

# SAFESPILL

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**IGNITABLE LIQUID DRAINAGE FLOOR ASSEMBLY (ILDFA)  
DESIGN GUIDELINE  
for  
NEW BUILD AND RETROFIT AIRCRAFT HANGAR  
CONSTRUCTION**

**Version 7.0  
Revised October 2025**

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# REVISION LOG

## October 2025, Version 7.0 Released

*Supersedes: Version 6.0 (February 2025)*

### Global Revisions

- Updated all references to UFC 4-211-01 (Change 4), NFPA 409 (proposed 2026 edition), and FM Datasheet 7-93 (2022).

### Chapter Specific Revisions

#### Chapter 4 – Hangar Coverage

- Refined spill-radius criteria.
- Expanded guidance on trench spacing and maximum profile lengths.
- Added images showing profile end-to-end connections.

#### Chapter 5 – Concrete Slab Design

- Updated slope and finish requirements per all code paths.
- Added new Section 5.5 – Concrete fill for retrofit hangars.
- Revised figures for recessed slab and transition hardware details.

#### Chapter 6 – Trenches

- Added discussion of corrosion concerns related to aluminum trenches as concrete formwork.
- Updated installation steps and new figures for prefabricated trench assembly.

#### Chapter 7 – Structural Specifications

- Revised slip-resistance data and clarified testing per ANSI/NFSI B101.1.

#### Chapter 8 – Floor Openings

- Updated grounding point figures and wiring schematics.
- Added new examples for utility access openings.

#### Chapter 9 – Flushing Water Requirements

- Added water-supply reliability guidance and source-redundancy notes.
- Updated booster-pump section with typical footprint and weight.

#### Chapter 10 – Discharge Pump Skid

- Clarified pump sizing, enclosure design, and control integration.

#### Chapter 11 – Controls System

- Clarified junction box mounting location.

#### Chapter 12 – Electrical Components in Trenches

- Revised conduit sizing tables and wiring descriptions.
- Updated solenoid valve enclosure details.

#### Chapter 13 – Containment & Drainage

- Fully rewritten with new example calculations for UFC, NFPA, and FM paths.
- Added containment vs OWS selection criteria and code-comparison tables.

#### Chapter 14 – Safespill Oil Water Separator (OWS) Skid

- Added typical OWS weight and external view figures.

#### Chapter 16 – Overhead Sprinkler System

- Added summary of full-scale fire-test data and sprinkler-activation findings.

#### Chapter 18 – Water Supply for Cold Weather Environments

- Added freeze-protection language and updated valve configuration diagram.

#### Chapter 19 – In-Slab Heating Compatibility (New)

- Introduced guidance for radiant-heat compatibility with ILDFA flooring.

## 1. Scope of Document

The scope of this document is to provide Ignitable Liquid Drainage Floor Assembly (ILDFA) design guidance for Architect & Engineering (A&E) firms in the early design stages of a new build hangar project or a retrofit project of an existing hangar. The goal is to provide sufficient information to specify an ILDFA for a project without the need for detailed input by the ILDFA manufacturer at the preliminary stages of design. However, this document should be considered merely a starting point for the design. Each project has unique challenges and Safespill should be consulted when situations not addressed by this document are encountered.

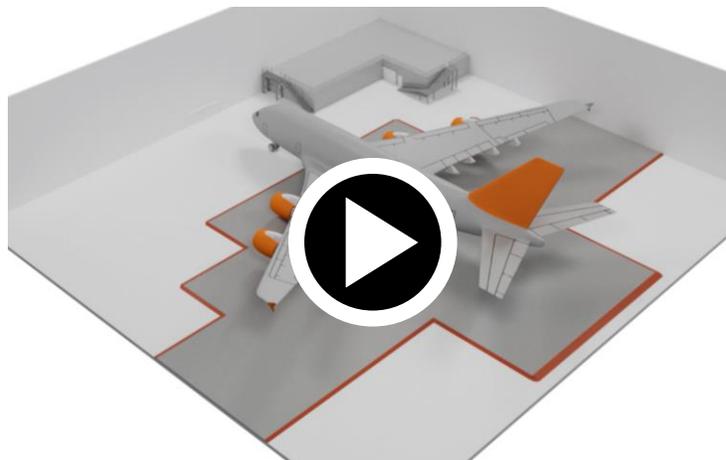
Safespill is committed to continuous improvement; therefore, best practices, installation, and manufacturing continuously evolve. Please check for the latest version of the document at: <https://safespill.com/technical-specs-resources/>

Before continuing to read this document, please view the following videos which provide background on the working principles of the system and how to approach layouts and sizing of the system.

### [Explaining the Safespill Floor](#)



### [Flooring Layout Options](#)



## 2. ILDFA Purpose

An ILDFA is designed to contain and remove ignitable liquid spills before they develop into a pool fire. In its basics, the ILDFA is a hollow aluminum extruded floor with a perforated top surface, connected to a trench system to remove any spilled liquid to an acceptable location (i.e., containment system, oil water separator, or as otherwise directed by the local authority). In the event a spill is ignited, the ILDFA will rapidly control and extinguish the ignitable liquid fire.

One application of an ILDFA is for Class B (fuel) fire protection inside an aircraft hangar, which is accepted under NFPA 409 (2022 Edition) for Group 1 & 2 hangars in combination with an overhead sprinkler system. ILDFAs are approved under FM Approval Standard 6090 and are the preferred method of fire protection for aircraft hangars according to FM Datasheet 7-93.

The U.S. Naval Facilities Engineering Systems Command (NAVFAC) has verified the daily operational use of the system and has multiple ILDFAs in use today. Unified Facilities Criteria (UFC) 4-211-01, "Aircraft Maintenance Hangars" is expected to be revised with Change 4 in 2025 to include guidance on the installation of ILDFA in retrofit and new build hangars. Relevant sections from UFC 4-211-01 are referenced in this document.

In addition, the U.S. Air Force Civil Engineer Center (AFCEC) has independently verified fire test performance of the ILDFA, as documented in this test report:  
<https://apps.dtic.mil/sti/pdfs/AD1168510.pdf>

### 3. Piping and Instrumentation

An ILDFA is divided into zones, each with a typical area of 1,320 ft<sup>2</sup> (122.5 m<sup>2</sup>) per zone. The standard zone width is 30 ft (9.2 m), and aluminum floor profiles are manufactured in lengths up to 39.3 ft (12.0 m).

Each zone includes the following dedicated components.

- Solenoid valve
- Fiber optic liquid detection sensors
- Flushing manifold

All tie-in points shown in Figure 3-1 represent the interface between Safespill’s scope of supply and that of the installing contractor. Upon request, Safespill can include these tie-ins within its scope.

If a project requires increased profile lengths to reduce the number of trenches or optimize layout, contact Safespill to review design options and confirm manufacturability and code compliance.

