BY ORDER OF THE
SECRETARY OF THE AIR FORCE

AIR FORCE OCCUPATIONAL SAFETY AND HEALTH STANDARD 91-110

1 JULY 1997

Safety

NONDESTRUCTIVE INSPECTION AND OIL ANALYSIS PROGRAM

OPR: HQ AFSC/SEGS
(SMSgt Pennie Hardesty)
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Certified by: HQ AFSC/SEG
(Thomas M. Pazell)
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The criteria in this standard are the Air Force's minimum safety, fire protection, and occupational health requirements for all areas where processes involve nondestructive inspection and analysis in Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) Standard 1910.1096, *Ionizing Radiation*. Major commands (MAJCOMs), direct reporting units (DRUs), and field operating agencies (FOAs) may supplement this standard when additional or more stringent safety, fire prevention, and health criteria are required. See Air Force Instruction (AFI) 91-301, *Air Force Occupational and Environmental Safety, Fire Prevention, and Health (AFOSH) Program*, for instructions on processing supplements or variances. Report conflicts in guidance between this standard, federal standards, or other Air Force directives through MAJCOM, DRU, or FOA ground safety offices to Headquarters Air Force Safety Center, Ground Safety Division, Safety Engineering and Standards Branch (HQ AFSC/SEGS), 9700 Avenue G, SE, Suite 222, Kirtland AFB NM 87117-5670. Describe the conflict in detail and provide possible recommendations to resolve the conflict. Only MAJCOM-endorsed correspondence will be forwarded to HQ AFSC/SEG for resolution.

This standard applies to all US Air Force organizations, including US Air Force Reserve personnel and Air National Guard personnel when on federal Service. It is intended to minimize or eliminate safety, fire, and health hazards to personnel and property. This standard applies to nondestructive inspection (NDI) and the oil analysis program (OAP). In the NDI area, magnetic particle, penetrant, eddy current, ultrasonic, radiographic, and visual inspection disciplines are covered. In the OAP area, both atomic emission and atomic absorption operations are covered. This standard provides Air Force personnel with guidance on safety, health, and fire prevention while performing NDI and OAP operations. The standard does not cover medical or explosive ordnance disposal radiography, and it does not apply to radiography accomplished with sealed gamma ray sources. Those portions of OSHA Standard 1910.1096 applicable to Air Force operations are implemented by this standard.

NOTE: AFOSH 127-series standards are being converted to 91-series standards and the 161-series standards will become 48-series standards. However, not all standards have been converted as of the effective date of this standard. To help you locate these documents, references to AFOSH standards are stated in

the updated series and standard number, with the outgoing series and standard number stated as “formerly designated as” in the ‘references’ section of **Attachment 1**.

SUMMARY OF REVISIONS

Administrative changes have been made to update this standard to electronic format. Paragraphs have been renumbered and references updated as required. A glossary of references, abbreviations, acronyms, and terms is at **Attachment 1**. Minor changes are annotated by a vertical bar (|) in the left margin.

1. Hazards and (or) Human Factors . Personnel engaged in NDI and OAP operations are exposed to several potential hazards. Those for NDI include exposure to flammable and combustible liquids and gases, absorption of toxic and hazardous chemicals through the skin and respiratory system, ionizing radiation, electric circuits and ultraviolet light. Also, NDI personnel are normally subject to some of the physical injuries associated with aircraft maintenance. Personnel involved in OAP are subject to the hazards of toxic and hazardous chemicals, damage to the eyes by ultraviolet radiation, and burns to the hands. Particular attention must be given to protection against exposure to toxic chemicals and ionizing radiation, since the effects of any overexposure may not become apparent for several years after exposure. Potential physical and health hazards can be effectively controlled by proper work procedures, controls, facility design, protective equipment, and clothing.

