U.S. Department
of Transportation

Federal Aviation
Administration

Advisory Circular

Subject: Aircraft Rescue and Fire Fighting (ARFF) Training Facilities	**Date:** 9/30/2010 **Initiated by:** AAS-100	**AC No.:** 150/5220-17B **Change:**

1. PURPOSE. This advisory circular (AC) provides guidance on the design, construction, and operation of aircraft rescue and fire fighting (ARFF) training facilities.

2. SCOPE. This AC contains information of ARFF training facilities that are both permanent and mobile, and utilize a flammable liquid hydrocarbon (FLH) or propane as a fuel.

3. APPLICATION. The Federal Aviation Administration (FAA) recommends the guidance and specifications in this AC for the design, construction, and operation of an ARFF training facility. In general, use of this AC is not mandatory. However, use of this AC is mandatory for the design, construction, and operation of ARFF training facilities funded through the Airport Improvement Program (AIP) or the Passenger Facility Charge (PFC) Program. See Grant Assurance No. 34, Policies, Standards, and Specifications, and PFC Assurance No. 9, Standards and Specifications.

4. CANCELLATION. This AC cancels AC 150/5220-17A, dated January 31, 1992, including Change 1, dated November 24, 1998.

5. PRINCIPAL CHANGES.

a. This version uses a new format and numbering system in order to conform to current AC formatting conventions.

b. Required elements for the mobile ARFF trainer have been modified to improve safety, reduce costs, and improve overall ease of use.

c. The alternate sizing provisions (using agent application and apparatus discharge rates) have been removed.

d. Referenced standards have been revised.

6. COMMENTS OR SUGGESTIONS for improvements to this AC should be sent to:

Manager, Airport Engineering Division (AAS-100)
ATTN: ARFF TRAINING FACILITY
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Michael J. O'Donnell
Director of Airport Safety and Standards

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CHAPTER 1. TERMINOLOGY AND REFERENCES

1.1. DEFINITIONS.

a. Air Operations Area (AOA). All airport areas where aircraft can operate, either under their own power or while in tow. The AOA includes runways, taxiways, apron areas, and all unpaved surfaces within the airport's perimeter fence.

b. Airport Apron (or Ramp). A surface in the AOA where aircraft park and are serviced (refueled, loaded with cargo, and/or boarded by passengers).

c. Control Time. The control time is the time required from the arrival of the first fire fighting vehicle and the beginning of agent discharge to reduce the initial intensity of the fire by 90 percent. For further information on control time, refer to National Fire Protection Association (NFPA) 403, Annex B, §B.2.

d. Extinguishment Time. Extinguishment time is the time required from the application of the agent of the first fire fighting vehicle to the time the fire is extinguished. For further information on extinguishment time, refer to NFPA 403, Annex B, §B.2.

e. Hazard. A condition, object or activity with the potential for causing damage, loss, or injury.

f. Manufacturer. The manufacturer, distributor, lessor, or supplier of fire fighting training facility equipment. This includes any provider of a fire fighting training program that incorporates training facility systems or equipment.

g. Spalling. A condition of deterioration in concrete pavements characterized by a pitting or flaking of the material.

1.2. ACRONYMS AND TERMS.

AC	Advisory Circular
ACI	American Concrete Institute
AFCS	Automatic Feedback Control System
AIP	Airport Improvement Program
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
AOA	Air Operations Area
API	American Petroleum Institute
ARFF	Aircraft Rescue and Fire Fighting
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CFR	Code of Federal Regulations
DOT	United States Department of Transportation
EPA	United States Environmental Protection Agency

FAA Federal Aviation Administration
FLH Flamm able Liquid Hydrocarbon
FML Flexible Membrane Liner
FOD Foreign Object Debris
GFI Ground Fault Interrupter
GSI Geosynthetic Institute
HCN Hydrogen Cyanide
HDPE High-Density Polyethylene
HVAC Heating, Ventilation, and Air Conditioning
ICAO Intern ational Civil Aviation Organization
JP8 Jet Propulsion Fuel, Type 8
LEL Lower Explosive Limit
MFCS Manual Feedback Control System
NCMA National Concrete Masonry Association
NEC National Electrical Code
NEMA National Electrical Manufacturers Association
NFPA National Fire Protection Association
NPDES Clean Water Act (National Pollutant Discharge Elimination System)
OSHA United States Occupational Safety and Health Administration
PCA Practical Critical Fire Area
PFC Passenger Facility Charge
RFFP II Rescue and Fire Fighting Panel
TCA Theoretical Critical Fire Area
TPH Total Petroleum Hydrocarbon
USACE United States Army Corps of Engineers
USAF United States Air Force
USEPA United States Environmental Protection Agency
UST Underground Storage Tank
VOC Volatile Organic Compound
WBDGT Wet Bulb/Dry Globe Temperature

1.3. APPLICABLE DOCUMENTS.

The following documents form part of this specification and are applicable to the extent specified:

a. Code of Federal Regulations (CFR):

14 CFR Part 139 Certification of Airports

40 CFR Part 280 Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST)

b. Federal / FAA Publications:

AC 150/5210-6 Aircraft Fire and Rescue Facilities and Extinguishing Agents

AC 150/5210-17	Programs for Training of Aircraft Rescue and Firefighting Personnel
AC 150/5230-4	Aircraft Fuel Storage, Handling, and Dispensing on Airports
AC 150/5300-13	Airport Design
FAA/AR-TN01/4	Aircraft Rescue and Firefighting Training Fuel Comparative Evaluation
EPA Test 9090	Test Methods for Determining the Chemical Waste Compatibility of Synthetic Liners
SS-S-200	Federal Specification for Sealing Compounds, Two-Component, Elastomeric, Polymer Type, FLH-Fuel-Resistant, Cold Applied

c. Military Publications:

USAF TO 00-105E-9	U.S. Air Force Technical Order, Aircraft Rescue Information (Fire Protection)
USACE CRD-C-621	Handbook for Concrete and Cement, Specification for Non-Shrink Grout
USACE CW-02215	Geotextiles Used as Filters

d. Industry Publications:

ACI 211	Proportioning Concrete Mixtures
ACI 305	Hot Weather Concreting
ACI 306	Cold Weather Concreting
ACI 318	Building Code Requirements for Reinforced Concrete
AISC	Specification for Structural Steel for Buildings
ANSI B-31.3	Chemical Plant and Petroleum Refinery Piping
API Standard 620	Design and Construction of Large, Welded, Low Pressure Storage Tanks
API Standard 650	Welded Steel Tanks for Oil Storage
API Standard 2000	Venting Atmospheric and Low Pressure Storage Tanks
API Standard 2550	Methods for Measurement and Calibration of Upright Cylindrical Tanks

API Pub. 1615	Installation of Underground Petroleum Storage Systems
API Pub. 1621	Recommended Practices for Bulk Liquid Stock Control at Retail Outlets
API Spec. 12	Shop Welded Tanks for Storage of Petroleum Liquids
ASTM A 775	Specification for Epoxy-Coated Reinforcing Steel Bars
ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 94	Standard Specification for Ready-Mixed Concrete
ASTM C 150	Specification for Portland Cement
ASTM C 260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C 401	Standard Classification of Castable Refractories
ASTM D 698	Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb Rammer and 12-inch Drop
ASTM D 751	Standard Method of Testing Coated Fabrics
ASTM D 1854	FLH-Fuel-Resistant Concrete Joint Sealer, Hot-Poured Elastic Type
ASTM D 3569	Joint Sealant, Hot-Applied, Elastomeric, FLH-Fuel-Resistant-Type for Portland Cement Concrete Pavements
ASTM D 3581	Joint Sealant, Hot-Poured, FLH-Fuel-Resistant Type, for Portland Cement Concrete and Tar-Concrete Pavements
ASTM D 3776	Standard Test Method for Mass Per Unit (Weight) of Woven Fabric
ASTM D 4437	Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymetric Sheet Geomembranes
ASTM E 96	Standard Test Method for Water Vapor Transmission of Materials
AWS D 1.1	Structural Welding Code – Steel
GRI-GM13	Test Methods, Test Properties, Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
GRI-GM19	Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

NFPA 30	Flammable and Combustible Liquids Code
NFPA 54	National Fuel Gas Code
NFPA 58	Standards for the Storage and Handling of Liquefied Petroleum Gases
NFPA 70	National Electrical Code (NEC)
NFPA 385	Standard for Tank Vehicles for Flammable and Combustible Liquids
NFPA 403	Standard for Aircraft Rescue and Fire-Fighting Services at Airports
NFPA 407	Aircraft Fuel Servicing
NFPA 412	Standard for Evaluating Aircraft Rescue and Fire-Fighting Foam Fire Equipment
NFPA 422	Aircraft Fire and Explosion Investigation

e. Sources:

(1) Federal regulations (CFR text) may be obtained from: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402

(2) Federal publications may be obtained from:

(a) FAA ACs from the FAA website at: http://www.faa.gov/regulations_policies/advisory_circulars/

(b) Federal and FAA Orders, Specifications, and Drawings: Federal Aviation Administration, ATO-W CM-NAS Documentation, Control Center, 800 Independence Avenue, SW, Washington, DC 20591. Telephone: (202) 548-5256, FAX: (202) 548-5501 and website: http://www.faa.gov/about/office_org/headquarters_offices/ato/service_units/techops/atc_facilities/cm/cm_documentation/

(c) FAA Technical Notes: National Technical Information Service (NTIS), Springfield, Virginia 22161 and website: actlibrary.tc.faa.gov

(d) EPA documents: U.S. Environmental Protection Agency, Office of the Science Advisor (8105R), 1200 Pennsylvania Avenue, NW, Washington, DC 20460 and website: www.epa.gov

(3) Military standards and specifications may be obtained from:

(a) HQ AFCESA/CEXF, ATTN: Fire and Egress Service Manager, 139 Barnes Drive Suite 1, Tyndall Air Force Base, FL 32403-5319, Telephone: (850) 283-6150, and website: www.dodffcert.com/00-105E-9/index.cfm

(b) USACE Publication Depot, ATTN: CEHEC-IM-PD, 2803 52nd Ave., Hyattsville, MD 20781-1102, and website: www.usace.army.mil/library

(4) Industry publications may be obtained from:

(a) American Concrete Institute (ACI), 38800 Country Club Dr., Farmington Hills, MI 48331 USA, Phone: 248-848-3700, FAX: 248-848-3701

(b) American Institute of Steel Construction (AISC), One East Wacker Dr. Suite 700, Chicago IL 60601, Phone: (312) 670-2400, FAX: (312) 896-9022, and website: www.aisc.org

(c) American National Standards Institute (ANSI), Attn: Customer Service Department, 25 W 43rd Street, 4th Floor, New York, NY, 10036, Phone: 212-642-4980, FAX: 212-302-1286, and website: webstore.ansi.org

(d) American Petroleum Institute (API), 1220 L Street, N.W., Washington, DC 20005

(e) American Society for Testing and Materials (ASTM), 1916 Race Street, Philadelphia, PA 19103

(f) American Welding Society, Inc. (AWS), 550 N.W. LeJeune Road, P.O. Box 351040, Miami, FL 33135

(g) Geosynthetic Institute (GSI), 475 Kedron Avenue, Folsom, PA 19033-1208, Telephone: 610-522-8440, FAX: 610-522-8441, Website: www.geosynthetic-institute.org

(h) National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02269

CHAPTER 2. DESIGN PRINCIPLES

2.1. GENERAL.

a. The purpose of an ARFF training facility is to provide a safe training environment that is also visually and physically realistic, repeatable, and able to be documented. Training must not be so controlled as to give firefighters a false sense of security, nor can it disregard established safety procedures for the sake of increased realism. A balance between realism and safety must therefore be reached to achieve optimal training.

b. The standards and guidance in this AC allow for the safe and realistic replication of the flames, heat, and reduced visibility that ARFF personnel may encounter during a response to actual airfield emergencies.

2.2. SYSTEM DESCRIPTION.

a. Types. There are two main types of ARFF training facilities that use two main types of fuel. ARFF training facilities can be either “fixed” or “mobile.” Fixed systems may use Flammable Liquid Hydrocarbons (FLHs) or propane as the training fuel, while mobile systems use only propane.

b. Components. ARFF training facilities contain the following functional units (Figure 2-1):

(1) Burn area

(2) Vehicle maneuvering area

(3) Aircraft mock-up

(4) Control station

(5) Support systems:

- Fuel delivery / collection
- Water delivery / collection
- Electrical

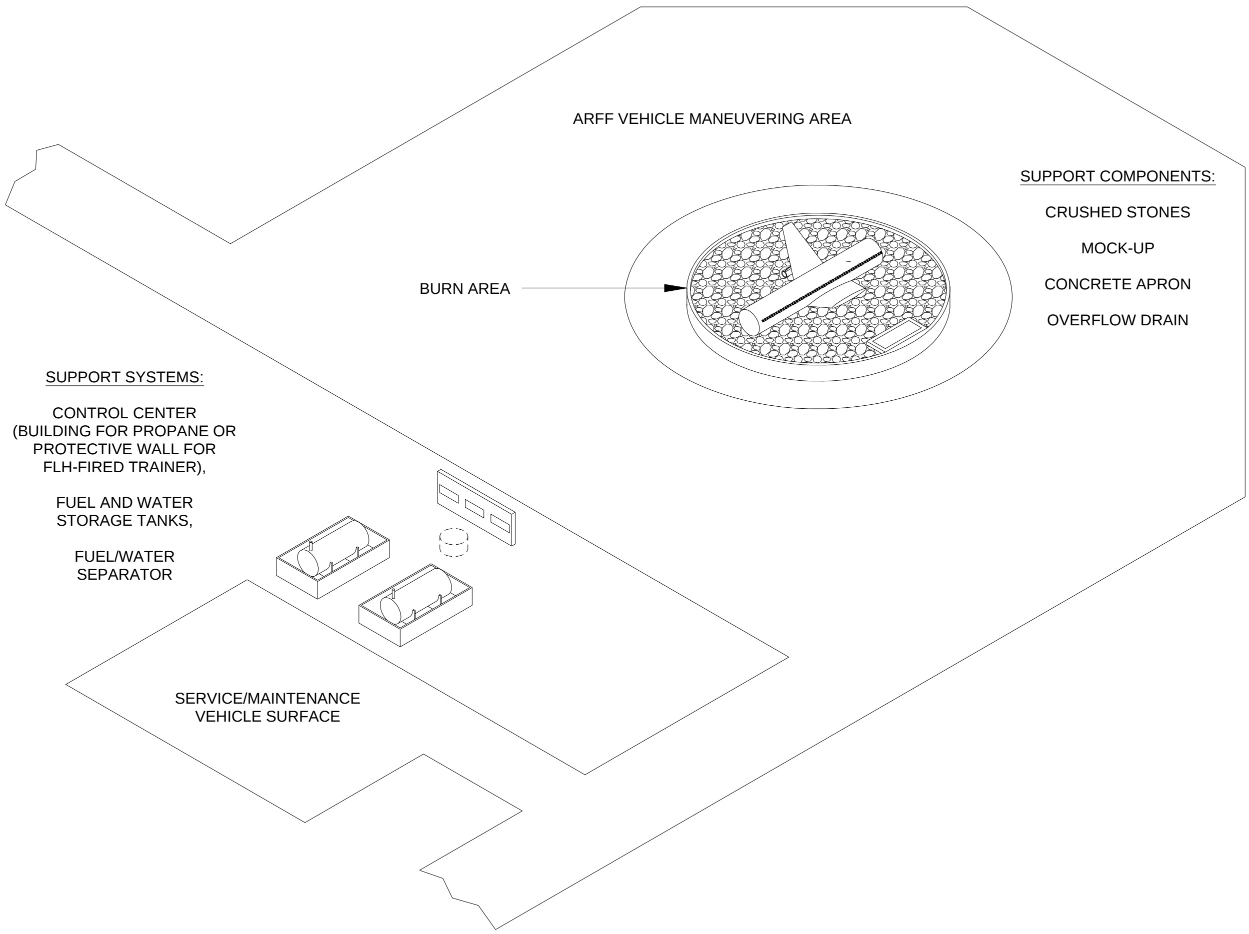


Figure 2-1. Basic components of a fire training facility

2.3. SYSTEM COMPONENTS.

a. Burn Area Structure. The burn area structure, or fire area, is the focal point of the training facility. It is designed to create a realistic aircraft accident fire environment and to contain training substances. Its size is a function of the typical aircraft serving the airport.

b. Vehicle Maneuvering Area. This area physically surrounds the burn area structure and should be large enough to allow for the tactical operation of ARFF vehicles as they approach the burn area structure and the realistic deployment of personnel using hand lines.

c. Aircraft Mock-up. A structure of a configuration and size that represents the typical aircraft servicing the airport. The mock-up is capable of presenting a variety of realistic exterior, component, and interior aircraft fires if specified. The mock-up may either be of a fixed or mobile type.

d. Control Station. A system that allows an operator to configure and control the live-fire exercises of the training facility. The station may utilize either manual or automatic control systems to control the simulation variables.

e. Support Systems. Support systems comprise the functional units needed for a training facility to function properly and implement the simulation of various types of aircraft fires. Each support system contains individual support components that make up the system (e.g., the fuel distribution system consists of a storage tank, pumps, associated piping, etc.). These systems include:

(1) Fuel delivery / collection.

(2) Water delivery / collection.

2.4. CRITICAL FIRE AREAS.

a. Critical Fire Areas. Figure 2-2 is a representation of the relationship between the theoretical critical fire area (TCA), the practical critical area (PCA), and a large aircraft. The actual size of the TCA is a function of the length and width of the specific aircraft of interest. Fires outside the theoretical critical area have no immediate impact on the life safety and rescue problem at the aircraft. The PCA is defined as an area approximately two-thirds of the TCA for any given aircraft. It is the minimum area that the first responding ARFF units need to keep fire-free during the aircraft evacuation process. Hence, the PCA is used in aircraft rescue and fire fighting system planning to quantify the tactical and logistical aspects of the problem. Therefore, it is vital in ARFF training facility design.

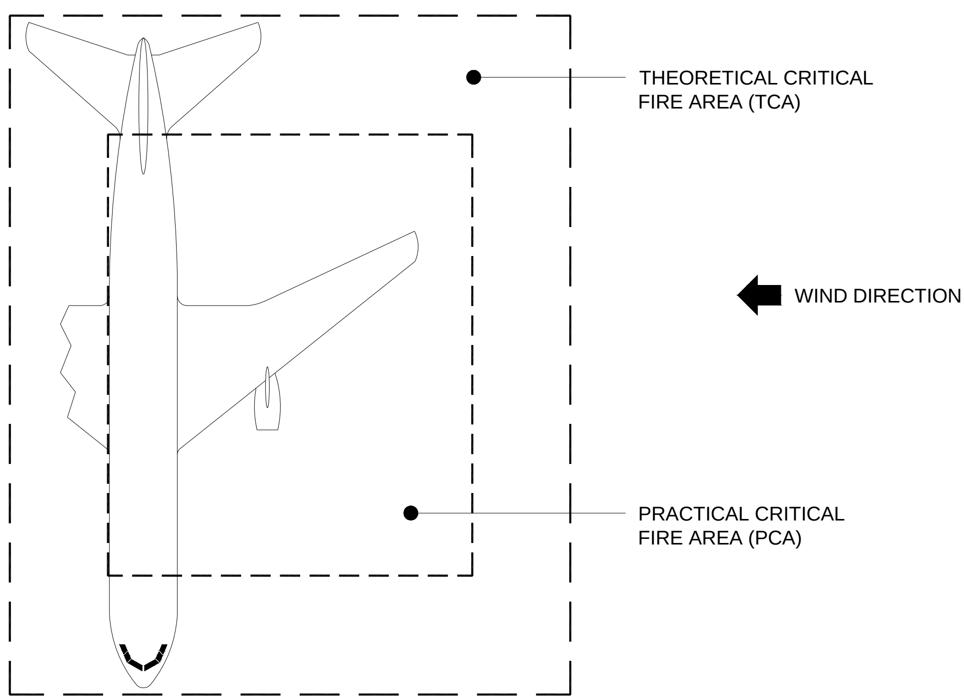


Figure 2-2. The critical fire areas

(1) **Theoretical Critical Fire Area (TCA).** The TCA serves as a means of categorizing aircraft in terms of the magnitude of the potential fire hazard in which they may become involved. It is not intended to represent the average, maximum, or minimum spill fire

size associated with a particular aircraft. For information on TCA, refer to NFPA 403, Annex B, §B.1.1.

(2) **Practical Critical Fire Area (PCA).** The PCA and the related quantities of extinguishing agents are based on criteria formulated during the Second Meeting of the International Civil Aviation Organization (ICAO) Rescue and Fire Fighting Panel (RFFP) in June 1972. The RFFP developed material indicating the practical area is two-thirds of the theoretical area based on the Panel's work, which included a study of extinguishing agents used on actual aircraft fires. In 99 out of 106 studied fires, the quantities of agents used were less than those previously recommended by ICAO. For information on PCA, refer to NFPA 403, Annex B, §B.1.1.

CHAPTER 3. FACILITY DESIGN AND SELECTION

3.1. GENERAL

The design and selection of a properly sized and furnished ARFF training facility is discussed in this Chapter by approaching each main facility component individually. Each of the components represent interdependent variables that will need to meet existing regulations and provide the best fit for an airport's physical and operational requirements.