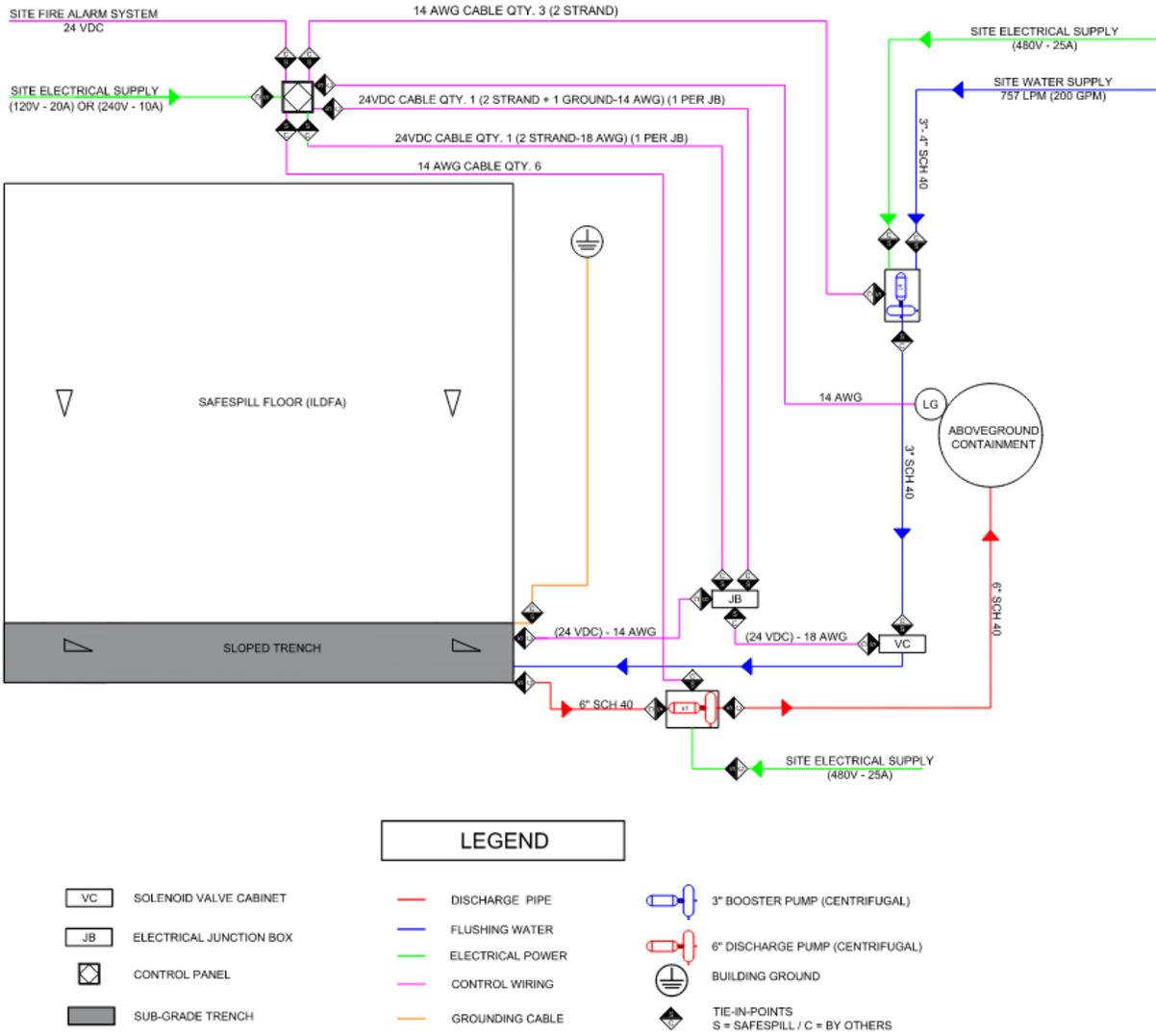


Figure 3-1: Simplified ILDFA Piping and Instrumentation Diagram (P&ID) of one zone

When a spill occurs in a zone, only the flushing manifold dedicated to that zone will activate. Each flushing manifold requires 50 GPM (189 LPM) of water supply.

In a scenario where a spill falls at the intersection of multiple zones, as shown in Figure 3-2, multiple zones in both the x and y directions will be activated. Up to 4 zones (i.e., zones 1, 2, 6, and 7 in Figure 3-2) would detect a spill and activate the associated 4 flushing manifolds.

In this case, 4 zones multiplied by 50 GPM/zone (189 LPM) will require 200 GPM (757 LPM) as the maximum water supply for the system.

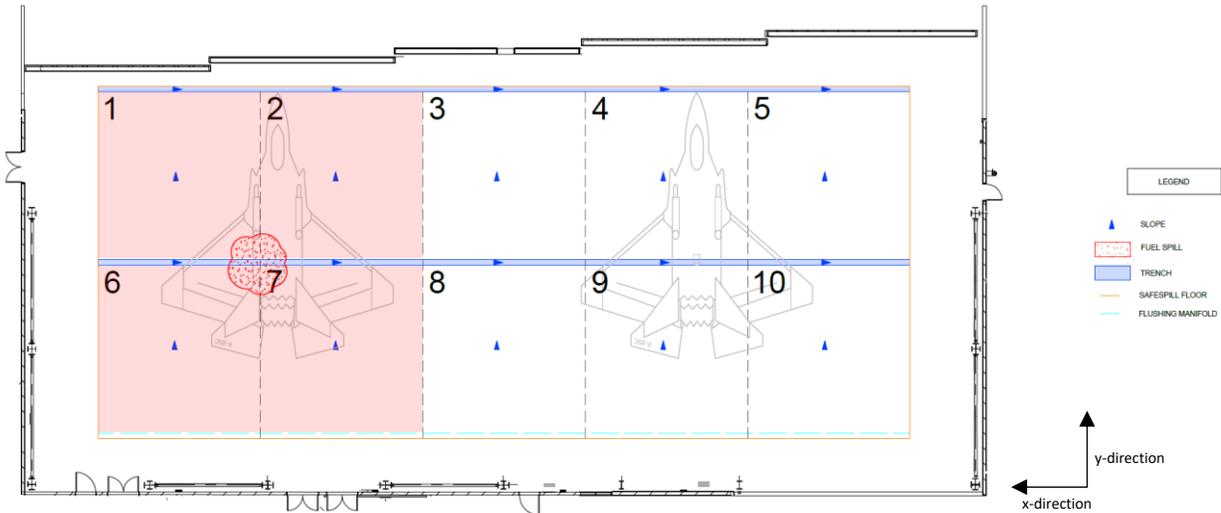


Figure 3-2: ILDFA layout drawing showing 4 zones activated by spill at intersection of 4 zones

## 4. Hangar Coverage

Wall-to-wall coverage of the hangar floor will provide the greatest flexibility in a variety of aircraft parking scenarios. The ILDFA can be offset from the wall if there are aircraft hangar bay clearance requirements established by the owner, such as required clearances from walls and fixed obstructions.

However, in hangars where the aircraft have designated parking spots, wall-to-wall coverage might not be necessary, and significant cost can be saved by reducing the floor coverage. For ILDFA installations following UFC 4-211-01, partial hangar bay coverage is only permitted when approved by the Component Fire Protection Engineer (CFPE, as defined by UFC 3-600-1) or Component Technical Representative (CTR).

For installations following UFC 4-211-01, ensure that the ILDFA covers all areas where a fuel spill could reasonably occur by drawing an 18 ft (5.5 m) radius from the outer edge of all areas containing fuel in the aircraft, such as fuel tanks and engines as shown in Figure 4-1 through Figure 4-3.

For installations following FM Datasheet 7-93 or NFPA 409 (2022 Edition) requirements, utilize a 16 ft (4.9 m) spill radius for small aircraft and an 18 ft (5.5 m) spill radius for large aircraft.

In accordance with FM Datasheet 7-93 (Chapter 2.2.2.2) and NFPA 409 (Chapter 8.2.13.4.1), “small” aircraft are defined as all aircraft up to 78 ft (24 m) in length with a fuselage width of less than 13 ft (4 m). For small aircraft, the maximum worst-case fuel spill scenario is 200 gpm (757 LPM), whereas for large aircraft over 78 ft (24 m), the maximum worst-case fuel spill scenario is 400 GPM (1,514 LPM).

To view the report with spill radius data and scenarios, [click here](#).

### 4.1. Flooring Layouts

Three examples of ILDFA hangar coverage are shown below. In Figure 4-1, a parking spot configuration across multiple bays is shown. In Figure 4-2, a wall-to wall ILDFA for multiple aircraft is shown. In Figure 4-3, a parking spot configuration for a single aircraft is shown.

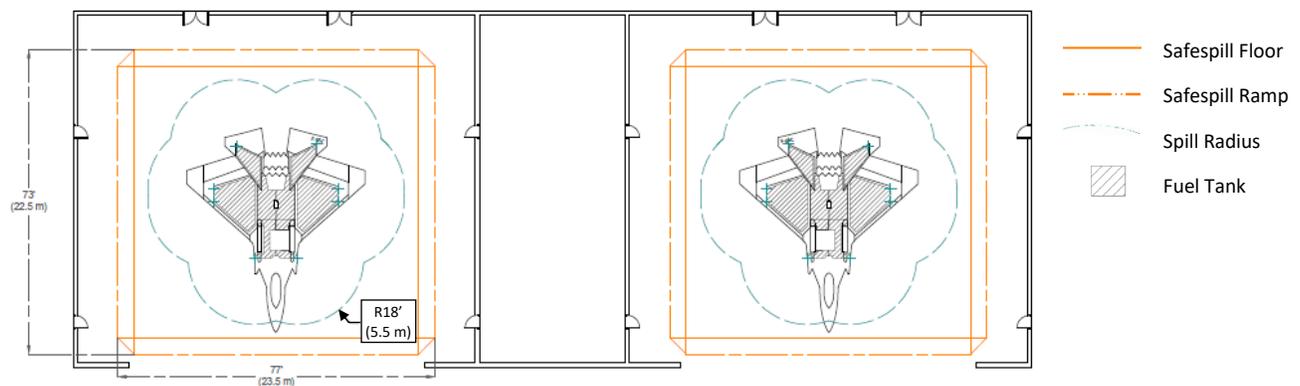


Figure 4-1: Example of a two-bay F-35C hangar with an ILDFA fixed to the spill radius