2. General Requirements:

2.1. Compressed Gases . Compressed gases commonly used in NDI and (or) OAP labs are nitrous oxide, acetylene, and sulfur hexafluoride. These gases are discussed below. Care and attention must be given to handling, storage, marking, and disposition of all compressed gas cylinders. Personnel required to work with compressed gases and gas cylinders shall be trained to have a thorough knowledge of the characteristics of compressed gases, cylinders, valves, and markings. Minimum training shall consist of a thorough comprehension of the applicable parts of Technical Order (TO) 42B5-1-2, *Gas Cylinders, Use, Handling, and Storage*.

2.1.1. Nitrous oxide is a hazardous gas even though it is nonflammable and nonirritating. It is an oxidizing agent and will support combustion of flammable materials. Do not introduce nitrous oxide into gas lines or equipment contaminated with oil or grease, since this action can cause spontaneous combustion and possible explosion. When inhaled in high concentrations, it affects the central nervous system and may induce symptoms closely resembling alcoholic intoxication. Inhalation of nitrous oxide without an ample supply of oxygen may result in respiratory failure and death.

2.1.2. Acetylene is a colorless, flammable gas, slightly lighter than air. Acetylene burns in air with an intensely hot, luminous, and smoky flame. The ignition temperatures of acetylene and of acetylene-air and acetylene-oxygen mixtures vary according to composition, initial pressure, initial temperature, and water-vapor content. It is a simple asphyxiant if present in concentrations high enough to deprive the lungs of oxygen and produce suffocation. However, the lower flammable limit of acetylene in air would usually be reached long before suffocation could occur as the result of an acetylene leak.

2.1.3. Sulfur hexafluoride (SF6) is a colorless, odorless, nontoxic, nonflammable gas. It can cause asphyxiation by displacing oxygen in the air. To preclude asphyxiation, care must be taken

not to release large quantities of the gas in unvented work areas. The amounts leaked into the air while performing normal X-ray tube repair do not create an asphyxiation hazard. Sulfur hexafluoride, when heated, liberates the hazardous gas fluorine. This possibility of producing fluorine gas exists in most X-ray tube heads. Precautions must be taken to guard against inhalation of sulfur hexafluoride released from X-ray tubes that have been energized.

2.2. Housekeeping . Good housekeeping is essential to safe operations in the NDI and OAP laboratories. Floors must be kept free of spilled liquids to minimize the possibility of slipping and falling. All work and storage areas shall be kept clean. Equipment and materials shall be stored in a proper and orderly manner.

2.3. Personal Protective Equipment (PPE):

2.3.1. PPE will be provided for NDI personnel according to AFOSH Standard 91-31, *Personal Protective Equipment*.

2.3.2. PPE will be kept clean, and if not individually issued, will be prominently displayed and (or) stored in the immediate vicinity where its use is required. Particular attention will be given to keeping the insides of gloves clean and dry.

2.3.3. Where a requirement for respirators has been established according to AFOSH Standard 48-1, *Respiratory Protection Program*, they shall be individually issued.

2.3.4. The NDI supervisor will ensure that all personnel are trained in the care and use of PPE and will enforce its use.

2.3.5. Additional requirements for PPE are contained in paragraph 3 of this standard.

2.4. Ventilation Systems . Only basic guidelines for NDI and (or) OAP laboratory ventilation are covered in this standard. For more details, including information on permissible exposure limits, flow rate requirements and design criteria, see AFOSH Standards 161-2, *Industrial Ventilation* and 48-8, *Controlling Exposures To Hazardous Materials. Ventilation* for OAP spectrometers must also comply with the requirements of the applicable equipment manual. (The bioenvironmental engineer shall determine which controls are required to protect workers from overexposure to airborne toxic contaminants.) Ventilation shall continue for a sufficient time after job completion to minimize residual vapors. Adequate makeup air must be provided. As a minimum, areas requiring evaluation for ventilation needs by the bioenvironmental engineering office are cleaning areas, penetrant tanks, emulsifier tanks, penetrant inspection viewing booths, stationary magnetic particle units, film processing rooms, and the OAP work area.