3.2. BURN AREA.

a. The fuel-spill burn area provides airport ARFF personnel with a realistic scenario to practice responding to, gaining control of, and extinguishing a ground-based, aviation fuel-spill fire typical of ramp service mishaps and aircraft accidents.

b. Dimensions. There are two primary methods to size a fixed burn area structure. The first method, referred to as the Airport ARFF Index Method, is based on the PCA of an average aircraft size that is common to the airport. The second method, referred to as the Empirical Area Simulator Method, takes advantage of the controlled simulator practices that are afforded by the use of propane fuel. The empirical area simulator method generally allows for smaller training facilities to be built on airports where space is limited or the use of free burning FLH fuel is prohibited. As such, this method is ideal for the sizing of mobile training facilities. Regardless of the type of facility, the Airport ARFF Index Method sets the upper limits for the square footage of the fundable burn area structure.

(1) **Airport ARFF Index Method.** The size of a burn area structure using the Airport ARFF Index Method must be in accordance with the practical critical fire area (PCA) of Table 3-1 for the given airport ARFF index. Although the size of the PCA for a specific aircraft is a function of the fuselage length and width, it has been found that for economies of design, the use of average aircraft dimensions, based on operationally similar groups of aircraft, provides technically acceptable values for burn areas that represent airport ARFF-indexed PCAs.

(a) Part 139, §139.315 is to be used to determine the aircraft rescue and firefighting Index (A through E) for airports serving Department of Transportation (DOT) certificated air carriers/commercial service. These numbers can then be converted to NFPA categories using NFPA 403, Chapter 4, Table 4.3.1. The Indexes for general aviation airports are also identified in NFPA 403, Chapter 4, Table 4.3.1 and cover the areas not governed by the FAA. It should be noted that part 139 takes precedence and that NFPA 403 may, in some cases, exceed part 139 requirements.

(b) The extinguishing agents, quantities, and discharge and response capability for each Index is referenced in NFPA 403, Chapter 5, Table 5.3.1 (b), in U.S. customary units and could be used to comply with §139.315. NFPA 403, Annex B, additionally describes the methodology used to arrive at the designated control times (§B.2), discharge rates (§B.3), and quantities of agents to be provided (§B.4 and §B.5).

(2) **Empirical Area Simulator Method.** The burn area structure for ARFF training facilities using a computer-controlled, propane-fired simulator must be sized as follows:

(a) For ARFF index A and B simulations, the burn area must be a circle with a diameter of least 100 feet (-1/+2 ft). A square or a rectangle, which will accommodate the required aircraft mockup, of an approximately equivalent area (7,855 ft) is acceptable.

(b) For ARFF index C through E simulations, the burn area must be a circle with a diameter of least 125 feet (-1/+3 ft). A square or a rectangle, which will accommodate the required aircraft mockup, of an approximately equivalent area (12,265 ft^2) is acceptable.

Table 3-1. Burn area structures as a function of airport ARFF index

Airport ARFF Index	Overall Aircraft Lengths Lower ft. (m)	Average ft. (m)	Upper ft. (m)	Average Fuselage Width	PCA sq. ft (sq. m)	Rectangular Burn Area (L/W-4/3)	Circular Burn Area Diameter ft. (m)
A	30 (9)	38 (12)	45 (14)	6 (2)	1171 (109)	40 x 30 (12 x 9)	39 (12)
A	45 (14)	53 (16)	60 (18)	10 (3)	1775 (165)	49 x 36 (15 x 11)	48 (15)
A	60 (18)	75 (23)	90 (27)	10 (3)	5527 (513)	86 x 64 (26 x 20)	84 (26)
B	90 (27)	108 (33)	126 (38)	10 (3)	7959 (739)	103 x 77 (31 x 23)	101 (31)
C	126 (38)	143 (44)	160 (49)	10 (3)	10539 (979)	118 x 89 (36 x 27)	116 (35)
D	160 (49)	180 (55)	200 (61)	20 (6)	14475 (1345)	139 x 104 (42 x 32)	136 (41)
E	200 (61)	225 (69)	---	20 (6)	18090 (1681)	155 x 116 (47 x 35)	152 (46)

c. Mobile Trainer.

(1) **Dimensions.** The area of the fuel spill fire on the ground for all mobile trainers can be calculated using the Empirical Area Simulator Method. However, the minimum area of the fuel-spill fire must not be less than 1,300 sq. ft (120 m^2); 400 sq. ft (37 m^2) of this requirement is met by the fuel spill fuselage fire leaving 900 sq. ft (84 m^2) to be met per paragraph 3.2.c.2, "Performance Criteria."

(a) Since firefighters at Index C, D, & E airports are required to be trained every third year (per FAA CERTALERT 04-18) in a facility meeting the square footage requirements in Table 3-1, there is no minimum acceptable burn area requirement for mobile trainers used by these airports during the interim yearly training. However, it is recommended that, if the mobile trainer fuel-spill fire simulation is to be included, the minimum square footage be no less than 2,600 sq. ft. (240 m^2). This additional 1300 sq. ft. (120 m^2) should only be included if selected as an option by the purchaser.

(2) **Performance Criteria.** The fuel-spill burn areas for a mobile trainer must be divided into controllable segments.

(a) The segments must be sized, configured, and operated in a manner that will present a realistic visual impression to firefighters approaching the scene and for a realistic response of the fire to agent application from hand lines or ARFF vehicle turrets. It is recommended that each fuel spill controllable segment be no larger than 150 sq. ft. (14 m^2), as larger areas (based upon current technology) may not be able to adequately represent fire fighter extinguishing actions.

(b) The fire presented within the fuel-spill burn area (when totally involved) must cover at least 95% of the surface of the burn area. When configurations other than the entire area are used, 92% of the surface area represented by the active segments must be covered with fire.

(c) The control segments which make-up the burn area, the control valve assemblies which control propane flow to the individual segments, and the pilot ignition system used to ignite the fuel-spill burn area must be designed for convenient set-up, break-down, and repackaging by instructors.

3.3. VEHICLE MANEUVERING AREA.

a. Dimensions. Facilities intended for vehicle operator and/or turret operator training must have a vehicle maneuvering area. For long-term cost effectiveness, the area should allow for the operation of future vehicles with more demanding operational characteristics.

(1) **Turret Discharge.** The area must accommodate the full turret discharge range while discharging dispersed and straight stream patterns during stationary and pump and roll operations.

(2) **Vehicle Mobility.** The area must accommodate the ARFF vehicle turning radius, backup requirements, and, with the longest vehicle parked perpendicular to the burn area structure, passage of other ARFF vehicles.

(3) **Approach Path.** There must be more than one approach path to the burn area.

b. Surface Properties.

(1) **Soil Load Bearing Capacity.** Soil load bearing capacity, treated if necessary, must exhibit good load bearing capacity of fully loaded ARFF vehicles operations and withstand the accelerating and decelerating traction forces and turning actions of wheels without severe rutting damage.

(2) **Sloped Surface.** To reduce the channeled rainfall and/or snow melt load on the drainage system, the maneuvering surface should sloped as follows:

(a) For facilities with a berm, slope away from the burn area structure to divert runoff.

(b) For facilities with a concrete curb, slope in two directions. The inner section (apron) up to ten feet (3.0 m) must slope towards the concrete curb with the outer section sloped away from the burn area. If the apron is paved, a smooth transition must be provided between it and the outer ground surface.

c. Access.

(1) **Paved Access Roads.** If the training facility access road is directly connected to an aircraft operational area, it must be paved for at least the first 500 feet (152 m) from the edge of the operational area. Paving this strip lessens the chance for foreign object debris (FOD) damage in areas intended for the movement of aircraft due to "tracking" of objects. Paved access roads must have signs in accordance with AC 150/5340-18, Standards for Airport Sign Systems.

(2) **Controlled Access.** All weather access to the training facility must be provided. A means must be provided to limit access to authorized personnel and to ensure that there is no unauthorized uses, such as, chemical dumping and trash burning on the burn area.

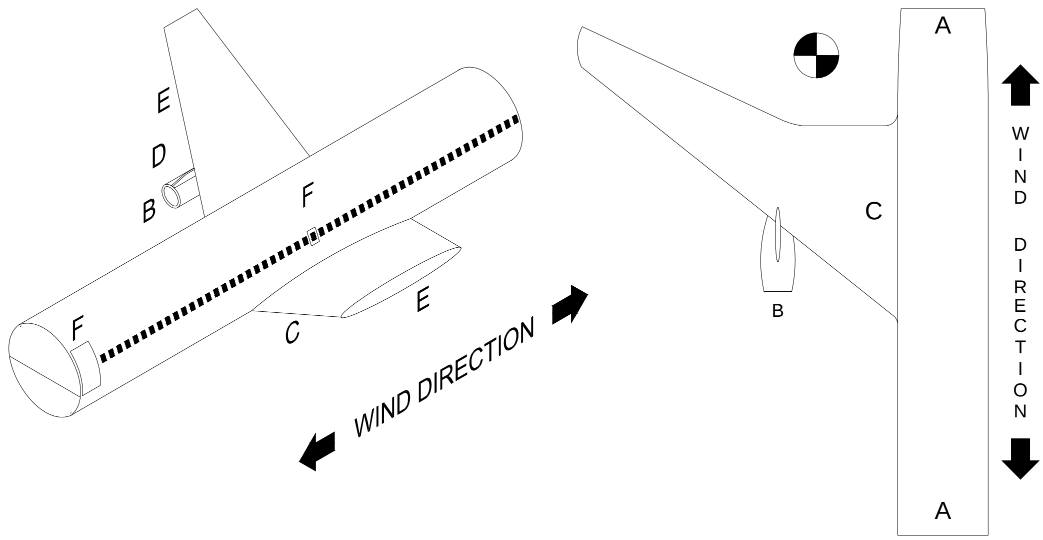
3.4. AIRCRAFT MOCK-UP.

a. An aircraft mock-up must be provided that can present the complications normally encountered in the suppression of a variety of real exterior and interior aircraft fires. Large pool fires and other training fire scenarios may be supported by either a single multi-purpose training mock-up or a pair of mock-ups.

b. Types.

(1) **Single Mockup Model.** The mock-up must be located within the burn area structure in a manner similar to that shown in Figure 2-1. The mock-up must have strategically located fire devices and other special features to simulate the variety of mandatory aircraft fires described in paragraph 4.4.e "Fire Scenarios." Figure 3-1 illustrates an example of a single wing, truncated mock-up with an elliptical cross section and FLH fuel nozzle or propane-fired gas burner element locations.

(2) **Split Function Mockups.** If this alternative approach is selected, two mockups must be provided that will permit the separation of the large pool fires from the other training fire scenarios. The major aircraft fuel spill simulator must be located within the burn area structure in a manner similar to that shown in Figure 2-1. The other mockup must contain all of the other mandatory fire scenarios that cannot be accommodated by the major spill fire simulator. It may be located in any convenient place within the training ground that is compatible with the overall training area layout and may be portable/mobile.



LEGEND:

: FUEL NOZZLE OR PROPANE BURNER ELEMENT LOCATION

A: GALLEY /COCKPIT/LAV/TRASH CONTAINERS

B: ENGINE NACELLE MOCK-UP

C: LANDING GEAR BRAKE/TIRES MOCK-UP

D: 3-DIMENSIONAL FUEL FIRES

E: UNDERWING DIFFICULTIES

F: REPLACEABLE "FORCED ENTRY" PANELS

Figure 3-1. Example of an aircraft mock-up

c. Dimensions. The primary consideration for the size and shape of the aircraft fuselage mock-up is to provide a viable target for practicing aircraft rescue and fire fighting operations. Hence, maintaining a reasonably realistic cross section and using a somewhat truncated length generally fulfills the functional requirements of a mockup. The mock-up structure for ARFF training facilities using either a controlled, propane-fired, or a FLH-fired simulator must have at least two doorways on each side for rescue training. The fuselage floor in all mock-ups intended for interior aircraft fire fighting operations must be capable of supporting the loads imposed by trainees during rescue and interior fire fighting exercises. The mock-up must be sized as follows:

(1) **Length.** For ARFF index A and B simulation, the fuselage mock-up must be at least 50 feet (15.25 m) long. For ARFF index C through E simulation, the fuselage mock-up must be at least 75 feet (23 m) long. If the mock-up is to be a mobile unit, the length of the longest component must be no longer/heavier than that which meets the legal length/axle weight transportability requirements for public highway transportation.

(2) **Height and Width.** The fuselage diameter must be at least 10 ft (3 m) for mock-ups with round cross sections. If rectangular, it must be at least 7 ft (2 m) wide by 7 ft (2 m) high.

(3) **Wing Span.** The wing span for the 50 ft (15 m) long mock-up must at least 25 ft (7 m) from the fuselage centerline to the wingtip. For the 75 ft (23 m) long mock-up, the wing span must be at least 30 ft (9 m). The spacing of wing support columns should evenly distribute the weight on spread footings to eliminate damage to the concrete or high density polyethylene (HDPE) flexible membrane liner (FML) floor. Additional geotextile fabric placed over the primary liner may be necessary to provide required protection in FLH-fired facilities.

(4) **Tail Section.** The mock-up may include a tail section with or without an engine pod. If installed, the dimension of the tail sections should be in approximate proportion to the basic mockup.

d. Mobile Trainer.

(1) The aircraft mock-up must be sized and proportioned to represent a commercial passenger aircraft (see paragraph 3.4.d.5, “Dimensions of an Operational Mock-Up” in this section). The overall dimensions when configured for training may be different from the dimensions required for transporting the mock-up between training sites. The absolute requirement for practical, cost-effective transportability will by its nature limit the upper limit on actual size. Functional realism, not actual size, must be the governing factor in assessing acceptability of the mobile trainer.

(2) The mock-up, when deployed for training, must present the fire fighter with approximately the same access constraints as found on commercial passenger aircraft.

(a) The height of access doorways and hatches from ground or wing level must approximate those on commercial passenger aircraft.

(b) Engine and wheel locations must be multi-configurable to simulate both high and low wing aircraft. For mock-ups that simulate aircraft boarding and require doors/hatches, the high-wing configuration is not required.

(c) The operation of doors and hatches must closely approximate those found on actual aircraft.

(d) At least three replaceable skin panel devices must be provided. One located midway along the fuselage above the passenger cabin window line (or one located along the top of the passenger cabin if specified by the purchaser), one giving access to the cargo / luggage compartment, and one located along the passenger cabin wall. These panels must be suitable to practice fuselage penetration for ventilation and remote, agent-penetrator application training.

(e) In addition to representative crew seating, the cockpit must be equipped with simulated throttles and Tee controls and any other mock instrumentation needed to support the required scenarios.

(3) Any purchaser-specific requirements relating to functional locations and dimensions of the mobile trainer components which differ significantly from the general requirements presented above or in paragraph 3.4.d.5, “Dimensions of an Operational Mock-Up” should be clearly addressed in the purchaser’s request for a proposal.

(4) **Dimensions Of Operational Mock-Up.** Table 3-2 provides guidance as to an acceptable range for the dimensions of the mock-up in the fully deployed training configuration.

Table 3-2. Dimensions – operational mock-up

DESCRIPTION	Minimum	Maximum
Fuselage	**ft (m)**	**Ft (m)**
Length	50 (15)	55 (17)
Height – ground to top of tail	13 (4)	20 (6)
Height – without tail	10.5 (3.20)	13.5 (4.11)
Width	7 (2)	9.5 (2.9)
Interior head height-center line	5.75 (1.75)	7 (2)
Aisle width	1.33 (.405)	2 (.6)
Doorways		
Height	5.5 (1.7)	6.5 (2.0)
Width	2.5 (.76)	3.5 (1.1)
Bottom of door to ground	4.0 (1.2)	6 (2)
Over-wing Escape Hatch		
Height	3 (.9)	3.75 (1.1)
Width	1.5 (.46)	2.5 (.76)
Bottom of door to ground	5.5 (1.7)	8 (2.4)
Weight of escape hatch	25 lb (11 kg)	50 lb (22 kg)
Wing		
Length – center line to wingtip, low wing	15 (4.6)	25 (7.6)
Height – low wing top to ground	4.0 (1.2)	6 (2)
Height – high wing top to ground	9 (3)	12 (3.7)
Weight of wing assembly	None	100 lb (44 kg)

(a) Table 3-3 provides an acceptable range for the packaged dimensions which met US Department of Transportation (US DOT) guidelines for over-the-road transportation at the time of this writing. The supplier must review the requirements as of anticipated delivery date and must make the customer aware of any changes needed in the bid request to comply.

Table 3-3. Dimensions – packaged mock-up

DESCRIPTION	Minimum	Maximum
Fuselage in Transport Mode	**ft (m)**	**ft (m)**
Overall Length – Trailer & fuselage	50 (15)	55 (17)
Height – ground to highest point	None	12 (3.7)
Width at widest point	None	8.5 (2.6)
Undercarriage clearance – lowest point	1.5 (.46)	None

(b) No individual component of the mobile trainer which requires moving, handling, or repositioning during the deployment, break-down, and repackaging process must weigh in excess of 100 lb (45 kg) unless some mechanical means to assist the operators is identified/provided.

NOTE: *The weight limit imposed on any single component of the mobile trainer is to allow two people to safely deploy the equipment without exceeding United States Occutional Safety and Health Administration (OSHA) guidelines of a 50 lb (23 kg) weight limit per person lift.*

3.5. CONTROL STATION.

The operational characteristics of the control station must be designed to ensure that the safety of personnel operating in and around the training facility is of highest priority. Unless otherwise stated, the following standards apply to both fixed and mobile training facilities:

a. Dimensions.

(1) **FLH Trainer.** This trainer must have a protective wall with a viewing window to provide an instructor or safety officer a complete visual view of the burn area structure for monitoring training exercises (see Figure 3-2). Additionally, the wall can provide protection to other training facility items such as, fuel and water storage tanks. The protective wall must:

(a) Be at least 150 ft (46 m) upwind with respect to the prevailing winds to alleviate blinding smoke and fire hazards caused by wandering gas vapors. Generally, the direction of prevailing winds is identical to the airport's wind rose. However, a different wind orientation is possible. For example, an airport may have a limited training season because of severe winters or heavy seasonal rainfalls. Under these restrictions, a different seasonal wind orientation may exist.

(b) Have a viewing window next to the control console to monitor training exercises.

(c) Have a height equal to the height of the tallest aboveground fuel tank but not over 8 ft (2 m) and, if used to protect a fuel tank, a width not less than 15 ft (4.6 m).

(d) Have a wind sock installed to indicate wind direction and wind shifts. The wind sock, if located closer to the burn pit, will be much more accurate than other wind indicators in the airfield. A significant change in wind direction may necessitate a stop in training in order for equipment to be repositioned. Proper attention to the wind direction is vital to ensuring the safety of personnel in the burn pit.

(2) **Propane Trainer.** The control center must provide an instructor or safety officer a complete visual view of the burn area structure for monitoring training exercises. The control center must be:

(a) Located at least 150 ft (46 m) upwind with respect to the prevailing winds from the burn area structure to alleviate smoke and flame impingement. However, a different orientation is possible, as noted in paragraph 3.5.a(1)(a).

(b) Equipped with the necessary computer hardware or other appropriate means to perform varying degrees and types of training exercises and a hard copy printer or other appropriate means to record training performance and provide permanent reports.

(3) **Mobile Trainer.** The maximum practical size (height, width, length, and weight) is governed by the need for the entire mobile trainer to be transportable on highways.

