

**INTRODUCTION TO
TELEPHONE SECURITY**

TSG STANDARD 1

March 1990

PREFACE

The National Telecommunications Security (NTS) Working Group (WG), formerly known as the Telecommunications Security Group (TSG), is the primary technical and policy resource in the U.S. Intelligence Community (IC) for all aspects of the Technical Surveillance Countermeasures (TSCM) Program involving telephone systems located in areas where sensitive government information is discussed.

TSG Standards will be replaced by and issued as Committee on National Security Systems Instructions (CNSSIs). Implementation of CNSS instructions/TSG standards neither prevents the application of more stringent requirements nor satisfies the requirements of other security programs such as TEMPEST, COMSEC, or OPSEC.

TSG Standard 1 is an introduction to telephone security that provides general information linked to the existing TSG standards and re-issued as CNSS instructions.

INTRODUCTION TO TELEPHONE SECURITY

PURPOSE

TSG Standard 1 provides background information on telephone security and explains some of the technical principles underlying the other TSG standards and newly issued CNSS instructions. This standard provides a systematic basis for determining the most appropriate telephone security measures to be applied. The NTSWG will revise and convert the existing TSG standards to CNSS instructions, as well as develop additional CNSS instructions as required.

APPLICABILITY

TSG Standard 1 applies to telephones located in government (or government contractor) sensitive discussion areas. It is concerned with on-hook audio security and does not apply to the interception of telephone conversations (Communications Security (COMSEC)). TSG 1 is only valid for telephones located in physically protected spaces (PPS).

DEFINITIONS

Many common telephone terms are not used consistently throughout the telephone industry. It is important when using the CNSS instructions/TSG standards that the terms defined in the glossary are not given any more or less meaning than specified. Definitions in other instructions may be more narrowly specified than in TSG 1, which allows for a more limited definition to be applied in a particular instruction.

TELEPHONE SECURITY PROGRAM

THE PROBLEM

One of the most serious technical security liabilities in the modern office environment is the presence of telephones. Telephones are connected to uncontrolled telephone lines. When the telephone is not in use, conversations occurring in its vicinity must not be transmitted out of the area. A serious security liability occurs when a telephone can pick up and transmit audio when on-hook.

Telephones can be made to exhibit this behavior even if it is not inherent in their design and construction. Telephones can be caused to pass audio by one or more of the following actions, referred to as penetrations:

1. Modification or reconfiguration of existing components
2. Installation of a clandestine technical surveillance device
3. Application of externally generated electrical voltages or control signals onto the telephone line
4. Modification of the telephone equipment or control unit software

Some telephones present an intrinsic audio security hazard, while on-hook the telephones pick up and transmit conversations occurring in the vicinity. There have been instances in which telephones have created an audio security hazard for reasons aside from the telephones' connection to uncontrolled telecommunications media. Some voice terminals, including speakerphones, intercoms, and some telephones, employ electronic audio amplifiers. Audio amplifiers may generate unintended radio frequency (RF) parasitic oscillations that are modulated by the audio signals being amplified. The RF oscillations are radiated through free space or coupled onto nearby conductors. A radio receiver tuned to the frequency of the RF oscillation may recover the original audio just as if it were an intended radio transmission.

The unintended radio broadcast of telephone or intercom conversations is unacceptable. The relevant concern is that an on-hook voice terminal might generate a radio broadcast of normal room conversations occurring in its vicinity. This can occur if the voice terminal maintains active RF circuits or audio amplifiers that are connected to, or contain microphonic components.

Measures taken to protect against these problems, either deliberate or unintentional, are known as on-hook telephone audio security.

COUNTERMEASURES

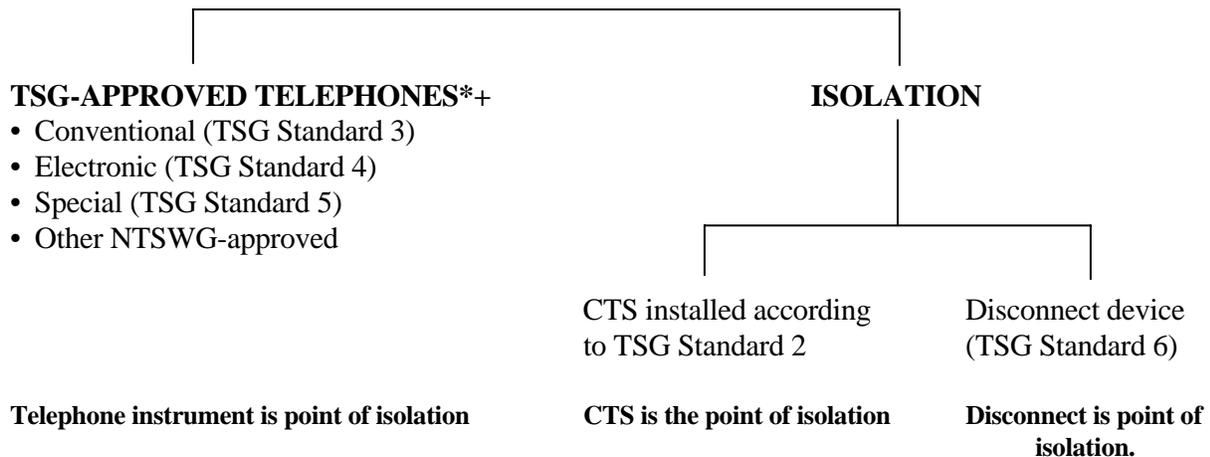
The only way to ensure absolute telephone security is to exclude telephones from sensitive discussion areas. However, in today's communications-oriented environment, that solution is impractical. As a result, the NTSWG has developed instructions that provide countermeasures for the security weaknesses of telephone equipment.