2.5. Occupational Health :

2.5.1. Hazardous Chemicals. Chemical and petroleum products used in NDI and OAP may cause respiratory irritation, skin irritation, or dermatitis if the worker is exposed. Adequate ventilation, respiratory protection, and PPE will be provided when required by Air Force directives or when specified by bioenvironmental engineering or safety personnel. Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes or body shall be provided within the work area for immediate emergency use. If personnel are exposed to materials less harmful than those previously addressed, but considered to be an irritant to the eyes, a portable eye wash that provides 15 minutes “continuous” flow may be used as an alternate for a plumbed eye wash. A water hose may not be used to meet the requirements in this paragraph. Medical attention will be obtained as soon as adequate flushing and (or)

drenching of the eyes and (or) body has been accomplished. Supervisors may contact the base bioenvironmental engineers for assistance in determining how to meet the requirements of this paragraph.

2.5.2. Solvents. 1,1,1 Trichloroethane (Methyl Chloroform) is authorized for use as a cleaner in the penetrant inspection process. 1,1,2 Trichloroethane is not authorized for use without special permission from the base bioenvironmental engineer. Respiratory protection is required for both solvents unless mechanical ventilation reduces vapor concentration at the worksite below permissible exposure limits as determined by the Base bioenvironmental engineer.

2.5.3. Ultraviolet Radiation (UV). The electric arc and the mercury vapor lamp on the oil analysis instruments can emit harmful ultraviolet radiation. Light shields provided in the instrument shall be used. The UV blacklight used in penetrant and magnetic particle inspection will be checked prior to use for cracked lenses. Damaged lenses shall be replaced prior to use. Battery powered lights shall only be used in lieu of the 110/220 volt powered blacklight when it is impossible to use the 110/220 volt powered light. TO 33B-1-1, *Nondestructive Inspection Methods* gives detailed instructions for testing of blacklights.

2.5.4. Ionizing Radiation. Personnel who may be exposed to ionizing radiation during the normal course of their duties or occupation shall wear personal radiation monitoring devices. These devices shall be individually issued and worn according to instructions given by the base bioenvironmental engineer and TO 33B-1-1, Chapter 5. At enclosed and (or) unshielded operating locations (X-ray machine control station) and areas accessible to non-monitored, personnel, exposure levels shall be monitored continuously during each operation with survey meters to determine ionizing radiation levels. Additional information on this subject is contained in OSHA 1910.1096.

2.5.5. Air and Water Pollution. Petroleum products and film processing chemicals will be disposed of according to local pollution control laws and as specified and approved by the environmental planner in civil engineering and the bioenvironmental engineer. See AFI 32-7080, *Pollution Prevention Program.*

2.5.6. Bioenvironmental, safety, or fire personnel, as appropriate, will be contacted by the supervisor when new chemicals, machines, or processes are introduced into the work area. This is necessary to ensure that all procedures are properly evaluated. Once evaluated, supervisors will brief personnel according to AFI 91-301.

2.6. Fire Prevention :

2.6.1. The storage, use, and handling of flammable and combustible liquids will be according to AFOSH Standard 91-43, *Flammable and Combustible Liquids,* and in coordination with the base fire department.

2.6.2. Supervisors will ensure that:

- Personnel are trained on the location, selection, and use of fire extinguishers, alarm systems, and evacuation procedures.
- Fire extinguishers are securely mounted, readily accessible, in a serviceable condition, and clearly visible. In locations where visual obstructions cannot be completely avoided, directional arrows will be provided to indicate the location of extinguishers and the arrow will be marked with the extinguisher classification. Contact the base fire department when deficiencies exist.

- All fire exits are kept unlocked and easily accessible at all times the area is occupied.

