# CHAPTER 1

# SAFETY

It is essential that all operating personnel working with communications and electronic equipment observe strictly the rules, procedures, and precautions applicable to the safe operation and repair of equipment. All personnel must be constantly alert to the potential hazards and dangers presented by this equipment and take all measures designed to reduce or eliminate accidents. The following references provide excellent information for an effective safety program:

- NAVMAT P-5100, "Safety Precautions for Shore Activities"
- NAVSHIPS 0967-000-0100, "Electronics Installation and Maintenance"

## 1.1 WARNING SIGNS

Safety precautions in the form of precisely worded and illustrated danger or warning signs shall be prominently posted in conspicuous places to prevent personnel from making accidental contact with high voltage leads such as antennas, power supplies, or other places where uninsulated contacts present the danger of electrical shock. Signs shall warn of the dangers of all forms of radiation hazards, acids and chemical inhalation, and all other potential sources of personnel danger. Figure 1-1 is illustrative of standard warning signs frequently encountered at shore communications stations.

## 1.2 TAGGING

During the installation of equipment, warning tags are used to note the existence of potential danger when individual circuits or stages are being checked out. The tags contain appropriate information to alert all personnel of the dangers involved and specific restrictions as to the use of the circuit. The equipment being installed shall be appropriately tagged in accordance with the directives of the local safety officer.

## 1.3 GROUNDING

Installation personnel, when working with equipment having high voltage devices, must ensure that the devices are grounded and that the high voltage circuits have been de-energized. Do not rely solely on the presence of interlock switches for protection from electrical shock. A shorting probe should be used to ground all potentially dangerous circuits and capacitors. Shorting probes may be ordered from stock under FSN 6625-146-1797 (see figure 1-2).

## 1.4 DISCHARGING CAPACITORS

Never attempt to connect the shorting probe directly across the capacitor to discharge the capacitor. Check to be certain that the equipment ground terminal is securely bonded to earth ground. Connect the braid-end of the shorting probe to the common ground terminal; then, hol ling the probe by its insulated handle, touch the probe end of the probe to each capacitor terminal. The capacitor should be discharged twice at intervals of not less than 15 seconds if the highest possible level of personnel safety is to be attained. It is a good idea to leave the shorting probe connected in place while you work on the equipment, to protect you from injury in case the equipment is accidentally energized.

## 1.5 ELECTRIC SHOCK

Accidental electric shock may result in serious injury or death to the individual by heart muscle spasm (ventricular fibrillation) or by paralysis of the respiratory center. It is a good practice to attach a shorting bar across capacitor terminals while working on the equipment. Electric shocks are never wholly without danger. Voltages between 200 and 1000 volts at commercial power-line frequencies are particularly harmful, since under these conditions heart muscle spasm and paralysis of the respiratory center occurs in combination. However, lower voltages can prove fatal. Electrical burns are usually of two types, those produced by heat of the arc which occurs when the body touches a high-voltage circuit, and those caused by passage of electrical current through the skin and tissue.

Fundamentally, current rather than voltage is the criterion for shock intensity. Three factors that determine the severity of electrical shock are:

- Quantity of current flowing through the body
- Path of current through the body
- Duration of time that the current flows through the body

The voltage necessary to produce the fatal current is dependent upon the resistance of the body, contact conditions, and the path through the body. See Table 1-1. Sufficient current passing through any part of the body will cause severe burns and hemorrhages. However, relatively small currents can be lethal if the path includes a vital part of the body, such as the heart or lungs.

When 60 hertz AC passes through a human body from hand-to-hand or hand-to-foot, it will have the following approximate effect: at about 1 milliampere (0.001 ampere) the shock is perceptible; at about 20 milliamperes (0.02 ampere) the shock is of sufficient intensity to prevent voluntary control of the muscles and a person may not be able to let go to free himself; at above 25 milliamperes (0.25 ampere) it may produce permanent damage to nerve tissues and blood vessels; and at about 100 milliamperes (0.1 ampere) the shock is fatal if it lasts for 1 second or more.

Before touching a victim of electric shock, the circuit should be deenergized or the victim freed from the live conductor by the use of some suitable nonconductive object such as a dry wooden stock or pole. Artificial resuscitation procedures appropriate to the victim's condition shall be started immediately. All personnel working on or near electrical equipment must be thoroughly instructed in the proper method of administering mouth-to-mouth, mouth-to-nose, back-pressure arm lift, and external heart massage methods of resuscitation.

## 1.6 IONIZING RADIATION HAZARDS

High-power radars and communications equipment have created new radiation hazards and pose serious problems to the electronic technician when exposed to this type of radiation. Modern electron tubes, such as high power klystrons, magnetrons, thyratrons, cathode-ray tubes, and high voltage rectifiers, when operated with electric potentials in excess of 16,000 volts, may generate X-rays. These rays may emanate from the tube if satisfactory shielding is not provided.

