TOPIC 2

TECHNICAL CONTROL SUBSYSTEMS, POWER, AND SAFETY

INTRODUCTION

Technicians must understand the basic structure and tools available within the technical control facility to coordinate the performance of the station's communications. As a member of any communications network, you will quickly see that being proficient at your job requires sound fundamental knowledge of your facility. This topic will attempt to give you a general understanding of technical control subsystems, power, and safety.

COMMON TECHNICAL CONTROL SUBSYSTEMS

A typical TCF requires the support of several internal, non-traffic-handling subsystems. The most common subsystems are orderwire (voice or data), intercommunications (intercom), alarm and alarm display, master clock, station power, ac power, and safety.

ORDERWIRE SUBSYSTEM

To perform the functions of coordination, circuit restoral, circuit rerouting, quality assurance, and status reporting, technical control personnel must have dedicated communications lines with subordinate activities, interconnecting TCFs or PTFs, and the appropriate DCA or CRITICOMM System Management (CSM) authority. The orderwire system provides for local and distant direct communications by either voice or data circuits.

A typical voice orderwire system locally provides coordination with subordinate PTFs (such as CLASSIC WIZARD sites), local telephone exchanges, communications centers, and other circuit users within the area of responsibility of the TCF. Figure 2-1 illustrates a typical local orderwire system.

Link orderwires provide communications between TCFs or PTFs interconnected by a DCS transmission link. The link orderwire allows quick reaction to problems on any segment of a specific link. Restoration priorities on orderwires are of the highest level within the TCF. Immediate restoration of an orderwire ensures fast, overall circuit restoration.

System orderwires interconnect TCFs that have been assigned extensive control office responsibilities within a specific geographical area. This provides the major TCFs, located at great

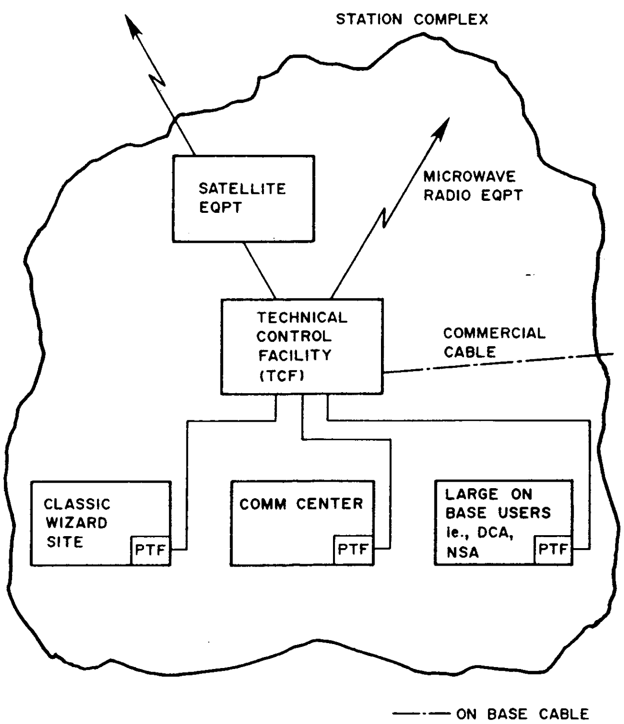

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Figure 2-1.—Typical local orderwire configuration.

distances, with direct communications. Typical orderwire systems are shown in figures 2-2 and 2-3.

INTERCOMMUNICATIONS (INTERCOM) SUBSYSTEM

The TCF intercom subsystem provides for technical coordination within the TCF, between the TCFs, and for nearby supporting and user agencies. At stations requiring additional intercom equipment, however, it is necessary to have individual intercom stations using a central intercom unit and the necessary remote units. The intercom system used may interface operationally with the orderwire system to provide maximum flexibility. Secure intercom systems should be provided, as necessary.

ALARM AND ALARM DISPLAY SUBSYSTEM

Each TCF should have centrally located alarm display panels to alert technical controllers and maintenance personnel of equipment and circuit degradation or failure. Display panels provide visible and audible indications of an alarm condition. A major alarm indicates a failure requiring immediate corrective action, a failure of critical common equipment, or a safety hazard to personnel or property. A minor alarm indicates a fault that has not degraded traffic-handling capabilities, but one that should be corrected as soon as possible.

TIMING AND SYNCHRONIZATION SUBSYSTEM

The Timing and Synchronization (T&S) subsystem should read Greenwich (ZULU) time in hours, minutes, and seconds on all visual readouts. Figure 2-4 shows the T&S subsystem in simple form.