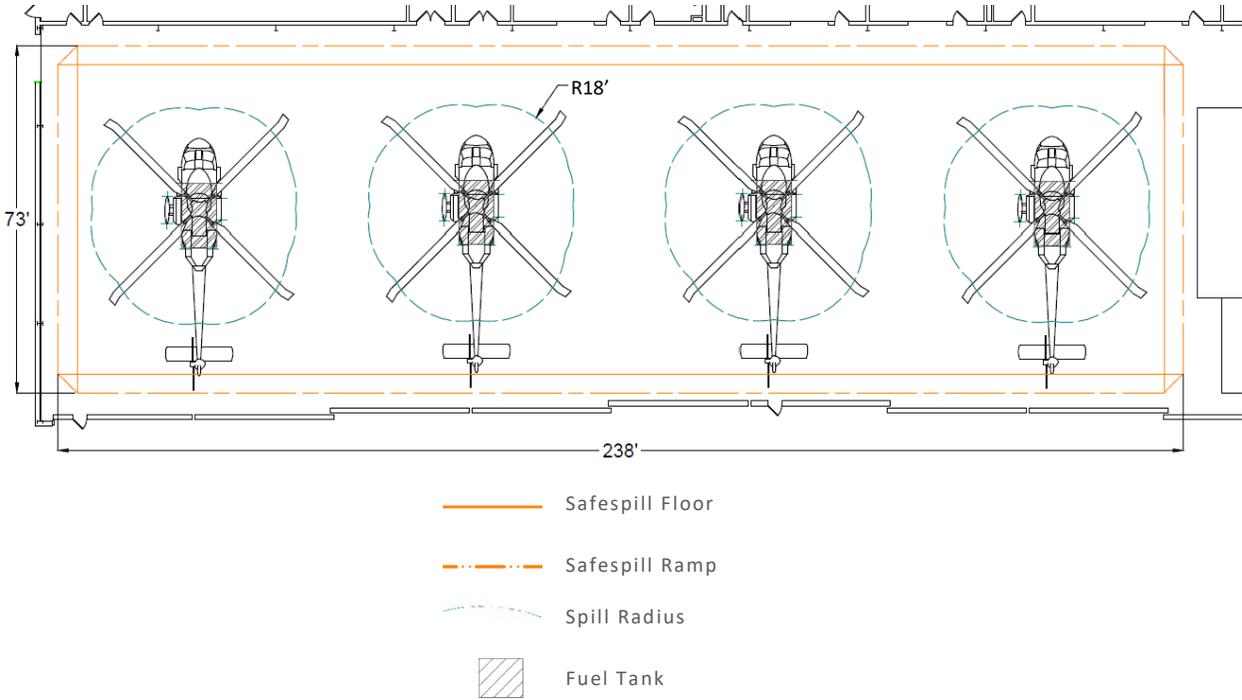


Figure 4-2: Example of a MH-60T Jayhawk hangar designed wall-to-wall, per UFC 4-211-01

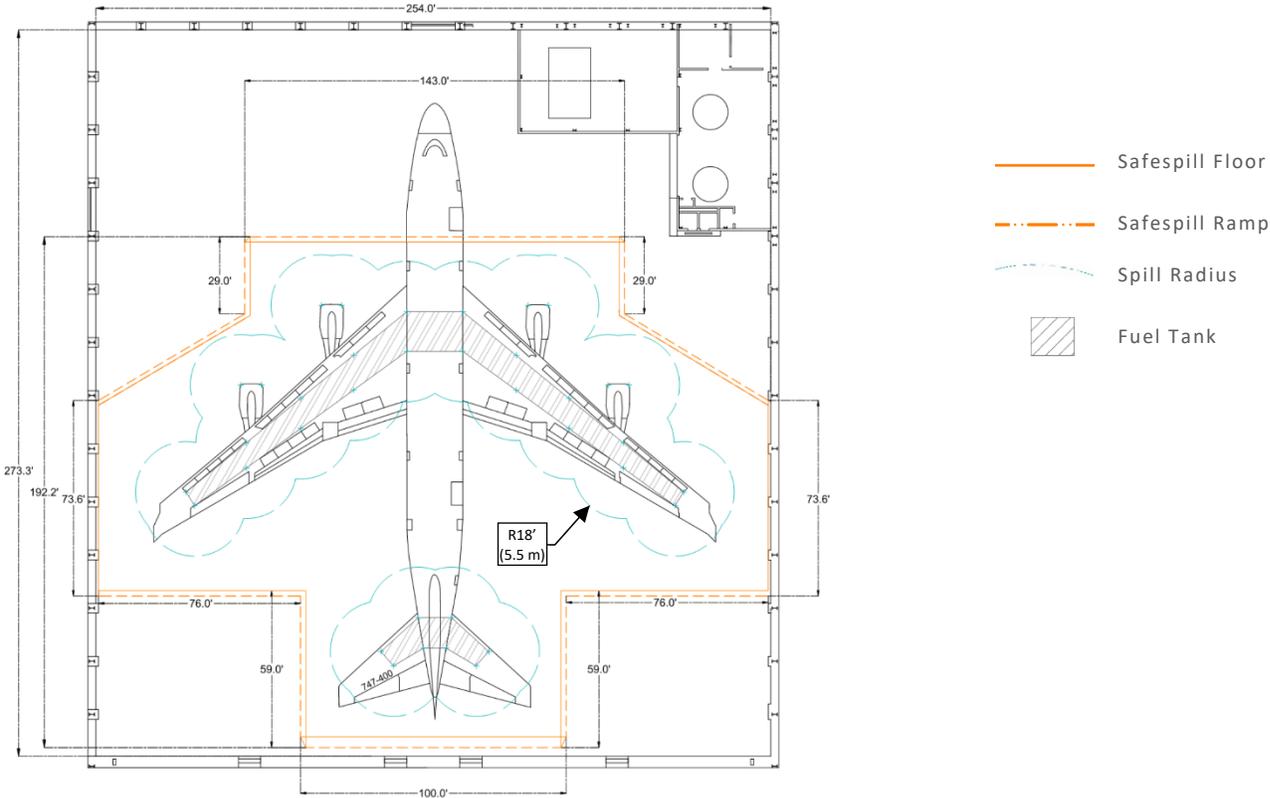


Figure 4-3: Example of a Boeing 747-400 hangar designed with a reduced ILDFA only covering potential spill areas

## 4.2. Trench Locations

The location of trenches in retrofit applications should be determined based on the slopes of the existing slab. In most cases, trenches are already present at the lowest points within the hangar, and are designed to align with the existing slopes of the hangar slab (refer to [Chapter 6, Trenches](#) for guidance on using existing trenches with ILDFA).

If trenches do not exist in the hangar, it is common for the hangar slab to feature a mono slope, with its lowest point located near the hangar door(s). In this case, a trench will be installed along the hangar door. This is also the preferred arrangement for new build applications.

It is recommended that, when determining trench location, trenches are positioned based on the hangar's aircraft parking configuration so that the ILDFA trench runs perpendicular to the aircraft and the slope runs parallel to the aircraft. This alignment prevents a spill from one aircraft migrating to and exposing adjacent aircraft.

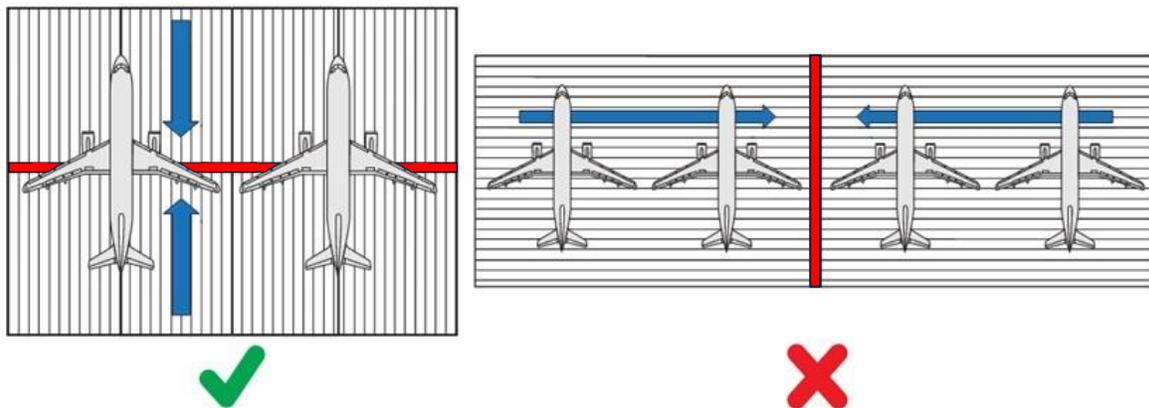


Figure 4-4: Example of recommended trench arrangement relative to aircraft (FM Datasheet 7-93, Fig. 2.2.2.2-1)

To reduce cost and construction time, the number of trenches should be minimized and ILDFA sections can be manufactured at different lengths to achieve optimum spacing of trenches.

ILDFA floor profiles are manufactured in lengths up to 39.3 ft (12.0 m). Safespill can provide longer continuous sections through end-to-end field connections, as shown in Figure 4-5 through Figure 4-7. However, the responsible engineer must consult Safespill prior to pursuing this option to confirm layout compatibility, manufacturability, and compliance with applicable codes and standards.