All X-rays, except those of very low energy, will penetrate human tissue and can cause damage which may be temporary or permanent. Some of the serious effects of overexposure to X-ray radiation are blood or bone-damage, skin cancer, mutations, ulcers, sterility, or cataracts.

The following precautions shall be taken by electronic technicians when performing maintenance on equipment which can produce X-ray radiation:

- When working with high-voltage electron tubes capable of producing X-rays, make certain that the radiation has been checked at all possible points of emission. Under normal operating conditions, there will probably be proper shielding for these tubes, but you should be aware of the possible increase in radiation under unusual conditions. Areas exposed to radiation should be checked to determine the radiation strength and, if necessary, to set some time limits for workers in the area. The recommended maximum intensity levels in controlled radiation areas is 100 milliroentgens per week or 2.5 milliroentgens per hour.

- Film badges or pocket meters should be worn in all radiation areas. This type of detector should be used with the understanding that radiation may be concentrated on some portion of your body where the detector is not carried. Several types of portable devices are available for monitoring or measuring radiation.

- Observe all warning signs on the equipment and all written safety precautions in the instruction manuals for the equipment that deals with X-ray hazards.

- Do not use jumper interlocks that permit the servicing of operating equipment with the protective X-ray shielding removed, unless such procedures are called for in the instruction manuals.

o Be sure to replace all protective X-ray shielding when servicing is complete, so that operating personnel or others will not unknowingly be subjected to harmful X-ray radiation.

o When bench testing X-ray producing electronic devices, be sure that adequate X-ray shielding is provided to protect all personnel in the testing area.

o Determine the latest safety precautions to be observed by maintenance personnel, by consulting the safety officer.

## 1.7 RADAR/MICROWAVE RADIATION HAZARDS

Radiation of electromagnetic waves in the radio frequency (RF) range can present a hazard to the electronic technician depending on the frequency and power of the incident wave. Radar, microwave, and communications transmitting antennas concentrate energy in narrow beams and can cause injury to the human body by internal heating of the tissues. Refer to NAVELEX Handbook 0101,106 for a complete discussion of electromagnetic radiation hazards.

The heating action of microwave radiation penetrates through the entire tissue down to the bone, where skin nerves are not present, to distinguish between the sensations of hot and cold. Thus, it is entirely possible for a person through whom RF current is passing to sustain destruction of nerve tissue and body organs as a result of excessive heat, even though the individual feels little or no sensation. Furthermore, the consequences of such destruction may not be realized for some time. It has been reported, for example, that delayed effects of both shock and RF heating include insanity, mental inertia, diseases of the blood vessels, eye cataracts, nerve disturbances of various kinds, disturbances in the heart conduction system, and destruction of the tissues of the pancreas. The amount of power absorbed by the body is frequency-dependent, and varies with different parts of the body. The exposed part of the body must be at least a tenth of a wavelength in size for any serious effect. The penetration of RF energy into living tissue is generally between a tenth and a hundredth of its wavelength. Below 1000 MHz, heating of the entire body takes place and a temperature rise would be noted. Between 1000 and 3000 MHz, the percentage of absorption approaches 100 percent. Above 3000 MHz more power is reflective, and the result is primarily surface heating.

Antennas of most radar and high-power scatter communication installations are generally located at heights above normal work areas. The greatest potential danger exists when personnel work on the antenna or in the radiation pattern. Signs that warn personnel of RF-radiation hazards should be placed at eye level at the foot of the ladder or other access means to all towers, masts, or structures where hazardous levels of radiation occur or are likely to occur. Equipment shall be tagged to prevent accidental turn-on when personnel are working on antennas or in their radiation field. In addition the following precautions shall be observed:

o Visual inspection of feed horns, open end of wave guides, and any opening emitting RF electromagnetic energy shall not be made unless the equipment is definitely secured for such an inspection.

o Exposure will be avoided in all areas where the radiation power levels are in excess of 0.01 watt/cm$^2$. The safe distance required for persons in the direct beams of selected radar sets are listed in NAVELEX Handbook 0101,106. This is the distance at which the radiated power density in the beam center is 0.01 watt/cm$^2$, when the equipment is operated at its rated output (see Table 1-2).

o Dummy loads shall be used where practicable during tuning, testing, or repairing RF transmitting equipment.

o Where test procedures require free space radiation, the radiating device will be positioned so as to avoid directing the energy beam towards personnel or inhabited structures. In the positioning of such radiating devices, care will be taken not to direct or reflect either the primary beam or secondary lobes in such a manner as to expose personnel.

o Aircraft employing high power radars shall be parked, or the antenna rotated, so that the beam is directed away from personnel working areas so as to avoid directing the antenna radiation pattern toward personnel or any other reflective surface.

o Ensure that radar antennas which normally rotate are rotated continuously while radiating, or are trained on a known safe bearing.

o Radars shall not be operated within the confines of a hangar or shop (except into a dummy load) unless the antennas are directed into a suitable absorbing screen or into an open area free of personnel or nearby reflective surfaces.