The two acceptable methods for attaining on-hook telephone audio security (see Telephone Security Options diagram):

1. NTSWG-approved telephone that incorporates security features
2. Isolation of telephones from uncontrolled lines

Where either NTSWG-approved telephones or isolation measures are possible, usage of both is not necessary. Neither approach is regarded as being better than the other.

TELEPHONE SECURITY OPTIONS



- * *All NTSWG-approved telephones are listed in TSG Standard 6.*
- + *May not be cost effective for large facilities.*

TSG-APPROVED TELEPHONES

NTSWG-approved telephones must have been evaluated by NTSWG and determined to meet on-hook audio security criteria. These telephones possess security properties that are intrinsic to the telephone itself. NTSWG type-accepted telephones are approved based on compliance with design and construction criteria contained in TSG Standards 3 and 4. A telephone that conforms to this criteria contains specific physical disconnect and isolation measures to ensure:

1. It cannot be caused to produce on-hook audio unless modified internally.
2. Its basic design does not facilitate modifications that could compromise audio security.
3. It can be easily inspected both physically and electrically to verify that the security measures are intact.

Redundancy of protective features is an associated consideration for type-accepted telephones, whereas the greater the redundancy, the greater the assurance that security will be maintained.

The specifications and procedures for obtaining type-acceptance are provided in the following TSG standards:

1. Standard 3 - Telephones Compatible with Conventional Central Office Interface.
2. Standard 4 - Electronic Telephones used with Computerized Telephone Systems.

Equipment manufacturers requesting type-acceptance for products must:

1. Demonstrate their product's conformance with the appropriate standards.
2. Supply technical data describing the product's design and supporting the products' technical claims.
3. Provide assurances that all units of the type-accepted model will continue to be manufactured in conformance with the design and data submitted as the basis for type-acceptance.

When the NTSWG approves a specific telephone model under the type-acceptance program, it may be used without additional isolation or disconnect measures.

The NTSWG type-acceptance criteria can be included directly in telephone procurement specifications. Manufacturers who wish to supply type-accepted telephones can use the NTSWG criteria for product evaluation and development. In addition, TSG Standards 3 and 4 explain how to obtain type-acceptance and define how the manufacturer can subsequently alter the telephone without affecting its type-accepted status.

TSG Standards 3 and 4 provide multiple categories of type-acceptance. This permits flexibility in selecting equipment so that the particular telephone security requirements of individual facilities

can be met economically.

Telephones with built-in speakerphones, speakerphone auxiliary units, and most other telephone accessory units may be type-accepted.

ISOLATION

Line isolation may be achieved by the use of NTSWG-approved disconnect devices or a computerized telephone system (CTS) installed in accordance with TSG Standard 2.

Disconnect devices separate the telephone from the uncontrolled line when the telephone is not in use. Telephone line isolation and disconnect devices prevent audio signals originating at the on-hook telephone from passing to uncontrolled telecommunications media. The line isolation or disconnects are interposed in the telephone line within the physically protected space to eliminate the hardwire conduction path when the telephone is on-hook.

For both isolators and disconnects, when the telephone is on-hook, all electrical connections to unprotected lines are completely severed. However, when a telephone is actually in use, signals must pass to the line for communication to take place. During use, isolators establish a temporary communication channel between the off-hook telephone and the unsecured line without using metallic connection, whereas disconnects provide a temporary metallic connection.

An approved isolator or disconnect device is one that has been evaluated by NTSWG and found to reliably prevent the passage of on-hook audio. TSG Standard 6 provides information on approved isolators and disconnects.

TSG Standard 2 provides installation requirements applicable to computerized telephone systems. If those requirements are strictly followed, private branch exchanges (PBX) and computerized key systems can be installed without separate isolation or disconnect devices because the required isolation will be achieved in the system itself.

Not all situations require the same level of security. A security countermeasure that is sufficient for one application could be inadequate for another. Generally, an appropriate level of security can be achieved with a selected combination of several countermeasures, including ones that would be deficient if applied individually.