2.6.3. Operations of particular concern are those which use petroleum solvents and removers for cleaning.

- Penetrants. Petroleum-based penetrants are combustible and have a flashpoint of approximately 175 degrees Fahrenheit (F).
- Emulsifiers. These petroleum-based detergent products are combustible and have a flashpoint of approximately 222 degrees F. Under certain conditions they will burn.
- Developers. Non-aqueous developers are flammable and may have a flashpoint as low as 50 degrees F.
- Solvents and Removers. Deodorized kerosene and PD680 Type II are combustible petroleum distillates with flashpoints of approximately 140 degrees F. These should be handled carefully and kept away from heat and open flames.
- Storage. Penetrants, deodorized kerosene, PD680 Type II, aerosol cans of penetrants, removers, and magnetic particle baths are combustible and (or) flammable materials and shall be stored according to AFOSH Standard 91-43.

2.6.4. Housekeeping. Soiled rags, paper towels, and craft paper and other trash contaminated with oil or grease will be placed in self-closing metal containers plainly marked to indicate contents. At the end of each shift, these containers will be emptied or placed in an approved location outside the shop for pickup or disposal. Clean rags will be kept in covered metal containers.

2.7. Electrical Safety for NDI Operations . NDI equipment to be used in hazardous areas shall meet TO 1-1-688, *Use of Electronic Equipment in Hazardous Areas,* requirements.

3. Specific Applications:

3.1. Penetrant Inspection . Precautions to be exercised when performing penetrant inspection include consideration of ventilation, skin irritation, fire, and use of blacklight. The following minimum safety requirements shall be observed:

- Provide adequate ventilation when penetrant inspection is being performed. When recommended by the base bioenvironmental engineer, wear an approved respirator working in areas where adequate ventilation cannot practically be provided.
- When handling penetrant materials, wear neoprene gloves and keep insides of gloves clean. Wash exposed areas of body with soap and water. Continual contact with penetrant materials may cause skin irritation and a removal of natural body oils. Do not allow 1,1,1-Trichloroethane cleaners and removers to intentionally come in direct contact with the skin. Also, do not use 1,1,2-Trichloroethane in the penetrant inspection process.
- Wear eye protection when spraying penetrant material. See AFOSH Standard 91-31.
- Wear eye protection, apron, and gloves when processing parts in the tanks of the penetrant inspection line. See AFOSH Standard 91-31.
- Avoid exposing pressurized spray cans to open flames. Temperatures in excess of 120 degrees F may cause bursting of the pressurized can with possible injury to personnel.
- Store penetrant materials in cool dry areas protected from direct sunlight.

- Install ultraviolet filters on all mercury vapor lamps used for penetrant inspection. Replace cracked, chipped, or broken filters before using the light. Injury to eyes and skin will occur if the light from the mercury vapor bulbs is not filtered.
- Place properly rated electric insulating floor matting on the floor in front of the penetrant line. Matting is required to reduce electrical and slipping hazards.
- Blacklight bulbs can reach an operating temperature of 750 degrees F. Do not lay hot blacklights on combustible surfaces. Provide brackets or hangers in the area of blacklight use. Exercise care when using hot blacklights so as to not burn hands, arms, face, or other exposed body areas.
- Ensure workers do not handle blacklights at the penetrant rinse station when washing parts, because of electrical hazard present. When practical, permanently mount blacklights at the wash station.
- Ensure the working area of the penetrant, emulsifier, and inspection booth is evaluated by bioenvironmental engineers to determine the degree of exposure of personnel. Provide ventilation or other appropriate control measures depending upon the hazard determined to exist.

3.2. Magnetic Particle Inspection . Precautions to be exercised when performing magnetic particle inspection include consideration of exposure to oils, pastes, and electrical current. The following safety requirements shall be observed when performing magnetic particle inspections:

3.2.1. Use rubber insulating floor matting, rated for the voltage of the equipment being worked on, in front of magnetic particle units. Replace insulating matting worn to one-half original thickness (approximately 1/8 inch). Use only one continuous length of matting and ensure it continues beyond the ends of the equipment for at least 24 inches.

3.2.2. Arcing caused by poor contact between the heads of the stationary magnetic particle machine or excessive magnetizing current may injure the eyes. Arcing may also cause ignition of combustible particle baths. Ensure good electrical contact between the heads and the inspected part to prevent this possibility.