## 1.8 INFRARED HAZARDS

Infrared (IR) radiations extend from the limit of the visible red region of the electromagnetic spectrum to the upper edge of the radio microwave region. Infrared rays are not visible to the human eye and require special equipment to detect and indicate the presence of these radiations. Infrared radiations have characteristics similar to those of visible light in that they can be reflected by mirrors and refracted.

Infrared equipment can be used in either active or passive applications. Active IR transmitters radiate energy which is reflected from a target and detected by a receiver. Passive IR receivers detect IR rays emitted by the object itself. Active IR applications present the greatest danger to the technician. One should avoid being exposed to the beam of an IR transmitter. Usually, the danger is not great because the heating effects of the beam can be felt before damage occurs. However, the eyes can be damaged before physical heating provides sufficient warning. Regardless of the power involved, all active-type IR transmitters should be regarded as potential hazards and all personnel should avoid looking into a source of IR radiation.

## 1.9 LASERS

A laser is an instrument which can generate a highly concentrated source of a focused light beam which can produce considerable heat when absorbed by a solid material. The name is an acronym derived from the phrase "Light Amplification by Stimulated Emission of Radiation". While little prior experience exists upon which to base long term biological effects from exposure to such concentrated light energies, serious damage to the eyes and skin does result from exposure to laser beams. The following rules should be established and precautions taken for the avoidance of potential injury to personnel:

o All personnel in areas using lasers should be informed about the potential hazard associated with accidental exposure to this form of radiation. In particular, stress should be given to the extraordinary danger of eye damage due to the optical amplification and efficient absorption of this organ.

o All lasers should be contained within a suitably controlled equipment or space so that uninformed personnel who may be casually in such an area cannot be accidentally injured.

o Where feasible, warning signs and signals should be provided to indicate that laser equipment is in operation.

o At least two men should be present at all times when lasers are in operation. Where the experiment indicates, a countdown procedure should be followed to minimize unnecessary potential exposure by permitting those present to close their eyelids.

o Research laboratory areas and maintenance shops working on laser devices should be closed areas. Only persons directly associated with the area should be permitted access. Special precautions should be taken with visitors to ensure against the possibility of accidental exposure.

o All personnel involved should be trained to avoid looking directly at an operating laser, or its reflection, in any type of operation. In laboratory and maintenance work, where exposure is at close range, all personnel within the room should be warned to turn their heads away during each firing of a pulse-type laser, unless the entire laser and all portions of its beam and target are enclosed by thick opaque shields or a light-tight housing.

o Equipment shall be operated for the minimum time required for the specific operation and laser light shall not be used when other sources of illumination can be used.

o Direct viewing of laser beams is prohibited. Viewing through attenuating materials may be performed only with permission of supervisory personnel.

- o Care must be maintained to provide adequate laser-beam shielding and equipment in the experimental circuit, such as lenses or filters, especially where the laser is emitting energy in the ultraviolet or infrared portions of the spectrum since the observer might be unaware of the reflection before damage to his eyes.

- o Reflecting surfaces such as mirrors, glass, and shiny metal which have a high coefficient for specular reflection shall be faced with diffuse substances when such surfaces are forward of the laser in the direction of the beam.

- o Exposure must be reported to the medical department immediately.

## 1.10 ELECTRICAL FIRES

Electrical fires are a most difficult type of fire to overcome and are frequently encountered by electronic personnel in the course of their duties. They are classified as a class "C" type of fire because they involve energized electrical equipment and special factors must be considered when extinguishing such a fire.

Electrical fires are caused by conditions such as overloading and arcing. Overloading results when the ampere rating of a conductor is exceeded. When this happens, the conductor begins to heat, causing a temperature rise in the insulation. When the insulation reaches its ignition temperature, a fire is started. Arcing generally occurs in high-voltage circuits. In many instances, however, where different potentials are separated by an insulating material, an arcing or leakage-current path may be established. This occurs when the insulation becomes contaminated by conductive particles. It can also happen when the insulation is subjected to moisture. In any case, when arcing has occurred, carbon deposits may remain or the insulation may carbonize. Use caution when extinguishing a fire caused by high-voltage arcing; the arc may re-establish itself.

### 1.10.1 Fire Prevention

General cleanliness in the area is essential for the prevention of fires. In addition, the following requirements are particularly applicable in an area where electrical equipment is being operated.

- o Avoid the use of flammable cleaning agents. Gasoline, benzene, ether, and similar flammable cleaning fluids shall never be used on energized or de-energized electrical apparatus. Alchohol should not be used for cleaning equipment as it damages most types of insulating varnishes.