Figure 4-5: Profile end-to-end connection shown close-up



Figure 4-6: Installation process for end-to-end connection

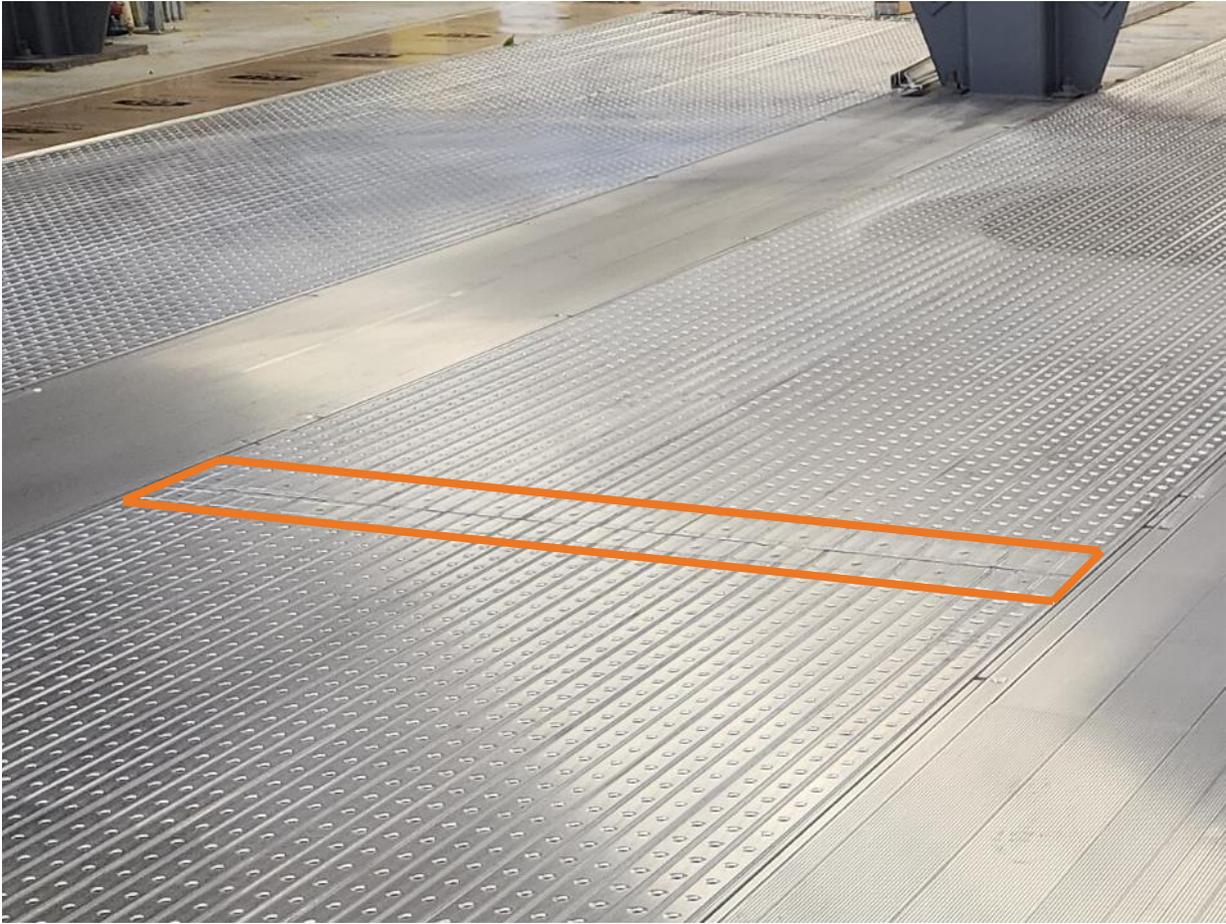


Figure 4-7: Finished ILDFA assembly with end-to-end connections indicated inside of red box

## 5. Concrete Slab Design

### 5.1. Concrete Slab Requirements

The ILDFA has been designed and tested to support the Maximum Takeoff Weight (MTOW) of any commercial or military aircraft under a compression load scenario.

The slope of the concrete slab should comply with the applicable code:

#### 5.1.1. NFPA 409 (2022 edition)

Section 7.12.2.5 requires a minimum slope of 0.5% (0.3°)

#### 5.1.2. FM Datasheet 7-93

The Datasheet requires minimum slope of 0.5% (0.3°).

- FM Datasheet 7-93 does not specify a required slope for an ILDFA and refers to the manufacturer's installation instructions and the product's listing in the FM Approvals Approval Guide.
- FM Datasheet 7-93, 2.2.2.3.2.2 is not applicable for ILDFA installations as this section provides requirements for "Emergency Drainage Systems" which are not equivalent to ILDFA.

#### 5.1.3. UFC 4-211-01, Change 4

Section 3-4.2.3 requires a slope with a minimum of 0.5% and a maximum of 1.5% (0.3° to 0.85°).

An ideal configuration for an ILDFA installation will slope the concrete slab toward the hangar door entrance.

## 5.2. New Construction: Recessed Concrete Slab

When designing an ILDFA for a new build hangar, recessing the slab by 2 inches (51 mm) will provide a flush transition between the concrete floor and the ILDFA. In this scenario, ramps will not be required.

Please note the ILDFA will be installed directly onto the concrete slab but should not be considered in determining the structural strength of the slab.

For example, a 10" (254 mm) slab thickness requirement for a hangar cannot be reduced to 8" (203 mm) with an ILDFA (the height of the ILDFA is 2" (50 mm)); the slab needs to remain 10" (254 mm) thick. The slab plus the ILDFA will be 12" (305 mm).

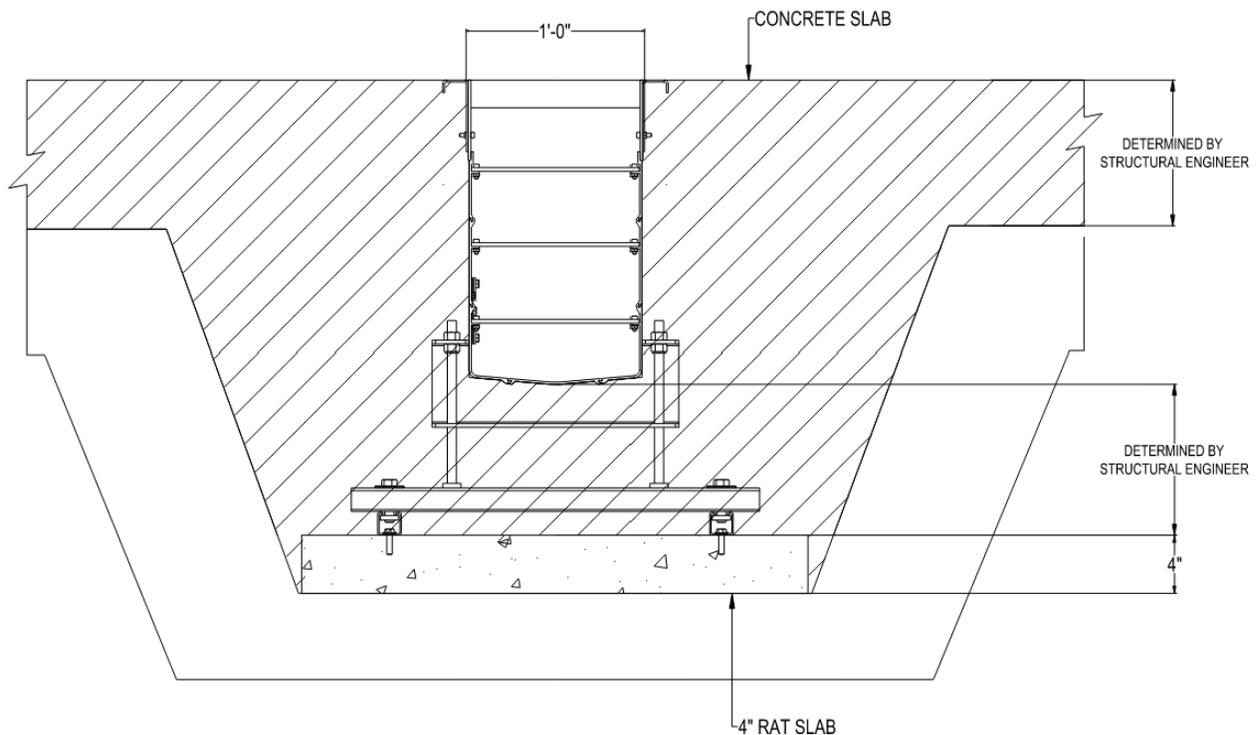


Figure 5-1: Slab design with prefabricated aluminum trenches

Recessed concrete must have a consistent slope between 0.5% and 1.5% toward each trench. Consistent flatness ensures that shimming requirements are minimized. “Very flat” finish in accordance with American Concrete Institute (ACI) 117 is recommended and slab irregularities should not exceed an elevation delta of 0.125” over 10 ft.

To reinforce the corners of formed or cut concrete, it is recommended that steel or aluminum angle be used as shown in Figure 5-2. Where dissimilar metals are used, fluoroelastomer (FKM, Viton™) seals will be installed to isolate metals and prevent galvanic corrosion.

ILDFA sizing will include a 1” – 2” (25 - 50 mm) gap around the floor perimeter, between the edge of the flooring and the concrete recess, to allow for construction tolerances. This gap should be coordinated during design and will be filled with concrete, epoxy or equivalent after the ILDFA is installed.