The LORAN-C navigation signals update a pair of disciplined oscillators that provide redundant 1-MHz reference signals to a clock distribution system. The clock distribution system then synthesizes the different frequencies, from 75 Hz to 12.932 MHz, that may be required at any given site. If the LORAN-C signal fades out temporarily, the disciplined oscillators free-run until the signals return. The T&S subsystem produces frequencies with a stability of better than +/− 100 nanoseconds. The T&S subsystem can

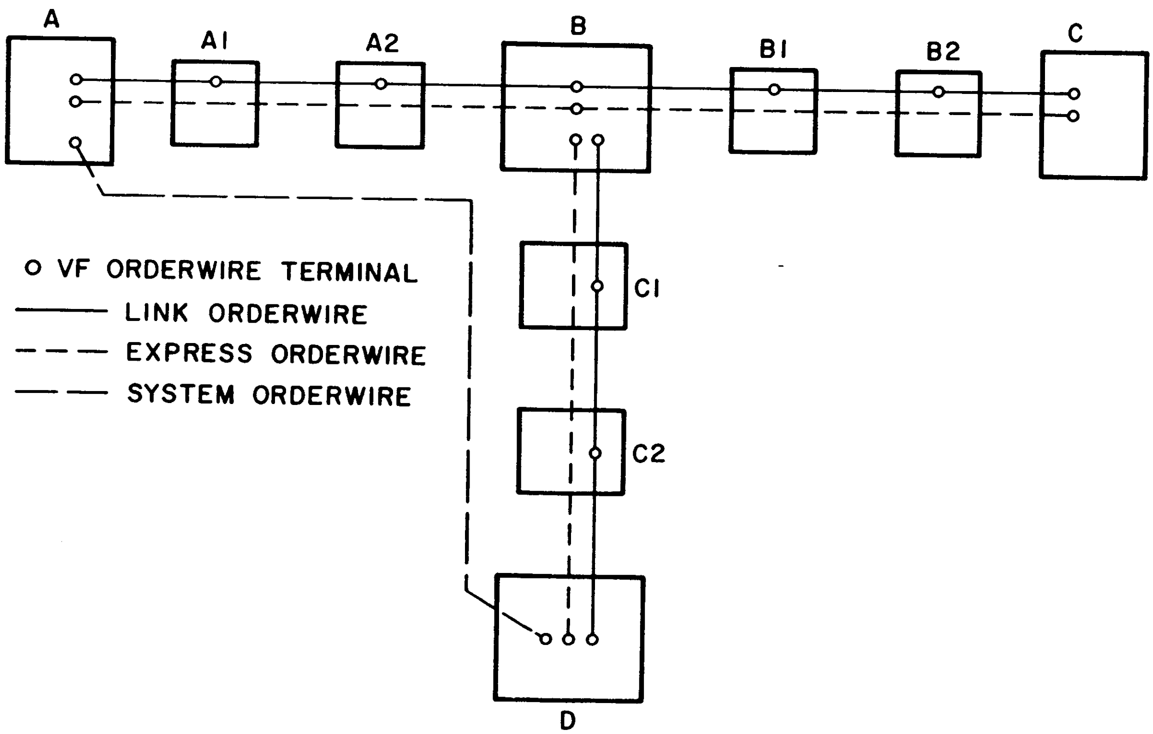

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Figure 2-2.—Typical link, express, and system orderwire configuration.

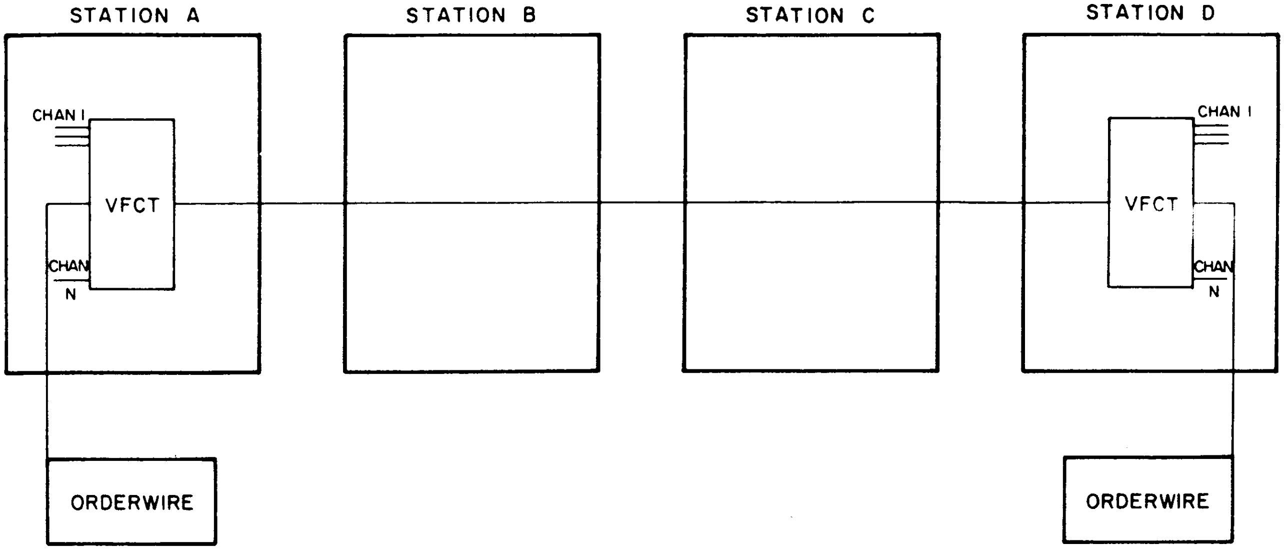

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Figure 2-3.—Typical VFCT or channel-packing orderwire layout.