- o Keep equipment clean and free of all deposits of oil, grease, carbon dust, etc. Equipment can become ignited by electrical arcing when covered by such deposits.

### 1.10.2 Firefighting

- o De-energize the circuit or equipment affected.

- o Call the fire department immediately.

- o Control the fire insofar as possible with the correct type of firefighting equipment until fire department personnel arrive. Firefighting equipment must be kept readily available at all times.

### 1.10.3 Fire Extinguishers

Recommended types of fire extinguishers for various types of fires are shown in foldout 1-1.

## 1.11 RADIOACTIVE TUBES

Electron tubes containing radioactive material are now in common use in radar, communications, guided missile systems, and test equipment. The radioactive material is found in such tubes as the TR, ATR, spark-gap, voltage regulator, glow-lamp and cold-cathode tubes. Radioactive material is intentionally added to these tubes to produce a continuous supply of ionized particles. This insures that the gas within the tube will always ionize at the same voltage. Because of the danger of personnel to radiation exposure, special care must be taken in the handling and disposal of radioactive tubes.

### 1.11.1 Radiation Hazards

As long as a tube containing radioactive material is not broken, the hazard is slight. The concentration of radioactivity in a normal collection of electron tubes at maintenance shops does not approach a dangerous level. However, at major supply points, the storage of large quantities of radioactive tubes in a relatively small area may create a hazard. A broken radioactive tube immediately becomes a hazard, since radioactive material may enter a person's body by inhalation, through the skin by way of an open wound, and with food. Radioactive material deposited within a person's body produces internal radiation which may injure or destroy blood-forming organs and body tissue. The removal of this hazard is limited by the rate of excretion of elements from the body and the natural radioactive decay of the material. The degree of injury depends primarily on the quantity of radiation energy absorbed by the body cells. If only a small amount of radioactive material is absorbed by the body, symptoms of internal injuries may not appear for years.

### 1.11.2 Handling Tubes

In handling radioactive tubes the following general practices should be observed:

- o Use extreme care in the handling of these tubes while installing or removing them from equipment.

o Tubes should not be removed from cartons until immediately prior to actual installation. This serves two purposes: to prevent accidental breakage, and to avoid the possibility of concentrating several radioactive tubes in a small volume (which would increase the effective intensity of radiation).

o When a tube is removed from equipment, it should be placed in an appropriate carton to prevent possible breakage. Do not leave a defective tube on work benches.

### 1.11.3 Decontamination of Area

o When breakage of a tube does occur material contaminated by the radioactive material should not be allowed to come in contact with any part of your body at any time. Take care to avoid breathing any vapor or dust which may be released by such breakage. Immediately locate all broken pieces, and isolate the area until the broken pieces have been removed or declared nonradioactive by test with an adequate radiation-sensitive device.

o When cleaning a contaminated area, you should wear rubber or plastic gloves. Large fragments of a broken tube should be removed with the aid of some tool, such as forceps, if they are available. The remaining particles can be removed with a vacuum cleaner, using a disposal collecting bag, or by wiping a wet cloth across the area. If a wet cloth is used, make one stroke at a time, and fold the cloth in half after each stroke, always using a clean side. When the cloth becomes too small, discard it and continue with a clean piece. Be careful not to rub the radioactive particles into the surface by using a back-and-forth motion. All debris, cloths, and bags used for cleaning should be sealed in a container such as a plastic bag, heavy waxed paper, or glass jar, and placed in a steel can for disposal.

o Upon leaving a contaminated area, personnel who have handled the radioactive material in any way will immediately remove the contaminated clothing and thoroughly wash their hands and face with soap and water.

### 1.11.4 First Aid

When a wound caused by a sharp radioactive object is sustained, mild bleeding should be stimulated by pressure about the wound and the use of suction bulbs. Do not suck the wound by mouth. Wash the wound with soap, and flush with plenty of clean water. If the wound is of the puncture type, or the opening is small, make an incision to promote free bleeding and to facilitate cleaning and flushing of the wound. A medical doctor should be notified for complete diagnosis and additional medical treatment. For additional information consult with "Radiation Health Protection Manual - NAVMED P-5055."

### 1.11.5 Disposal of Radioactive Material

The disposal of radioactive material may be accomplished by burying in soil or in the ocean. Exact disposal instructions will be as prescribed by the local radiological safety officer, in accordance with the latest local, state, and national ecological legislation.

## 1.12 CATHODE-RAY TUBES

Extreme caution must be exercised when handling a cathode-ray tube (CRT). The glass envelope encloses a high vacuum, and, because of the large surface area, the envelope is subject to considerable force due to atmospheric pressure.

### 1.12.1 Personal Protection

To avoid serious injury, adequate precautions must be taken at all times to minimize the danger of breaking the envelope and resulting in a violent implosion of the glass envelope. Safety goggles, gloves, and protective clothing should be worn when handling the CRT.