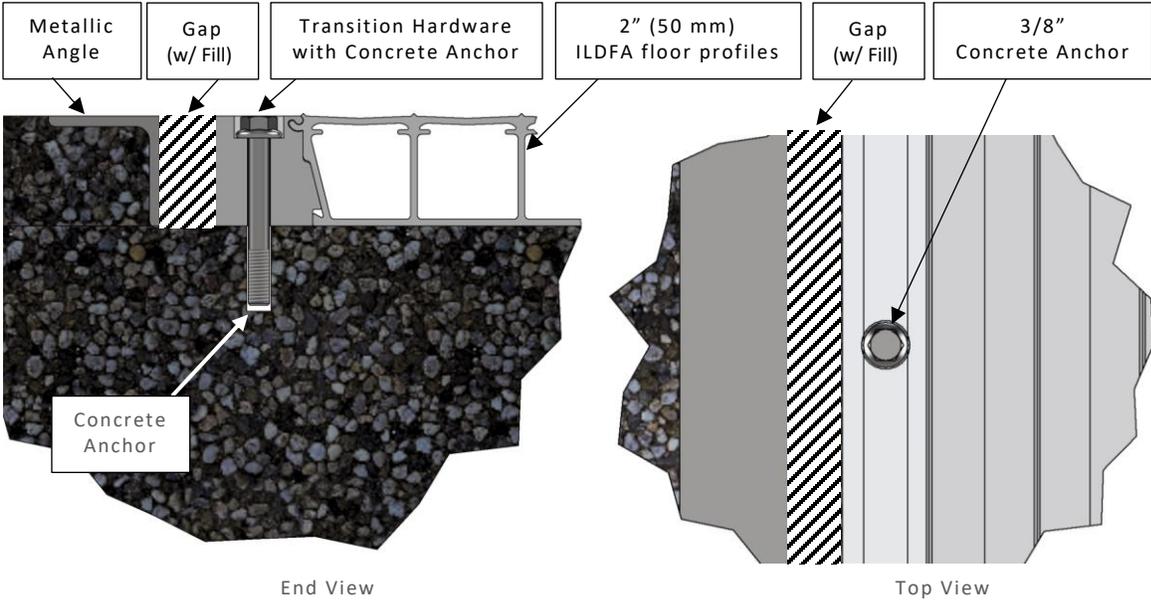


Figure 5-2: Transition from Hangar Slab to ILDFA with Recessed Concrete

When a trench is located in a recessed area, trench girders must extend across the trench and be supported on the concrete between the edge of the trench and the transition hardware. The design for this transition is detailed in Figure 5-3. The required distance from the edge of the trench to the end of the transition hardware is 6-1/2" (140 mm). With a 1" – 2" (25 - 50 mm) gap for construction tolerances, the slab should be designed with a recess located 7-1/2" (165 mm) to 8-1/2" (190 mm) from the edge of the trench.

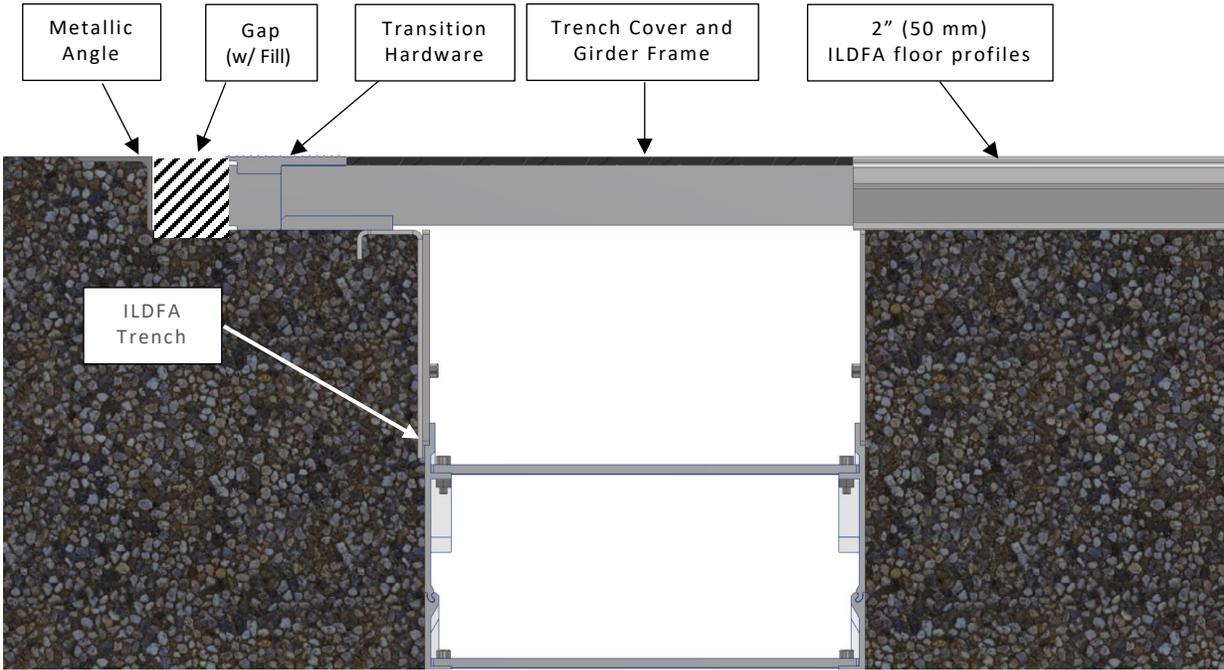


Figure 5-3: Transition from Hangar Slab to ILDFA at trenches

## 5.3. Existing Slab: Shimming

If the existing hangar slab meets the required slope of 0.5% to 1.5%, but has a limited number of inconsistencies or low spots, aluminum flat bar can be used to shim individual sections to meet the slope requirements. Figure 5-4 shows an example of shimming the ILDFA to match the 0.5% slope during installation.

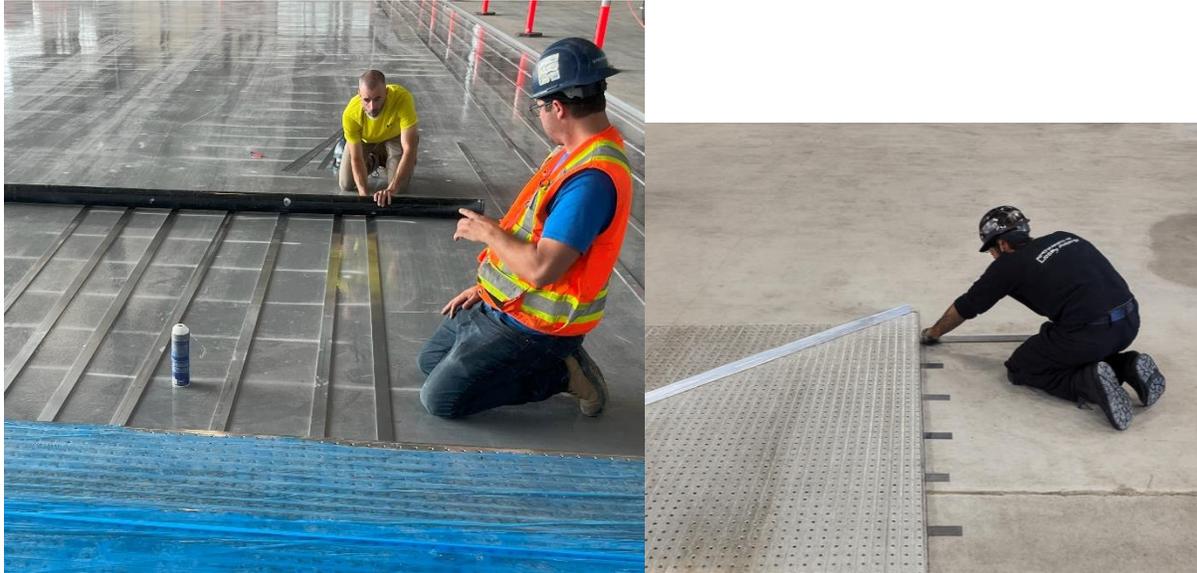


Figure 5-4: Aluminum flat bar used for shimming to proper slope requirements during installation

When shimming is necessary, a structural engineer should confirm that the spacing and shim heights are adequate to support the expected loading scenarios. Typically, when Safespill ILDFA profiles require shims, they are placed every 12" (300 mm) with shim heights no greater than 2" (50 mm). Each aluminum shim is secured to the concrete slab using an epoxy resin specified for concrete and metal adhesion (Hilti HIT-RE 500 V3 is one example).



Figure 5-5: Example of shim installation under ILDFA.

### 5.4. Retrofit Hangar: Ramps

For retrofit installations that require the ILDFA to be installed directly on the hangar slab, ramps will be installed on all sides of the floor. Ramps are anchored to the slab using concrete anchors to restrict movement.