ACCEPTABLE TELEPHONE SECURITY CONFIGURATIONS

The following diagrams show examples of commonly used acceptable telephone security configurations. These are not necessarily the only acceptable telephone security configurations. If another configuration is desired, the department or agency should contact the appropriate security authority to determine if the desired configuration meets telephone security standards.

TSG STANDARDS

The CNSS instructions/TSG standards describe methods for achieving on-hook audio security and assist the user in selecting among available alternatives. A complete list of CNSS instructions/TSG standards is provided in the appendix. The TSG standards, a part of the national effort to protect information, are issued by the NTSWG. The NTSWG is composed of representative of Federal departments/agencies concerned with national security.

UNATTENDED OFF-HOOK TELEPHONE SECURITY

When a telephone is left unattended during the course of a call (e.g., retrieval of a file), personnel within the work area may not realize or be aware that the telephone is off-hook and discuss sensitive information. Positive security countermeasures will prevent this type of security incident.

Unattended off-hook security can be accomplished by implementing one of the following security countermeasures:

1. Hold feature that does not allow audio from the telephone to leave the PPS.
2. Hold feature provided by a controlled CTS (TSG Standard 2).
3. Hold feature internal to the telephone that prevents audio from exiting the telephone when the hold feature is activated.
4. Hold feature that allows the handset to be cradled when the hold feature is activated.
5. Push-to-operate handset that can be used if an appropriate hold feature is not available (TSG Standard 6.)

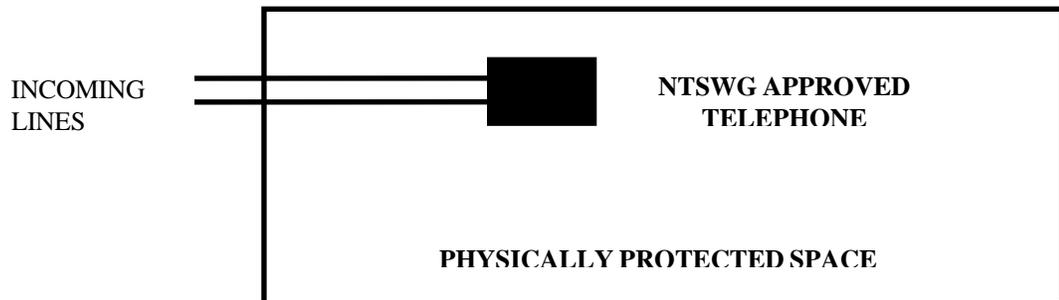


Figure 1 – NTSWG Approved Telephone

Notes:

1. No additional isolation/disconnect required.
2. TSG Standard 6 will state whether additional ringer protection is required for each particular telephone model. Additional ringer protection will not be required if a type-accepted telephone is used.

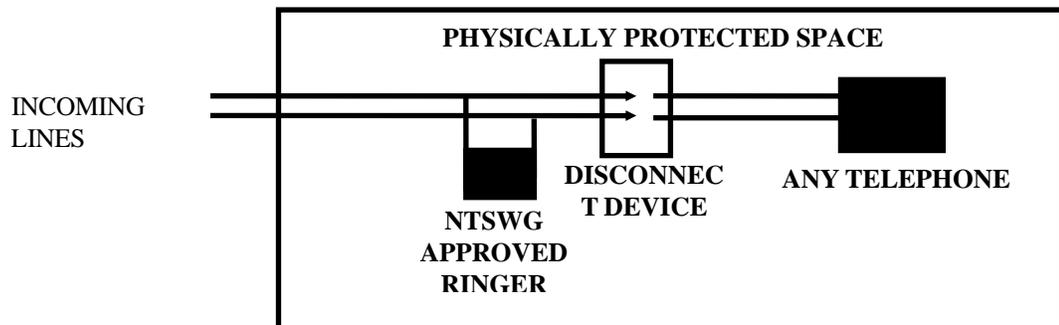


Figure2 – Disconnect Device

Notes:

1. NTSWG-approved telephone is not required.
2. NTSWG-approved ringer is required.
3. TSG Standard 6 will state whether additional ringer protection is required for each particular telephone model or disconnect.