### 1.12.2 Handling the CRT

The electronic technician must be familiar with the special instructions on handling the tube provided by the manufacturer in the instruction manual. The tube should remain in the packing carton until ready for installation in the equipment. When removing tube from carton be careful not to strike or scratch the envelope or exert any pressure on the tube neck. Never hold the tube down, always stand it on its face on a thick piece of felt or padded surface. During installation the technician should not stand directly in front of the tube. In the event of an implosion, the electron gun and neck may be propelled at a high velocity through the face of the tube. In addition to the danger of implosion due to breakage, rough handling may also cause displacement of the electrodes within the tube enough to cause faculty operation.

### 1.12.3 Disposal of Defective Tubes

Before disposing of a defective CRT, the tube should be rendered harmless from implosion by breaking the vacuum seal. This can be done by placing the defective tube in an empty carton and carefully break off the locating pin from the tube base. With a small screwdriver or probe, break off the top of the glass vacuum seal to allow air to enter the tube

When disposing of a broken tube, be careful not to get any of the chemical phosphor compound, with which the face of the CRT is coated, on your hands or into skin breaks. The compound may be extremely toxic.

## 1.13 ANTENNAS

Special precautions must be taken by all personnel working in or around antenna systems to guard against accidents resulting from electrical shock. High power-supply voltages and RF voltages are ever present. The safety rules and regulations prescribed for each installation must be rigidly enforced and observed.

Towers, supports, guy wires, anchors, turnbuckles, etc. must be inspected at regular intervals for evidence of any system deterioration from a safety viewpoint resulting from wind, ice, vibration, and loosing of cables. Prompt corrective action must be taken of all actual or incipient defects.

## 1.14 PREPARATION OF ELECTROLYTE

When preparing electrolyte, observe the following safety precautions.

### 1.14.1 Safety Precautions

- o Use lead or rubber vessels and glass stirring rods.
- o Wear rubber boots, apron, and gloves to protect clothing and skin.
- o Wear goggles to protect the eyes.

**WARNING**

Water added to acid causes a violent reaction which could result in personal injury or equipment damage.

- o Add acid to water, not water to acid.

### 1.14.2 First Aid

If, in spite of observing the above precautions, a man should be splashed with acid or electrolyte on an area other than in the eyes, immediately follow this procedure:

**WARNING**

It is essential that a large quantity of water be used; a small quantity will not only be ineffective, but could do more harm than good.

STEP 1. Wash affected area with a LARGE quantity of fresh water.

STEP 2. Apply petroleum jelly (vaseline), boric acid, zinc ointment, or, if none of these are available, a clean lubricating oil.

STEP 3. Send victim for medical treatment.

The procedure to be followed if acid has entered the eyes is as follows:

**WARNING**

Do not use a syringe nozzle or other such pressure method for this treatment because of the danger of mechanical injury to the eye.

STEP 1. Immediately flush eyes with a large quantity of fresh water. Pull the lower lid outward and direct a steady but gentle stream of water into the pocket thus created; repeatedly squeeze a water-saturated gauze sponge or wad of cotton into eye.

STEP 2. After flushing, wash eye with a solution consisting of two tablespoons of baking soda in a pint of water.

STEP 3. Apply clean mineral oil or liquid petroleum.

STEP 4. Send victim for medical treatment.