3.2.3. Use care when handling articles placed between the heads of a magnetizing unit to avoid injuring the hands.

3.2.4. Although the materials are nontoxic, continuous exposure to oils and pastes used in the wet bath method may cause dermatitis or cracking of the skin. Use protective gloves in this process.

3.2.5. When maintaining a magnetic particle suspension oil of less than a 200 degrees F flashpoint in a Type II Stationary Magnetic Particle Machine, the following minimum safety requirements apply:

- Provide an adequate surface area exhaust ventilation system as determined by the local base bioenvironmental engineer.
- Maintain less than 25 gallons of liquid suspension in the tank.
- Cover the liquid suspension by a screened drain board.
- Provide a portable fire extinguisher, sufficient in size and (or) volume to suppress any fire which may occur from the magnetic particle suspension oil. The fire extinguisher size and (or) volume shall be determined by the local fire chief.

3.2.6. The use of prods is prohibited on aircraft parts. Ensure they are not used in any hazardous area.

3.3. Eddy Current and Ultrasonic Inspection. Eddy current and ultrasonic equipment can safely be used in and around aircraft provided the following electrical safety guidelines are followed.

3.3.1. Exercise care when performing maintenance on or around the cathode-ray tube (CRT) of this equipment.

3.3.2. Ensure the CRT is electrically discharged according to applicable manufacturer's technical manuals prior to performing any maintenance on the equipment.

3.3.3. Use care not to break the CRT, since a violent implosion can result.

3.3.4. An extreme hazard exists if eddy current and ultrasonic equipment are used improperly in hazardous areas. Consult paragraph 2.7 of this standard for guidance on electrical safety requirements.

3.4. Radiographic Inspection . This section covers essential minimum safety requirements for industrial radiography. For more detailed operational information, consult TO 33B-1-1 which covers radiographic inspection procedures and radiation protection standards.

3.4.1. Supervision. Supervisors of radiographic operations will:

- Maintain storage and operational control of all industrial radiographic equipment.
- Provide personal dosimetry for individuals who may be exposed to ionizing radiation during the normal course of their duties or occupations. Refer to AFI 48-125, The US Air Force Personnel Dosimetry Program, TO 33B-1-1, and the base bioenvironmental engineer for instructions how to issue and wear the monitoring devices.
- Procure and maintain adequate radiation survey instruments and establish a survey instrument calibration program.
- Maintain exposure devices, radiographic facilities, radiation warning signs, and associated safety equipment. (See TO 33B-1-1 for more detailed information.)
- Maintain utilization logs as required by TO 33B-1-1.
- Keep a copy of the latest radiation protection survey report performed by bioenvironmental engineering or the US Air Force Occupational and Environmental Health Laboratory and ensure corrective actions are taken and documented on all recommendations made in the report.
- Use the fall length of control cables and coolant hoses to keep cooler and control unit as far away from the X-ray tube as possible.
- If working from ground level, in an enclosure, elevate the X-ray control and cooler on a secure frame or maintenance stand at least 18 inches above ground.

3.4.2. Qualification of Industrial Radiographers. All industrial radiographers must complete an Air Force-approved course of instruction in the use of industrial X-ray equipment, including radiation hazard control, and demonstrate an understanding of approved radiographic practice. Qualification of radiographers may be through the US Air Force Nondestructive Inspection Course, or through equivalent training in courses conducted by industry or civilian institutions. Approval by

the AF NDI Program Office, Kelly AFB, Texas, is required when training in non-US Air Force courses is to be substituted for the Air Education and Training Command Course.

3.4.3. Radiation Protection Surveys for Protective Installations:

3.4.3.1. A radiation protection survey of all new installations (and existing installations not previously surveyed) shall be made by a health physicist or a qualified bioenvironmental engineer before the installation is placed in routine operation. The installation shall be inspected to verify or determine the present or expected occupancy of adjacent areas, the operation of audible or visible warning signals, interlocks, mechanical, or electrical restrictions of the positioning of the radiation source, delay switches, and other devices that have a bearing on radiation protection as required in TO 33B-1-1.