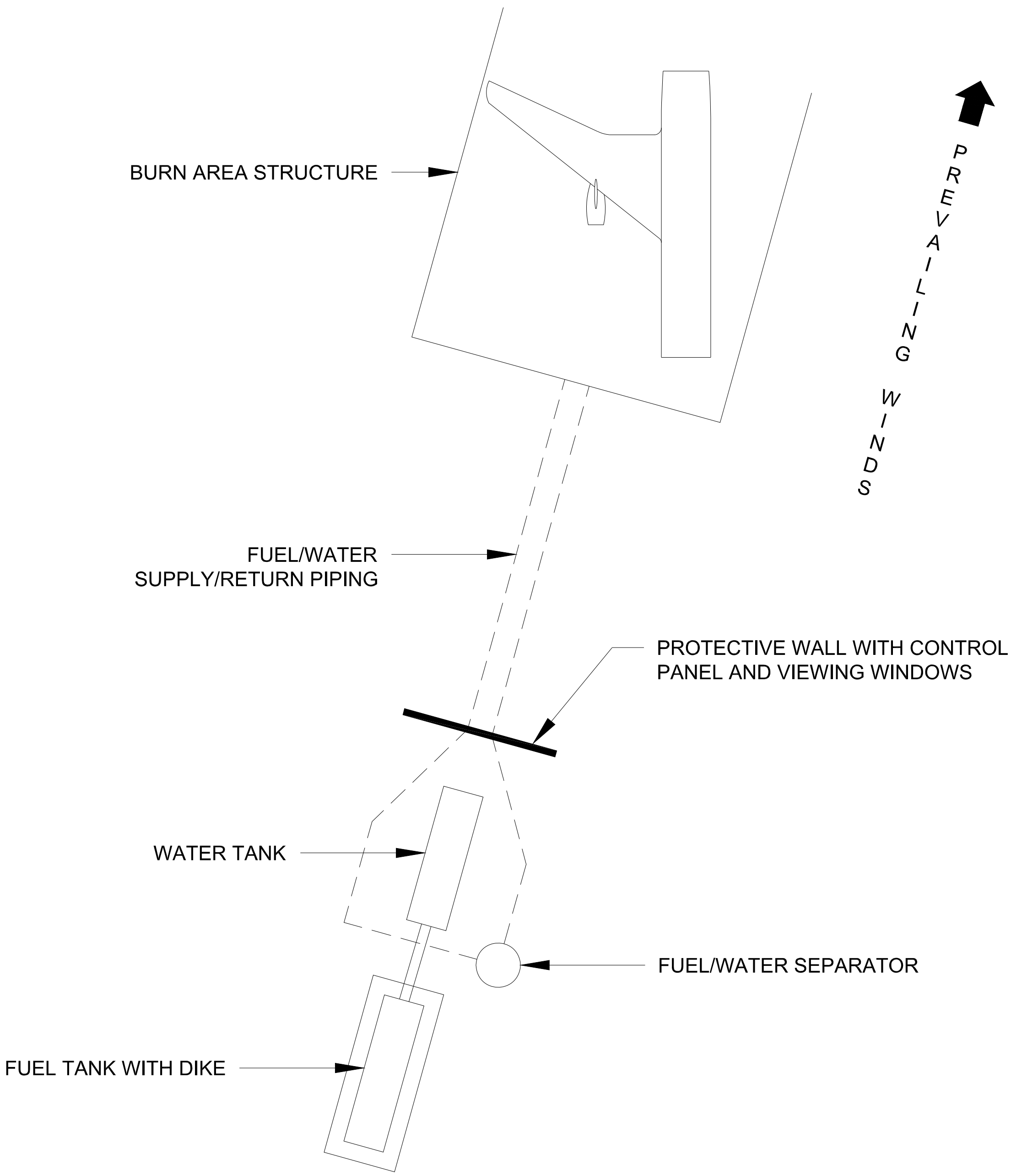


Figure 3-2. Example location of a control center

b. Control System.

(1) **Visibility.** The control center must be so arranged and provided with sufficient window area to allow the operator, while operating the control system, a 180° view of the exterior. Depending on the specific site set-up, that view should allow oversight of the active, exterior side of the fuselage, the fuel-spill burn area and the propane storage and delivery system.

(2) **Communications.**

(a) Control centers must have a communications system that fulfill the command and control needs of the system operator, a safety officer, and one or more instructors for a simple, reliable means of communicating during system operation.

(b) The control center must be radio-equipped in a manner that will allow the system operator to maintain audio contact with an instructor and a safety officer when either or both are inside the fuselage, outside the fuselage, or at the fuel-spill burn area at any given time.

(c) The communications system must be compatible with existing local communications systems, including the ability to operate without interfering with existing airport and aircraft operations.

(d) In the event of a significant trainer emergency, the system operator may be assisted by having a direct connection to a central station/airport first responder team.

(3) **Emergency Stops.** The control center must be equipped with a manual emergency shut-down device (E-stops) for each fire scenario. Upon activation of any of the emergency stops, all flames must be extinguished within ten seconds.

(a) **Remote E-stops.** In addition, a means must be provided to comply with the requirement for E-stops listed for this and each of the following other paragraphs:

Section	Paragraph(s)
3.5	c(5) & d(2)
4.6	a.(2).(d)

(4) **Operational Warnings.**

(a) The control system (manual or automatic) must provide for setup and calibration and continuous monitoring and troubleshooting of all safety systems. It must provide for auto-shutdown under any conditions warranting such action.

(b) The control system must be configured so that the safety systems defined in this section will, if an unsafe condition occurs, override the operation of the control center, and cause rapid shut down of fuel supply and initiate ventilation of the mock-up.

(5) **Performance Documentation.** If specified by the purchaser, the control station will be capable of electronically recording training scenarios (including the system's variable

settings), participant rosters, and performance logs, and to enable these data to be printed using common word-processing software at an off-site location.

(6) **Environmental Control.** The control center space must be designed to house the control system components and protect them from weather when not in use. For mobile trainers, a climate-controlled (Heating, Ventilation, and Air Conditioning, or HVAC) control center is not allowed.

(7) **Variable Control.** The control system must permit the fire control variables associated with each of the training fire scenarios to be configured by the system operator so as to repeat a given training scenario. System setup and calibration data must be clearly displayed for manual recording (or automatic recording, if specified by the purchaser).

(8) For automatic systems, the control system must automatically measure the agent application rate and provide control of the fire, including the increase or reduction of the fire based on firefighter performance. Each fire scenario must have sufficient thermo heat sensor positions to detect the agent application across the full coverage area of the fire.

(9) For mobile trainers, the control center may be an integral part of the overall unit.

c. Operator's Station. The station must:

(1) be configured to allow the operator to rapidly configure, reconfigure, and run the training scenarios;

(2) provide the operator with a means to identify potential problems associated with the various training scenarios by warnings and alarms with both visual and audible cues; and

(3) provide a means to facilitate subsystem testing, maintenance, and trouble-shooting. Built in diagnostics must be provided to assist the operator in identifying and isolating items in the system which may require calibration and/or replacement.

(4) When not in use, access to the operator's station must be protected by a reliable security device. This can include stowing the operator station in the locked tractor or trailer. (Mobile trainer only)

(5) A means must be provided to run each fireplace (except interior fuselage scenarios) from either the operator station with radio communications among the operator, one or more instructors, and a safety officer or by an instructor from a local control pendant. In the latter case, the system operator must be able to monitor performance and activate an E-stop for each fire scenario from the operator control station.

(a) Each scenario must have specific fire behavior variables associated with the characteristics of the fire being simulated and operational features associated with the extinguishing of that particular type of fire.

(b) A means must be provided to configure the various fireplace variables from the operator's station. Access to the control system configuration, operation, and maintenance functions must be through a reliable security device.

(c) A means must be provided to ensure that the variables are configured prior to the start of a training scenario. For automatic control systems, once the scenario has begun, the variables must be locked and cannot be changed until after the completion of the training exercise.

d. Pendant Control. A local control pendant must be provided. The pendant must allow an instructor to activate the interior fuselage training scenarios from inside the fuselage mock-up.

(1) Prewired stations located near each of the other fire scenarios must be provided with quick connect fittings to facilitate connecting a local control pendant. All pendants provided must have sufficient, but not less than ten feet, control cable to allow the instructor to observe the fire fighter's performance without interfering with their access to the scenario.

(2) All pendants provided must be equipped with an emergency shut-down switch which shuts-off all propane supply to the trainer, and, for interior fire scenarios, automatically ventilates the fuselage mock-up.

(3) Other controls on the pendants must include smoke emit, pilot enable, fire start, and (for interior fires only) ventilation enable. For automatic control systems, an indicator must also be provided to inform the instructor that the control system is detecting agent application.

(4) An unused switch and sufficient unused control wires must be provided to allow the connection of an optional fireplace function which may be added to the mobile trainer at a later date.

3.6. FUELS.

a. National environmental air and water quality regulations have increasingly become more stringent over the years poses are getting more and more stringent. These regulatory changes make it particularly difficult for ARFF personnel to get quality firefighting training, especially if the fuel normally used in their ARFF training station is no longer allowed. The environmental regulations are increasing the cost of operating liquid hydrocarbon-based training facilities and forcing several training facilities to close or transition to propane. Therefore choosing the proper fuel for the training station is a critical, and difficult, choice.

b. Types. The two main types of fuel used in ARFF training stations are Flammable Liquid Hydrocarbons (or FLHs) and Propane. This AC specifies the use of either an appropriate FLH fuel (such as the conventional transportation fuels of gasoline, diesel, jet fuel, or combinations of these) or an appropriately controlled propane fueled system.

(1) **FLH.** The typical FLH fuel used in trainers is JP8. Recent changes to environmental legislation has required many to consider using FLH alternatives or propane fuels.

(2) **FLH Alternatives.** The use of alternate FLH fuel(s), which can be appropriately controlled to provide the simulated affect of the typical FLH fuel spill fire and/or the other required fire scenarios is acceptable and encouraged. Research conducted by FAA has shown that the use of alternative fuels can provide significant advantages over JP8 (DOT/FAA/AR-TN01/4, Aircraft Rescue and Firefighting Training Fuel Comparative Evaluation). Tests on the alternative fuel's smoke density, total petroleum hydrocarbon (TPH), and volatile organic compounds (VOCs) showed major improvements over JP8. The alternative significantly reduces the smoke generated, reducing the production of environmentally harmful by-products and contaminated water runoff.

(3) **Propane.** The use of a propane-fired trainer to simulate a FLH fire will eliminate the hydrocarbon/water/agent discharge and disposal problems associated with FLHs. This type of simulator will also minimize air pollution problems. In addition, the rapid automatic or manual shutdown capability offered by the computer system is a significant safety enhancement as well as a versatile tool for the rapid recycling of a given training scenario by the instructor.

c. Quantities. The fuel type and quantity appropriate for the intended aircraft fire simulation, (evenly distributed over the burn area structure) is as essential to meaningful training. There are separate considerations for each type of fuel used in the training facility.

(1) **FLH.** The total fuel needed for a meaningful FLH training fire should be viewed as three separate quantities, each having a specific purpose.

(a) **Pre-burn.** This quantity should be sufficient to provide a 30-second pre-burn over the entire area before extinguishing operations start. This pre-burn is needed to ensure that the fire area is fully involved and that the fuel surface temperature is sufficiently high to sustain a challenging, stabilized fire.

(b) **Control time.** This second quantity includes at least enough fuel to ensure that the established fire can burn beyond the pre-burn time, at full intensity, over the unextinguished portions of the fire area for the duration of the training session, usually one minute. Without this second quantity, the fire will self-extinguish in less than one minute giving the impression that the trainee was successful.

(c) **Post-burn.** Although small, this quantity will ensure that the trainee achieved the training objective, i.e., extinguished the fire in the practical critical fire area within one minute. This third quantity allows the fire to burn beyond the desired control time when the trainee is unable to successfully extinguish it. Hence, the instructor has indisputable evidence that additional training is needed.

(2) **Propane.** The quantity of propane appropriate for the simulation of the intended FLH fire (evenly distributed over the burn area structure) is also essential for the creation of a realistic training fire. In addition, as the fire is attacked by the trainee, the appearance of the proper applicator discharge rate/fire area control/control time relationships must be maintained. The use of propane affects the planning for fuel quantity requirements in two ways.

(a) First, it eliminates the need for the pre-burn and post burn fuel quantities. This is because the propane burner control system will meter propane into the burn area at an adjustable, predetermined rate. Hence, when initiated, the fire will start almost instantly over the entire portion of the burn area selected by the instructor. Thus, there is no pre-burn time required to obtain a stabilized, fully involved scenario. The fire will then continue to burn at the proper intensity over the preselected portion of the burn area until correct extinguishment procedures have been completed, or until stopped by the instructor. Hence, the instructor knows exactly why the fire went out.

(b) The second consideration in planning for the appropriate fuel quantity needed to support the fire area during a training session is a three part problem.

- First, the propane storage must have sufficient capacity to support a meaningful amount of training fire burn time between refills. Therefore, the actual tank capacity for this portion of the facility will depend on the expected use rate and the response time of the propane supplier.
- Secondly, the tank must have sufficient working pressure to supply the needed propane flow to the burn area over the ambient temperature range that the training facility is expected to be used.
- Finally, the propane supply line from storage to the multiple burner distribution lines must have sufficient capacity to support the fuel requirements of the maximum number of burners that are needed at one time to generate a given scenario.

d. Consumption.

(1) **FLH.** All three of the fuel components discussed above offer potential fuel savings through the refinement of the training facility operational procedures and the proficiency of the trainees. For example, if the pre-burn fire can be established quickly over the entire fire area, the quantity of fuel used can approach that needed for the 30 second pre-burn time. As trainees become highly proficient, i.e., consistently extinguishing the fire in less than the desired control time, both control time and post-burn fuel quantities can also be reduced.

(2) **Propane.** The ability to control both the rate of addition and the flow time of the fuel flowing into the fire site, i.e., the total consumption rate offers additional fuel savings over the traditional pre-measured, free burning, FLHs. For example, instructors can completely shutdown all fuel flow immediately as soon as a training session meets the training objective or when additional instructions are needed by a fire fighter having trouble during a training burn. In addition, the intensity of the fire can be selected by the instructor in terms of flame height, duration of the extinguishment effort, and the percentage of the burn area utilized for any given exercise; all contribute to fuel savings.

3.7. ADDITIONAL SYSTEM CONSIDERATIONS.

a. Siting. Current and future airport operations must be taken into account. The training facility must be sited:

(1) Outside of all restricted areas noted in AC 150/5300-13, Airport Design.

(2) Where smoke and the associated thermal plume will not hinder aircraft operations or air traffic control (ATC) tower's surveillance of the movement area.

(3) Where the aircraft mockup (e.g., tail height) and support components (e.g., buildings) will not interfere with navigational aids.

(4) Greater than 1,000 ft (300 m) from residential areas and 300 feet (90 m) from airport buildings and public vehicle parking lots.

b. Utilities. The availability of electricity and water utilities within 900 feet (275 m) and access to a sanitary sewer within 300 feet (91 m) should be a component of the site selection process. Their utilization simplifies the operation of a training facility and, if permitted, effluent disposal. Where a mobile mockup is to be used, consideration should be given to the accessibility of utilities for the resupply of consumables and where necessary the disposal of retained effluent.

c. Decontamination Area. For FLH trainers, a decontamination area is needed on site to decontaminate Personal Protective Equipment (PPE) prior to personnel returning to the station. The soot and byproducts of the fire can be a carcinogenic hazard, and can contaminate vehicles and stations if not properly removed after training. The drainage/runoff should lead to a fuel/water separator or other suitable processing system.

d. Fire Suppression System. The installation of a fire suppression system in the form of a water deluge design has proven to be effective. The ability to connect this system to the main water system supplying the fire fighting training water is recommended. This system may also be connected to an emergency shutdown system or a remote system controlled by a building automation system.

e. Facility Observation. A 24-hour surveillance system that is monitored by a central station, such as Airport Control Center or Air Traffic Control Tower may be appropriate in certain airport situations.

f. Environmental Factors.

(1) Operation of the training facility requires compliance with Federal, State, and local environmental and operational permits.

(2) A detailed review of applicable Federal, State, and local environmental and fire regulations is necessary for the effective planning, design, and operation of a training facility. Many jurisdictions have regulations that impose effluent discharge limits, air quality operating restrictions, e.g., VOC regulations, and facility fire prevention inspection programs. Advanced knowledge of these requirements will help avoid delays in construction and the curtailment or termination of training. Additionally, both near-and long-term land requirements for the training facility and the intended use of adjacent lands should be identified and addressed early in the site selection process.

(3) **Topography.** Relatively flat land offers both improved runoff control and lower site preparation cost.

(4) **Proximity to Water Supply Wells and Wetlands.** Water supply wells and wetlands in the vicinity must be protected by siting the training facility as far as possible from them. Prior to any construction, the selected site must first receive approvals by the Federal, State, and local environmental authorities. If sited in the vicinity of a well, the site should be on the down-gradient side of the well.

(5) **Soil Permeability.** The presence of a natural or the addition of a low permeability confining layer such as clay or silt below the burn area structure and its immediate area helps to lessen the downward migration of inadvertent releases of FLH fuels.

(6) **Flood Plain.** Training facilities should be sited above the 100-year flood plain as defined in FAA Executive Order 11988. This lessens the possibility of washing contaminates out of containment areas and degrading the local soil and groundwater.

(7) **Mitigation of Effluent Discharge to Nearby Streams.** Training facilities must include containment measures to preclude overland access to perennial streams by inadvertent release of FLH fuels. This access creates an environmental risk under direct low-flow conditions to such a receiver. Any effluent discharge into "navigable waters" as defined by the United States Environmental Protection Agency (USEPA) requires a permit under Section 402 of the Clean Water Act (NPDES).

(8) **Mitigation of FLH Quantities.** The greatest harm to groundwater and soil qualities is attributed to FLHs released directly onto the soil during training. Hence, the simplest mitigation measure for maintaining groundwater and soil qualities is to reduce the amount of fuel placed in the burn area. Only that amount of fuel needed to create a training fire of the desired duration and intensity should be placed in the burn area structure for each training session. In practice there should be very little fuel remaining in the burn area structure after fire extinguishment. To assist this effort, a means must be provided for the training officer to closely monitor the quantity of fuel allowed into the burn structure for training.

CHAPTER 4. OPERATIONAL STANDARDS

4.1. GENERAL.

The standards in this chapter are provided to ensure the safe operation of an ARFF training facility. As in the previous Chapter, the components for fixed, mobile, FLH, and propane systems are treated infividually.

4.2. BURN AREA.

a. There are two primary building material options for the construction of fixed burn area structures. Fixed structures may use either concrete (Figure 4-1) or FML (Figure 4-2) as the primary material for burn area structures.

b. FLH – Concrete Option.

(1) **Basic Design.** The basic design consists of a rigid floor and walls to retain fluids and a secondary means of containment to safeguard the groundwater.

(2) **Design Service Temperature.** The design service temperature of the burn area structure must be 2,100°F (1,149°C).

(3) **Floor and Wall.** The floor and walls must be of an air-entrained, reinforced Portland cement concrete in accordance with paragraph 5.2, "Cast-In-Place Concrete." Floors must slope to channel water towards interior drains for drainage and to simplify routine maintenance and structural inspections. Interior drains must be fitted with a screen or a comparable device to preclude the migration of crushed stones into the drain. A drain system must be placed below the floor to relieve the build up of hydraulic pressures beneath the burn area structure. If a perforated drain pipe is placed, it must be wrapped in a geotextile fabric to prevent migration of foundation materials.

(4) **Protection from Heat.**

(a) Protection for building materials from the heat energies is provided by an overlying layer of crushed stones submerged in water. The minimum depth of the crushed stone layer must be six inches (15 cm) taking into account the sloping floor. Crushed stones must be in accordance with paragraph 4.2.c.(a).(5), "Interior Crushed Stones for the Burn Area Structure."

(b) Materials for fabricating the exposed portion of the reinforced wall, i.e., the curb, must be in accordance with the next paragraph, 4.2.b.(5), "Refractory Concrete Curb, FLH."

(5) **Refractory Concrete Curb, FLH.** To attain safer service temperature ranges for exposed curbs, thereby reducing the hazards of explosive spalling, refractory concretes must be specified in lieu of Portland cement concretes. Both pre-fabricated and ready field mixes, termed "castables," adequately receive and absorb the destructive forces of thermal shock and flame impingement. Castable refractories must be in accordance with paragraph 5.3, "Refractory

Concrete." An added benefit in specifying pre-fabricated sections is quality control in their manufacturing. Refractory concrete field mixes that require the addition of aggregates, binder, and clean water must not be allowed.