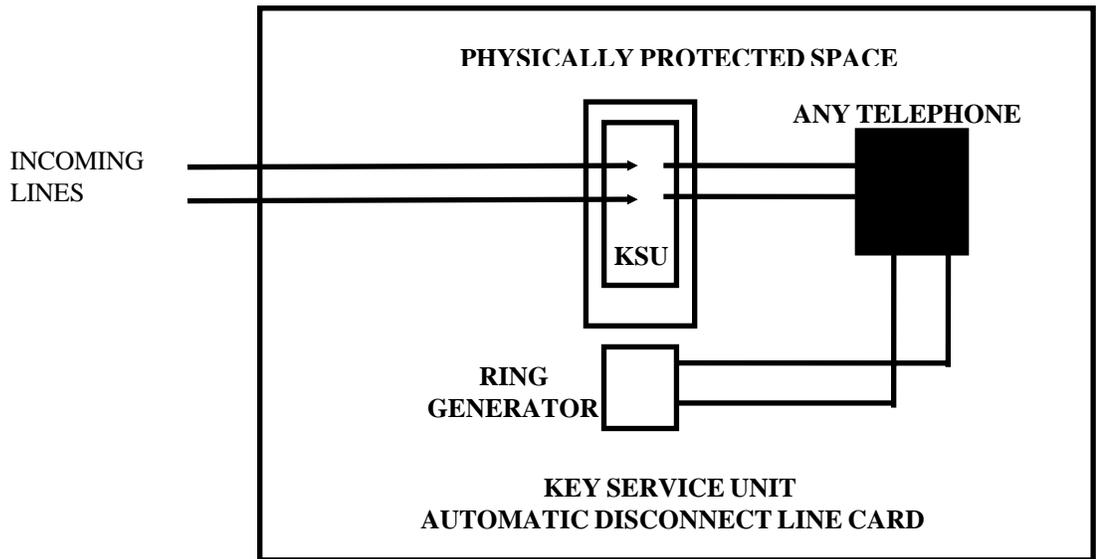


Figure 3 – Disconnect/Isolation using an Automatic Disconnect Line Card in a Key Service Unit

Notes:

1. TSG-approved telephone not required.
2. All wiring between the key service unit (KSU) and the telephone must be contained within the PPS.
3. No additional ringer protection is required because the KSU is equipped with a local ring generator.

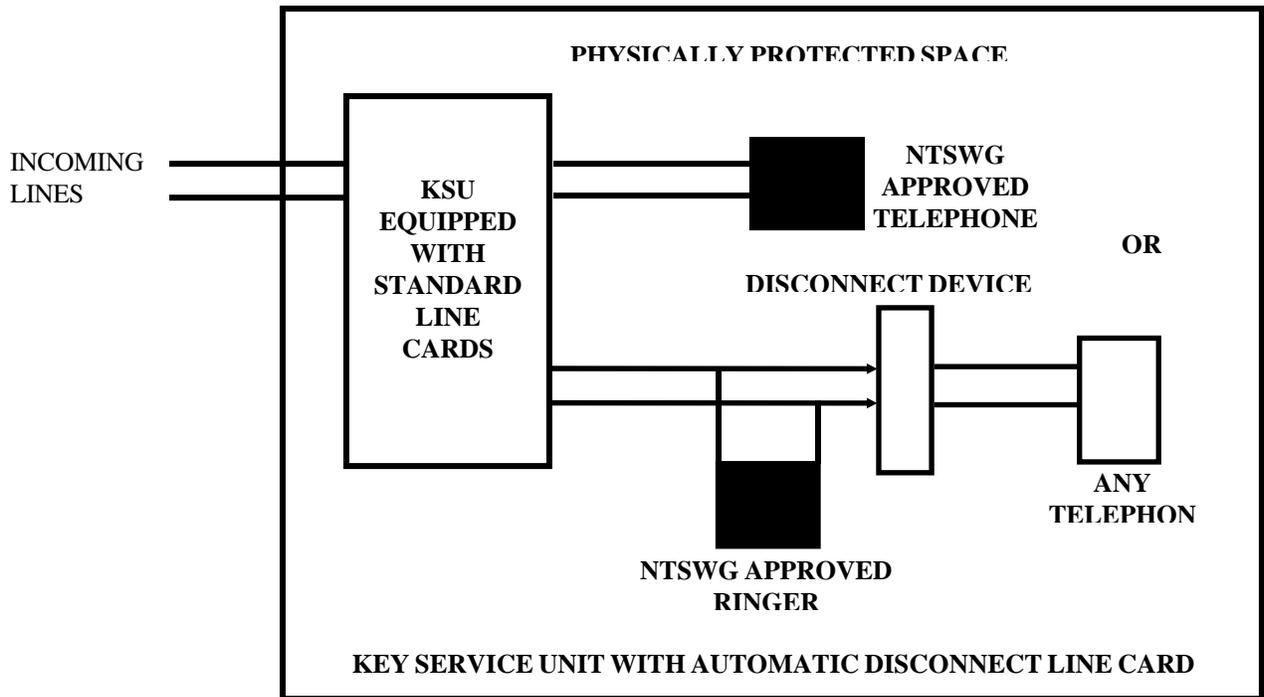


Figure 4 – Telephone security for a KSU with standard line card using a NTSWG-approved telephone

Notes:

1. Either NTSWG-approved telephone or disconnect device must be used.
2. TSG Standard 6 will state whether additional ringer protection is required for that particular model of telephone
3. Ringer protection is not required if a type-accepted telephone is used.
4. Installing a local ring generator (see figure 3) with the KSU removes the need for additional ringer protection.