3.4.3.2. A resurvey or evaluation by a health physicist or qualified bioenvironmental engineer shall be made at least every 3 years and when changes have been made in shielding, operation, workload, equipment, or occupancy of adjacent areas which may have compromised radiation protection. If supplementary shielding is installed as a result of a radiation protection survey, another survey shall be made to confirm the adequacy of the shielding after the modification. Radiation exposure measurements shall be made in all adjacent areas that can be occupied. The measurements shall be made under practical conditions of operation resulting in the greatest exposure at the point of interest. X-ray apparatus shall be operated at the maximum kilovoltage and at its maximum milliamperage for continuous operation at the voltage. In evaluating the results of the survey, consideration shall be given to actual operating conditions, including workload, use factors, occupancy factors, and attenuation of the useful beam provided by objects permanently in the path of the useful beam.

3.4.3.3. All interlocks, safety and warning devices, remote monitoring systems, etc., shall be inspected for proper operation according to TO 33B-1-1.

3.4.3.4. A perimeter will be established for unshielded installations according to TO 33B-1-1 by a qualified industrial radiographer each time portable equipment is used in open areas to ensure that exposures are adequately controlled.

3.4.3.5. When radiography requires the use of an industrial radiographer and radiation monitors, the X-ray machine controls shall be placed so all monitors of the entire perimeter of the barrier can be seen or heard by the radiographer. If this is not possible, a hand-held battery powered communication device of intrinsically safe design may be utilized.

3.4.4. Radiation Protection Standards. The Basic Radiation Protection Standards adopted by the US Air Force are contained in TO 33B-1-1, Chapter 5, Section 9. This TO will be maintained in the NDI office at all times.

3.4.5. Calibration and Use of Radiation Survey Instruments. At least two operable, calibrated survey instruments shall be used during all radiographic operations. The instruments shall have an adequate instrument response for the range of radiation energies encountered.

3.4.6. Personnel Monitoring Requirements. A personal monitoring device (film badge or thermoluminescent dosimeter [TLD]) and two pocket dosimeters shall be worn by all industrial radiographers during all radiographic operations, according to TO 33B-1-1. A personal monitoring device shall be assigned to and worn by only one person as required by AFI 48-125.

3.4.7. Classification of Installations. Radiographic installations are classified as protective, enclosed, and unshielded. See TO 33B-1-1 for installation requirements, selection, and operational procedures.

3.5. Oil Analysis Program (OAP). Precautions to be exercised when performing oil analysis operations include consideration of exposure to acids, electric current, and petroleum distillates.

3.5.1. Skin contact with trichloroethane shall be avoided. Workers will use impervious gloves when handling trichloroethane. Mechanical ventilation will be provided in the area of sample vessel cleaning according to AFOSH Standard 48-2.

3.5.2. Personnel performing spectrometer maintenance with power applied will be thoroughly familiar with safety procedures in the manufacturer's equipment maintenance manual. A safety observer will be present when power-on maintenance is performed. Spectrometers will be grounded as specified in the applicable manufacturer's equipment maintenance manuals.

3.5.3. Waste oil and cleaning rags will not be allowed to accumulate in the OAP lab. Waste oil, not to exceed 5 gallons, may be stored in the lab in an approved metal container. Waste cleaning rags and towels will be removed from the lab at the end of each shift.

3.5.4. Electrodes and sample vessels used in the atomic emission spectrometer can cause hand burns. Used electrodes will be removed with a folded tissue or towel. Tongs will be provided for removing sample vessels that have overheated.

3.5.5. To prevent eye damage from ultraviolet radiation, the lighted mercury vapor lamp and electric arc of the emission spectrometer will not be viewed with the naked eye. Light shields and filters in the instrument shall be used. Continuous viewing of the atomic absorption spectrometer flame should be avoided because of its brightness.