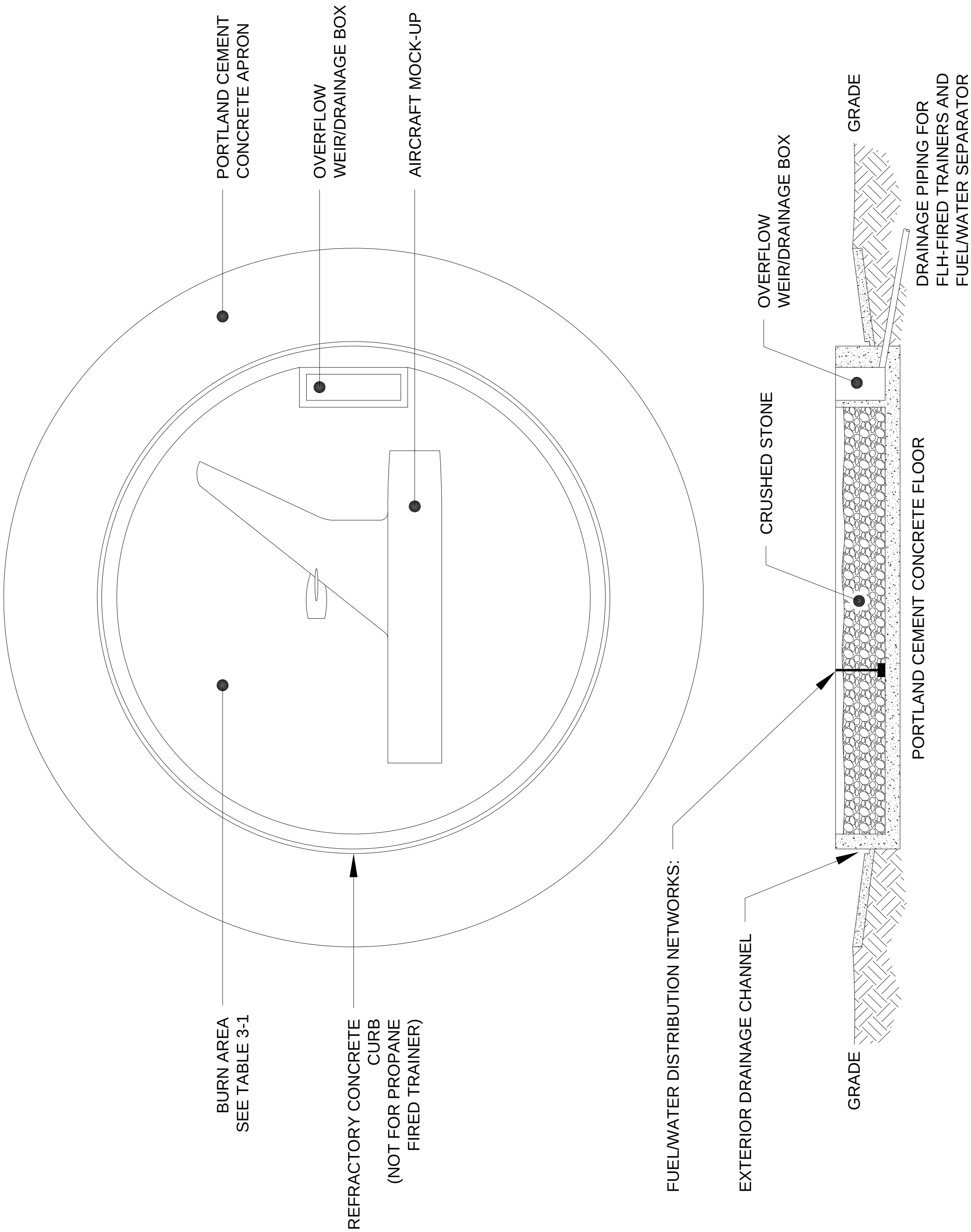


Figure 4-1. Example of a concrete burn area structure (not to scale)

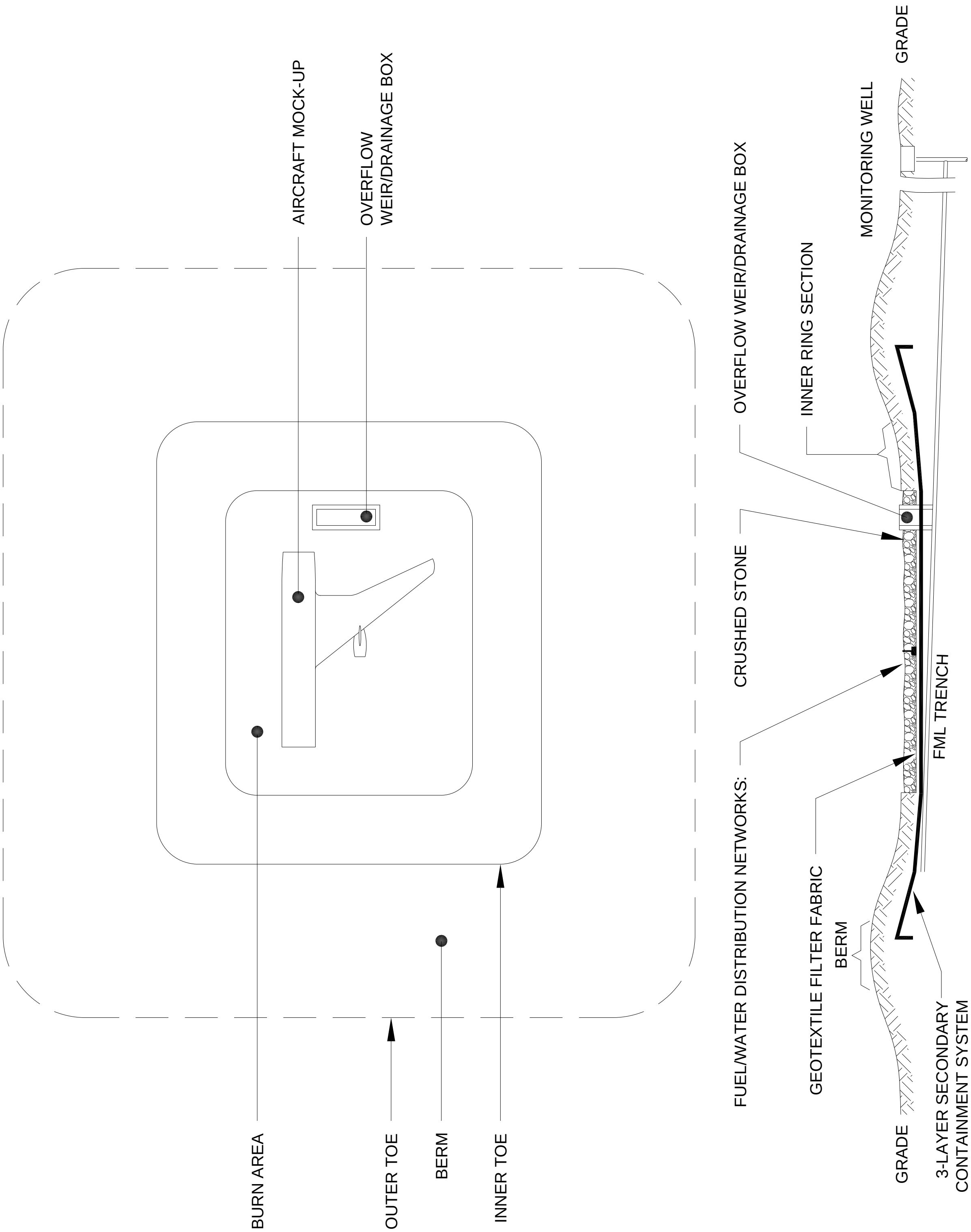


Figure 4-2. Example of a flexible membrane liner burn area structure (not to scale)

(a) **Perimeter Curb Height and Width.** The difference in height between the top of any curb and an adjoining walking surface must not exceed 8 inches (20 cm). The minimum width at the top of the curb must be at least 6 inches (15 cm). These dimensions furnish fully clothed trainees a nonhazardous footing when entering and exiting the burn area structure under fire fighting conditions.

(b) **Interior Separation Curbs.** FLH-fired trainers can reduce the quantities of training fuel and water (that immerses the crushed stones) by erecting interior separation curbs to permit specific zonal training. The height and width of such curbs must comply with perimeter curb standards. The curbs should be lower than the perimeter curb, for example at least 2 inches (5 cm) lower but not more than 4 inches (10 cm). Drainage of zonal areas can be performed by drainage gates located below the top surface of the crushed stones. Drainage gates must meet the design service temperature of the burn area structure.

c. FLH - Flexible Membrane Liner (FML) Option.

(1) **Basic Design.** The basic design consists of a sealed three layer system of two HDPE flexible membrane liners (FML) separated by an interior drainage flow net (see Figure 4-2). The system continues downward and beyond the burn area structure to function as a collection system to accumulate, detect, and permit removal of any leaked fluids. FMLs should not to be used as a structural component.

(2) **Design Service Temperature.** The design service temperature of the burn area structure must be 2,100°F (1,149°C).

(3) **Floor and Walls.** The sloped floor and sloped walls must be fabricated from two layers of HPDE FMLs that are sealed (seamed) and separated by a materially compatible interior drainage flow net. The lowest point of the system must be located outside of the burn area structure where a monitoring well houses a leak detection device, Side slopes must follow the HDPE FML manufacturer's recommendation for wall stability, generally 3:1. The three layer system surrounding the burn area structure must be mechanically anchored below the berm and covered with backfill material. Berm and backfill material must be in accordance with paragraph 4.3.b, "Berm, FML."

(a) **HDPE FML System.** The upper HDPE FML functions as the primary holding basin of fluids while the lower secondary HDPE FML collects and channels leaked fluids for detection. The secondary liner must have the ability to contain at least 100 percent of the volume of the upper primary liner and be sealed to the primary liner. A geotextile fabric must be placed between the secondary liner and foundation material to protect the liner from foundation material. HDPE FMLs must be in accordance with paragraph 5.4, "Flexible Membrane Liner."

(b) **Interior Drainage Flow Net.** The interior drainage flow net separates the primary and secondary HDPE FMLs to provide leaked fluids flow paths for detection at the monitoring well. The design pattern of the net must allow collected fluids multi-directional flow paths to the detection device. Flow nets must end next to the perimeter of the sealed HDPE FMLs, i.e., below the berm. Interior drainage flow nets must be in accordance with paragraph 5.5, "Drainage Flow Net."

(c) **Protection from Heat.** Protection for building materials from heat is provided by an overlying layer of sand and crushed stones submerged in water and an inner ring section (defined in paragraph 4.3.b(3), "Inner Ring Section").

- **Sand.** A minimum of six inches (15 cm) of sand followed by a minimum of 12 inches (30 cm) of crushed stones must be placed immediately above the primary liner. Sand must be of natural river, bank, or manufactured sand, washed, free of silt, clay, loam, friable, or soluble materials, and organic matter, graded in accordance with American Society for Testing & Materials (ASTM) C 136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates, within the recommended limits of "Fine Aggregate" category of ASTM C 33, Standard Specification for Concrete Aggregates (optional paragraph 5.2 is acceptable).

- **Crushed Stones.** Crushed stones must be in accordance with paragraph 4.2.c.(5), "Interior Crushed Stones for the Burn Area Structure."

(d) **Drains.** The drainage system above the primary liner must preclude the migration of sand and crushed stones, e.g., drain covers with filters, use of perforated drain pipes. Drain components subjected to FLHs must have positive sealed joints as compared to rubber gaskets. Polymer drain components (plastics) must be compatible with FLHs.

(e) **Geotextile Filter Fabric.** A geotextile filter fabric must be placed directly above the sand layer to stop the intermingling of crushed stones with the underlying sand layer. The sand layer protects the primary liner from being punctured by intruding crushed stones and exploratory maintenance. The fabric must end under the inner ring section. Geotextile filter fabrics must be in accordance with paragraph 5.6, "Geotextile Filter Fabric."

(4) **FML Trench and Monitoring Well.** A FML trench must extend beyond the burn area structure and slope continuously downward to accommodate a monitoring well. The trench must use the same FML used for the burn area structure. The monitoring well must have a leak detection device within a sump.

(5) **Interior Crushed Stones for the Burn Area Structure.** The crushed stones (or another medium known to be suitable for the intended service) placed within the burn area structure function as a quick drainage medium, level walking surface, and a heat absorbent shield. For FLH-fired trainers, crushed stones additionally help to counteract the drifting of fuel by wind forces. The crushed stones must be angular, well graded, and free of shale, clay, friable materials, and debris with a nominal maximum aggregate size of 1 1/2 inches (3.8 cm) and a nominal minimum size of 1/2 inch (1.3 cm). Standard size number 4 (four) of ASTM D 448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction, and standard size numbers 4 (four) and 5 (five) of ASTM C 33 are possibilities. Grading must be in accordance with ASTM C 136.

(a) **Wind Effects.** Grossly asymmetric fires are the result of the FLH drifting under the influence of wind forces. This phenomena reduces the fire area, varies flame heights, and causes uneven heats and excessive smoke. To mitigate this problem, a crushed stone surface should be used which will protrude partially above the liquid fuel layer (e.g., 0.5 to 1 in (1 to 3 cm).

NOTE: *Aggregates, e.g., those containing quartz, that are prone to fracture when they experience a large volume change at temperatures well below the design service temperature should not be permitted.*

d. Propane Option.

(1) **Propane Burn Area Structure.** When compared to a FLH-fueled trainer, an appropriately controlled, propane-fueled system permits significant simplification of the design requirements of the burn area structure. For example, the lack of a water sublayer may reduce the size needed for water storage and the complexity of the distribution system. Also, some State Environmental authorities may not require certain of the protective measures needed to prevent ground water contamination. When appropriately controlled, the propane-fired systems also greatly reduce the "smoke plume" and air pollution problems associated with liquid fuels.

(a) **Basic Design.** The basic design for fixed systems must use either the rigid or the flexible burn area structure alternatives discussed in paragraph 4.2., "Burn Area." Modifications are permitted as may be required by the unique properties and functions of the propane system design.

(b) **Design Service Temperature.** Since total exposure to heat is better controlled (as compared to FLHs), construction materials used in the burn area structure must be materials demonstrated to withstand the exposure temperature. For example, under the rigid alternative refractory material for the curb is not required. Instead, curb material must be concrete masonry block units or air-entrained Portland cement concrete with an f'_c = 3,000 psi (20,000 kPa). Selection of masonry units must note National Concrete Masonry Association (NCMA) - TEK STD 117, Evaluation of Concrete Masonry Walls After Being Subjected to Fire. The curb height and width standards of paragraph 4.2.b.(5)., "Refractory Concrete Curb, FLH" of this AC also apply.

(c) **Floor and Wall.** The floor and wall materials (non-curbs) must be an air-entrained Portland cement concrete with an f'_c = 3,000 psi (20,000 kPa) that is reinforced. Portland cement concrete must be in accordance with paragraph 4.2.b.(3)., "Floor and Wall." Floors must slope to channel water towards drains for drainage and to simplify routine maintenance and structural inspections. Drains must be fitted with a screen or a comparable device to preclude the migration of crushed stones into the drain. A drain system must be placed below the floor to relieve the build up of hydraulic pressures beneath the burn area structure. If a perforated drain pipe is placed, it must be wrapped in a geotextile fabric to prevent migration of foundation materials.

4.3. VEHICLE MANEUVERING AREA.

a. Concrete Apron.

(1) **Building Material.** The apron must be an air-entrained Portland cement concrete. This material, compared to refractory concretes, is acceptable since temperature and energy

radiant stresses are less severe than those experienced by the curb. The compressive strength of the concrete must be adequate to support fully loaded ARFF vehicles.

(2) **Slope.** The concrete apron must slope towards the curb of the burn area structure to collect training spills, rainfall, and snowmelts. If the apron has a drainage channel adjacent to the curb, the drainage channel must be covered with drain covers that withstand both bearing loads and high temperatures. The transition joint between the upper portion of the concrete apron and the ARFF vehicle maneuvering surface must be as smooth as practical.

(3) **Length.** The length of the concrete apron must be 10 percent of the square root of the total square footage of the burn area structure, but not less than 6 feet (1.8 m) or more than 12 feet (3.7 m).

(4) **Thermal Treatments for Portland Cement Concrete Aprons.** The following items can increase the thermal resistance of ASTM C 150 type Portland cement concretes to lessen the frequency of concrete thermal spalling.

(a) **Unit Weight.** Lightweight concretes, i.e., unit weights of 85 to 115 pcf (1,360 to 1,840 kg/m3), offer greater thermal insulation than normal or heavy weight concretes. As a rule, a decrease in concrete unit weight results in increased thermal insulation (i.e., lower conductivity values). Structural lightweight aggregates should be in accordance with ASTM C 330, Specification for Lightweight Aggregates for Structural Concrete.

(b) **Binder.** Greater thermal resistance is possible by using calcium aluminate cements or binders with increased Alumina, $A1_20_3$, and Silica, $Si0_2$ contents. Replacing aggregates with more cement binder also lowers thermal conductivity values.

(c) **Aggregate Size.** For normal weight concretes of unit weights between 135 to 160 pcf (2,160 to 2,560 kg/m^3), decreasing the maximum aggregate size increases thermal resistance.

(d) **Free Moisture Content.** Lowering the free moisture content of hardened concrete increases its thermal insulation by an associated reduction in thermal conductivity values (smaller thermal expansions).

(e) **Air Content.** An increase in the percentage of air content provides greater insulating values, particularly for air contents above 10 percent. Lightweight concretes achieve even greater insulating improvements at this percent air content compared to normal weight concretes.

b. FML, Berm.

(1) **Slope.** The slope of the berm must provide a gentle, nonhazardous footing for fully clothed trainees entering and exiting the burn area structure under fire fighting conditions. To provide such footing, slopes must range from 4:1 to 3:1 (horizontal:vertical).

(2) **Backfill Material.** The backfill material specified must be uniformly graded, free of friable or soluble materials, clay, loam, and silt, and other debris and must contain a much <u>higher</u> percentage of fines than the crushed stones specified in paragraph 4.2.c.(5), “Interior Crushed

Stones for the Burn Area Structure." The selected covering material should not cause the liner to be punctured and have good erosion resistance. Table 4-1 offers one possibility. The higher percentage of fines serves to (1) provide a protective heat absorbing blanket for the primary liner, and (2) limit the fluid/water mixture's downward penetration into the inner toe of the berm by more readily conveying it towards the lower, more porous, crushed stone layer.

Table 4-1. Example gradation of backfill material for berm and adjoining inner ring section

Sieve Size	Percent Passing by Weight
2.0 in (5.1 cm)	100
1.0 in (2.5 cm)	95-100
0.75 in (1.9 cm)	80-100
5/8 in (1.6 cm)	75-100
3/8 in (.95 cm)	50-85
No. 4	35-60
No. 10	22-50
No. 16	15-35
No. 40	15-30
No. 200	5-10

(3) **Inner Ring Section.** The Inner Ring Section must continue downward from the inside toe of the berm for a maximum horizontal length of 9 feet (2.75 m). Besides being composed of the same backfill material and executing the above dual functions, it marks for FLH-fired trainers the upper level of the training fuel and water sub-layer mixture. Regardless of the fuel alternative, the backfill cover at the innermost point must be a minimum of 18 inches (46 cm) to protect the primary liner from heat.

4.4. AIRCRAFT MOCKUP.

a. Orientation. As is shown in Figure 3-1, any fixed mock-up located within the burn area structure, must be orientated with its axis directed towards the control center or the prevailing winds.

b. Shape and Exterior Materials. The shape of the mock-up should generally represent an aircraft. For example, the fuselage may take the shape of a long narrow building with vertical walls, circular windows, and an arched roof. Selected materials must be those with the ability to withstand high radiant energies, direct flame impingement, and repeated thermal cycling stresses. Figure 4-3, reprinted from NFPA 422, Aircraft Fire and Explosion Investigation, provides thermal performance of metals, such as iron, to fabricate the fuselage and wing. Exterior materials other than metal that meet the design service temperature such as those found in fire training towers are also acceptable. Precautions should be taken to exclude air pollutant generating materials such as plastics (as burning polyurethane can release hydrogen cyanide (HCN)) and rubber tires.

c. Placement of Fuel Nozzles, Propane Burner Elements, and Water Nozzles. Placement of fuel nozzles or propane burner elements should be based on the specific type of fire to be simulated (see Figure 3-1). Nozzles or elements located adjacent to the mock-up should be evenly spaced around its exterior wall. To increase the mock-up's service life, provisions for internal water spray, water drains at all low points, and air vents on the sides and top of the mock-up's main body, wing(s) and, if present, the tail section must be provided. The air vent pattern must provide adequate openings in conjunction with appropriate spacing to prevent the build up of an explosive fuel-air mixture within the mock-up itself.

d. Mobile.

(1) **Internal Air Temperature Monitoring and Control.** A means to monitor and control the temperature level within the mockup must be provided. The following performance criteria are the minimum acceptable.

(a) **Location.** A temperature monitoring sensor assembly should be installed approximately 3 ft (1 m) above the passenger cabin floor and 8 ft (2 m) from the nearest edge of the fire in the passenger cabin fire scenario. Exact locations are dependant on cabin station design.

(b) **Temperature Limits.** The sensor must be calibrated against a wet bulb/dry globe temperature (WBDGT) measurement during the on-site test and calibration of the mobile trainer by the supplier.

- The lower safety limit must be equivalent to a WBDGT of 200°F (93°C) at the sensor location.
- The upper limit must be equivalent to a WBDGT of 350°F (177°C) at the sensor location.