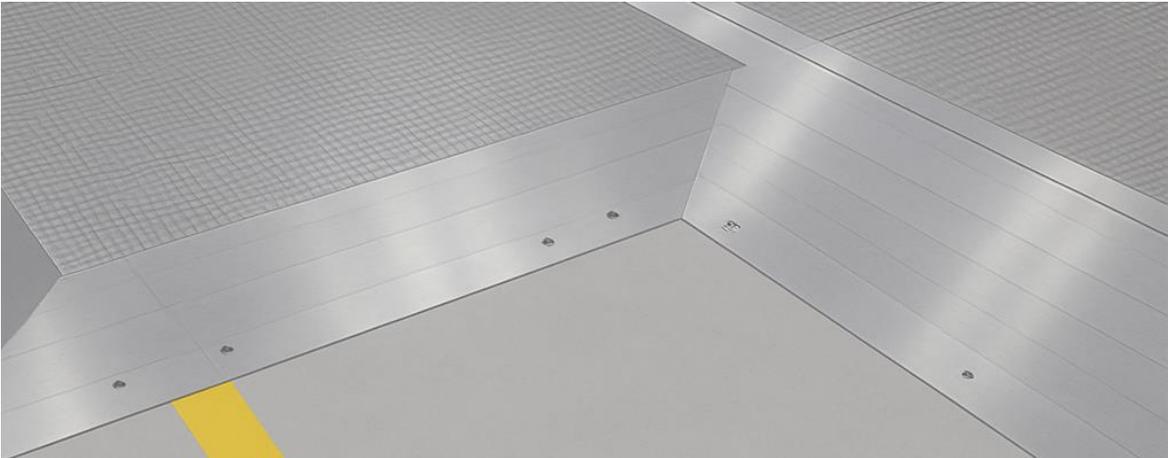


Figure 5-6: ILDFA Standard Sloped Access Ramps

Standard ramps for the ILDFA have a length of 40 in (1.0 m) from the edge of the floor and will be utilized to the maximum extent possible. For locations where aircraft enter and exit the floor, standard ramps will be utilized.

In areas where only maintenance equipment and personnel will access the floor, it may be acceptable to utilize ramps with a steeper slope. This can maximize the amount of usable floor space and provide clearance around doors, stairways, and other preexisting obstructions within the hangar. Steep ramps have a length of 24 in (0.6 m) from the edge of the floor.

If the hangar will house a rotary aircraft or other aircraft that has a tow-bar or tug with a short elevation clearance, it may be necessary to use a 1:48 sloped entrance ramp.



Figure 5-7: ILDFA with 1:48 sloped entrance ramp for helicopter with short elevation clearance

## 5.5. Retrofit Hangar: Concrete Fill

Concrete fill may be used around the perimeter of the ILDFA in place of aluminum ramps, particularly where columns, walls, or other obstructions limit the available clearance for standard ramp installation. Concrete fill is installed after the ILDFA has been positioned and aligned.

The concrete fill should be formed so that it is flush with the top surface of the ILDFA, providing a smooth, continuous transition for personnel and maintenance equipment. The finished surface should slope toward the ILDFA at not less than 0.5% (0.3°) so that any liquid that spills onto the concrete fill will drain back onto the ILDFA surface rather than pooling outside of the ILDFA footprint.

Concrete fill is a practical alternative to ramps in localized areas such as around structural columns or perimeter walls. While ramps remain the preferred method for primary aircraft access points, concrete fill provides a versatile solution that can be selectively implemented where obstructions or complex geometry require adaptation.

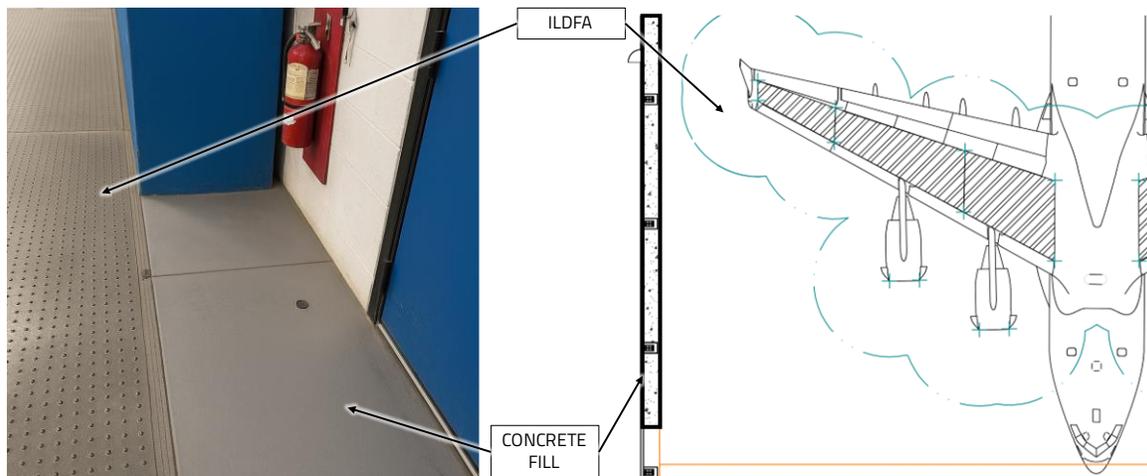


Figure 5-8: Concrete fill used along perimeter wall (left) and layout drawings of hangar with concrete fill indicated (right).



Figure 5-9: Example of concrete fill used around columns in center of hangar.

## 6. Trenches

### 6.1. Structural Considerations for Trenches

Due to the design of the trenches and trench cover girder frame, the aluminum trench shells do not experience loading from aircraft moving over the trench covers. Forces generated by aircraft are distributed through the trench cover to the girder frame and into the concrete slab as shown in Figure 6-1.

For new build projects, the aluminum trench shells serve as formwork for concrete, but are not structural.

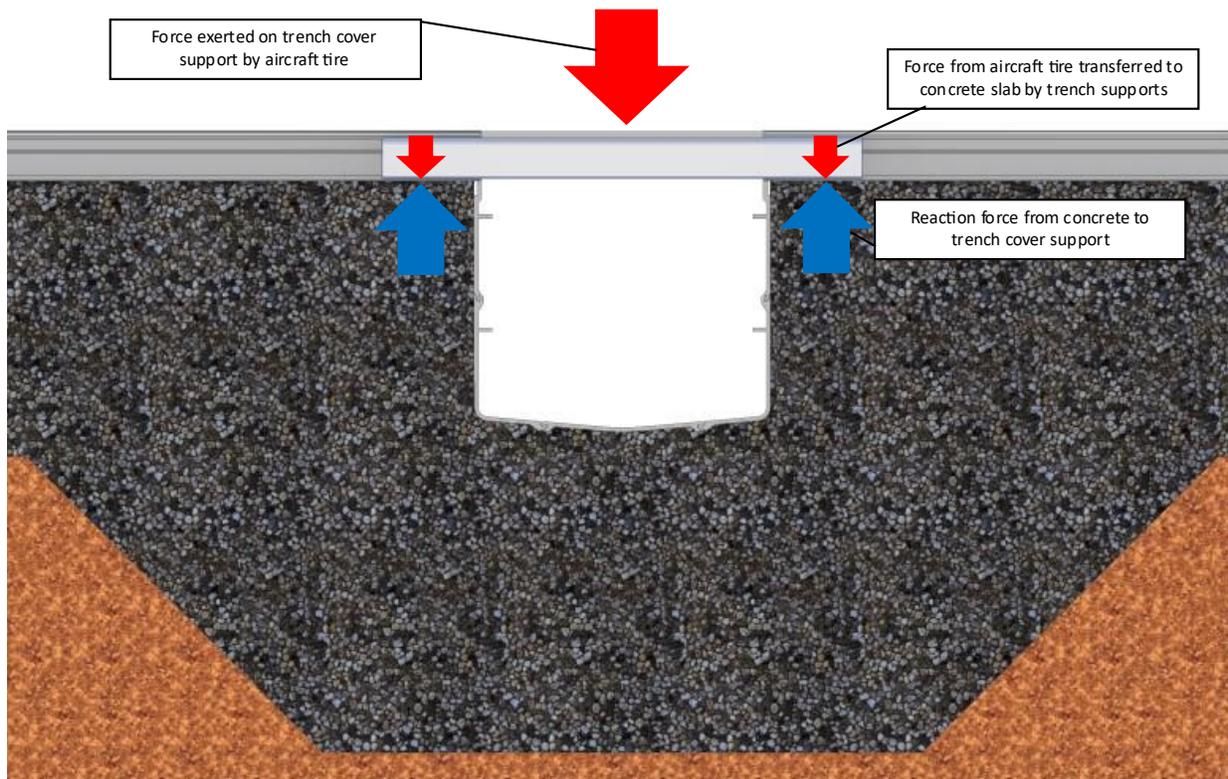


Figure 6-1: Rendering of aluminum trench and concrete slab showing force transferred from aircraft tire to concrete.

Trench covers and girder frames have been designed using finite element analysis to ensure that supports can handle point load capacity for the Maximum Takeoff Weight (MTOW) of the largest airframe as described in [Section 7.1, Point Load Capacity](#).

Girders located under the trench cover lid are fitted into the profile channels and span the width of the trench.

Figure 6-2 shows the girders fit into the profile channels, with the trench cover lid removed and the first profiles removed. Figure 6-3 shows the installation of the trench cover lids and Figure 6-4 shows the completed installation of the trench covers.