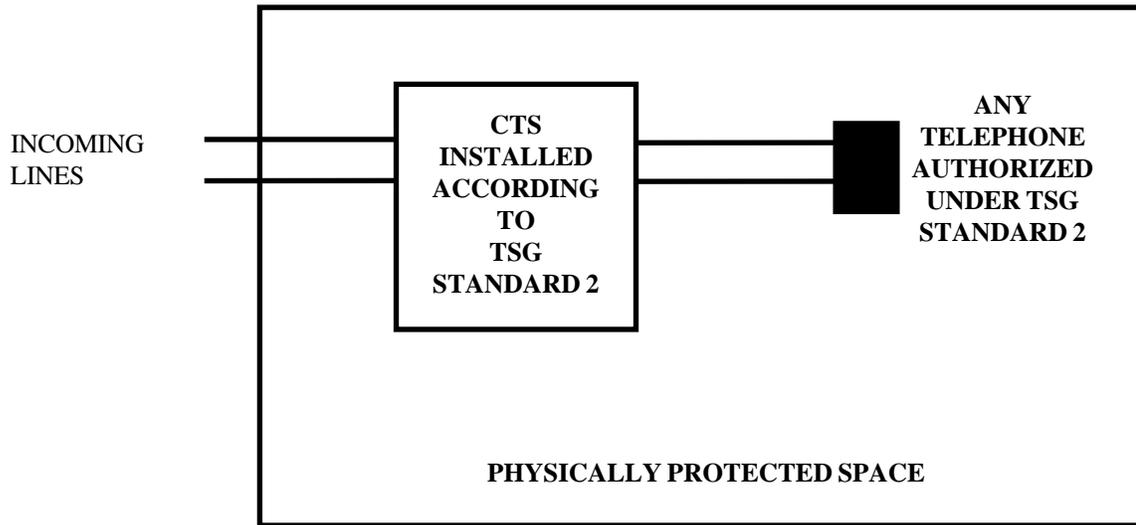


Figure 5 – Properly installed Computerized Telephone System

Notes:

1. Neither NTSWG-approved telephone or disconnect device is required if requirements of TSG Standard 2 are met.
2. Additional ringer protection is not required.

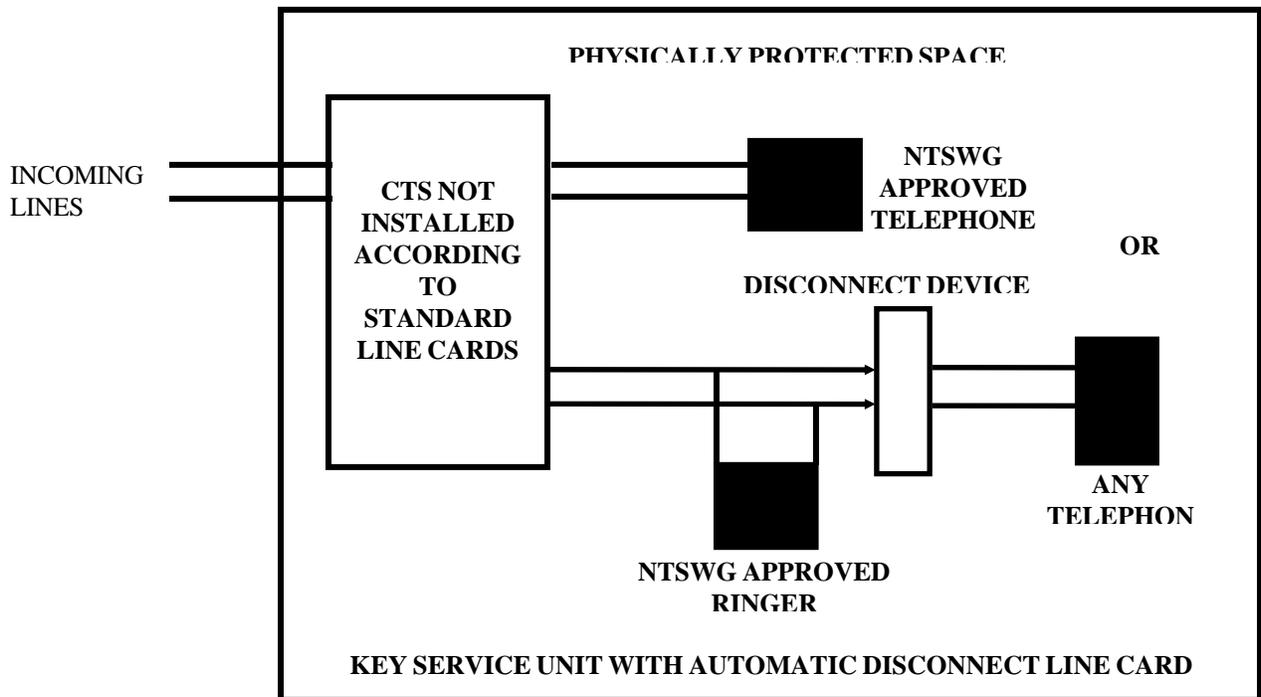


Figure 6 – Computerized Telephone System not installed in accordance with TSG Standard 2

Notes:

1. Either an NTSWG-approved telephone or a disconnect device must be used.
2. TSG Standard 6 will state whether additional ringer protection is required for a particular telephone model.
3. Ringer protection is not required if a type-accepted telephone is used

Speakerphones are designed to pick up and transmit nearby conversations. The speakerphone feature should be prohibited in common office areas to avoid inadvertent or intentional transmission of sensitive information.