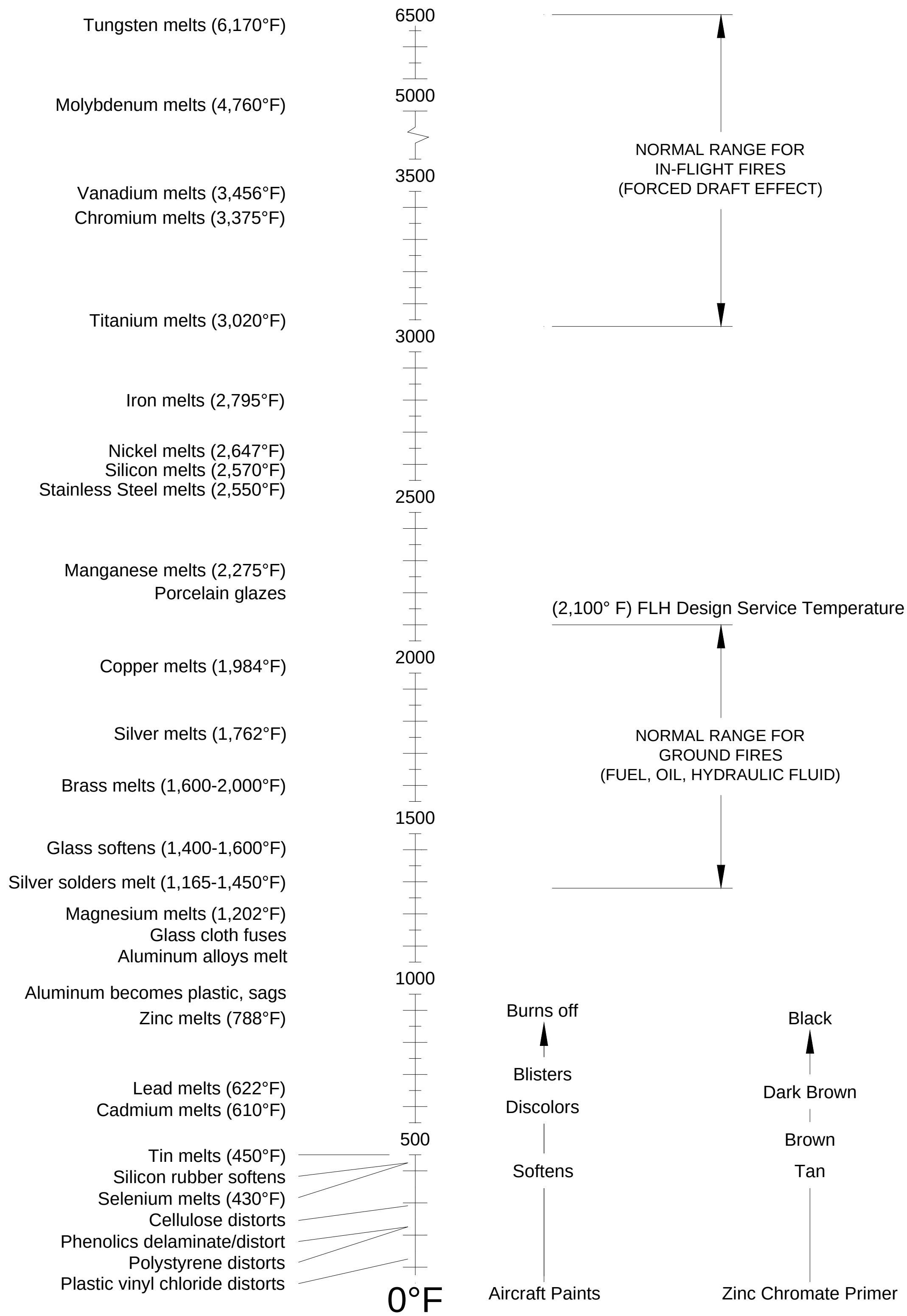


Figure 4-3. Metal material selection guide for mock-ups (reprint from NFPA)

(c) Temperature Control. The system must:

- Initiate cabin air augmentation, when interior fire scenario is specified, when the temperature at the sensor location exceeds the lower limit and permit the training to continue.

- Shut down all burners and smoke generators in the compartment if the temperature increases sufficiently to reach the upper safety limit.

- Continue the cabin air augmentation until the temperature is below the lower safety limit.

(d) **Temperature Alerts.** A means must be provided at the control center to monitor the cabin interior temperature and to visually and audibly alert the system operator when the upper temperature limit has been reached.

(2) **Pre-Ventilation / Ventilation.** It is recommended that the mobile trainer be set up with the nose into the prevailing winds and entire aft section open in order to provide a constant natural ventilation. The mobile trainer fuselage mock-up must be provided with a means to perform the following functions:

(a) **Natural Ventilation.** The mobile trainer must have open flight deck windows. The rear of the mobile trainer must have at least 30 sq. ft. (2.8 m^2) of opening(s) for constant natural air ventilation.

(b) **Pre-ventilation.** A means must be provided to ensure that pre-ventilation of the interior fuselage, when interior fire scenario is specified, must occur upon activation of the trainer at the beginning of every training day. Power and fuel for all fire generation equipment serving interior fuselage fireplaces must be locked out until at least a 3-minute pre-ventilation cycle is completed or until detectable propane levels are below the 5% lower explosive limit (LEL) background requirement.

(c) **Control Ventilation.** Control ventilation mode must provide a source of combustion air during a training fire scenario in the main cabin. Positive pressure control ventilation is permitted, but not required to comply with the intent of this section. The mobile trainer, including burner design, may or may not require positive pressure ventilation for safe and effective operation.

- If the propane concentrations within the fuselage reach 10% of LEL during a training exercise, the purge air must be activated to increase air flow to the training fires to improve propane combustion, and training must be permitted to continue.

- The purge air must also be activated to help maintain safe temperature levels within the mockup if lower level temperature warning is detected, and training must be permitted to continue.

(d) **Purge Ventilation, Emergency Mode.** The purge ventilation system must, as indicated above, be designed to work in concert with the control ventilation under normal operating conditions. It must also be capable of responding to emergency conditions as follows:

- The interior temperature at the sensing station exceeds the high level limit.
- A training scenario is terminated by any of the manual E-stops.
- A training scenario is automatically terminated by a safety hardware malfunction.
- The propane vapor concentration monitoring system reports the concentration of propane has exceeded the pre-set upper limit of 25% of LEL.
- The system must be designed to remain at purge ventilation until the emergency condition is corrected and then to return to control ventilation mode in preparation for the next training exercise.

e. Fire Scenarios. Both fixed and mobile trainers must be capable of simulating the following training fire scenarios, unless otherwise noted. Detailed additional scenarios are described in Appendix A.

(1) **Class A Fires.** Baggage compartment and interior cabin fires, such as galleys, cockpit, lavatory, trash containers, that can be accessed through replaceable “forced entry” exterior panels or doors and landing gear, brake/wheel fires by an under-the-wing “landing gear” device. For the simulator using FLHs, a stock of class A combustibles will be required to “refit” the mock-up for cabin and cargo training scenarios. Where this class of fire scenario is being provided by a propane-fired simulator, there is no requirement for a stock of Class A fire consumables.

(2) **Class B Fires.**

(a) **Fixed.** Large pool fires, engine nacelle fires, and ruptured wing fuel fires. The last two must provide cascading or 3-dimensional fire training exercises.

(b) **Mobile.** Fires involving aviation fuel typical of the following:

- For Index A & B airports, simulated fuel-spill fire on the ground. See paragraph 6.3.b for the minimum fuel-spill burn area. For Index C, D, and E airports, this type of fire scenario is optional.
- Turbo-jet or turbo-prop engine, typical fuel leak fire in engine aft section. The device must be equipped to provide an idle, running, runaway, and cascading (3-dimensional) running fuel fire. The running and runaway fires will require that the cockpit throttles be closed.
- **Class A & D fire.** Typical of that encountered in a wheel/brake assembly, including the provision of an instructor-activated bursting tire noise.

(3) **Other.** For safety reasons, Class C (energized electrical) and Class D (combustible metal) fires, must not be part of the FLH-fired mockup. Separate “stand alone” fixtures will be needed for these scenarios. Simulated Class C and D fire scenarios must be provided as an integral part of the propane-fired mock-up.

4.5. CONTROL STATION.

a. Scenario Activation. The method provided to activate each fire scenario must be designed and constructed to operate in a logical and predictable manner. The following sequence of events are required:

(1) Start the selected fire scenario by first initializing the pilot flame. Under no circumstances must any valve which controls the flow of propane to a fireplace be able to be opened without the confirmed presence of a pilot flame.

(2) Once the pilot is confirmed, the valves controlling the flow of vaporized or liquid propane must be opened by a separate “fire control” command from the control station (or a local control pendant as applicable) and allow fuel flow to the fireplace where the vapors must be ignited by the confirmed pilot.

b. Feedback Control Systems. Two types of feedback control systems exist: a Manual Feedback Control System (MFCS), which requires the operator to judge the efficiency of the agent application and control the flame response; and an Automatic Feedback Control System (AFCS), where sensors detect agent application and control the flame response.

(1) The options for each type of trainer are as follows:

(a) For fixed, ARFF Index A and B trainers, either a MFCS and/or AFCS may be used.

(b) For fixed trainers that are ARFF Index C and above, only AFCS may be used.

(c) For mobile trainers, both an MFCS and AFCS are required.

(2) When both a MFCS and AFCS are installed, provisions must be made for the operator to easily switch between manual or automatic control prior to initiating a specific exercise during a training session. Failure of the automatic control system’s hardware or software will not preclude operating the mobile trainer via the MFCS.

(3) For AFCS:

(a) A computer (or other appropriate means capable of providing the required fire simulation performance) must regulate the flow of propane gas to burner elements based on information received from agent application, radiant energy, heat output, or other appropriate detectors that evaluate the appropriateness of the pattern of applied agent and activate a series of control valves that control propane flow to the trainer’s burn area.

(b) Burner response devices must be capable of providing a consistent, realistic flame response in all training scenarios. They must also be capable of keeping the build-up of propane inside the mock-up during extinguishing agent application to a level of 10% or less of the LEL when the combustion air augmentation device is working normally.

c. Hardware Malfunction. A safety hardware malfunction detection and reporting system must be provided.

(1) The detection system must be capable of:

(a) Continuously checking for proper function of the critical safety components within the trainer.

(b) Alerting the operator when a malfunction is detected.

(c) Initiating appropriate action if the failure affects system safety.

(2) The hardware malfunction reporting system must, in the event of excessive levels of propane, unsafe compartment temperatures, or failures of any safety component, send a warning signal to the control center identifying the affected subsystem.

(3) The control system, depending upon the specific warning signal received, must initiate purge ventilation, extinguish all flames and pilots, shutdown the propane gas supply, and display applicable alarms and warnings at the operator control center.

4.6. SUPPORT SYSTEMS.

a. Emergency Shutoff System.

(1) Each fuel distribution system must have an emergency shutoff system to quickly and completely stop the flow of fuel in an emergency. Operating controls for emergency shutoff must be located so as to be readily and safely accessible in the event of an emergency or spill. Location and placarding of shutoff devices must conform to NFPA 407, Aircraft Fuel Servicing.

(2) **Propane.**

(a) **Emergency Shutdown.** It is especially important that any propane-fueled training system be able to reduce the potential accumulation of unburned propane in the fire areas and prevent the hazardous build-up of propane for any interior fire scenarios. Where unsafe conditions are identified, the system must be able to be shut down automatically and manually.

(b) **Automatic Shutdown.** The automatic device must be capable of detecting emergency conditions and of automatically initiating shutdown when:

- The air temperature at:

– 3 ft (0.9 m) above the floor exceeds 350°F (177°C) at the temperature measuring station and,

– 1 ft (0.3 m) below the ceiling exceeds manufacturer's recommended temperature at the temperature measuring station (in order to reduce heat damage to the simulator).

- The propane concentration in the mock-up interior reaches 25% of the LEL,
- A safety hardware component failure is detected, or
- The electric power is lost.

(c) **Manual Shutdown.** A means must be provided in the mobile trainer control center for the system operator to preempt (E-stop) the automatic system. The E-stop must be capable of immediately shutting down all training fires when the operator, using a single, one-handed motion, activates a single button, switch, or lever.

(d) **Remote Shutdown.** A network of E-stops must be provided at all mock-up doorways and emergency exits, and on each fireplace local control pendant provided. The device must:

- Permit any instructor, safety officer or fire fighter to immediately shut down all training fires by the activation of a single button, switch, or lever using only a single, one-handed motion, while wearing standard firefighter hand protection.
- Prevent the mobile trainer from being restarted until the activated E-stop has been manually reset.
- Be hardwired to operate independently of the mobile trainer control center.

b. Fuel Distribution System.

(1) **For FLH Systems.**

(a) **Basic Design.** The system consists of the fuel storage tank(s), metered supply piping system, explosion-proof pump(s), metered independent zonal fuel delivery network, and the burn area fuel delivery network (see Figures 4-4 and 4-5).

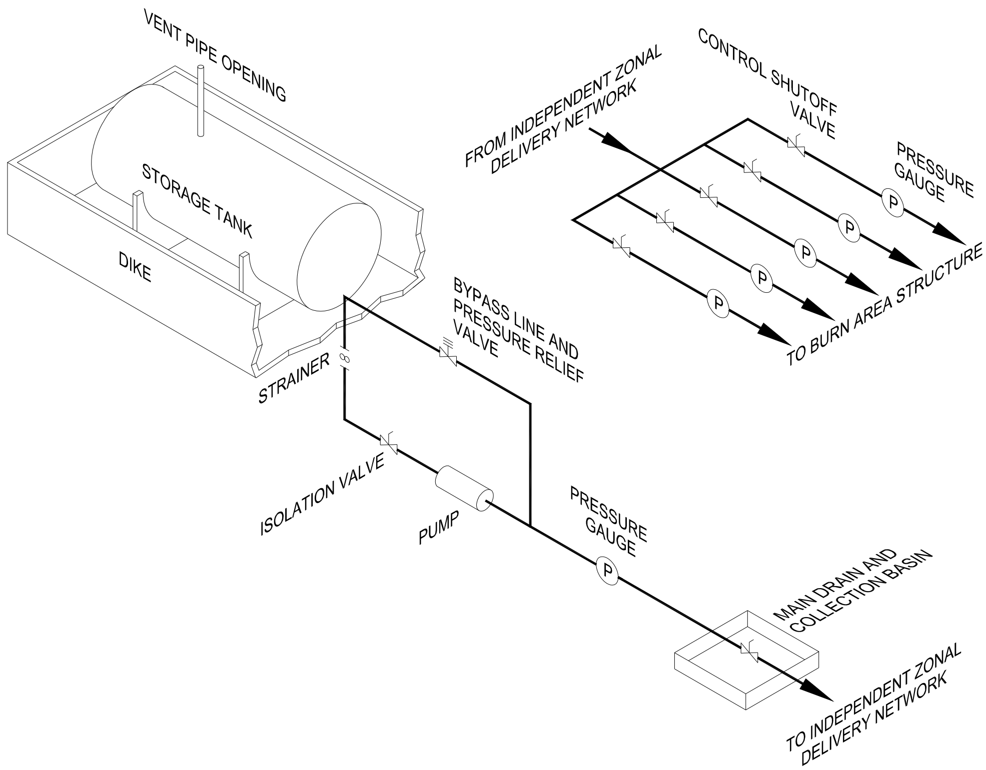


Figure 4-4. Example of an FLH storage tank, pump, supply piping, and independent zonal delivery network

(b) **General Tank Requirements.**

- **Capacity.** Tank capacity must at least equal the sum of the fuel quantities for (a) two successive burns, (b) the volume of the supply piping system, and (c) fuel quantities required to maintain the design discharge rate and duration for all systems operating simultaneously.

- **Tank Fill Cap.** The tank's fill cap must be protected by either a recessed vault or have painted barrier posts. For security, fill caps must have locking capability.

- **Fuel Transferring Protection.** An adequate means for static electrical discharge protection during fuel transfer must be installed. For guidance see NFPA 407, Aircraft Fuel Servicing.

(c) **Pumps.**

- **Type.** All pumps must be an explosion-proof/weatherproof, electrically driven motor design and type that deliver the design discharge flow rate. The design discharge flow rate must consider the hazardous generation of static electricity that accompanies fuel transfer. Rapid transferring of fuel causes the fuel to be electrostatically charged. If the charge on the fuel is sufficiently high upon being sprayed by the nozzles, a static spark could occur and prematurely ignite the flammable mists and vapors. However, a reasonable delivery time is sought to preclude explosion or fire hazards (flammable fuel atmosphere inside and outside the burn area structure if ignition is delayed) and for environmental reasons (poisonous vapors).

- **Installation.** Pumps installed outside of a shelter must be located not less than 5 ft (2 m) from any building opening. Pumps installed in a building must be in a separate room with no opening into other portions of the building. The pump room must be adequately ventilated to prevent explosive vapors from collecting and posing an explosive or fire hazard. Pumps must be adequately anchored and protected against physical damage.

(2) **For Propane Systems.** An propane gas distribution system consists of one or more containers with a means for conveying propane gas from the containers to the trainer's fire generation control system which must interface with agent application detectors and components intended to achieve control of quantity, flow, pressure, or state (either liquid or vapor). The propane gas system described must not use oxygen or contain ammonia.

(a) **General Design Criteria**. The design objective for the mobile trainer propane system must be for the propane concentration levels within the fuselage not to exceed 5% of the LEL of propane in air under normal, standby (passive) operating conditions, i.e., the facility is operational and no fire scenario is running. As a minimum, the mobile trainer system must contain discreet, identifiable safety features capable of performing in the manner described below.

(b) **Detectors.**

- Agent application detectors must be located in an array within the burn area structure to evaluate the effectiveness of the applied agent's pattern. Gathered information must then be transmitted to the computer for controlling fire propagation via flow control valves, e.g., to reduce fuel flow and cause the fire to recede and extinguish.

- Another means may be used to provide the simulator operator with the feedback necessary to reliably assess fire fighter agent application performance if it can be shown that the resulting simulator performance provides safe, realistic, and repeatable training scenarios.

- **Propane Level Monitoring.** The mock-up must be equipped with a two-channel, drawn-sample, propane detector system to sample the interior fire area for any buildup of propane.

  – The propane detection system must operate independently of the mobile trainer control center and must be capable of activating the ventilation/purge-air system as described above.

– If the propane concentrations within the fuselage continue to rise during a training scenario, and reach 25% of LEL, the system must close all gas supply valves and keep the purge ventilation system active for a minimum of 3 minutes or until the unburned propane level has been reduced below 10% of LEL, whichever is longer.

(c) **Fire Generation System.**

- The fire generation system for the fuel spill fire must consist of a network of main flame burner elements arranged throughout the fuel spill fire burn area, and a number of burner control modules that will control the flow of propane to the burner elements.

- **Fuel Ignition.** A means of fuel ignition must be employed that is effective under all normal weather and operational conditions and can reliably ignite all nozzles or elements selected by the instructor for a given exercise.

- **Burner Elements.** The network of burner elements must be arranged across the fuel spill fire burn area so that each element will distribute propane to a segment of the total area. The arrangement must be such that control of propane flow to each element must produce a flame that will realistically grow and spread across the burn area, and then realistically recede and extinguish as the propane flow is manipulated in response to the appropriate agent application. Each element must be arranged along the surface, or below the surface so as to be protected by the crushed stone. The elements must be designed and supported to prevent their movement or damage by normal operation of the trainer. If above the surface, their maximum height is 3.0 in (7.6 cm).

- **Burner Control Module.** Each burner control module must provide an ignition source, e.g., a pilot flame, to ignite a portion of the fuel spill fire, a safety shutoff valve that will stop all flow of propane to the elements under that module's control in an emergency or upon loss of electrical power, and a series of control valves that will modulate propane flow to individual burner elements. All burner control modules must be operable from the fire generation control center and must reliably control propane flow to individual burner elements according to preset/predetermined parameters that are realistically related to the progress of the extinguishment effort.

- **Combustion Air Augmentation.** A means must be provided to ensure adequate combustion air is available to all burners to be operated, singularly or in combinations, inside the fuselage mock-up when interior fire scenario is specified. To be acceptable, the means used to augment the combustion air must be capable of keeping the concentration of propane that could build up inside the mock-up, during extinguishing agent application, to a level that is no higher than 10% of LEL.

(d) **Pilot Flame Monitoring.** The pilot flame for each fireplace, including the fuel-spill fire scenario, must be monitored by a flame safeguard system.

- The control unit must be located in the associated burner control assembly and must monitor the pilot flame associated with the burner to ensure that a pilot flame (positive ignition source) is present for the duration of each training exercise.

- The pilot flame monitoring device must, upon loss of the pilot flame monitoring signal, be capable of causing the propane fuel valves (vapor or liquid) serving the specific fireplace to automatically close. In addition, the device must, under no circumstances, allow a propane burner fuel control valve to open if the presence of the associated pilot flame is not confirmed.

(e) **Fail-safe Propane Control Valves.** All valves used to control the flow of either vaporized or liquid propane from the propane supply tank must be of a type designed to fail safe in the closed position. The valves may be either electric solenoid or pneumatically operated valves that close on loss of activating power. Acceptable valves must have proof-of-closure switches to send a confirmation signal to the moible trainer control center when the valves are deactivated or on loss of power. A green indicator labeled "Open Propane Valve" and a red indicator labeled "Closed Propane Valve" must be provided at the mobile trainer control center.

(f) **Containers.** Containers must be designed, fabricated, tested, and marked (stamped) in accordance with the (1) Regulations of the U.S. Department of Transportation, Rules for the Construction of Unfired Pressure Vessels, Section VIII, Division 1, (2) ASME, Boiler and Pressure Vessel Code, or (3) the API-ASME, Code for Untired Pressure Vessels for Petroleum Liquids and Gases, applicable at the date of manufacture.

- **Container Appurtenances.** Fabrication and performance provisions must be in accordance with NFPA 58. Container appurtenances include pressure relief, connections for flow control (filling, withdrawal, equalizing), liquid level gauging devices, and pressure gauges.

- **Container Markings.** Containers must be marked as provided in the Regulations, Rules, or Code under which they are fabricated or in accordance with NFPA 58.

- **Location of Containers.** Containers must be located in accordance with NFPA 58.

(g) **Piping and Piping Systems.** The system must have pipe, tubing, hose, and flexible rubber or metallic hose connectors and other valves and fittings as required to safely convey propane gas in either the liquid or vapor state at various pressures from point to point.

(h) **Buildings or Structures Housing Propane Gas Distribution Facilities.** Propane gas distribution facilities that are housed in separate buildings used exclusively for the purpose or in rooms attached to, or located within, buildings used for other purposes, must be in accordance with NFPA 58. This chapter covers the construction, ventilation and heating of structures housing propane gas systems referenced in NFPA 58.

(i) **Building Housing Propane Containers.** Though a separate building is not required to house propane gas containers, the construction and ventilation of such a structure must be in accordance with NFPA 58, Standards for the Storage and Handling of Liquefied Petroleum Gases.

c. Mobile Trainer Fuel System.