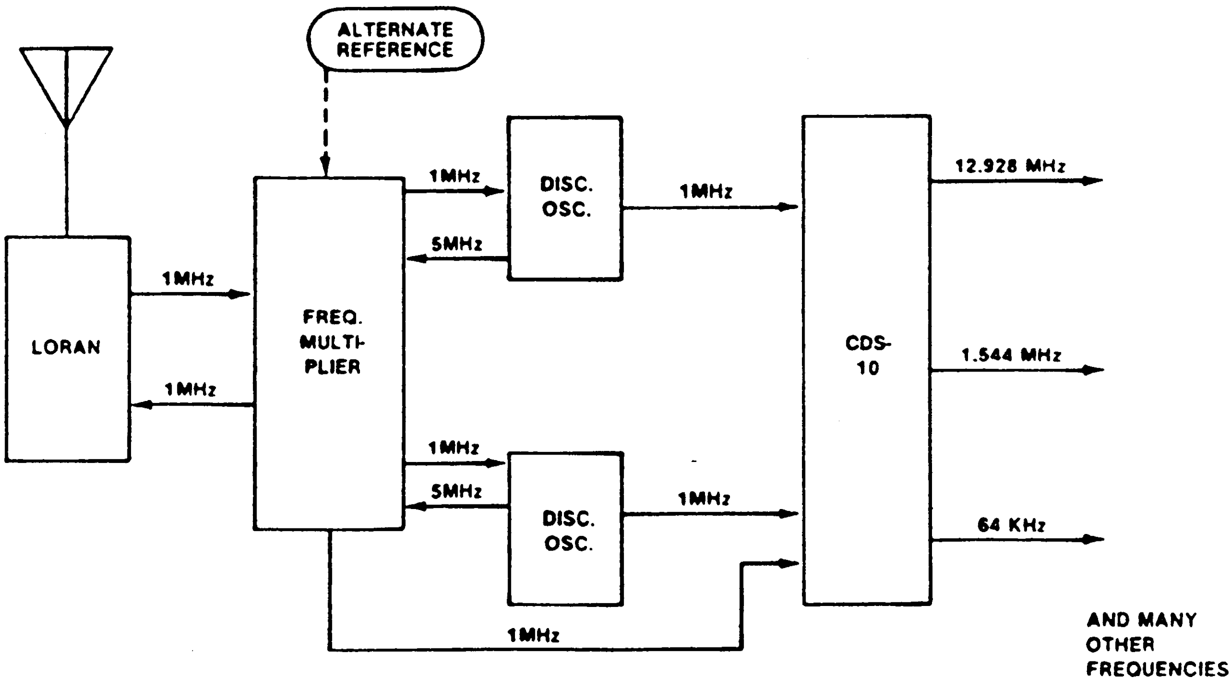

Figure 2-4.—Timing and synchronization subsystem.

also accept an alternate frequency reference, such as a cesium beam or Global Positioning System (GPS) receiver, if available.

There are no routine procedures or tests required for T&S. The best performance can be obtained by following a hands-off philosophy under normal circumstances. The loss of the LORAN-C signal for periods up to several hours' duration may be a common occurrence but the T&S subsystem is designed to operate properly through such periods by coasting on the disciplined oscillators. If the LORAN-C signal is lost for more than 8 hours, site maintenance must check the receiver for malfunction.

If a circuit or trunk is engineered and wired correctly, and if the equipment is working properly, the transmit and receive clocks at any given site on any given trunk or circuit will have exactly the same frequencies (within the specifications of the T&S subsystem). Check these frequencies by watching both of them together on a dual-trace oscilloscope. You will probably see some jitter, but the two signals should not be "marching" past one another. If a user complains of excessive resynchronizations, and there are no other obvious problems on the circuit or trunk, the above quick test should be performed to verify that the T&S subsystem is performing properly. If it fails this simple test, the problem should be turned in to maintenance for action.

COVERLET SUBSYSTEM

The T&S subsystem used within the NAVSECGRU is called the COVERLET subsystem. It presently receives timing source from the LORAN-C and a cesium beam, which is an extremely accurate timing standard that generates a 5-MHz signal. This signal is broken down into 1 MHz, 100 kc, and 1 pps. The combination of these signals results in an extremely accurate time standard. Descriptions of COVERLET equipments are in topic 4.

STATION POWER SUBSYSTEM

The power used in a TCF depends on the equipment power requirements, amount, geographical location, and facility size. The equipment power requirements dictate the type of power (ac or dc), the amount of power required to support all loads, and the voltage level frequency.

AC POWER SUBSYSTEM

The ac electrical power distribution within a TCF or PTF is grouped into load categories. Each category, critical technical load, non-critical technical load, and utility load is fed from one or more separate power-distribution load buses. Figure 2-5 shows the categories of TCF loads, the purpose of each, and their relationship to the overall station loads. Critical loads are distinguished from non-critical loads according to whether or not a power failure of connected equipment would interrupt the operation of communications circuits.

Critical Technical Load

The *critical* technical load is that part of the technical load required for continuous operation, automatic switching, and operation of DCS equipment approved for supply from an Uninterruptible Power System (UPS). If the ac electrical power to this load fails, the result is a communications outage. Thus, the critical technical load has no-break power derived from the facility's UPS. Upon interruption of the station's primary power, the auxiliary power source picks up the entire station's load. If both primary and auxiliary power are lost, the UPS will maintain ac power on the critical technical load.