SUMMARY

Telephones are one of the most significant vulnerabilities to sensitive discussion areas. Telephones can be exploited for clandestine surveillance through inherent weaknesses (hazards) or by deliberate modification (penetration). Rapid advances in communication technology have made the development of user-friendly telephone security solutions vital to the protection of sensitive discussion areas.

ANNEX A

References

(List of CNSS Instructions/TSG Standards)

CNSS instructions/TSG standards are available to all organizations within the United States Intelligence Community from the respective cognizant security authority (CSA). Individual instructions/standards may be released to non-governmental personnel who need them to accomplish work required by the U.S. Government. Any such release is to be accomplished by a letter identifying the instruction/standard as an official government document, which may not be disseminated further without specific approval of the issuing department or agency.

CNSS Instruction No. 5000, Guidelines for Voice Over Internet Protocol (VoIP) Computer Telephony

- Prescribes the requirements for the secure implementation and use of a VoIP telephony system in any U.S. Government or government contractor facility.
- Establishes requirements necessary in order to achieve on-hook audio security for VoIP telephones and/or systems located in sensitive discussion areas.

Standard 1, Introduction to Telephone Security

- Provides telephone security background and TSG-approved options for telephone installations in US Government sensitive discussion areas.
- Applies to all personnel concerned with telephone security.

Standard 2, TSG Guidelines for Computerized Telephone Systems

- Sets forth the planning, installing, maintaining, and managing requirements for CTS.
- Applies to all personnel involved in writing contracts, planning, installing, maintaining, inspecting, and system administration.

Standard 3, TSG Type-Acceptance Program for Telephones Used With the Conventional Central Office Interface

- Identifies a program that outlines specifications for design and manufacture and procedures required for type-acceptance.
- Applies to all personnel involved in writing contracts, manufacturing, and inspecting.

Standard 4, TSG Type-Acceptance Program for Electronic Telephones Used in Computerized Telephone Systems

- Identifies a program that outlines specifications for design and manufacture and procedures required for type-acceptance.
- Applies to all personnel involved in writing contracts, manufacturing, and inspecting.

Standard 5, On-Hook Telephone Audio Security Performance Specifications

- Specifies the amount of audio leakage allowed in the on-hook condition of telephones without disconnects.
- Applies to all personnel involved in writing contracts, manufacturing, and inspecting telephones, such as, a STU-III.

Standard 6, Telephone Security-Group Approved Equipment

- Lists NTSWG-approved equipment
- Applies to all personnel concerned with procurement and use of NTSWG-approved equipment

ANNEX B

Definitions

The terms and definitions listed apply strictly to this and the other existing TSG standards only. Many of the terms used herein have no related meaning in any other context, but do provide a precise and unambiguous meaning to describe NTSWG requirements. Where terms are involved that are employed by the telephone industry, the usages given are intended to be consistent with most common industry practices. Usage, generally, varies significantly within private, public, and government sectors.

- a. **Annunciator:** A device for producing an audible signal to announce an incoming call.
- b. **Audible Signal:** A sound that is specifically emitted by the telephone to be audible anywhere in its immediate vicinity.
- c. **Auxiliary Unit:** A device connected to the telephone by means other than the station mounting cord or the handset cord.
- d. **Built-In Microphone:** A microphone located in the body of the telephone rather than in the handset.
- e. **Conventional C. O. Interface:** The interconnection standard that is used by telephones (or other terminal equipment) designed and constructed in compliance with Part 68, FCC Rules and Regulations, for connection to the North American public switched telephone network (PSTN).
- f. **Cord:** A flexible assembly of individually insulated electrical wires enclosed in a common insulating jacket and fitted with terminating connectors used to provide the electrical connections between two separate, distinct units or component parts.
- g. **Critical Subassembly:** Any subassembly that is not a focal subassembly but that contains components essential to the operation of positive security functions.
- h. **Computerized Telephone System (CTS):** A generic term used to describe any telephone system that uses centralized stored program computer technology to provide switched telephone networking features and services. Referred to commercially by such terms as computerized private branch exchange (CPBX), private branch exchange (PBX), private automatic branch exchange (PABX), electronic private automatic branch exchange (EPABX), computerized branch exchange (CBX), computerized key telephone systems (CKTS), hybrid key systems, business communications systems, and office communications systems. In the case of this instruction the CTS includes the PBX, call manager, or server that administers the voice network and sets up the voice communication, voice gateways that bridge between the IP and the circuit switched PSTN infrastructures, and IP network switching/routing components that control communication between VoIP telephones.