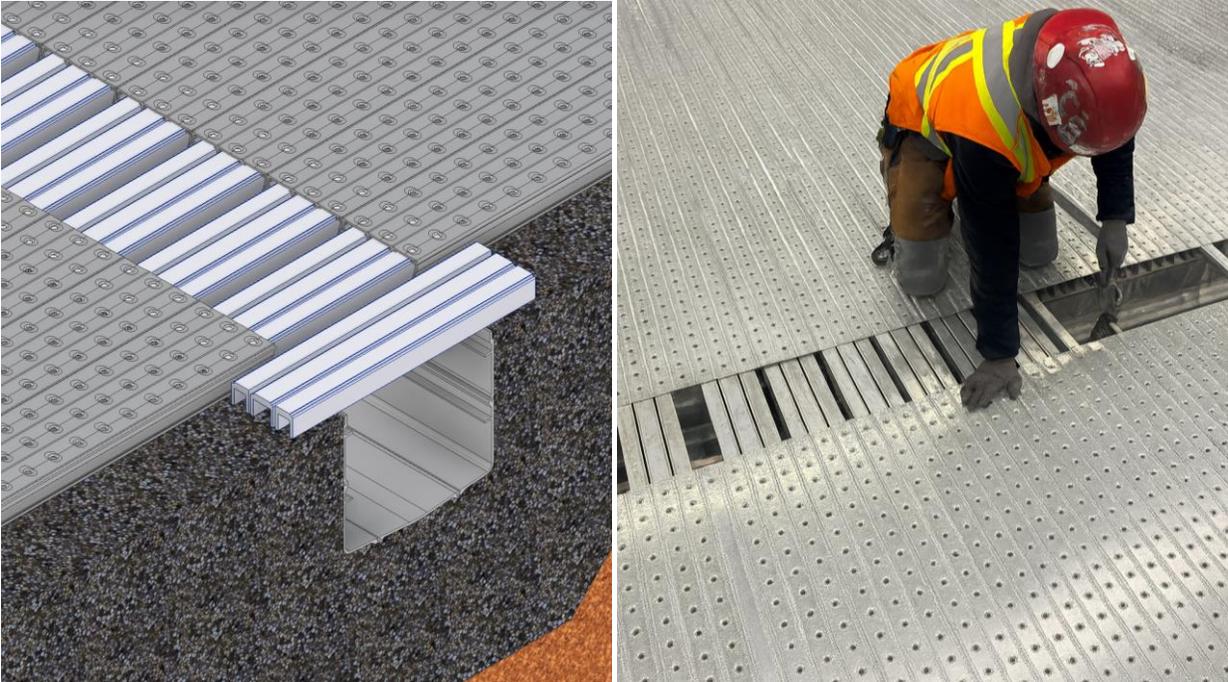


Figure 6-2: (Left) Render showing Trench cover support girders. First profiles and trench lid removed to show girder supports. (Right) Trench support girders installed in the field



Figure 6-3: Trench cover lids partially installed with some support girders still exposed (Left). Installing bolt cover on trench cover lid (Right).



*Figure 6-4: Finished installation of trench cover lid.*

## 6.2. Trench Design

Safespill recommends the use of our prefabricated aluminum trenches for ILDFA systems. Prefabricated trenches are delivered to the project site with all necessary flushing manifold supply piping and electrical conduits already installed. Supplying prefabricated trenches with these components reduces production costs and installation time. Once the trenches are installed, piping and conduit runs are connected end to end, eliminating additional fabrication steps in the field.

If suitable trenches already exist in the hangar, it is possible to utilize these trenches if the following conditions are met:

1. The existing trenches are in acceptable locations based on the information discussed in Section 4.2, "Trench Locations."
2. The existing trenches meet the volumetric flow requirements and constructability necessary to accommodate plumbing and electrical conduits as described above.

When existing trenches are utilized, the internal slope of the trench is required to be a minimum of 0.5% (0.3°) to ensure all liquid drains to the lowest point.

When new trenches are installed, they are designed and manufactured with an internal slope of 0.5% (0.3°) to ensure liquid drains to the lowest point. When installed, the top edge of the trench should be level and flush with the surrounding concrete slab. The minimum depth of trenches is 19" (480 mm) to allow for proper flow of spilled liquid and piping conduit.

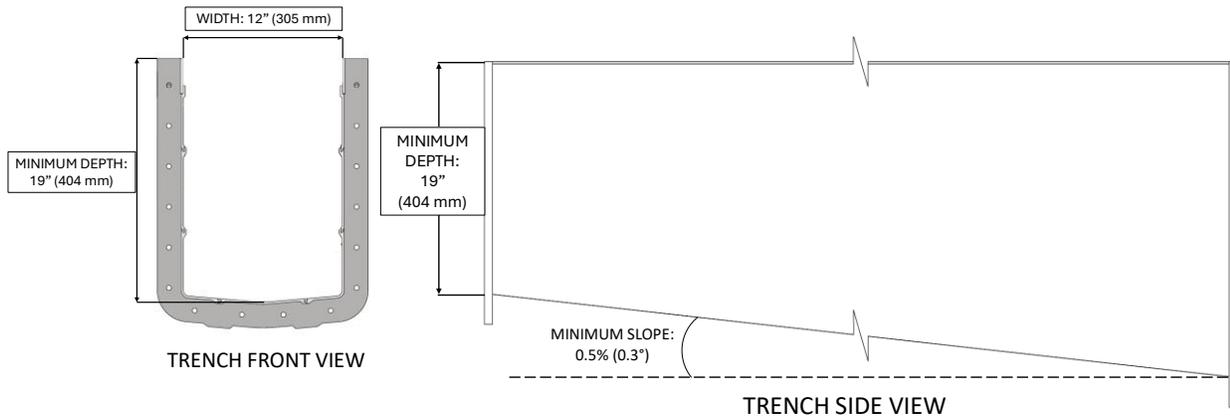


Figure 6-5: Trench Slope and Depth Requirements

## 6.2.1. Trenches in Retrofit Hangars

For retrofit projects without existing trenches, the existing hangar slab will need to be cut and prefabricated aluminum trenches will be installed and back-filled with a cast-in-place concrete.

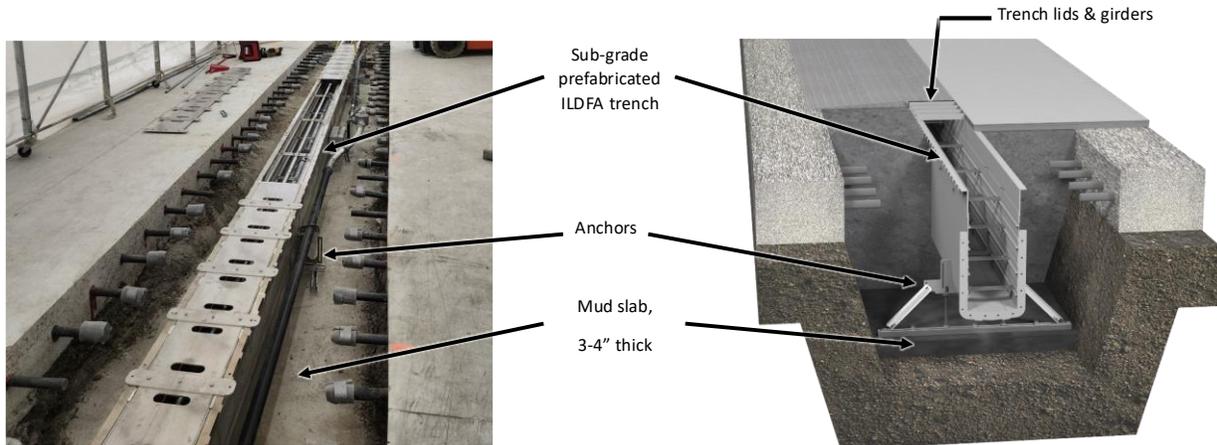


Figure 6-6: ILDFA prefabricated trench for retrofit projects

Additional rebar and structural reinforcement may be necessary depending on the thickness of the existing slab. A structural engineering analysis will need to be conducted to determine required reinforcement to ensure structural integrity of the concrete slab.

Prefabricated aluminum trench shells are supplied with adjustable trench supports. Trench supports are welded to the trench shell and connected to a standard 1-5/8" (41 mm) aluminum strut channel using threaded rods and angled struts. The aluminum strut channel is anchored to the mud slab, which should be sloped at a minimum of 0.5% (Figure 6-5). Threaded rods can be adjusted to level the trench and angled struts are secured once the required height is reached to prevent the trench shell from moving and twisting during the concrete backfill pour.

A step-by-step process for installation of ILDFA prefabricated trench on retrofit applications is shown on the following page.

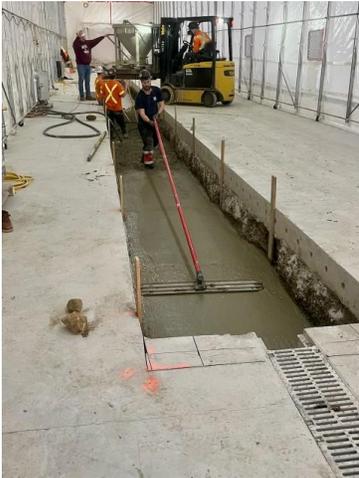
# RETROFIT - TRENCH PREP



CUT THROUGH SLAB



EXCAVATE/COMPACT



POUR MUD/RAT SLAB

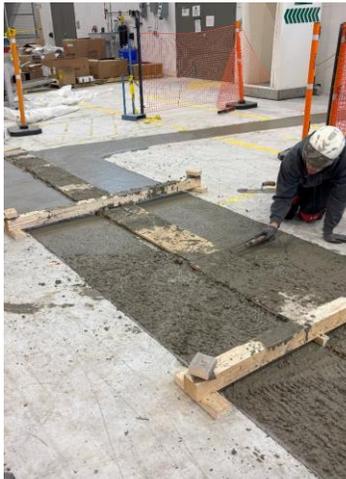
# RETROFIT – TRENCH INSTALLATION



PLACE/ALIGN TRENCH



CONNECT UTILITIES



POUR CONCRETE

## 6.2.2. New Build Hangars

For new build hangars, cast-in-place trenches are not limited to specific depths or lengths when concerning the ILDFA. A structural engineer should determine the maximum dimensions of the cast-in-place trenches that the existing soil conditions allow.