Non-Critical Technical Load

The *non-critical* technical load is that part of the technical load not required for continuous-circuit or synchronous-circuit equipment operation. The non-critical technical load bus provides power for communications support equipment, such as teletypewriter monitor machines, test equipment, and equipment cabinet and rack convenient outlet receptacles. Failure of this electrical power will not cause a communications-circuit outage.

Utility Load

The *utility* load is an electrical load supporting utility outlets, office and work area lighting, non-critical ventilation, air conditioning, and other facilities that do not directly support communications equipment. A failure of this utility load will not disrupt communications-circuit operations.

The distribution circuit-breaker panels for the critical and non-critical technical loads are on the wall of the TCF, near the feeder ac ducts or conduits. These panels are the main point of distribution for the required power.

SAFETY SUBSYSTEM

No matter how dangerous the work, familiarity often leads to carelessness. When you are working with communications equipment—or with any electronic equipment—remember one rule: **SAFETY FIRST**. Dangerous voltages energize much of your equipment. Accidental contact with high voltages can result in unconsciousness or even death. Power-supply voltages range up to

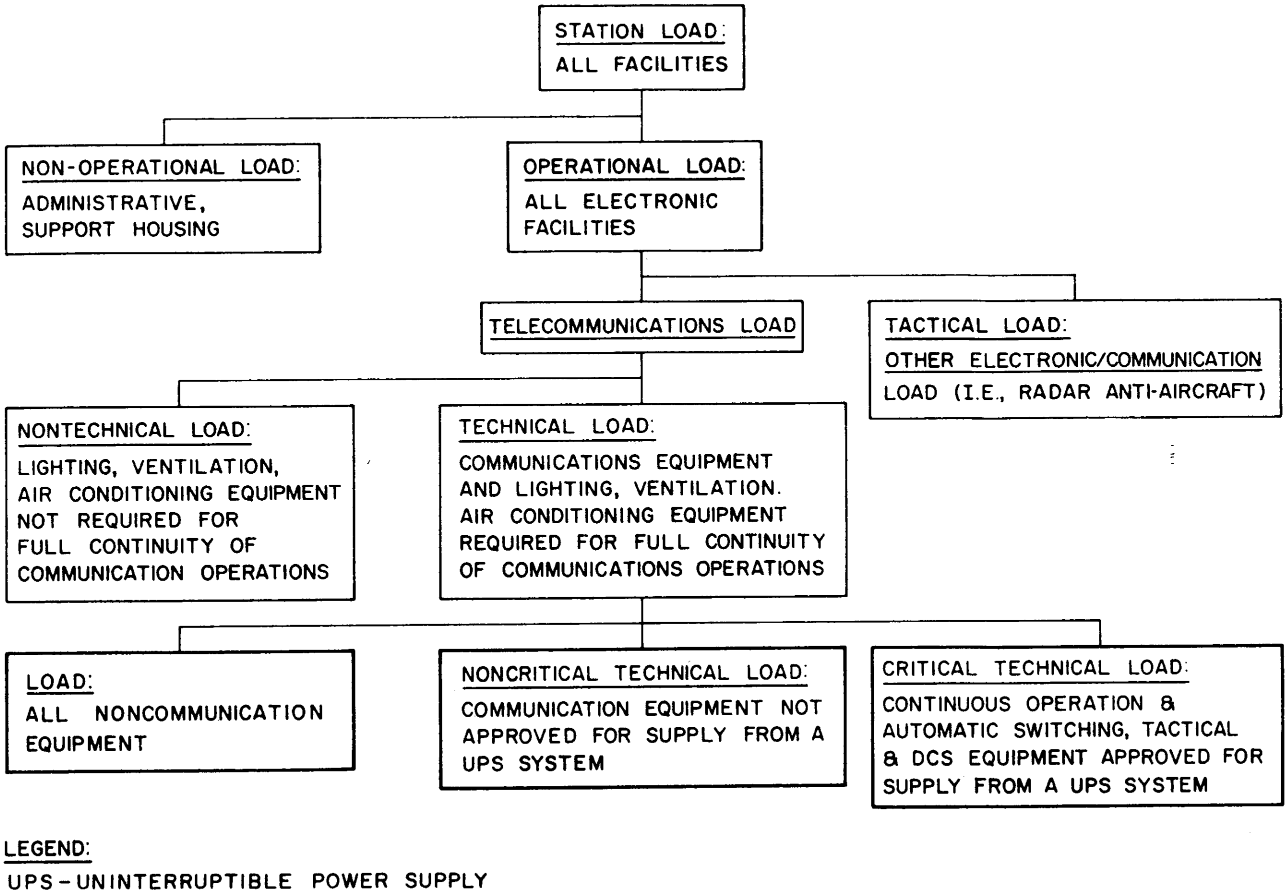

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Figure 2-5.—Categories of TCF and PTF loads in relation to station loads.

40,000 volts, and radio-frequency voltages are even higher. Safety is everyone's responsibility! Most accidents are preventable. However, the common belief exists that such accidents are the inevitable result of unchangeable circumstances or fate. This is not true. Accidents do not occur without a cause; most accidents are the direct result of some deviation from prescribed safe operating procedures.