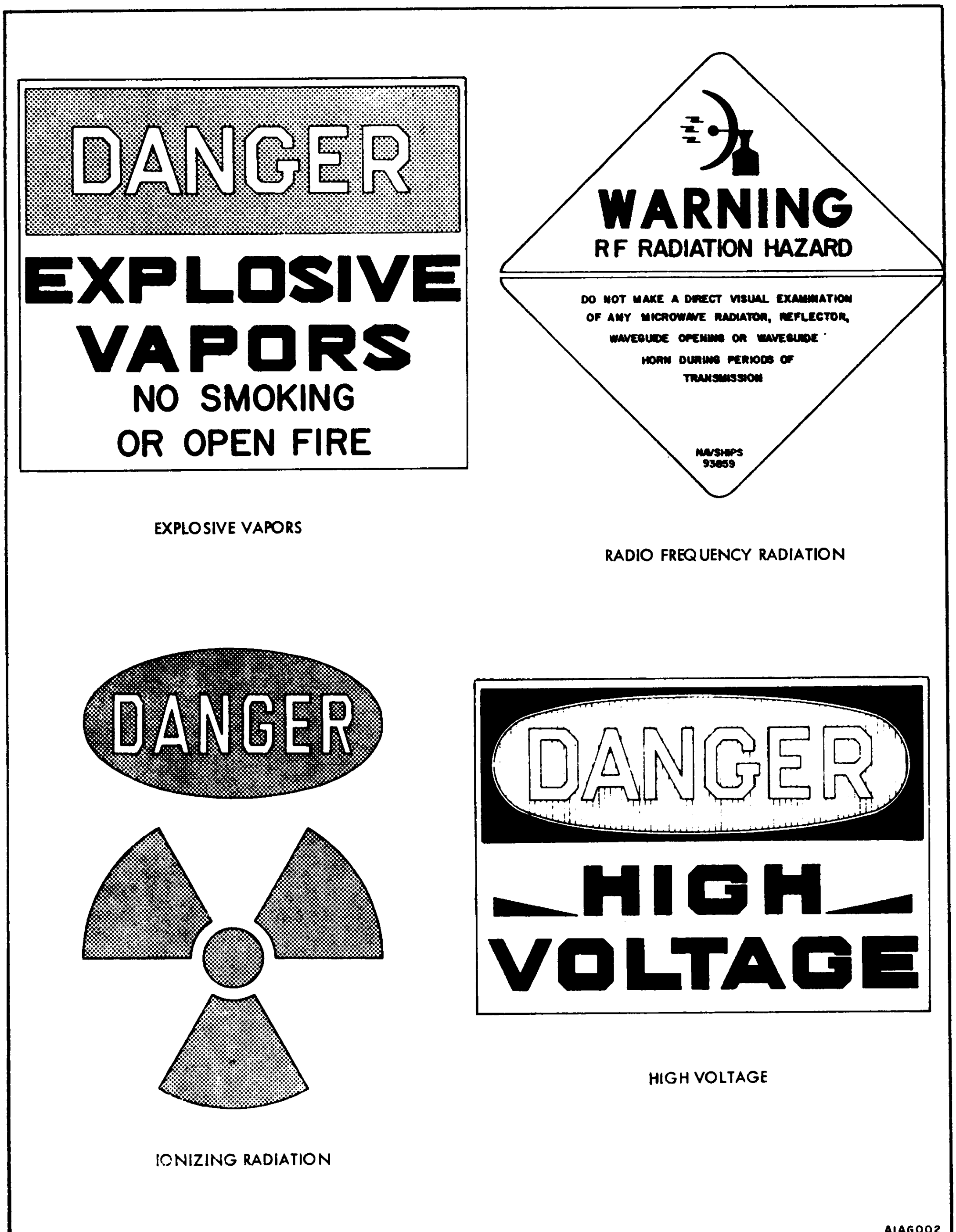


Figure 1-1. Typical Warning Signs

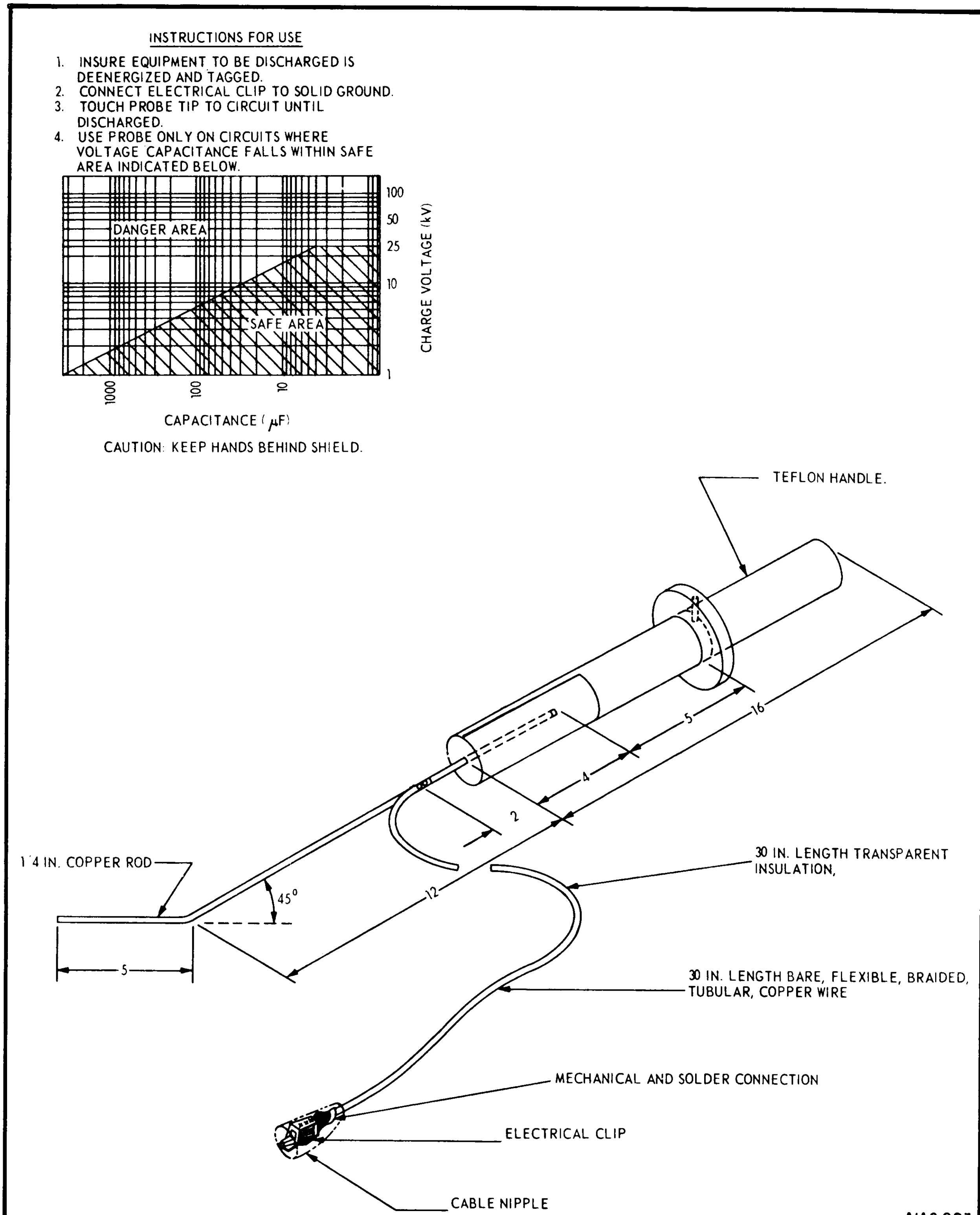


Figure 1-2. Approved Safety Shorting Probe

Table 1-1. Probable Effects of Electric Shock

| CURRENT VALUES (MILLIAMPERES) | | EFFECTS |
|---|---|---|
| AC 60 Hz | DC | |
| 0-1 | 0-4 | Perception |
| 1-4 | 4-15 | Surprise |
| 4-21 | 15-80 | Reflex Action |
| 21-40 | 80-160 | Muscular Inhibition |
| 40-100 | 160-300 | Respiratory Block |
| Over 100 | Over 300 | Usually Fatal |

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Table 1-2. Field Intensity and Power Density Conversion Chart
(Related by Free Space Impedance = 377 ohms)