(1) The primary design objective is to provide a propane supply and distribution system that ensures all interior (enclosed compartment) fire scenarios can only be supplied with vaporized propane fuel.

(2) The functional objective of the simulator fuel system must be to provide the ground fire scenario and other exterior aircraft component fire simulations on and around the mock-up (e.g., engine, brake, and wheel fires) with either or both vaporized or liquid propane as may be required to present a realistic, controllable fire scene.

(3) **Compliance with Standards.**

(a) **Supply.** The fuel supply system is to be designed to meet NFPA 54, National Fuel Gas Code, and NFPA 58, Standard for LP Gas Storage and Use.

(b) **Propane Hoses, Piping, Fittings, and Couplings.** The propane hoses, piping, fittings, and couplings must conform to the guidelines established in NFPA 54 and NFPA 58. Fuel supply hoses, piping, fittings, and couplings placed on the ground between the fuel supply and the mobile trainer must be protected by covers when set up. These items must also be protected from weather when stored for transport.

NOTE: *It may, in some cases, be necessary for the* mobile trainer *to comply with state or local codes regarding the storage and use of propane in addition to the NFPA references cited above.*

(4) **Performance Criteria.**

(a) **Supply.** If a propane storage tank is to be transported, it must be in an approved, transportable, self-contained system. The size of this storage facility must be adequate to support a typical 8-hour training day. It must have a fill connection that is compatible with commercial propane fuel service equipment.

- The vapor supply system must provide adequate pressure and volume to allow any three fuselage-based fireplaces and the fuel-spill burn area pilot ignition system to function at the same time.

- The liquid propane supply system must be designed to provide for a fully functional fuel-spill burn area operation in conjunction with the simultaneous operation of up to three fuselage fireplaces with no degradation of system performance as it relates to realistic fire scenarios.

(b) **Propane Hoses, Piping, Fittings, and Couplings.**

- The system must be designed to take advantage of rated, quick-disconnect fittings and couplings wherever possible.
- The fittings and couplings for the liquid supply system and vapor supply system must be marked, coded, or otherwise identified to prevent accidental connection of the liquid supply to vapor burners and pilots.
- The hoses, piping, fittings and couplings must be of sufficient diameter to permit adequate flow of fuel to fire scenarios to meet the operating requirements for a visually realistic fire scenario.

(c) **Marking, Coding, and Color-Coding.** Vapor supply, liquid supply, propane hoses, piping, fittings, and couplings must be marked, coded, color-coded or otherwise identified for proper assembly.

d. Water Distribution System for FLH Trainers. The system consists of a water storage tank(s), metered supply piping system, water pump(s), independent zonal delivery network and the mock-up water spray network (see Figures 4-4 and 4-5).

NOTE: *For propane-fired systems, a water spray cooling system utilizing local utility water supply pressure may be required if the mock-up structure is not designed to withstand the heat and thermal cycling of the fuel spill fire.*

(1) **Design of Water Storage Tanks.**

(a) **Materials and Fabrication.** The storage tank must be designed and built in accordance with recognized engineering standards for the materials being used. Some industry standards are American Water Works Association (AWWA) D 100-84, Welded Steel Tanks for Water Storage, AWWA D 103-80, Factory-Coated Bolted Steel Tanks for Water Storage, and AWWA D 120-84, Thermosetting Fiberglass-Reinforced Plastic Tanks.

(b) **Tank Capacity.** The tank capacity must be based on the sum of either the water sublayer for FLH-fired training facilities for two successive burns or operational quantities required for a propane-fired training facility, plus the volume of the supply piping system, the required water flow rate and pressure to maintain the design discharge rate and duration for all systems operating simultaneously, flushing operations (repeated exercises) and, if included, the continuous mock-up water spray treatment.

(c) **Support, Foundations, and Anchorage.** The design of tank supports and connections in areas subjected to earthquakes must be in accordance with Appendix E of API Standard 650 or Appendix B of API Standard 620.

(d) **Identification.** Aboveground tanks must have the phrase “CONTAMINATED WATER” printed on both longitudinal sides. Lettering must be at least 1 ft (30 cm) in height and of a contrasting color.

(2) **Design of Metered Water Piping System.** The metered water piping system must be structurally designed to safely accommodate the flow rate and fluid pressure needed to maintain proper water discharge levels at all zones operating simultaneously. Other design requirements and recommendations are cited below.

(a) **Corrosion Protection.** System components installed in the presence of a corrosive environment must be of corrosion resistant materials or be covered with protective coatings.

(b) **Identification.** For identification, all exposed water system components outside the burn area structure should be painted in accordance with applicable codes or standards.

(3) **Water Pump.** The water pump must be sized to meet the water discharge rates for (1) all spray nozzles operating simultaneously, (2) the water sublayer, (3) the continuous mock-up water spray treatment, if necessary, and (4) the burn area flushing/turn-around time for FLH-fired trainers. The water pump must be of an explosion proof type when it is housed adjacent to a fuel pump.

(4) **Design of Independent Water Zonal Delivery Network.** Each independent zonal delivery pipe must have a control valve with a pressure gauge to regulate the water flow within the burn area. Placement of the zonal control valve must provide quick and easy access. Placing zonal delivery networks below grade offers piping networks improved protection.

(5) **Design of Water Spray Network.** Upon entrance to the burn area structure, each zonal delivery pipe should feed, via a distribution header, branch pipes (risers) having the determined number of water spray nozzles (see Figure 4-5). The maximum height of any nozzle protruding above the crushed stone surface must be 3.0 in (7.6 cm). The number of required nozzles must be based on the nozzle's discharge characteristics and the particular function to be achieved. Care should be taken in positioning nozzles that water spray does not miss the target surface. Each nozzle riser must be supported from below and plumbed for uniform water delivery. Supports must be heat resistant.

e. Fuel/Water Separator For FLH Trainers. FLH fuel trainers must have a fuel/water separator to recycle fuel and water quantities for setup and those resulting from training. Besides the financial savings achieved through recycling, the additional cost for frequent disposal of contaminated FLHs and water is eliminated.

(1) **Pump Design.** The fuel/water separator must be equipped with an explosion-proof pump.

(2) **Separator Capacity.** The capacity must handle the total quantity of fluids collected from at least two training sessions, plus ten percent. Depending on operating permits, extra capacity for captured rainfalls and snow melts may need to be provided. For facilities where high volume or frequent use is anticipated, the separator capacity must be sized to accommodate the anticipated use level, plus ten percent.

(3) **Secondary Containment.** The separator must have a secondary means of containment, for example, a flexible membrane liner.

f. Overflow Weir/Drainage Box for FLH Trainers. The top of the overflow weir(s) or drainage box should be slightly higher than the fuel level which is kept at or slightly below the protruding edges of the crushed stone surface. Metal grates that withstand the design temperature should rest on "L" iron sections attached to a concrete vault. Collected flows must have a drain pipe that directly feeds the fuel/water separator system for recycling. A gas-tight trap in the weir or between the weir and the fuel/water separator must be installed to avoid possible fuel vapor-air explosions. Weir/drainage boxes may be attached to or near the periphery of the burn area structure.

g. Storage Tanks for FLH Trainers.

(1) **Underground Storage Tanks (UST).** The installed UST must be in accordance with 40 CFR Part 280. These regulations concern proper installation, spill and overfill prevention, corrosion protection, and leak detection. It is important to remember that these regulations apply to the entire UST system, that is both the tanks and underground piping.

(a) **Spill and Overfill Prevention.** Many of the leaks at USTs are actually the result of spill and overfill errors, two separate problems. Although new USTs must be equipped with both spill and overfill protection prevention devices, transfer of fuel should be constantly observed. Fuel transfer practices are found in AC 150/5230-4, Aircraft Fuel Storage, Handling, and Dispensing on Airports, API Publication 1621, Recommended Practices for Bulk Liquid Stock Control at Retail Outlets, NFPA 30, Flammable and Combustible Liquids Code, and NFPA 385, Standard for Tank Vehicles for Flammable and Combustible Liquids.

(b) **Burial Depth and Cover for USTs.**

- **Steel Tanks.** Standard engineering installation practices related to adequate firm foundations, anchorage and buoyancy requirements, noncorrosive inert blanket materials, etc. must be used The depth of cover placed over a tank is dependent upon whether the tank will or will not be subjected to vehicle traffic. Installation practices must be in accordance with API Publication 1615-79, Installation of Underground Petroleum Storage Systems, or NFPA 30 unless otherwise directed by the engineer.

- **Non-Metallic Tanks.** The installation must follow manufacturer’s instruction with the minimum cover as specified for steel tanks unless otherwise directed by the engineer.

(c) **Tank Placement.** Tank placement must be at a distance that protects the tank from the “radiant” heat loads generated by the burn area structure.

(2) **Above Ground Storage Tanks for FLH Trainers.** An aboveground storage tank with a minimum capacity of 1,100 gal (4.2 kl) is defined by EPA as an underground storage tank (UST) when its below ground storage capacity is 10 percent or more, including underground piping.

(a) **Overfill Prevention.** Since fuel transferring errors cause most spills and overfills, it is recommended that aboveground tanks, even though not required by EPA, have UST overfill prevention.

(b) **Dike Designs.** A dike must be provided for each aboveground tank to prevent the accidental discharge of fuel from endangering other facility components, adjoining property, the groundwater, or a waterway.

- **Capacity.** The capacity of the dike must equal the sum of the total tank volume and the volume displaced by the tank that is below the height of the dike.

- **Walls and Floor.** Material for the walls and floor must be of reinforced concrete, solid masonry, or a combination. Walls must be liquid tight under a full applied hydrostatic head. Normal wall height above the interior dike floor should be less than 6 ft (2 m). If a dike wall is greater than 6 ft (2 m), the wall must have special provisions for normal and emergency ingress and egress.

- **Subdivided Dikes.** Dikes that house two or more fuel tanks must contain an intermediate curb to form individual dikes.

- **FLH Fuel Resistant Concrete Joint Sealer.** One of the following FLH-fuel-resistant concrete joint sealers must be specified: (1) ASTM D 1854, FLH-Fuel-Resistant Concrete Joint Sealer, Hot-Poured Elastic Type, (2) ASTM D 3569, Joint Sealant, Hot-Applied, Elastomeric, FLH-Fuel-Resistant-Type for Portland Cement Concrete Pavements, (3) ASTM D 3581, Joint Sealant, Hot-Poured, FLH-Fuel-Resistant Type, for Portland Cement Concrete and Tar-Concrete Pavements, or (4) Federal Specification ss-s-200, Sealing Compounds, Two-Component, Elastomeric, Polymer Type, FLH-Fuel-Resistant, Cold Applied.

- **Penetrating Pipes.** Pipes passing through a dike must be designed to prevent excessive stress and leaks as a result of settlement or fire damage.

(c) **Support, Foundations, and Anchorage.** The design of tank supports and connections in areas subjected to earthquakes must be in accordance with Appendix E of API Standard 650, Welded Steel Tanks for Oil Storage, Appendix B of API Standard 620, Rules for Design and Construction of Large, Welded, Low Pressure Storage Tanks, or the jurisdiction having authority.

h. Supply Piping System.

(1) **For FLHs.** The metered fuel supply piping system, regardless if it is part of an UST system or not, must be in accordance with 40 CFR Part 280. These regulations concern proper installation, corrosion protection, and leak detection. The design of the piping system must meet the mechanical and thermal stresses and the working pressure that are capable of maintaining the fuel discharge at the design rate for all zones operating simultaneously.

(a) **Design of Independent Zonal Fuel Delivery Network.** Each fire zone delivery pipe must have a meter, pressure gauge, and control valve to regulate the flow within the burn area structure. Zonal control valves must be located for easy emergency access. For protection, the zonal delivery network must be placed below grade.

(b) **Design of Burn Area Structure Fuel Delivery Network.** Upon entrance, each zonal delivery pipe may feed, via a distribution header, into supported branch pipes (risers) with the predetermined number of fuel nozzles (see Figure 4-5). Supports for risers must be of heat resistant materials. Each nozzle riser must be supported below and plumbed for uniform fuel delivery. Correct placement of the nozzle heads is above the crushed stone surface with each nozzle having several horizontal discharge openings. The maximum height of a nozzle protruding above the crushed stone surface must not exceed 3.0 in (7.6 cm). Nozzle coverage should consider nozzle discharge characteristics and its particular objective. Care must be taken in positioning nozzles so that sprayed fuel does not fall outside the burn area structure.

(c) **Identification.** All exposed fuel elements and components outside the burn area structure must be painted and identified according to applicable codes or standards.

(2) **For Propane.**

(a) Field installation of propane gas distribution systems utilizing components, subassemblies, container assemblies and container systems must be in accordance with NFPA 58 or as described by the jurisdiction having authority. Plans of fixed installation must be submitted to the authority having jurisdiction before the installation is started.

(b) **Leak Detection Alarm System.** All enclosed spaces containing propane piping or other propane related equipments, must be adequately furnished with propane leak detectors and an alarm system. On detection of 10 percent or more of the lower explosive level of propane, the alarm system must be activated. The detection system must be active at all times when propane is contained in the piping and propane related equipment. If the training facility is active at the time of a leak detection, the system must automatically shut down the entire propane system and activate all enclosed space ventilating devices.

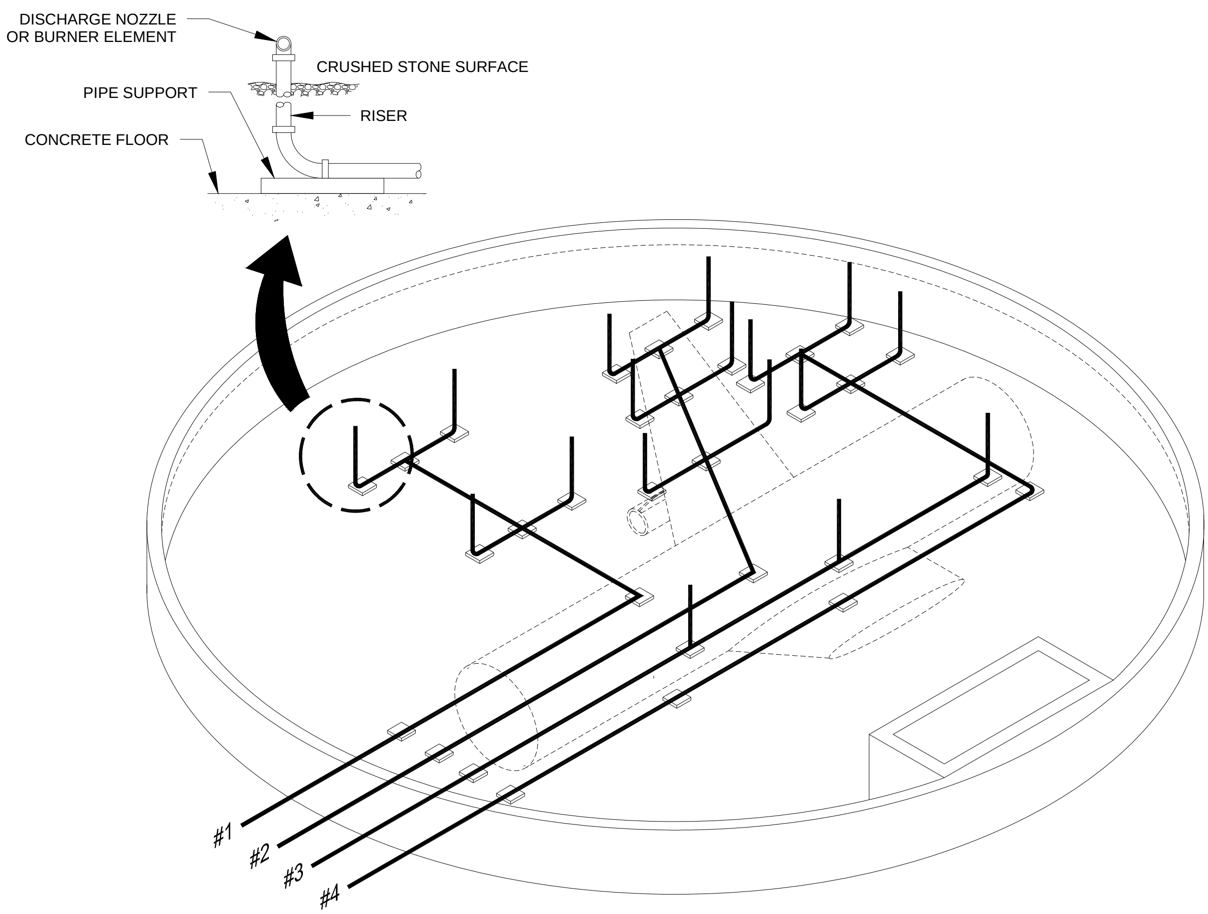


Figure 4-5. Example of a fuel/water delivery network with four independent delivery zones

(c) **Practices.** The design, construction, installation, and operation of all propane gas systems must be in accordance with NFPA 58 or those portions of propane gas systems covered by NFPA 54, National Fuel Gas Code.

(d) **Piping (including hose), Fittings, and Values.** Piping (including hose), fittings, and valve designs and material specifications used to connect container appurtenances with the balance of the propane gas distribution system must be in accordance with NFPA 58 and, for those applicable portions, to NFPA 54.

(e) **Vaporizer Location.** The propane vaporizer, which is used to turn liquid propane into vaporized propane, should be located at a safe distance (at least 100 ft (30 m)) from a bulk storage facility. This arrangement would eliminate the ignition source if a leak in the vaporizer unit were to occur.

(3) **For Water.** Requirements for the materials, design, fabrication, installation, and workmanship of the piping system for water must be in accordance with ANSI B-31.3, Chemical Plant and Petroleum Refinery Piping, or NFPA 30 unless otherwise directed by the engineer.

i. Mobile Trainer Electrical Systems.

(1) **General Design Criteria.** The design objective of the electrical system is to provide a power source and a power distribution grid for the mobile trainer that will permit it to operate at any location without the need to connect to any outside electrical power supply.

(2) **Compliance with Standards.**

(a) **Power Supply.** The unit must be a commercially available unit which complies with all existing engine and generator standards for outdoor industrial applications.

(b) **Electrical Wires, Cables, and Connectors.** All wires, cables, and connectors must comply with the National Electric Code with regards to voltage and current carrying capacity, insulation, jacketing, and protection. The jacketing and protection of all interconnect cabling must be appropriate for current carrying capacity. In addition, the jacketing and protection of all interconnect cabling must be appropriate for the aggressive nature of this application.

(3) **Performance Criteria.**

(a) **Electrical Power Supply.** The generator must operate on commercial, automotive grade diesel fuel. The fuel tank must be adequate to provide full power to the mobile trainer for up to ten hours of continuous operation. In addition, the generator must have sufficient capacity to support the "as-built" mobile trainer and to have a spare load capacity of approximately 25%.

(b) **Electrical Wiring, Cabling, and Connections.**

- All electrical connections between the various components, the power supply, and control systems must be prominently identified, marked, and polarized in a manner that will prevent improper connection. Whenever possible, quick connect/disconnect electrical connectors must be used.

- Outdoor rated, Ground Fault Interrupter (GFI) convenience receptacles (duplex) must be provided. The interior of the operator station must be provided with sufficient receptacles to support the control system requirements without the use of extension cords. In addition, at least one GFI receptacle must be on the exterior of the operator station and at least one GFI receptacle at each end of the fuselage mock-up. These must be sized to allow the operation of common electrical power tools.

- All wiring within the system must be clearly identified by color coding or some other acceptable means of circuit identification. A system wiring diagram must be provided as part of the deliverable mobile trainer documentation. It must clearly show the means of identification used in the completed mobile trainer.

4.7. Mobile Trainer Transportability.

a. General Design Criteria.

(1) The overall design objective is to provide a training device that can simulate the specified aircraft fires and can be transported from airport to airport or to any other suitable (accessible) location within a given geographic region.

(2) The mobile trainer shall be designed and constructed so no special licenses or permits will required for over the road transport in the continental United States.

NOTE: *The specific, intended area of operation should be clearly defined by the purchaser in the request for bids. The purchaser should also determine whether or not there are any restricted bridges, tunnels, or any other traffic restrictions in the area where the* mobile trainer *would be prohibited or whether the* mobile trainer *will require unique design or packaging to ensure that it can be moved throughout the intended area of operation.*

(3) The functional objective of the mobile trainer's transportability is to minimize the number of person-hours and specialized equipment or tools required to set up or to disassemble and re-pack the mobile trainer. Safety considerations dictate that three operators are the minimum number of personnel needed to perform actual training. Hence, this would be a cost-effective design target for the set up and re-pack functions.

(4) The packaging of all of the mobile trainer subsystem components must be designed and fabricated so that the equipment is packaged for transport in the same manner each time.

(a) The packaging material, methods, and the packed configuration of the mobile trainer system must be designed and manufactured for long use and durability.

(b) The packaging must also be designed to protect the equipment from shock and vibration damage during over-the-road transportation.

(c) The construction materials selected and the fabrication methods used for the electrical and propane distribution subsystems must be appropriate for a transportable device that will be disassembled and assembled numerous times over its useful life. Both the design and the functional objectives are to provide a mobile trainer that is free of loose electrical system connections and propane system leaks.