One purpose of safety rules is to remind individuals of the dangers inherent in their work. Training personnel to observe safety precautions can be instrumental in avoiding preventable accidents, and in maintaining an accident-free work environment. Operating procedures and work methods adopted with hazard prevention as a specific criteria do not expose personnel unnecessarily to injury or occupational health hazards. Potential accidents can be prevented if the cause is detected and if appropriate remedial action is taken.

RESPONSIBILITY FOR SAFETY

The commanding officer is ultimately responsible for personnel safety. This responsibility includes establishing the policies and goals for the command's safety program. Article 0732 of *U.S. Navy Regulations* states:

> "The commanding officer shall require that all persons concerned are instructed and drilled in applicable safety precautions and procedures, that they are complied with, and that applicable safety precautions or extracts therefrom are posted in appropriate places. In any instance where safety precautions have not been issued or are incomplete, he shall issue or augment such safety precautions as he deems necessary, notifying, when appropriate, higher authorities concerned."

Commanding officers cannot delegate their responsibility for the safety of personnel under their commands. They must, however, necessarily delegate their authority to officers and petty officers within the command to ensure that all prescribed safety precautions are understood and enforced. All supervisory personnel are responsible for ensuring that safety precautions are strictly adhered to in their own work areas. Furthermore, individuals concerned must strictly observe all safety precautions applicable to their work or duty. Thus, as mentioned earlier, accident prevention is everyone's responsibility—not just a delegated few.

Alertness is essential in detecting and reporting unsafe work practices and conditions before they cause accidents. All personnel must

- observe all posted operating instructions and safety precautions;
- report any unsafe condition, equipment, or material;
- warn others if they are believed to be endangered by known hazards or by their failure to observe safety precautions;
- wear protective clothing or use approved protective equipment, when necessary;
- report to their supervisor any injury or evidence of impaired health occurring in the course of their work or duty; and
- exercise reasonable caution in emergencies or in other unforeseen hazardous conditions.

Post-accident investigations reveal that the majority of accidents result from unsafe practices, most known beforehand to be unsafe and in violation of safety practices, rules, regulations, or directives. Other human factors found to be the cause of accidents include fatigue, monotony, preoccupation, mental or physical problems, improper supervision, and lack of motivation. Individuals do not always act or react as they were trained. Accidents resulting from any of these factors are usually attributed to human error. To reduce human error as a predominant cause of accidents, all personnel are responsible for acquainting themselves with the environmental hazards surrounding them. Additionally, they must condition themselves to be alert, both mentally and physically, so that they can protect themselves and others by not foolishly or unnecessarily exposing themselves to hazards.

Accidents do not happen without a cause. When individuals are aware of their work hazards, fewer accidents result.

ELECTRICAL SHOCK

Current, rather than voltage, is the criterion of shock intensity. The passage of even a very small current through a vital part of the human body can cause death. The voltage necessary to produce the fatal current depends upon such factors as body resistance, contact conditions, and the path of current through the body. The probable effects of shock are shown in table 2-1.

You must understand that 115 volts, or even lower voltages, can cause a fatal shock—fatalities have been recorded from as low as 40 volts! Tests have shown that body resistance under unfavorable conditions may be as low as 300 ohms, and possibly as low as 100 ohms from temple to temple if the skin is broken. Volt for volt, dc potentials are not as dangerous as ac potentials. Reasonably safe, "let-go currents" (60-Hz ac), are 9.0 milliamperes (mA) for men and 6.0 mA for women, while the corresponding values for dc are 62.0 mA for men and 41.0 mA for women.

Table 2-1.—Probable Effects of Electrical Shock

Ac, 60 Hz (mA)	Dc (mA)	Effects
0 to 1	0 to 4	Perception
1 to 4	4 to 15	Surprise
4 to 21	15 to 80	Reflex action
21 to 40	80 to 160	Muscular inhibition
40 to 100	160 to 300	Respiratory block
Over 100	Over 300	Usually fatal

WARNING

Do not attempt to administer first aid or come in physical contact with an electrical shock victim before the power is shut off, or, if the power cannot be shut off immediately, before the victim has been removed from the live conductor.

SYMPTOMS OF ELECTRICAL SHOCK

In the event of severe electrical shock, the victim will usually turn very white or very blue. The pulse is extremely weak or entirely absent, unconsciousness is complete, and burns are usually present. The victim's body may become rigid in a few minutes. This condition can be caused by muscular reaction to shock. It should not necessarily be considered as rigor mortis. Therefore, artificial respiration must be administered immediately, regardless of body stiffness, since recovery from such a state has been reported.

RESCUE OF VICTIMS

The rescue of electrical-shock victims depends upon prompt first aid. When attempting to administer first aid to an electrical-shock victim, proceed as follows:

1. Shut off the power.

2. If the power cannot be deactivated, remove the victim immediately, observing the following precautions:

   a. Protect yourself with dry insulating material.

   b. Use a dry board, belt, dry clothing, or other available non-conductive material to free the victim (by pulling, pushing, or rolling) from the power-carrying object.

DO NOT TOUCH THE VICTIM!