| VOLTS/m | dBμV/m | WATTS/m$^2$ | dBW/m$^2$ | WATTS/CM$^2$ | dBW/CM$^2$ | mW/CM$^2$ | dBm/CM$^2$ |
|---|---|---|---|---|---|---|---|
| 10,000 | 200 | 265,000 | +54 | 27 | +14 | 26,500 | +44 |
| 7,000 | 197 | 130,000 | +51 | 13 | +11 | 13,000 | +41 |
| 5,000 | 194 | 66,300 | +48 | 6.6 | +8 | 6,630 | +38 |
| 3,000 | 190 | 23,900 | +44 | 2.4 | +4 | 2,390 | +34 |
| 2,000 | 186 | 10,600 | +40 | 1.1 | 0 | 1,060 | +30 |
| 1,000 | 180 | 2,650 | +34 | .27 | -6 | 265 | +24 |
| 700 | 177 | 1,300 | +31 | .13 | -9 | 130 | +21 |
| 500 | 174 | 663 | +28 | .066 | -12 | 66 | +18 |
| 300 | 170 | 239 | +24 | .024 | -16 | 24 | +14 |
| 200 | 166 | 106 | +20 | .011 | -20 | 11 | +10 |
| 100 | 160 | 27 | +14 | $27x10^{-4}$ | -26 | 2.7 | +4 |
| 70 | 157 | 13 | +11 | $13x10^{-4}$ | -29 | 1.3 | +1 |
| 50 | 154 | 6.6 | +8 | $6.6x10^{-4}$ | -32 | .66 | -2 |
| 30 | 150 | 2.4 | +4 | $2.4x10^{-4}$ | -36 | .24 | -6 |
| 20 | 146 | 1.1 | 0 | $1.1x10^{-4}$ | -40 | .11 | -10 |
| 10 | 140 | .27 | -6 | $27x10^{-5}$ | -46 | .027 | -16 |
| 7 | 137 | .13 | -9 | $13x10^{-6}$ | -49 | .013 | -19 |
| 5 | 134 | .066 | -12 | $6.6x10^{-6}$ | -52 | $66x10^{-4}$ | -22 |
| 3 | 130 | .024 | -16 | $2.4x10^{-6}$ | -56 | $24x10^{-4}$ | -26 |
| 2 | 126 | .011 | -20 | $1.1x10^{-6}$ | -60 | $11x10^{-4}$ | -30 |
| 1 | 120 | $27x10^{-4}$ | -26 | $27x10^{-8}$ | -66 | $2.7x10^{-4}$ | -36 |
| 0.7 | 117 | $13x10^{-4}$ | -29 | $13x10^{-8}$ | -69 | $1.3x10^{-4}$ | -39 |
| 0.5 | 114 | $6.6x10^{-4}$ | -32 | $6.6x10^{-8}$ | -72 | $66x10^{-4}$ | -42 |
| 0.3 | 110 | $2.4x10^{-4}$ | -36 | $2.4x10^{-8}$ | -76 | $24x10^{-6}$ | -46 |
| 0.2 | 106 | $1.1x10^{-4}$ | -40 | $1.1x10^{-8}$ | -80 | $11x10^{-6}$ | -50 |
| 0.1 | 100 | $27x10^{-6}$ | -46 | $27x10^{-10}$ | -86 | $2.7x10^{-6}$ | -56 |
| $70x10^{-3}$ | 97 | $13x10^{-6}$ | -49 | $13x10^{-10}$ | -89 | $1.3x10^{-6}$ | -59 |
| $50x10^{-3}$ | 94 | $6.6x10^{-6}$ | -52 | $6.6x10^{-10}$ | -92 | $66x10^{-8}$ | -62 |
| $30x10^{-3}$ | 90 | $2.4x10^{-6}$ | -56 | $2.4x10^{-10}$ | -96 | $24x10^{-8}$ | -66 |
| $20x10^{-3}$ | 86 | $1.1x10^{-6}$ | -60 | $1.1x10^{-10}$ | -100 | $11x10^{-8}$ | -70 |
| $10x10^{-3}$ | 80 | $27x10^{-8}$ | -66 | $27x10^{-12}$ | -106 | $2.7x10^{-8}$ | -76 |
| $7x10^{-3}$ | 77 | $13x10^{-8}$ | -69 | $13x10^{-12}$ | -109 | $1.3x10^{-8}$ | -79 |
| $5x10^{-3}$ | 74 | $6.6x10^{-8}$ | -72 | $6.6x10^{-12}$ | -112 | $66x10^{-10}$ | -82 |
| $3x10^{-3}$ | 70 | $2.4x10^{-8}$ | -76 | $2.4x10^{-12}$ | -116 | $24x10^{-10}$ | -86 |
| $2x10^{-3}$ | 66 | $1.1x10^{-8}$ | -80 | $1.1x10^{-12}$ | -120 | $11x10^{-10}$ | -90 |
| $1x10^{-3}$ | 60 | $27x10^{-10}$ | -86 | $27x10^{-14}$ | -126 | $2.7x10^{-10}$ | -96 |
| $700x10^{-6}$ | 57 | $13x10^{-10}$ | -89 | $13x10^{-14}$ | -129 | $1.3x10^{-10}$ | -99 |
| $500x10^{-6}$ | 54 | $6.6x10^{-10}$ | -92 | $6.6x10^{-14}$ | -132 | $66x10^{-12}$ | -102 |
| $300x10^{-6}$ | 50 | $2.4x10^{-10}$ | -96 | $2.4x10^{-14}$ | -136 | $24x10^{-12}$ | -106 |
| $200x10^{-6}$ | 46 | $1.1x10^{-10}$ | -100 | $1.1x10^{-14}$ | -140 | $11x10^{-12}$ | -110 |
| $100x10^{-6}$ | 40 | $27x10^{-12}$ | -106 | $27x10^{-16}$ | -146 | $2.7x10^{-12}$ | -116 |
| $70x10^{-6}$ | 37 | $13x10^{-12}$ | -109 | $13x10^{-16}$ | -149 | $1.3x10^{-12}$ | -119 |
| $50x10^{-6}$ | 34 | $6.6x10^{-12}$ | -112 | $6.6x10^{-16}$ | -152 | $66x10^{-14}$ | -122 |
| $30x10^{-6}$ | 30 | $2.4x10^{-12}$ | -116 | $2.4x10^{-16}$ | -156 | $24x10^{-14}$ | -126 |
| $20x10^{-6}$ | 26 | $1.1x10^{-12}$ | -120 | $1.1x10^{-16}$ | -160 | $11x10^{-14}$ | -130 |
| $10x10^{-6}$ | 20 | $27x10^{-14}$ | -126 | $27x10^{-18}$ | -166 | $2.7x10^{-14}$ | -136 |
| $7x10^{-6}$ | 17 | $13x10^{-14}$ | -129 | $13x10^{-18}$ | -169 | $1.3x10^{-14}$ | -139 |
| $5x10^{-6}$ | 14 | $6.6x10^{-14}$ | -132 | $6.6x10^{-18}$ | -172 | $66x10^{-16}$ | -142 |
| $3x10^{-6}$ | 10 | $2.4x10^{-14}$ | -136 | $2.4x10^{-18}$ | -176 | $24x10^{-16}$ | -146 |
| $2x10^{-6}$ | 6 | $1.1x10^{-14}$ | -140 | $1.1x10^{-18}$ | -180 | $11x10^{-16}$ | -150 |
| $1x10^{-6}$ | 0 | $27x10^{-16}$ | -146 | $27x10^{-20}$ | -186 | $2.7x10^{-16}$ | -156 |

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