(5) The supplier must completely describe in the training material (See paragraph 6.9 above) the recommended method for setting up the mobile trainer when it arrives on site, breaking it down for transportation to another site, and transporting the mobile trainer between sites.

b. Fuel-Spill Burn Area. The fuel-spill burn area and its support equipment must be designed to either park into the fuselage trailer or onto a separate, dedicated ancillary equipment trailer.

c. Aircraft Fuselage Mock-up. The mock-up must be designed to be transported over the interstate highway system and to meet US Department of Transportation (USDOT) guidelines for operation on the public highways without special wide-load or hazardous materials permits.

(1) The mock-up may be designed with trailer components such as hitches, axles(s), brakes, lights, and support jacks incorporated into the mock-up, or it may be designed for deployment from a standard flatbed trailer.

(2) Regardless of the method selected, the trailer must not require a special tractor or unique hitch arrangements, i.e., the type of hitch, brake, and lighting connections provided must be those in common use in the commercial trucking industry.

d. Simulator Control Center. The control center must be designed to ship on the towing tractor as part of the fuselage trailer or on a separate dedicated ancillary equipment trailer.

(1) The whole control center is to be designed so that the operator control system, the communications system, specialized maintenance tools, spare parts and materials, the operator's manuals, books, and the paperwork associated with the operation of the mobile trainer are all transported with the towing tractor, fuselage trailer or dedicated equipment trailer when the system is in transit.

(2) The control center and the interior furnishings must be designed and manufactured to protect the equipment and material stored inside when the trainer is in transit and to limit damage to the interior surfaces of the control center.

e. Propane Fuel Supply. The fuel supply subsystem, when being transported as part of the mobile trainer system, must be designed to be shipped either as part of the fuselage trailer or on a separate dedicated ancillary equipment trailer. The subsystem must be capable of holding at least 1000 gallons (3785 l) of fuel, which allows for the requirements of Section 3.6 of this AC to be met.

(1) The manufacturer will also provide, as part of the required training material, a description of the procedure for having the propane subsystem purged and sealed for transport and inspected and filled once deployed.

(2) The manufacturer must include, as part of the subsystem documentation, a description of any licenses or permits required for interstate transport of the mobile trainer.

NOTE: *Purchaser should clearly define the intended area of operation in the request for bids.*

f. Electrical Power Supply. The power generation subsystem must be designed so that it either packs into the mock-up trailer or onto a separate trailer dedicated for ancillary equipment. Permanent mounting on a dedicated equipment trailer is an acceptable means of providing transportability.

g. Electrical Cabling, Connectors, and Wiring. The electrical cabling and connectors must be designed either to pack into the fuselage trailer or onto a separate, dedicated ancillary equipment trailer. Cables must be stored on reels and connectors must have protective covers.

h. Propane Hoses, Piping, Fittings, and Couplings. The propane hoses, piping, fittings, and couplings must be designed either to pack into the fuselage trailer or onto a separate dedicated ancillary equipment trailer. Hoses must be stored on reels, piping and fittings in dedicated cases or boxes, and couplings must be provided with protective covers.

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CHAPTER 5. CONSTRUCTION MATERIAL STANDARDS

5.1. STRUCTURAL STEEL.

a. Material Acceptance and Storage. All reinforcing structural steel, including metal accessories necessary for placing, spacing, supporting and fastening reinforcement, must conform to the levels of quality specified to perform the functions intended. Upon delivery, these items must be checked for conformance to specifications and then properly stored from dirt, grease, and the environment.

b. Practices. All steel design, fabrication, and erection must be in accordance with the American Institute of Steel Construction (AISC), Specification for Design, Fabrication, and Erection of Structural Steel for Buildings, and with the AISC, Code of Standard Practice for Steel Buildings and Bridges, unless otherwise directed by the engineer.

(1) **Steel Reinforcing Bars and Welded Wire Fabric.** Tolerances and placement for reinforcing bars, welded wire fabric, and metal devices necessary for placing, spacing, supporting, and fastening reinforcement must conform to the American Concrete Institute (ACI) 318-83, Building Code Requirements for Reinforced Concrete. For corrosion protection of rebars, protective coatings such as epoxy coatings are recommended. If specified, they must be in accordance with ASTM A 775, Specification for Epoxy-Coated Reinforcing Steel Bars.

(2) **Welding.** Welding practices must be in accordance with AWS D 1.1, Structural Welding Code - Steel, and appropriate AISC welding specifications, unless otherwise directed by the engineer. Welders must be qualified in accordance with AWS D 1.1, Structural Welding Code - Steel.

5.2. CAST-IN-PLACE CONCRETE.

a. Material Acceptance. Portland cement concrete must be mixed and delivered in accordance with ASTM C 94, Standard Specification for Ready-Mixed Concrete. Cement must be Type I (normal), II (exposure to sulfate bearing soils and seawater), or III (high early strength) Portland cements in accordance with ASTM C 150, Specification for Portland Cement. The minimum 28-day compressive strength must be 4,000 psi (28,000 kPa) for FLH concrete retaining structures, e.g., burn area structure, concrete fuel/water separator vaults (not the apron or dike) and 3,000 psi (20,000 kPa) for propane-fired trainers. Upon placement, concrete must have a slump of 1 to 4 inches (ACI 211) and percent air (±1%) in accordance with paragraph 4.5.1 of ACI 318.

b. Practices. Concrete design must be in accordance with ACI 318 unless otherwise directed by the engineer. Regions subject to moderate or high seismic risks must note Appendix A, Special Provisions for Seismic Design, of ACI 318. Hot weather and cold weather concreting practices must be in accordance with ACI 305R, Hot Weather Concreting, and ACI 306R, Cold Weather Concreting. Special emphases must be observed during (1) placement of concrete, i.e., concrete must be deposited continuously in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause seams or planes of weakness, and

(2) curing of concrete, i.e., controlled curing is one of the best precautions to make concrete watertight.

c. Clean Water. Water must be clean, potable, and free from pronounced odor.

d. Aggregates. The nominal maximum aggregate size must be 0.75 in (1.9 cm) in accordance with ASTM C 33 (e.g., coarse aggregate size number 67). The material must be free of injurious amounts of shale, alkali, organic matter, loam, or other deleterious substances. Paragraph 5.3.2 of ACI 211 must be observed, e.g., in no event must the nominal maximum size exceed 1/5th of the narrowest dimension between sides of forms.

e. Admixtures. Air-entrained admixtures must comply with ASTM C 260, Standard Specification for Air-Entraining Admixtures for Concrete. Calcium chloride must not be used as an admixture. All other chemical admixtures and mineral admixtures must meet the appropriate standard specifications set forth by ASTM.

f. Non-Shrink Grout. Grout must be a non-shrink grout in accordance with U.S. Army Corps of Engineers CRD-C-621, Handbook for Concrete and Cement, Specification for Non-Shrink Grout, unless otherwise specified by the engineer.

g. Surface Finish. Surface finishing must proceed only after surface water has disappeared and concrete has set sufficiently to support the weight of workers and equipment. The surface must dry naturally, e.g., do not dust surface with dry cement or sand. A power-driven float machine must be used to float the surface of the burn area floor to produce a finish true to elevations and slopes with a uniform granular texture. Hand floats must be used in areas inaccessible to power-driven floats. Surfaces must be leveled to within 1/4 inch in lo-foot in all directions unless otherwise specified by the engineer. Concrete aprons and other walking surfaces must be broomed with a flexible bristle broom to produce a non-slip texture in a direction transverse to that of traffic or at right angles to the slope of the surface.

h. Cementitious Waterproofing. Cementitious waterproofing must be provided on the "positive" inside surfaces of FLH fuel concrete retaining structures. Materials used for waterproofing must follow manufacturer's application instructions to ensure proper penetration and closure of concrete capillary tracts. The selected cementitious waterproofing system must become permanent and be non-toxic, inorganic, free of calcium chloride and sodium based compounds.

i. Fuel Resistant Concrete Joint Sealant. For FLH-fired trainers, the engineer must specify one of the following fuel-resistant concrete joint sealant: (1) ASTM D 1854, (2) ASTM D 3569, (3) ASTM D 3581, or (4) Federal Specification ss-s-200.

5.3. REFRACTORY CONCRETE.

a. Material Acceptance. Castable refractory concretes must be a class B or C (regular, not an insulating type castable) in accordance with ASTM C 401, Standard Classification of Castable Refractories. Additional requirements may be specified by the manufacturer to offset the rapid heating and cooling stress cycle, e.g., fast-fire variety castable to offset explosive spalling.

b. Practices. All construction practices and materials for placement, anchorage, finishing, curing, drying, firing of refractory castable concrete must be as specified by the refractory manufacturer. Since refractories behave differently when compared to Portland cement concretes, contractor must have prior construction experience with the product or be properly supervised by the refractory manufacturer.

c. Electrical Systems. Electrical systems, equipment, wiring installation, and testing must comply with latest revisions of NFPA 70, National Electrical Code (NEC), and other applicable State and local regulations. Where codes and/or standards conflict, the more stringent must apply.

5.4. FLEXIBLE MEMBRANE LINER.

a. Material Acceptance. The liner must be a high-density polyethylene (HDPE) flexible membrane liner (FML) of a non-extractable plasticizer quality certified by the Geosynthetic Institude (GSI), or equivalent. It must:

(1) Have a minimum nominal gauge thickness of 80 mils (0.080 inch).

(2) Meet the material property standards for 80-mils noted in standard specification GRI-GM13, Test Methods, Test Properties, Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes and GRI-GM19, Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

(3) Meet the material compatibility tests of the EPA Test 9090 for the fuels and fire fighting foams used in training. If the solution is not homogenous, i.e., consists of more than one phase, then tests should evaluate each phase.

(4) Be chemically compatible and appropriate for site specific considerations as covered in GRI-GM13 and GRI-GM19. Considerations include moist environments, supporting soil environments, constant stress under load at both normal and elevated temperatures.

(5) Not exceed the maximum permeability rate for FLH fuel established by the applicable State (e.g., State Department of Natural Resources) or local authority. Permeability tests may be in accordance with ASTM E 96, Standard Test Method for Water Vapor Transmission of Materials, performed with the type of hydrocarbon fuel to be contained.

(6) Have a high temperature resistance of 240°F (116°C) without performance failure.

(7) Have a high resistance to abrasion, humidity, rot, mildew, vermin, bacterial deterioration, and sunlight (UV).

b. Bonded Seams. The seam is a critical part of the FML system. Seams may be either factory or field constructed in accordance with GRI-GM13 and GRI-GM19, for site specificity and chemical compatibility.

(1) Factory and field seaming techniques must be as listed in GRI-GM13 and GRI-GM19.

(2) Factory seams must meet the 80 mil physical property requirements of GRI-GM13 and GRI-GM19.

(3) Field seams must be in accordance with ASTM D 4437, Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymetric Sheet Geomembranes, for determining the integrity of field seams.

(4) Field seaming and repairs must be in accordance with GRI-GM13 and GRI-GM19 at no additional cost to the airport sponsor.

(5) All seams must be permanently marked with an identification number.

c. Penetrations: Interface Components, Liner Tubes, Sleeves, etc. Penetration of FMLs, e.g., by pipes, and FMLs attached to structures must be in accordance with GRI-GM13 and GRI-GM19. All liner attachments and penetrations must be verified to be liquid tight. A variety testing methods can be used such as, hydrostatic, vacuum, ultrasonics, or an air jet.

d. Installation. Contractors must have either prior installation experience for the type of liner material selected or an installation experience level approved by the applicable State (e.g., State Department of Natural Resources) or local authority. Prior to liner placement, GRI-GM13 and GRI-GM19 must be addressed, i.e., considerations for chemical compatibility and site specificity. Liner installation must meet the manufacturer's recommendations and the following.

(1) The subgrade supporting the liner must be prepared and maintained in accordance with GRI-GM13 and GRI-GM19. If a soil stabilizer to control erosion is used, e.g., chemical binding agent, it must be chemically compatible with the liner.

(2) Further protection of the secondary FML must be accomplished by placing on the prepared subgrade either a minimum of 6.0 in (15 cm) of base material (e.g., sand per item 1 above) or a geotextile padding of at least 15 mils (0.015 inch). Placement of either material must not be accomplished over a porous, wet, spongy, or frozen subgrade.

(3) The base (or the prepared subgrade that is covered only by padding) must be uniformly compacted to ensure against liner settlement and provide uniformly sloped surface(s) for interior drains and leak monitoring. Compaction must be 95 percent of that obtained in accordance with Method D, of ASTM D 698, Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb Rammer and 12-inch Drop. Optimum moisture content of backfill materials must be maintained to achieve the required compaction density. Backfilling must not be accomplished over a porous, wet, spongy, or frozen base. It is recommended that the site engineer provide visual inspection during compaction operations of areas that support a structure with an attached FML.

(4) Concrete or other rigid surfaces adjacent to the liner must have all rough edges and projections removed. Extruded expansion materials and joint sealers (compatible with the liner) must also be removed and flush with the concrete surface.

(5) The perimeter of the sealed double liner system must be mechanically anchored below the berm (or FML trench) with at least a 20 in (50 cm) protective cover of backfill material.

(6) Care must be taken during covering operations to prevent damage to the liner by mechanical equipment.

(7) The cut of the FML trench must be sufficiently wide to enable installation and inspection of the FLM, and, if included, pipes and utilities.

(8) The location and elevation of the sump housing the leak detection device must be verified.

(9) Resulting tears, punctures, or other defects in the liner during installation must be repaired, tested, and certified to be leak free by the installer at no additional cost to the airport sponsor. Repairs to the liner must be patched using the same type of liner material.

(10) Once the FML trench has been installed, it must be backfilled by a method that does not disturb elevations or damage the trench FML, leak detection device, pipes, and utility lines. Hand tamping must be performed in areas inaccessible to compaction equipment.

5.5. DRAINAGE FLOW NET.

a. Material Acceptance. The drainage flow net must be compatible with the FML and the chemicals used in training, e.g., hydrocarbon fuels, training foams. Also, the net must withstand bearing loads to maintain effective flow characteristics (i.e., hydraulic transmissivity) towards the leak detection device.

b. Installation. Installation of the drainage flow net must be in accordance with the manufacturer’s recommendations. The net must terminate near the perimeter of the FML system, i.e., under the berm. If tears, punctures, or other defects result from installation, they must be repaired by the installer at no additional cost to the airport sponsor.

5.6. GEOTEXTILE FILTER FABRIC.

a. Material Acceptance. The geotextile filter fabric must have the following properties, unless otherwise specified by the engineer:

(1) A woven or nonwoven fabric compatible with the chemicals it contacts.

(2) Minimum puncture strength equal to 120 lb (54 kg) when tested in accordance with ASTM D 751, Standard Method of Testing Coated Fabrics, modified by using 5/16 or .31 in (7.9 mm) diameter cylinder.

(3) Equivalent opening size in fabric, minimum 100 and maximum 50, as determined by Corps of Engineers Guide, Specification CW-02215, Geotextiles Used as Filters.

(4) Minimum weight of fabric equal to or greater than 8 oz/y^2 (270 g/m^2) determined in accordance with ASTM D 3776, Standard Test Method for Mass Per Unit (Weight) of Woven Fabric.

b. Installation. Installation must be in accordance with manufacturer's recommendations and:

(1) Prior to placing the fabric, the receiving foundation material must be properly compacted and have surface gradients and elevations verified.

(2) Fabric applied to a surface must have sufficient slack to prevent tearing when the overhead layer of crushed stones is placed.

(3) Fabric edges must be lapped a minimum of 1 ft (.3 m) to prevent separation at overlapped edges when the overhead layer of crushed stones is placed.

(4) A minimum 6.0 in (15 cm) cover of crushed stones must be placed over fabric prior to operating equipment on covered area.

(5) End joints of the fabric must be placed 2 ft (.6 m) into the "inner ring section".

(6) Tears, punctures, or other defects must be repaired by the installer at no additional cost to the airport sponsor.

5.7. PIPING DISTRIBUTION SYSTEMS.

a. Since faulty piping installation is a significant cause of UST system failures, proper installation is crucial to ensure their structural integrity of the piping distribution system. To reduce occurrences, the engineer should make sure that installers carefully follow the correct installation procedures called for by industry codes. For example, particular attention should focus on proper layout of piping runs, complete tightening of joints, and adequate cover. It is noted that the airport operator will need to certify on a UST notification form, available from the State, that installation was by a qualified installer.

b. Corrosion Protection. Underground metallic piping must be protected against corrosion in accordance with paragraph 3-2.7 of NFPA 58.

c. For FLHs.

(1) **Acceptance Test.** After cleaning and before being buried, covered, or concealed, the piping system from the storage tank to the discharging nozzles (capped) within the burn area structure must be proven tight before it is placed in service. The hydrostatic test must be not less than 150% of the working pressure to demonstrate tightness and conformance in accordance with NFPA 30 unless, otherwise directed by the engineer.

(2) **Test for Emergency Shutoff Device.** The emergency shutoff device(s) must be checked for proper operation prior to placing the system in service.

d. For Propane.

(1) **Propane Gas Equipment.** Fabrication and performance for pressure containing metal parts of propane gas equipment such as pumps, compressors, vaporizers, strainers, meters, sight flow glasses, and regulators, must be in accordance with NFPA 58. Systems, or individual components assembled to make up systems, must be approved in accordance with NFPA 58.

(2) **Testing.** After assembly, piping systems (including hose) must be tested and proven free of leaks at not less than the normal operating pressure. Piping within the scope of NFPA 54, must be pressure tested in accordance with that Code. Tests must not be made with a flame.

(3) **Testing of Equipment and Systems.** Systems, or individual components assembled to make up systems, must be approved in accordance with NFPA 58.

e. For Water.

(1) All piping systems, before being covered, enclosed, or placed in service, must be flushed thoroughly with water (i.e., before spray nozzle connections) in order to remove foreign materials which may have entered during the course of installation. Cleanliness of sections where flushing is not practicable should be determined by visual inspection.

(2) After cleaning and before being buried, covered, or concealed, all water piping systems must be hydrostatically tested at not less than 150% of the working pressure to demonstrate tightness and conformance in accordance with NFPA 30.

5.8. STORAGE TANKS.

a. For recycled water.

(1) **Practices.** Since the recycled water may contain low traces of hydrocarbon fuels or other contaminants, the tank must be suitable for storing them. Tank installation must be in accordance with NFPA 30 unless, otherwise directed by the engineer. The tank surface and all ferrous-metal appurtenances must be cleaned, primed, and painted.

(2) **Testing.** Prior to service, the tank must be tested in service in accordance with the applicable paragraphs of the code under which it was built. Upon fastening tank delivery connections, a tightness test must be conducted prior to placing the system in service in accordance with NFPA 30. Except for underground tanks, tightness test must be performed at the operating pressure with either air, inert gas, or water. Leaks must be corrected and the system retested.

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APPENDIX A. FIRE TRAINING SCENARIOS

A-1. Exterior Aircraft Fire Incident Scenarios.

a. Ground Fuel Spill. The purpose of this scenario is to present realistic and challenging exercises upon which both new and experienced firefighters can develop a level of confidence and proficiency necessary for them to position themselves properly, to utilize proper agent application techniques, to manage limited extinguishing agent resources to fight the fire, and to create a safe pathway to the aircraft mock-up.

(1) The fuel-spill burn area must be sized as defined in paragraph 3.2.c., "Mobile Trainer."

(2) It must be designed and constructed to operate in a manner that will provide ARFF personnel with exposure to a radiant heat load approximating that commonly associated with aviation fuel-spill fires of similar size.

(3) It must also be designed and constructed to operate in a manner that will ensure that responding firefighters get a visual perception that they are approaching a fire size typical of a commercial passenger aircraft fuel-spill fire.

(4) The design and construction of the controls for this scenario must provide the operator with the means to define the size, shape (within the predefined grid of control segments), and the extinguishing difficulty level of the fire scenario to be presented for each training exercise.

(5) A means of control must be provided to ensure that once the operator has selected the variable settings, the fire scenario can only be ignited from the operator control station.

(6) Once ignited, the ground fire must then begin to grow by spreading from segment to segment within the fuel-spill burn area. The fire must spread from one segment to the next only after presence of flame on the adjoining segment is detected. The fire must grow in this manner until all of the preselected segments are covered in fire. The flame height on the fuel-spill fire area must be proportional to the number of burning segments.

(7) For AFCS systems:

- Sensors within the individual control segments must provide feedback to the control system. Based upon the predetermined settings of the extinguishing difficulty level, the fire must respond to proper agent application by receding in a realistic manner and eventually extinguishing.

- If sensors within the individual control segments detect that the application of water is stopped too early (based on the preselected level of soak time), the fire must be allowed to rekindle.

- A means must be provided to ensure that once a control segment has been extinguished (proper soak time per preselected variable) it must remain inactive until the completion of a training scenario.

NOTE: *Although this inability to reflash after complete extinguishing is not an entirely realistic fire response situation, this safety feature is required to eliminate a potentially unsafe condition, i.e., a control segment becoming alive while firefighters are standing on it.*

b. Engine Nacelle Fires. The purpose of this scenario is to present a realistic training exercise to teach the proper fire area approach and to develop the agent application techniques needed to achieve safe engine fire extinguishing. The mock-up must be designed and constructed to provide fire fighters the opportunity to deal with a turbo prop engine and/or a jet engine.