3. Administer artificial respiration immediately after removing the victim from the power-carrying object.

CARDIOPULMONARY RESUSCITATION (CPR)

At least annually, all personnel who are engaged in the operation and maintenance of electronic equipment must demonstrate their practical knowledge in the application of CPR. If necessary, the electronics officer will arrange for additional training so that all personnel can maintain proficiency in CPR. For detailed guidance, refer to OPNAVINST 5100.19, *Navy Safety Precautions for Forces Afloat.*

GENERAL SAFETY PRECAUTIONS AND POLICIES

When working with electronic circuits, operational and maintenance personnel must remember that accidents are often caused by carelessness. Before starting any work on such circuits, you must take certain precautions. Lock or place in the OFF position, and tag with a warning tag, all circuit breakers and switches of de-energized circuits. See figure 2-6.

This safety precaution, together with those outlined in equipment technical manuals and Maintenance Requirement Cards (MRCs), comprise a nucleus for issuing detailed instructions for accident-free installation, maintenance, and operation of electronic equipment and facilities, both ashore and afloat.

INTENTIONAL SHOCKS ARE FORBIDDEN

The intentional taking of a shock at any voltage is always dangerous and is **STRICTLY FORBIDDEN**. Use a test lamp, voltmeter, or

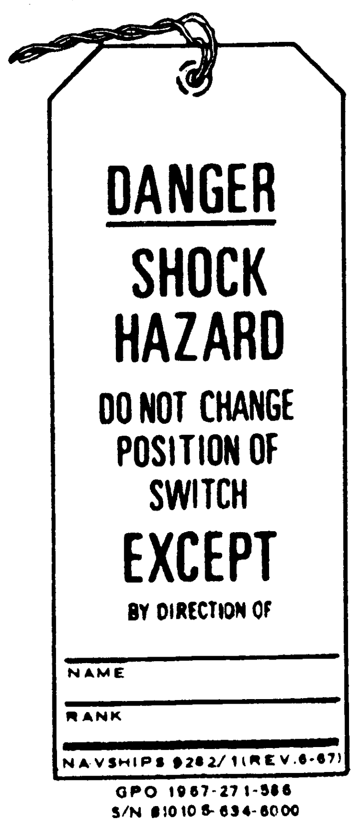

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Figure 2-6.—Warning tag for marking open position of switches.

some other approved indicating device to determine if a circuit is de-energized before servicing or repairing equipment. The indicating device must be suitable for obtaining the desired check without jeopardizing personnel. It must be used only with other authorized safety devices. Never implicitly trust insulating material; treat all wiring as if it were bare of insulation. Insulating material has failed before and could fail again.

RUBBER MATTING

To eliminate likely causes of accidents and to afford maximum protection to personnel from the hazards of electrical shock, only approved rubber matting may be used on the deck in electronic spaces. In many instances, post-accident investigations have shown that the operating locations and areas around electronic equipment were covered with only general-purpose, black rubber matting. Never use this type of matting because its electrical characteristics do not provide adequate insulating properties to protect personnel from the possibility of electrical shock. Also, the material used in this matting is not fire-retardant.

The careful design and fabrication of approved floor matting material minimizes the possibility of accidents. To ensure that the matting remains safe for use, keep the matting free of all

