Alarm Systems. Many facilities employ alarm systems to detect and alert personnel of life threatening or security threatening situations. These systems employ passive or active sensors terminated on an annunciator panel. Such systems can also act as fortuitous conductors and could require isolation filtering and separation treatment similar to telephone and intercom system.

(U) Miscellaneous Fortuitous Conductors. Building utilities and other support elements can become fortuitous conductors due to the use of metallic materials. Heating, ventilating and air conditioning systems air ducts, water pipes, and gas pipes can require protection depending on their proximity to RED equipment and their distribution into uncontrolled areas. If conductors are identified as likely fortuitous conductors of TEMPEST signals into uncontrolled areas, the normal treatment is to insert a non-conductive section in the plumbing or duct work at the boundary of the inspectable space of the RED equipment. It is important to follow NEC, OSHA, and any local building and fire codes when isolating various conductors. Some metallic distribution facilities must be electrically bonded to the building structure or the fault protection subsystem. Some materials can be prohibited in utilities such as sprinkler systems or pressurized systems. Life safety and compliance with all applicable building codes are an overriding concern when considering isolation of fortuitous conductors. For this reason and also due to the quantity and variety of potential fortuitous conductors throughout a facility, isolation of such conductors should be accomplished when practical. There are often alternative procedures to avoid TEMPEST conduction problems with such fortuitous conductors via relocation of equipment, or specific grounding of the fortuitous conductor.

(U) Radio Transmission or Reception Devices. Any device that transmits or receives a radio signal is a potential security risk in a facility processing NSI. The risk is higher for radio transmission devices and in facilities using non-TEMPEST equipment. Traditional station designs place radio communications (combat net radio, microwave systems, etc.) away from the processing area. If not carefully controlled, other radio devices such as cellular telephones, cordless telephones, wireless local area networks (LANs) or portable satellite communications systems can be installed in a facility near RED equipment. Radio transmission equipment should be prohibited from all classified processing areas. If a mission requirement or space limitation demands that transmitters must be installed in classified processing areas, the separation recommendations must be met for such installations. A CTTA review is required to evaluate the risks of TEMPEST vulnerabilities. Reception devices such as radios, television receivers, receive-only beepers can be installed if authorized by cognizant security authorities and if installed in compliance with the separation recommendations.

(U) Commercial Television System Installation. When commercial television systems are installed in secure areas, the CTTA should determine the countermeasures to prevent a video cable entering the secure area from conducting compromising emanations out of the secure area. The countermeasures depend on the type of cable used to bring the signal into the secure area. If an optical fiber cable is used at the entry point to the secure area, no additional countermeasure is required. If a metallic cable is used at the entry point, it must be a shielded metallic cable and use an amplifier/attenuator system that must be located at the point where the cable enters the secure area. Only the type of amplifier/attenuator system that provides one-way filtering should be used. An attenuator could be required if the amplified signal overdrives the television receiver. The attenuator will also provide additional reverse attenuation. The length of metallic cable penetrating the secure area must be kept to a minimum. The use of a video recording device as an electronic filter is not allowed, since it does not provide proper filtering. If not installed properly, the recording device can amplify signals in both directions and not provide for one-way filtering. If a control box is used, it should be collocated with the amplifier/attenuator system. If a recording device is used with the system, it cannot be used to play or record classified information (unless the incoming video cable is disconnected) and must be conspicuously marked advising of this restriction. Amplifiers that can amplify signals in both directions should not be used. Commercial television system equipment and cables should comply with separation guidance.

9.10. (U) Other Considerations

(U) Inspectable Space. The inspectable space can vary considerably from one facility location to another. It is important to understand the boundaries of the inspectable space surrounding a facility to properly apply RED/BLACK countermeasures. The site designated CTTA should define the boundary.

(U) Facility Shielding. In certain instances, systems processing NSI are so large and complex that application of TEMPEST protective measures to the equipment can be impossible or exorbitantly expensive. In such cases, the entire facility can be shielded and power, signal and utility penetrations of the shield treated to block and remove conducted CE. This approach should be implemented only after a thorough cost comparison analysis of alternative security countermeasures. Obtain guidance from a CTTA to determine requirements and recommended methods for shielding.

(U) TEMPEST Suppressed Equipment. TEMPEST equipment have been tested in accordance with NSTISSAM TEMPEST 1-92 and demonstrated to comply with conducted and electromagnetic radiation limits of Level I, Level II or Level III.