- i. CTS Electronic Telephones: Telephone sets expressly designed to operate with specific CTSs to obtain the various features and services offered by those CTSs. These telephones are not compatible with normal central office service and cannot be connected directly to standard central office lines.
- j. Disconnect: A device that [1] inserts a break at some point in the normal hard-wire conduction path that exists between a telephone and its telecommunications medium, and [2] only when the telephone is in the in-use state, establishes a temporary metallic connection across that break.
- k. Focal Subassembly: Any subassembly that contains transducers or other potentially microphonic components.
- l. Hands-Free Answering: A feature available on some telephones and telephone systems that, when certain types of incoming calls occur, either automatically places the telephone in the in-use state or allows the user, without any manual action, to initiate the in-use state by means of a voice-activated switch.
- m. Handset: A combined telephone earpiece (containing a receiver element) and mouthpiece (containing a transmitter element) mounted on a handle.
- n. Handset Cord: A flexible assembly of individually insulated electrical wires enclosed in a common insulating jacket and fitted with terminating connectors: used to provide the electrical connections between the handset and the main body of the telephone.
- o. Handset Mounting: The receptacle, bracket, cradle, or other support specifically provided on the main body of the telephone to hold the handset when it is not in use; the handset mounting is fitted with a means to detect whether or not the handset is in place in (or on) the handset mounting.
- p. Hazard (Telephone Security): A telephone security hazard occurs when the inherent properties of a telephone (or any telephone equipment) installed in a sensitive discussion area, render it capable of producing idle state microphonic signals on unprotected telecommunications media. When a hazard exists, audio surveillance of the sensitive discussion area is available from the idle state telephone without any non-standard modifications to the telephone.
- q. Headset: A combined telephone earpiece (containing a receiver element) and mouthpiece (containing a transmitter element) assembly to be worn on the user's head.
- r. Hookswitch: The device employed to determine if the handset is or is not in place in (or on) the handset mounting is termed the hookswitch regardless of how it operates. In some cases the hookswitch will not involve any sort of mechanical switch and/or break any incoming loop current.
- s. House Cabling: The wiring and associated frames that provide the electrical connections

between the telephone system and the individual blocks or jacks for each voice terminal station mounting cord.

- t. **Idle State (Voice Terminal):** A voice terminal is in the idle state whenever it is not in the in-use state (see below). When the telephone is in the idle-state the telephone shall be designed to prevent the codec from passing audio electrically outside of the telephone assembly.
- u. **In-Use State (Voice Terminal):** A voice terminal is in the in-use state if it is communicating to its network system and is either initiating, terminating or actively engaged in user communications.
- v. **Isolator (Isolation):** A device that [1] inserts a break at some point in the normal hard-wire conduction path that exists between a telephone and its telecommunications medium, and [2] only when the telephone is in the in-use state, provides a temporary communications channel across that break without establishing an end-to-end metallic connection.
- w. **Key Telephone System:** A system of telephones and connections to the PSTN or PBX that provides the telephones with selective access to the PSTN or PBX connections by means of pick-up keys located at or near the telephones.
- x. **Manual Action:** An action that requires that the user touch, move, lift, or otherwise manipulate by hand, some control or part of the telephone. An operation that is actuated by the user's voice does not qualify as a manual action.
- y. **Microphone:** Any component among whose intended functions include performing as a transducer to produce an electrical analogue output from an audio-frequency sound pressure waveform input.
- z. **Microphonic:** Any component, regardless of its intended functions, that exhibits transducer behavior to produce an electrical analogue output from an audio-frequency sound pressure waveform input is termed microphonic.
- aa. **Network System:** An assembly of member terminals, control facilities, and intercommunication facilities that can establish and maintain a communications link between any two of the member terminals.
- bb. **Off-hook (Telephone):** A telephone in the in-use state.
- cc. **On-hook Audio Security or On-hook Telephone Audio Security:** The use of positive measures to protect on-hook telephones against passing room audio is known as on-hook audio security or on-hook telephone audio security.
- dd. **On-hook (Telephone):** A telephone in the idle state.
- ee. **Operationally Inactive Transducer:** A telephone has many functional states (e.g., in-use, idle, incoming ring, incoming voice announcement, off-hook, speakerphone,

programming...). When the specific state of the telephone does not require a particular transducer to perform any action, that transducer is referred to as an operationally inactive transducer for the state in question.

- ff. PBX (Private Branch Exchange): A PBX is a local switched telephone network that is itself a member of the PSTN, and provides access to the PSTN for its member terminals.
- gg. Physically Protected Space (PPS): The space inside one physically protected perimeter. Separated spaces of equal protection may be considered to be part of the same PPS if the communications links between them are provided sufficient physical protection.
- hh. Pressure Response Level: The pressure response level of a microphone is the ratio of voltage output to sound pressure level input.
- ii. PSTN (Public Switched Telephone Network): The ordinary dial-up telephone system.
- jj. Push-to-Operate Handset: There are three forms of push-to-operate handset.