(1) The mock-up must be designed and constructed to provide the following mounting locations for an engine fire scenario:

- One above, on, or in a low-wing fuselage configuration;
- One below the wing on a high-wing type aircraft; and
- One on the tail (typical DC-10 or MD-11) of a low-wing type fuselage.

(2) The design and construction of the controls for this scenario must provide the operator with the means to define both the complexity (engine off or engine running) and the level of extinguishing difficulty (static internal fuel fire or fire with flowing/3-dimensional fuel fire running to the ground) of the fire scenario to be presented for each training exercise.

(3) The engine-off internal fires must be located in the exhaust area of the engine and give the appearance of a small fuel leak fire.

(4) The engine-running fire scenario must have the complication of a flaming exhaust plume added to the engine-off scenario. This scenario must require that action be taken to shut down the engine fuel supply, i.e., close the mock throttle from the flight deck before extinguishing can be accomplished.

(5) A fireplace element that gives the appearance of a fire with fuel flowing out of the engine (3-dimensional fuel fire) and running to the ground must be provided as a selection to increase level of difficulty for the engine fire scenarios.

(6) The engine-off and engine-on fires must be designed and constructed to respond to the appropriate direct application of agent (water) to the hot exhaust area or to agent applied through an access panel located on the side of the engine mock-up. When the 3-dimensional fuel fire element is active, the design must provide for a means to keep the basic engine fire burning until the 3-dimensional fire has been extinguished.

(7) Once the operator has selected the variable settings from the control station, the means of control for this scenario must permit pilot and fire initiation by either the operator from

the control station or by an instructor from the local control pendent near the engine on the fuselage mock-up.

(8) A means must be provided to ensure that the fire (after being ignited by the pilot) will then grow to the flame height appropriate for the level of difficulty selected, e.g., engine exhaust area, the engine exhaust with exhaust fire plume, and either of the above with the 3-dimensional fuel flow complication added.

(9) A means must be provided so that smoke can be emitted from the engine exhaust area at any time. It must be operated independently of the fire.

(10) For AFCS systems:

- Sensors within the engine fireplace must provide feedback to the control system. Based upon the predetermined settings of the extinguishing difficulty level, the fire must respond to proper agent application by receding in a realistic manner and eventually extinguish.

- If sensors within the engine or the 3-dimensional fireplace detect that the application of water is stopped too early (based on the preselected soak time) the fire must be permitted to rekindle.

c. Hot Brake/Wheel Fire. The purpose of this scenario is to provide fire fighters the opportunity to deal with the hazardous conditions associated with overheated brakes. The fireplace must be designed and fabricated to present a realistic training exercise to teach the proper fire area approach and to develop the agent application techniques needed to achieve safe wheel and brake fire extinguishing.

(1) The design and construction of the aircraft mock-up should allow for the wheel/brake fire scenario to be located underneath the wing, in the low-wing configuration and along side the fuselage in the high-wing configuration. The fire and smoke emission area must be located between the dual wheels of a mockup landing gear assembly.

(2) A means must be provided for this fire scenario to operate in either a smoke only or a fire and smoke mode.

(3) The design and construction of the controls for this scenario must provide the operator with the means to define both the intensity (smoke only or smoke and fire) and the level of extinguishing difficulty (short soak or long soak) of the fire scenario to be presented for each training exercise. The fires must respond to the direct application of water stream to the hot brake area.

(4) A means must be provided to ensure that the wheel / brake fire will grow within the brake area to the flame height appropriate for the level of difficulty selected, e.g., short soak or long soak.

(5) A means must be provided for the on-site instructor to activate a device that will simulate the explosive, pressure-releasing sounds of a wheel safety-plug blow-out .

(6) For AFCS systems:

- Sensors within the fireplace must provide feedback to the control system. Based upon the predetermined settings of the extinguishing difficulty, the fire and/or smoke must respond to proper agent application by receding in a realistic manner and eventually extinguish.

- If sensors within the fireplace detect that the application of water is stopped too early (based on the preselected level of difficulty), the fire must be permitted to rekindle.

d. 3-Dimensional Running Fuel Fire. This fire scenario must be incorporated into the engine fire scenarios as described above.

A-2. Interior Aircraft Fire Scenarios (Optional).

a. Passenger Compartment. The purpose of this scenario is to provide fire fighters a safe opportunity to deal with the hazardous conditions associated with gaining entry into the limited space typical of a commercial passenger aircraft, maneuvering hand lines under low-visibility in a congested space, and a realistic Class A fire typical of that produced by the interior furnishings of an aircraft.

(1) The fireplace must be designed and fabricated to give the perception of being a main passenger compartment fire and must be designed to provide control of the following variables: extinguishing difficulty, flame growth rate, maximum flame height, soaking time, and visibility. It must be possible to emit smoke into the fuselage at any time and it must function independently of the fire.

(2) After the scenario variables have been selected by the system operator, the interior cabin fire scenario must only be capable of initiation by the instructor from the local control pendent located inside the fuselage mock-up.

(3) The fireplace must be designed and constructed to respond to water spray from either a direct hose attack or as applied by a penetrating nozzle through the skin penetration area.

(4) A means must be provided to ensure that the interior cabin fire will grow at the predetermined rate and to the predetermined flame height in the main passenger compartment. The fire must cover approximately 1/4 of the length of the interior of the fuselage in flames when the maximum flame height setting has been selected. Flame height must reach at least the top of the luggage rack.

(5) For AFCS systems:

- Sensors within the fireplace must provide feedback to the control system. Based upon the predetermined settings of the extinguishing difficulty, the fire and/or smoke must respond to proper agent application by receding in a realistic manner and eventually extinguish.

- If sensors within the fireplace detect that the application of water is stopped too early (based on the preselected soak time) the fire must be permitted to rekindle.

b. Flight deck. The purpose of this scenario is to provide fire fighters a safe opportunity to deal with the hazardous conditions associated with maneuvering hand lines and applying extinguishing agent under low-visibility, congested conditions, and to deal with a realistic Class C fire.

(1) The fireplace must be designed and fabricated to give the perception of being an instrument panel fire in the flight deck compartment and must be designed to provide control of the following variables: extinguishing difficulty, flame growth rate, maximum flame height, soaking time, and visibility. It must be possible to emit smoke into the flight deck at any time, independently of the fire.

(2) After the scenario variables have been selected by the operator, the flight deck fire scenario must only be capable of initiation by the instructor from a local control pendent located inside the fuselage mock-up.

(3) A means must be provided to ensure that the instrument panel fire will grow at the predetermined rate and to the predetermined flame height in the flight deck compartment.

(4) The fireplace scenario must be designed and constructed to respond to water spray only after action has been taken to "turn off" electrical power to the instrument panel. If agent is applied prior to the power disconnect action, an alarm must sound to highlight the improper technique and the fire must be allowed to grow according to the preset variables.

(5) For AFCS systems:

- Sensors within the fireplace must provide feedback to the control system. Based upon the predetermined extinguishing difficulty settings, the fire and/or smoke must respond to proper agent application by receding in a realistic manner and eventually extinguish.

- If sensors within the fireplace detect that the application of water is stopped too early (based on the preselected soak time) the fire must be permitted to rekindle

c. Cargo compartment. The purpose of this scenario is to provide fire fighters a safe opportunity to deal with the hazardous conditions associated with gaining access to the cramped space typical of a commercial passenger aircraft cargo / luggage stowage area, maneuvering hand lines under low-visibility, congested condition, and to deal with a realistic fire involving packaged Class A materials typical of airline passenger luggage and air freight.

(1) The fireplace must be designed and fabricated to give the perception of being a cargo/luggage compartment fire and must be designed to provide control of the following variables: extinguishing difficulty, flame growth rate, maximum flame height, soaking time, and visibility. It must be possible to emit smoke into the compartment at any time, independently of the fire.

(2) After the scenario variables have been selected by the operator, the cargo fire scenario must be capable of initiation only by an instructor from a local control pendent located outside the fuselage mock-up.

(3) The fireplace must be designed and constructed to respond to water spray from either a direct hose attack or as applied by a penetrating nozzle through a skin penetration area.

(4) A means must be provided to ensure that the cargo compartment fire will grow at the predetermined rate and to the predetermined flame height in the compartment. The fire must cover approximately half of the interior of the cargo area in flames when the maximum flame height setting has been selected. At maximum flame height, fire must reach the ceiling of the compartment.

(5) For AFCS systems:

- Sensors within the fireplace must provide feedback to the control system. Based upon the predetermined settings of the extinguishing difficulty, the fire and/or smoke must respond to proper agent application by receding in a realistic manner and eventually extinguish.

- If sensors within the fireplace detect that the application of water is stopped too early (based on the preselected soak time), the fire must be permitted to rekindle.

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APPENDIX B. ADDITIONAL SYSTEM STANDARDS.

B-1. Design Standards.

a. Total Life. An ARFF training facility must be designed to perform its intended function for its "total life" period when maintained according to the manufacturer's instructions. The "total life" for which the equipment is designed, assuming it is used and maintained in accordance with the manufacturer's recommendations, must be a minimum of 10 years.

b. Power Supply. In the event of a power failure, the system must have the capability to extinguish all fires.

B-2. Construction Standards.

a. General Requirements:

(1) All equipment and material must be new, undamaged, and of the best grade; decisions concerning quality, fitness of materials, or workmanship are determined by the purchaser.

(2) Where items exceed one in number, the manufacturer must provide products from the same component manufacturer with identical construction, model numbers, and appearance.

(3) Insofar as possible, products must be the standard and proven design of the manufacturer.

(4) The manufacturer must install electrical connections for power, controls, and devices in accordance with the National Electrical Manaufacturers Association (NEMA) and NEC recommendations and requirements. Transmitting equipment must be installed and adjusted in accordance with manufacturer's published instructions and the requirements specified herein.

b. Workmanship. The manufacturer must install all equipment, materials, specialties, etc., in accordance with the best engineering practice and standards for this type of work.

c. Materials:

(1) Equipment exposed to the weather must be weatherproof type.

(2) All external components must be constructed and finished in a manner to inhibit corrosion based on the purchaser's specific environment.

(3) All machined surfaces must be coated with a suitable rust preventative.

d. Parts:

(1) Standard and Commercial Parts. Insofar as practicable, commercially available standard parts complying with commercial and/or military standards must be used throughout.

(2) Interchangeability and Replaceability.

(a) All parts having the same manufacturer's part number must be directly and completely interchangeable with each other with respect to installation and performance.

(b) All components and assemblies incorporated in the equipment must be designed and manufactured to dimensional tolerances which permit future interchangeability and facilitate the replacement of parts.

(3) Spare / Replacement of Parts. The manufacturer must develop and provide to the purchaser a parts list, including associated replacement/repair costs.

(4) Substitutions. The purchaser must approve any material or equipment designated as an "or equal" product, but these items must be clearly distinguished and noted in the technical manuals as substitutions.

e. Name Plates and Instruction Plates.

(1) All nameplates must be made of a material which is not degraded by weathering or exposure to water, heat, or fire fighting agents. The information may be engraved, stamped or etched on the plate. All plates must be securely mounted in a conspicuous place on or near the item it identifies or for which it gives instructions.

(2) Nameplates must show make, model, serial number, and other such data as may be appropriate for positive item identification.

(3) Instruction plates must provide specific directions to be followed for safe, efficient operation, or servicing the trainer. These plates must include specific warnings or cautions as may be necessary to protect operation and maintenance personnel from such hazards as high voltage, pressure and temperature, sharp edges, moving parts, or hazardous materials. These plates must be so located and of sufficient size to be readily seen under normal operating and service conditions.

f. Codes, Standards, Regulations, and References. The manufacturer must recognize and comply with all codes and standards applicable to the design and construction of this type of equipment which are generally accepted and used as good practice in the industry.

B-3. Installation and Acceptance Standards.

a. Installation:

(1) Obstructions and other standards. Training facilities must conform to applicable airport obstruction criteria, marking and lighting, and equipment design and installation standards.

(2) Prior to installation, the manufacturer must obtain all site construction, environmental, and coordination requirements for installation of the detection system at the airport.

(3) Unless otherwise specified by the purchaser, installers of mechanical and electrical work must participate in any pre-installation meetings at the project site to review conditions of other related project work.

(4) The manufacturer must provide trained personnel at the time of delivery to place the device into operation.

(5) Equipment located outside of paved surfaces should be designed and built with ease of maintenance in mind.

b. Quality Assurance. The manufacturer must test all of the equipment installed under this specification and demonstrate its proper operation to the purchaser. The manufacturer must furnish all required labor, testing, instruments and devices required for the conduct of such tests.

(1) The manufacturer must install all electrical, instrumentation, and mechanical works to the satisfaction of the purchaser, with inspecting authorities having jurisdiction.

(2) The manufacturer must notify the purchaser in writing of any instances in the specifications that are in conflict with applicable codes. The manufacturer must perform all work in accordance with applicable laws, rules, or regulations.

(3) Deviations from the specifications required for conformance with the applicable codes and/or laws must be corrected immediately, but not until such deviations have been brought to the attention of the purchaser.

(4) For applicable codes and/or laws that govern the minimum design requirements: where this AC calls for materials, vents, sizes, design details, etc., in excess of the code requirements, the AC takes precedence.

c. Inspection. The manufacturer will establish a formalized final inspection regimen to ensure each system is adjusted as designed, all systems are operating properly, and the finish in complete and undamaged. The purchaser may choose to participate in the final inspection of designated systems.

d. Testing. After the equipment has been installed and the various units have been inspected, adjusted/calibrated, and placed in correct operating condition, the equipment must be field tested in accordance with the purchaser's testing procedures and requirements. The field tests must demonstrate that the equipment functions are in compliance with the specifications over the entire range of operation. The manufacturer must report any unusual conditions and correct deficiencies of any of the units.

(1) **Manufacturer's Certification.** The manufacturer must comply with this requirement by providing a written certification that the item(s) or function(s) required by the sections marked with a "C" in Table A-1 have been provided and that they comply with this guide specification or the manufacturer's own advertised specification, whichever is more demanding.

(2) **Functional Tests.** The manufacturer must conduct functional tests on each of the subsystems marked with a "T" in Table A-1. These tests may be conducted either during the construction/installation of the subsystem or as part of a final integrated systems operational check-out. The results of these tests must be recorded and signed by the test manager. A copy of the signed test report(s) must be made part of the documentation package.

(3) **Acceptance Demonstrations.** The manufacturer must comply with this requirement by conducting a demonstration of the training facility that will verify that each of the items or performance criteria marked with a "D" in Table A-1 have been provided. These acceptance demonstrations may be conducted at the manufacturer's facility, at the purchaser's airport, or at another mutually acceptable demonstration site.

e. Manuals and Publications. The following operation and maintenance manuals must accompany the delivered equipment. The quantity of items is specified by the purchaser. No special format is required. All Original Equipment Manufacturer (OEM) documentation related to major components and subsystems must be included. The documentation package must also include one signed copy of each certification and each test report required by paragraph b.c.(4), "Testing" in Appendix B. These documents must be packaged in a manner suitable for filing.

(1) **Operator's Manual.** The Operator's Manual must include all information required for the safe and efficient operation of the control system, the electrical power supply, the propane supply, and any special attachments or auxiliary equipment associated with the set-up, calibration, operation, break-down, and repackaging of the trainer for transport. The manual must at least:

(a) Cover the procedures required to make the facility operational upon its arrival at a training site.

(b) Give a general description of and step-by-step instructions for the operation of each fireplace.

(c) Provide checklists for the daily maintenance inspections, mission readiness checks, and any safety system calibrations that the operator is expected to perform prior to each new training day.

(d) Provide schedules for required calibrations, preventive maintenance, and required periodic maintenance.

(e) Provide a recommended spare parts list.

(2) **The Parts Manual.** The Parts Manual must include illustrations and exploded views, as needed, to properly identify all parts, assemblies, subassemblies, and special equipment. The parts list must indicate the quantity of each item required in the training facility. The manual must contain an alphabetical and a numerical parts list in addition to a table of contents. It must also contain an appendix listing the name and phone number for at least one source of all purchased parts.

(a) All components of assemblies shown in illustrations or exploded views must be identified by reference numbers which correspond to the reference numbers in the parts lists.

(b) All purchased parts must be cross-referenced with the OEM's name and part number.

(3) Maintenance / Service Manual, containing a preventive maintenance schedule.

B-4. Equipment Training and Maintenance Standards.

a. Training:

(1) The functional objective of the Operator Training Course is to provide the designated operator(s) with the skills and knowledge needed to perform the manufacturer's recommended inspections, calibrations, and preventive maintenance and to ensure that the operator is qualified to operate the ARFF trainer in a consistent, efficient, and safe manner.

(2) The manufacturer must provide trained personnel at the time of delivery to adequately train airport/airline staff in the operation and maintenance of the detection equipment.

(3) Training must include written operating instructions that depict the step by step operational use of the detection system. Written instructions must include, or be supplemented by, materials which can be used to train subsequent new operators.

(4) Training topics must include trouble shooting and problem solving, in the form of theory and hands-on training, for personnel designated by the purchaser.

(5) At least 16 hours of training for airport/airline personnel must be provided by the manufacturer. Training selected personnel as part of a "Train the Trainer" program will also satisfy this requirement. Training must consist of both class room and hands-on instruction and must cover at least the following topics:

(a) A functional description of the control system, the electrical power supply, and the propane fuel supply.

(b) The theory of the facility's operation.

(c) Detailed operational procedures, including the hands-on operation, of each fireplace.

(d) Detailed procedures for performing all required calibrations.

(e) Frequency and procedures for all operator required maintenance.

(f) Set-up, break-down and repackaging procedures.

(g) Emergency shut-down procedures

(6) **Operator Performance Criteria.** Upon the completion of training, the manufacturer must issue to each participant a certificate of competency. To receive a qualified operator's certificate, each trainee must be present for and complete 100% of the specified training course, pass a written review/test covering the safety critical elements (to be identified by the training provider) of the trainer's operation, and demonstrate an ability to properly and independently operate each of the fire training scenarios.

b. Maintenance:

(1) Preventive. The manufacturer must develop and provide to the purchaser written documentation on recommended preventive maintenance actions.

(2) Cleaning. The manufacturer must develop and provide to the purchaser written documentation on recommended cleaning procedures, including solvent types and tools.

(3) Inspection. The manufacturer must develop and provide to the purchaser written documentation on regularly scheduled maintenance inspection procedures. A focus on sensitive equipment and schedule timelines must be included in the documentation.

B-5. Procurement Guidance: The following table on Quality Assurance provisions must be met by the manufacturer of a mobile training facility:

Table B-1. Quality assurance requirements

Para. No. Topic	Type of Assurance		Date "D" Completed	Action Required by the Manufacturer
3.2.c Fuel Spill Burn Area	**C**			**C** = The manufacturer must certify in writing that the items or functions have been provided and that they comply with the general design criteria and that they meet performance requirements of the applicable paragraph in this guide specification and any referenced consensus standards or with the manufacturer's own advertised specification, whichever is more demanding. The written certification(s) must be provided as part of the deliverable documentation. **T** = The manufacturer must conduct a performance test for each function as part of the manufacturing process and must provide a signed test report or memo as part of the deliverable documentation. **D** = The function of each item must be demonstrated to the purchaser. These performance demonstrations must be part of the acceptance inspection process. The ability to meet the specified performance criteria must be witnessed by at least one purchaser's authorized representative. **D*** = This requirement will be considered fulfilled at the successful completion
3.2.c.(1) Dimensions		D		
3.2.c.(2) Performance Criteria		T D		
3.4.d Aircraft Mock-up	**C**			
3.5.b Control System		T D		
3.5.c Operator's Station, Exterior Aircraft Fire Incident Scenarios - ALL		T D		
3.5.d Pendant Control, Interior Aircraft Fire Scenarios - ALL		T D		
4.4.d Aircraft Mock-up	**C**			
4.4.d.(1) Internal Air Temp. Monitoring & Control		T D		
4.4.d.(2) Pre-ventilation / Ventilation		T D		
4.5 Control Station	**C**			
4.5.b. Feedback Control Systems		T D		
4.5.c Hardware Monitoring		T D		
4.6 Support Systems	**C**			
4.6.a.(2).(a) Emergency Shutdown		T D		
4.6.b.(2).(b) Propane Level Monitoring		T D		
4.6.b.(2).(c) Combustion Air Augmentation		T D		
4.6.b.(2).(d) Pilot Flame Monitoring		T D		
4.6.b.(2).(e) Fail-safe Propane Control Valves		T D		
4.6.c Fuel System Requirements	**C**			
4.6.c.(4) Performance Criteria – Supply		T D		
4.6.i Electrical System Requirements	**C**			
4.6.i.(3) Performance Criteria – Electrical Power Supply		T D		
4.7 Mobile ARFF Trainer Transportability	**C**			
4.7.a General Design Criteria		D		
4.7.c Aircraft Fuselage Mock-up		D**		
App. B.1.d Name Plates and Instruction Plates		D		
App. B.1.e Manuals and Publications		D		
App. B.2.a Training Course Requirements		D*		

				of a training session provided for the initial group of the purchaser's designated system operating personnel. **D**** = This acceptance test function will require the demonstration of at least one complete cycle of break-down, packaging, over-the-road transportation, unpacking/setup and operation of the mobile trainer. Origin and destination sites should be mutually agreed to by the purchaser and the manufacturer.