3.6. Aircraft Maintenance NDI Operations. Personnel performing NDI operations on aircraft shall be familiar with general aircraft safety procedures in addition to the safety procedures associated with NDI. The major sources of aircraft maintenance accidents are falls, strains from lifting, fire or explosion, electrical shock, crushing of body or limbs in moving components, and walking into protruding objects. NDI personnel working on aircraft shall be familiar with the hazards of the aircraft they are working on. See applicable aircraft technical orders for additional guidance.

3.7. NDI Equipment and Fire Protection Systems . Prior to operating equipment which utilizes blacklights, X-rays, or forms of ultraviolet and (or) infrared rays, contact the base fire department. Some fire suppression systems are actuated by ultraviolet or infrared detectors and must be disabled prior to operation of this NDI equipment or other management actions taken to preclude actuation of the fire suppression systems.

ORIN L. GODSEY, Brig General, USAF
Chief of Safety

Attachment 1

GLOSSARY OF REFERENCES, ABBREVIATIONS, ACRONYMS, AND TERMS

References

Air Force Instruction (AFI) 32-7080, *Pollution Prevention Program.*

AFI 48-125, *The US Air Force Personnel Dosimetry Program.*

AFI 91-301, *Air Force Occupational and Environmental Safety, Fire Prevention, and Health (AFOSH) Program.*

Air Force Manual (AFMAN) 32-1094, *Criteria for Air Force Precision Measurement Equipment Laboratory Design and Construction* (formerly designated Air Force Manual [AFM] 88-4, Chapter 10).

AFOSH Standard 48-1, *Respiratory Protection Program.*

AFOSH Standard 48-2, *Industrial Ventilation* (formerly designated AFOSH Standard 161-2).

AFOSH Standard 48-8, *Controlling Exposures To Hazardous Materials.*

AFOSH Standard 91-31, *Personal Protective Equipment.*

AFOSH Standard 91-43, *Flammable and Combustible Liquids* (formerly designated AFOSH Standard 127-43).

Occupational Safety and Health Administration (OSHA) 29 Standard Code of Federal Regulation (CFR) 1910.1096, *Ionizing Radiation.*

National Fire Protection Association (NFPA) 70, *National Electrical Code (NEC).*

Technical Order (TO) 1-1-3, *Inspection and Repair of Aircraft Integral Tanks and Fuel Cells.*

TO 1-1-688, *Use of Electronic Equipment in Hazardous Areas.*

TO 00-25-232, *Control and use of Insulating Matting for High Voltage Application.*

TO 00-25-234, *General Shop Practice Requirements for the Repair, Maintenance, and Test of Electronic Equipment.*

TO 33B-1-1, *Nondestructive Inspection Methods.*

TO 42B5-1-2, *Gas Cylinders, Use, Handling, and Storage.*

Abbreviations and Acronyms

AFI—Air Force Instruction (new designation)

AFM—Air Force Manual (obsolete designation)

AFMAN—Air Force Manual (new designation)

AFOSH—Air Force Occupational Safety and Health

AFSC—Air Force Safety Center

C—Celsius

CFR—Code of Federal Register

CRT—Cathode Ray Tube

DRU—Direct Reporting Unit

F—Fahrenheit

FOA—Field Operating Agency

HQ—Headquarters

MAJCOM—Major Command

NDI—Nondestructive Inspection

NEC—National Electrical Code

NFPA—National Fire Protection Association

OAP—Oil Analysis Program

OSHA—Occupational Safety and Health Administration

PDO—Publishing Distribution Office

PPE—Personal Protective Equipment

TLD—Thermoluminescent Dosimeter

TO—Technical Order

UV—Ultraviolet

Terms

Blacklight—Light in the near ultraviolet spectrum, e.g. light having wave lengths of 3200 to 4000 Angstrom units, and which is used to stimulate fluorescence in various dyes.