[1] A telephone handset equipped with separate push-to-activate momentary-contact switches, one for the transmitter element and one for the receiver element. Either switch when not activated shorts the leads to its respective transducer and completely disconnects the transducer from the mounting cord

[2] A telephone handset equipped with a single push-to-activate momentary- contact switch. When the switch is not activated, the leads for both the transmitter element and the receiver element are shorted and are disconnected from the mounting cord wires.

[3] A telephone handset equipped with both a single push-to-activate momentary- contact switch and with an isolation amplifier that allows audio signals to travel from the mounting cord to the receiver element but not from the receiver element to the mounting cord. When the switch is not activated, the leads for the transmitter element are shorted together and are disconnected from the mounting cord wires.

- kk. Receiver Element: The speaker located in the handset or headset earpiece. This transducer converts audio-frequency electrical signals to acoustic signals that are audible when the earpiece is held against the user's ear.
- ll. Ringer: An annunciator that cannot be used for voice calls, announcements, or paging. A ringer can only produce specific audible signals.
- mm. Speaker: Any component among whose intended functions include performing as a transducer to produce a sound pressure analogue output from an input audio-frequency electrical waveform.
- nn. Speaker Microphone: Any component whose intended functions include performing both as a microphone and as a speaker.

- oo. **Speakerphone:** A feature that permits a telephone to be used without lifting the handset. A speakerphone may be physically incorporated into the telephone set or it may consist of one or more auxiliary units. A usable speakerphone contains a microphone or, microphone-amplifier combination, which is sensitive enough to pick up normal conversational speech levels at a distance of several feet and a speaker, or speaker-amplifier combination, that transduces the normal telephone signal levels to sound pressure levels which can be heard at a distance of several feet.
- pp. **Station Mounting Cord:** A flexible assembly of individually insulated electrical wires enclosed in a common insulating jacket and fitted with terminating connectors and used to provide the electrical connections between the main body of the telephone and the blocks or jacks that terminate the house cabling.
- qq. **Station Port:** The dedicated circuits in a CTS that are connected via wires in the house cabling to specific blocks or jacks supporting individual telephone sets.
- rr. **Subsidiary Conductor:** Refers to focal subassemblies that have been modified to incorporate positive security measures. A subsidiary conductor is any metallic conductor that crosses the boundaries of the modified subassembly specifically to support the positive security measures. The subsidiary conductor was not present in the original subassembly.
- ss. **Telecommunications Medium:** A means of transporting electrical information from one communications terminal to another.
- tt. **Telephone -** A voice terminal that, regardless of whatever other functions it performs, is a member terminal of a telephone network and accomplishes all the incoming and outgoing signaling and voice interfacing necessary for operation in that network.
- uu. **Telephone Network:** A network that, regardless of whatever other functions it performs, provides temporary speech communications links between member voice terminals. The essential characteristics of a telephone network are: [1] that it recognize when a member terminal is initiating a call (goes off-hook), [2] that it identify the terminal being called (number dialed), [3] that it announce the incoming call (rings the called terminal), and [4] that it maintain a voice grade communications channel between the calling and called terminals only for the duration of the call.
- vv. **Transducer:** A component of the telephone that either converts electrical signals to acoustic signals or acoustic signals to electrical signals: includes microphones, ringers, speakers, and speaker-microphones.
- ww. **Transmitter Element:** The microphone located in the handset or headset mouthpiece. This transducer converts acoustic signals spoken directly into the mouthpiece to analogue audio- frequency electrical signals for transmission to the main body of the telephone.

- xx. **TSG-Approved Telephone:** TSG-approved, is synonymous with NTSWG-approved, status is awarded to telephones that have been technically evaluated by the government's National Telecommunications Security Working Group, formerly known as the Telephone Security Group, and determined to meet all applicable on-hook telephone audio security criteria. An NTSWG-approved telephone provides all necessary security features as intrinsic properties of the telephone itself.

- yy. **Type-Accepted Telephone:** An NTSWG-approved telephone model that the NTSWG has evaluated in response to a formal application by its manufacturer, and has been approved and awarded a NTSWG type-acceptance number. The NTSWG telephone type-acceptance program is the primary vehicle for evaluating commercial telephones for NTSWG approval. NTSWG has issued type-acceptance standards that specify the on-hook security design, construction, and performance characteristics required for various genres of telephones and type-acceptance classes.

- zz. **Uncontrolled/Unprotected Line or Uncontrolled/Unprotected Telecommunications Medium:** A telecommunications medium, such as a telephone wireline, that is not provided continuous positive physical protection against unauthorized, clandestine intercept of the information it is being used to convey.

- aaa. **Voice Terminal:** A generic term used to describe any device that, regardless of whatever other functions it performs, provides an intentional transmit and/or receive interface between a human talker/listener and an electric or electronic communications system. All voice terminals contain transducers; a microphone is necessary if there is a transmit function and a speaker if there is a receive function. Telephones, speaker-phones, and intercom sets are common examples of voice terminals.