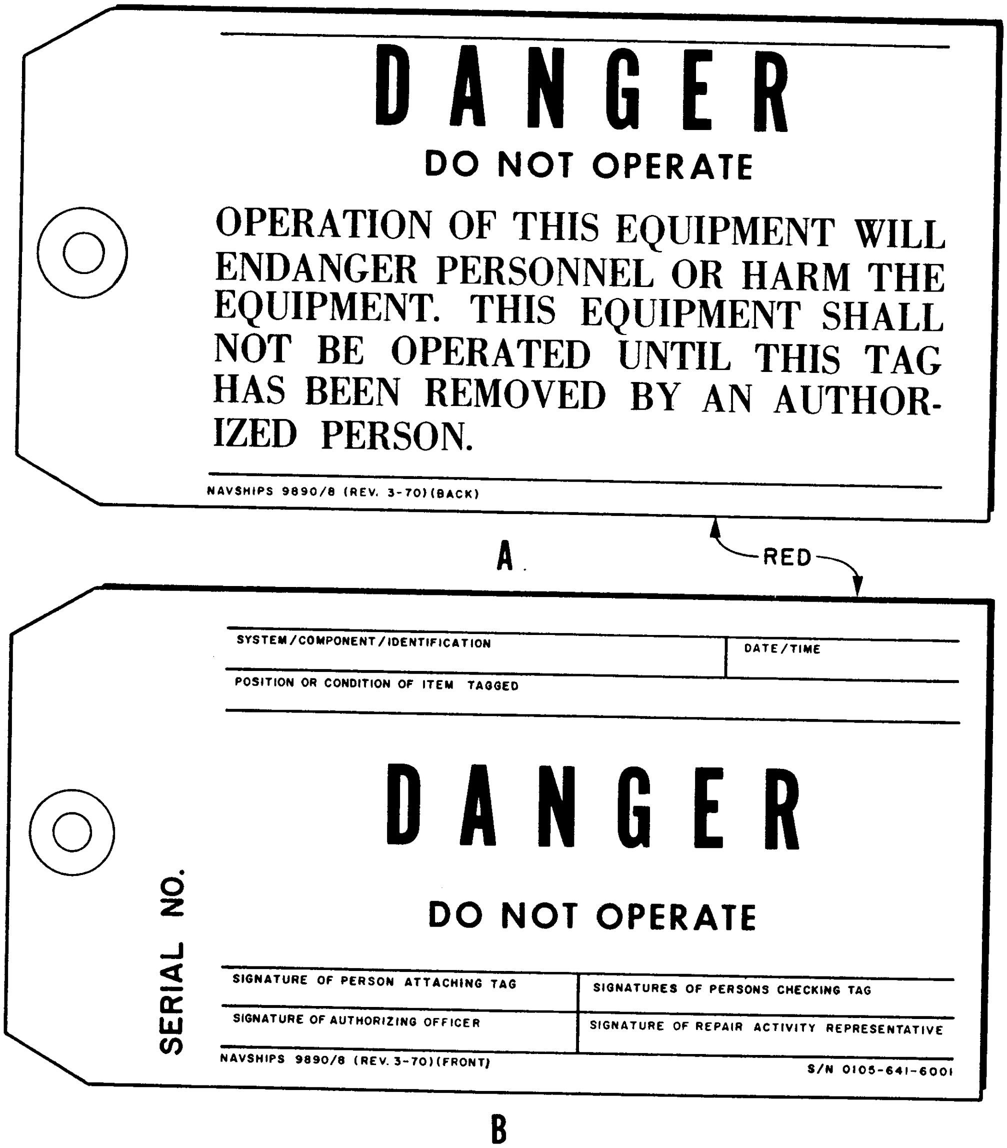

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Figure 2-7.—Danger warning tag.

foreign substances. Contaminants can impair or destroy the dielectric properties of the matting, making it unsafe for use. Therefore, it is necessary to perform both periodic visual inspections and cleanings. During visual inspections, personnel must ensure that the dielectric properties of the matting have not been impaired or destroyed by oil impregnation, piercing by metal chips, cracking, or by other causes. If a section or an entire length of matting is found defective, replace it immediately with new matting material.

PERSONNEL SAFETY

Never work on electronic equipment by yourself; have an individual who is qualified to give first aid for electrical shock (a safety observer) present at all times. The safety observer must know which circuits and switches control the equipment and also must know the emergency procedures to follow. Because of the danger of fire, damage to material, and possible injury to personnel, only authorized and qualified persons may perform repair and maintenance work on electronic equipment.

TAG-OUT PROCEDURES

Tag-out procedures are required to protect against accidental energizing of equipments. It is the physical disconnecting of the power source and attaching tags as shown in figures 2-7 and 2-8.