Combustible Liquid—A liquid having a flashpoint at or above 100 degrees F (37.8 degrees Celsius [C]). Combustible liquids are categorized as Class II or Class III liquids and are further subdivided as follows:

- Class II liquids are those having a flashpoint at or above 100 degrees F (37.8 degrees C) and below 140 degrees F (60 degrees C), except any mixture having components with flashpoints of 200 degrees F (93.3 degrees C) or higher, the volume of which makes up 99 percent or more of the total volume of the mixture.
- Class IIIA liquids are those having flashpoints at or above 140 degrees F (60 degrees C) and below 200 degrees F (93.3 degrees C), except any mixture having components with flashpoints of 200 degrees F (93.3 degrees C) or higher, the total volume of which makes up 99 percent or more of the total volume of the mixture.
- Class IIIB liquids are those having flashpoints at or above 200 degrees F (93.3 degrees C).

Flammable Liquid—A liquid with a flashpoint below 100 degrees F (37.8 degrees C) except any mixture having components with flashpoints of 100 degrees F (37.8 degrees C) or higher, the total volume of which makes up 99 percent or more of the total volume of the mixture. Flammable liquids are categorized as Class 1 liquids and are further subdivided as follows:

- Class 1A are those that have a flashpoint below 73 degrees F (22.8 degrees C) and boiling points below 100 degrees F (37.8 degrees C).

- Class 1 B are those that have flashpoints below 73 degrees F (22.8 degrees C) and boiling points at or above 100 degrees F (37.8 degrees C).
- Class 1C are those that have flashpoints at or above 73 degrees F (22.8 degrees C) and below 100 degrees F (37.8 degrees C).

Flashpoint—The minimum temperature at which a liquid gives off vapor within a test vessel in sufficient concentration to form an ignitable mixture with air near the surface of the liquid. Flashpoints are established using several standard closed cup test methods.

Ionized Radiation—Electromagnetic or particulate radiation, which may cause ionization within the cells or tissues of the body. Alpha and beta particles, gamma rays, and X-rays are examples of ionizing radiation.

Hazardous Areas—Areas where combustible vapors, dusts, fibers, etc., may accumulate in sufficient concentrations to create the possibility of being ignited. These areas are defined in National Fire Protection Association (NFPA) 70 *National Electrical Code (NEC)*. When aircraft are involved, the following criteria apply:

- When the aircraft is located outside an enclosure, the hazardous area is considered as within a 5-foot radius of fuel-carrying portions of the aircraft, extending to the ground.
- When the aircraft is located inside enclosures, the hazardous area is considered as within a 5-foot radius from the fuel-carrying portions of the aircraft, extending to the floor, and the entire enclosure floor below an 18-inch level. The enclosure includes any structure which provides walls and (or) doors (either open or closed) on all sides around the aircraft at ground level.
- When the aircraft has been defueled and purged according to TO 1-1-3, *Inspection and Repair of Aircraft Integral Tanks and Fuel Cells*, the area will not be considered hazardous unless the aircraft is located inside an enclosure with unpurged aerospace or ground vehicles.

Hazardous Material—A substance which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritant, or otherwise harmful may cause injury or harm to the person.

May—Indicates an acceptable or satisfactory method of accomplishment.

Occupational Exposure to Ionizing Radiation—An exposure incurred as a result of an individual's employment or duties. Occupational exposure shall not be deemed to include the exposure of an individual to sources of ionizing radiation for the purpose of medical diagnosis or therapy.

Radiation Protection Survey—An evaluation of potential radiation hazards associated with the use of industrial X-ray and gamma ray equipment under specified conditions. When appropriate, such evaluation includes inspection of equipment, examination of its location with reference to controlled and uncontrolled areas in the immediate environment and measurements of exposure levels in the environment arising from operation of the equipment.

Rem—A measure of the dosage of ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose from 1 roentgen (r) of X-rays (1 millirem (mrem) = 0.001 rem).

Shall—Indicates a mandatory requirement.

Should—Indicates a preferred method of accomplishment.

Toxic Material—A material which causes an adverse physiological response in the human body.

Will.—Is also used to indicate a mandatory requirement and to express a declaration of intent, probability, or determination.