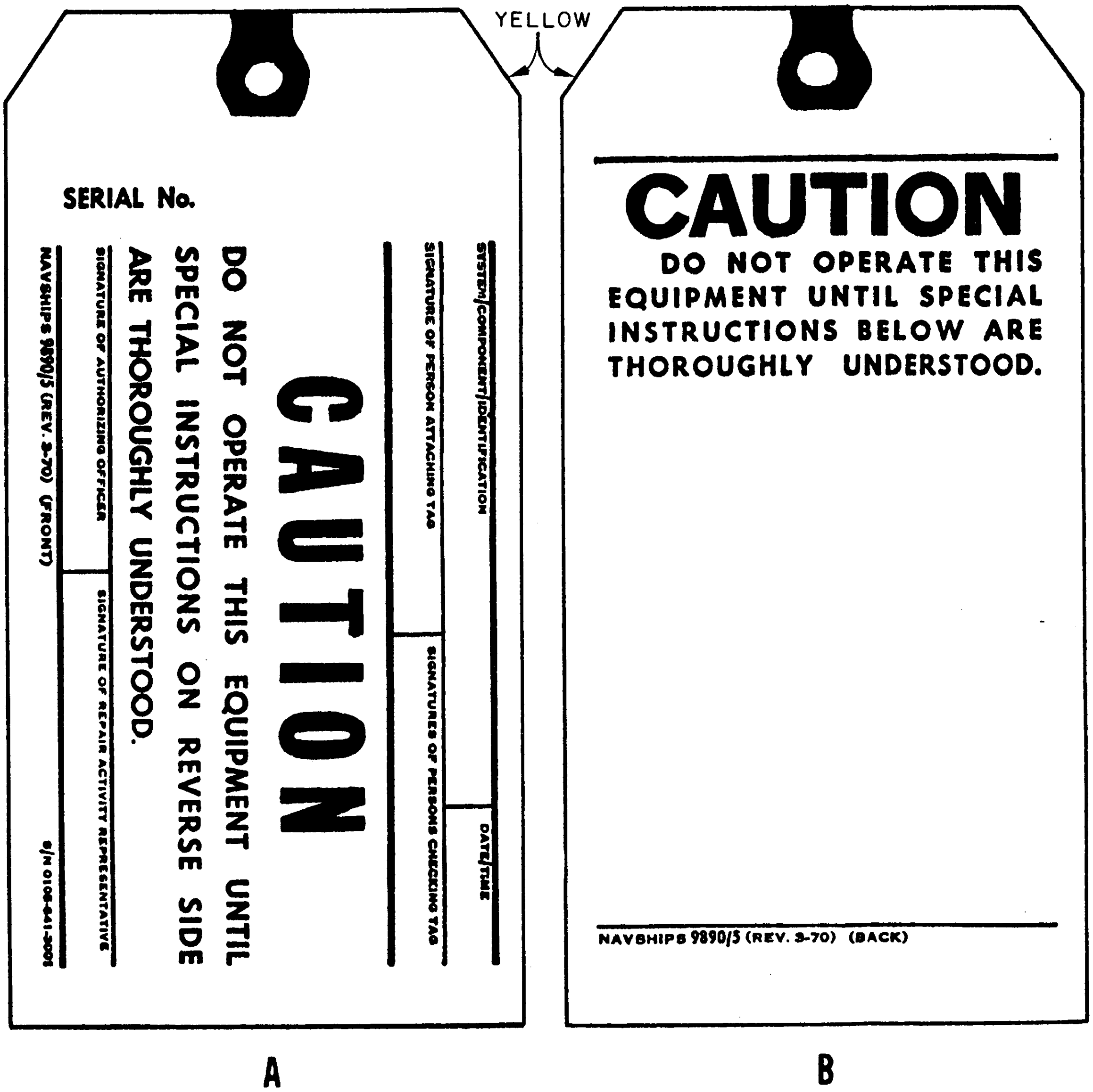

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Figure 2-8.—Caution warning tag.

Tag-out procedures are necessary due to the complexity of modern ships and the cost, delays, and hazards to personnel that could result from the improper operation of equipments. OPNAVINST 3120.32A, *The Standard Organization and Regulations of the U.S. Navy*, provides procedures to be used to prevent improper operation when a component, equipment, system, or portion of a system is isolated or in an abnormal condition. Type commander directives further amplify the provisions of the tag-out procedure. Tag-out procedures are mandatory. The tag-out log is the control document used to administer tag-out procedures.

WARNING SIGNS AND POSTERS

Warning signs and suitable safeguards must be provided to

- prevent personnel from accidently coming in contact with dangerous voltages,
- warn personnel of the possible presence of explosive vapors and Radio-Frequency (RF) radiation, and
- warn personnel of other dangers that may cause injuries.

Equipment installations are not complete until suitable safeguards are instituted and appropriate warning signs are conspicuously posted.

High-voltage and shock-hazard warning signs must be installed on, or in the vicinity of, equipments or accessories having exposed conductors at potentials of 30 volts or above. Exposed conductors include those that may give personnel a shock by physical contact. The signs must be posted in accordance with authorized procedures to ensure that personnel can read them clearly upon entering a space.

Compartments or walk-in enclosures containing equipment with exposed conductors presenting shock hazards in excess of 30 volts must have a **DANGER--HIGH VOLTAGE** sign posted conspicuously at each entrance.

These requirements are *minimum* requirements, and are in accordance with NAVSEA S9AA0-AA-SPN-010/GEN-SPCC, *General Specifications for Ships of the United States Navy*. Although the requirements direct the posting of these signs within the entrances of compartments and walk-in enclosures, additional signs may also be posted at or near the exposed conductors within the space.

The **DANGER--HIGH VOLTAGE** sign, shown in figure 2-9, is 7" × 10" and is made of 18-gauge steel. This sign or laminated placards of various sizes may be ordered through the Navy's stock system.

PROMOTING SAFETY

Through the use of safety reminders and by personal example, you will pass safety consciousness on to your subordinates. All personnel, even the "old hands," occasionally need to be reminded to work safely. The number of senior

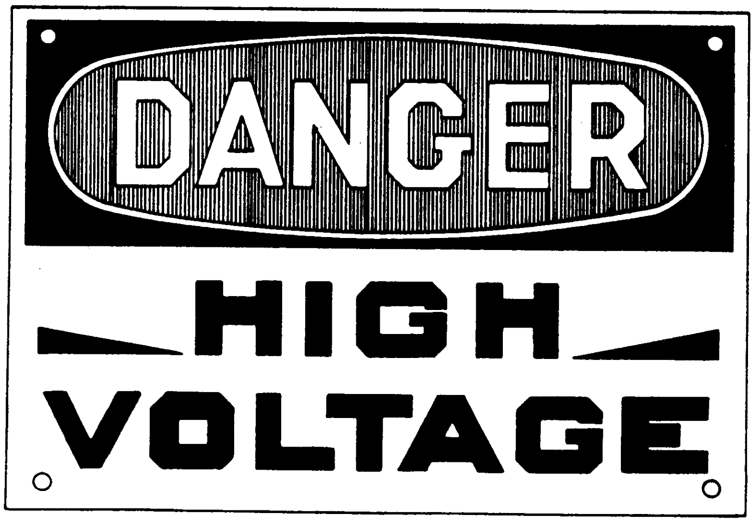

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Figure 2-9.—High-voltage warning sign.

personnel involved in fatal accidents bears out this fact.

Promoting safety within the division can be done in various ways. For instance, posters of the types shown in figure 2-10 are helpful as safety reminders and in promoting safety.

Change or rotate safety posters regularly to different working areas to draw attention to them.

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Figure 2-10.—Safety posters.

Posters left in one area for extended periods of time tend to be ignored.

Periodic safety inspections made by the division's junior petty officers can also be helpful in promoting safety within the group. First, such inspections establish control of the safety program; second, they make the inspectors mindful of the procedures necessary to ensure personnel safety.

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