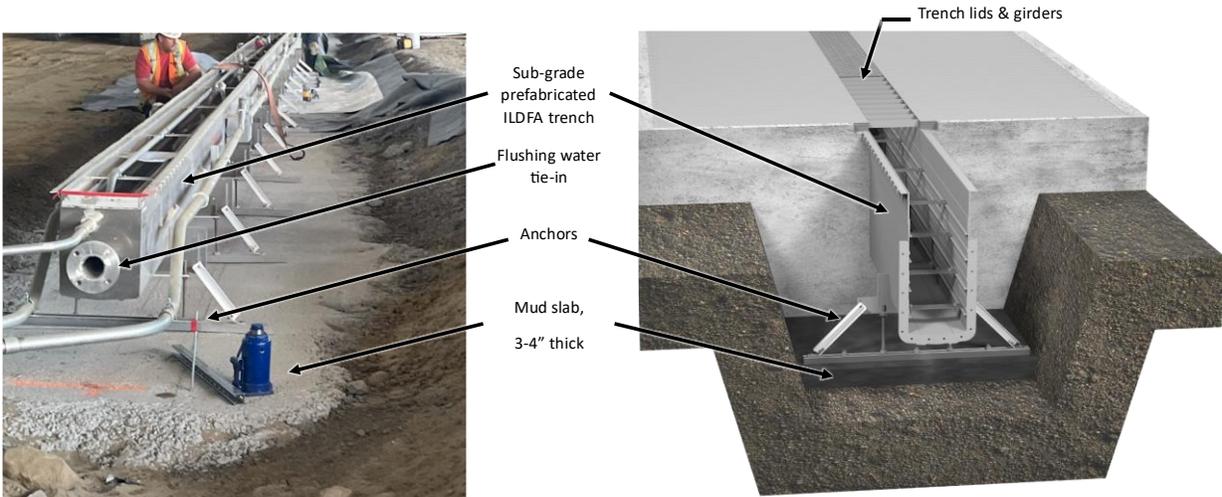
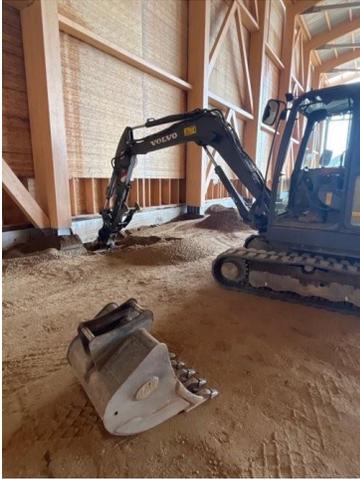


Figure 6-7: ILDFA prefabricated trench for new builds

Cast-in-place aluminum trench shells for new builds are supplied with adjustable trench supports. Trench supports are welded to the trench shell and connected to a standard 1-5/8" (41 mm) aluminum strut channel using threaded rods and angled struts. The aluminum strut channel is anchored to the mud slab, which should be sloped at a minimum of 0.5% (Figure 6-5). Threaded rods can be adjusted to level the trench and angled struts are secured once the required height is reached to prevent the trench shell from moving and twisting during the slab pour.

A step-by-step process for installation of ILDFA prefabricated trench on new build applications is shown on the following page.

# NEW BUILD – TRENCH PREP



EXCAVATE



POUR MUD/RAT SLAB



PLACE/ALIGN TRENCH

# NEW BUILD – TRENCH INSTALLATION



CONNECT DISCHARGE LINE  
*UNDERGROUND VIA GRAVITY SHOWN*



CONNECT UTILITIES  
*PLUMBING & ELECTRICAL*



SLAB POUR

### 6.3. Effects of Aluminum Formwork in Concrete Construction

Although aluminum components may experience some corrosion when in contact with uncured concrete, Safespill successfully utilizes aluminum trench shells as formwork for cast-in-place trenches. While initial corrosion rates during the concrete pour may be up to 0.0375 in/yr (950  $\mu\text{m}/\text{yr}$ ), the corrosion rate declines sharply once concrete cures and negligible corrosion rates are observed within the first year from install. Safespill trenches are designed with a minimum thickness of 5/32" (4 mm) and the estimated total corrosion depth is less than 0.015 in (0.38 mm) over the lifetime of the installation.

Where a potential exists for aluminum ILDFA components to be in contact with metals such as cast-iron grates, steel rebar, or carbon steel angle, non-conductive isolation materials should be applied to prevent galvanic corrosion. Fluoroelastomer (FKM, Viton™) or bituminous coatings are recommended for isolation between the aluminum trench and dissimilar metals..

For more information on this topic, please refer to the sources below:

Herting, G., & Odnevall, I. (2021). Corrosion of aluminum and zinc in concrete at simulated conditions of the repository of low active waste in Sweden. *Corrosion and Materials Degradation*, 2(2), 150–162. <https://doi.org/10.3390/cmd2020009>

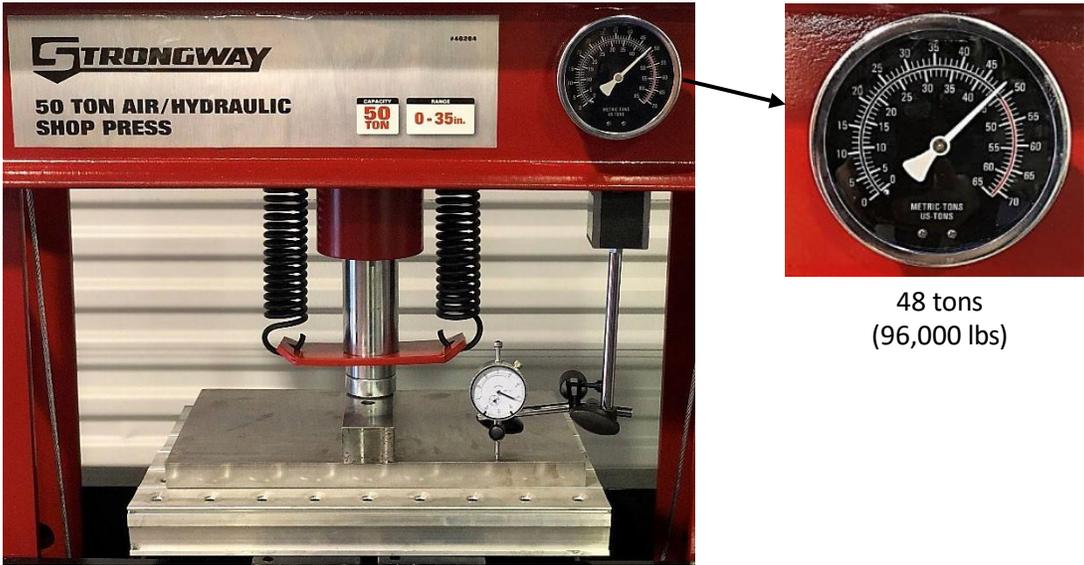
Luo, D., Li, F. & Xing, G. (2022). Corrosion resistance of 6061-T6 aluminium alloy and its feasibility of near-surface reinforcements in concrete structure. *REVIEWS ON ADVANCED MATERIALS SCIENCE*, 61(1), 638-653. <https://doi.org/10.1515/rams-2022-0048>

# 7. Structural Specifications

## 7.1. Point Load Capacity

The ILDFA floor profiles are manufactured out of 6000 series Marine-Grade Aluminum which provides corrosion resistance and high strength, allowing the system to have a life span of more than 50 years.

Destructive testing was conducted to determine the point load capacity of the ILDFA floor profiles. The ILDFA was able to support 96,000 lbs (43,545 kg) distributed over a 9” x 16” (229 mm x 406 mm) area, which represents the contact area of a fighter jet tire.



48 tons  
(96,000 lbs)

Figure 7-1: Load testing demonstrates ILDFA can support 96,000 lbs (43,545 kg) distributed over 9” x 16” (229 mm x 406 mm)

It should be noted that using aircraft tire pressure to estimate point load is a conservative estimate, as it assumes that all pressure exerted within the tire is transferred directly to the contact area between the tire and the surface below it. However, the elasticity of the tire also absorbs some of this force.

Table 7-1 utilizes the point load capacity demonstrated above to calculate safety factors for various aircraft. Typically, small aircraft such as fighter jets exert the greatest point load.

Table 7-1: Calculation of ILDFA Safety Factor for multiple aircraft

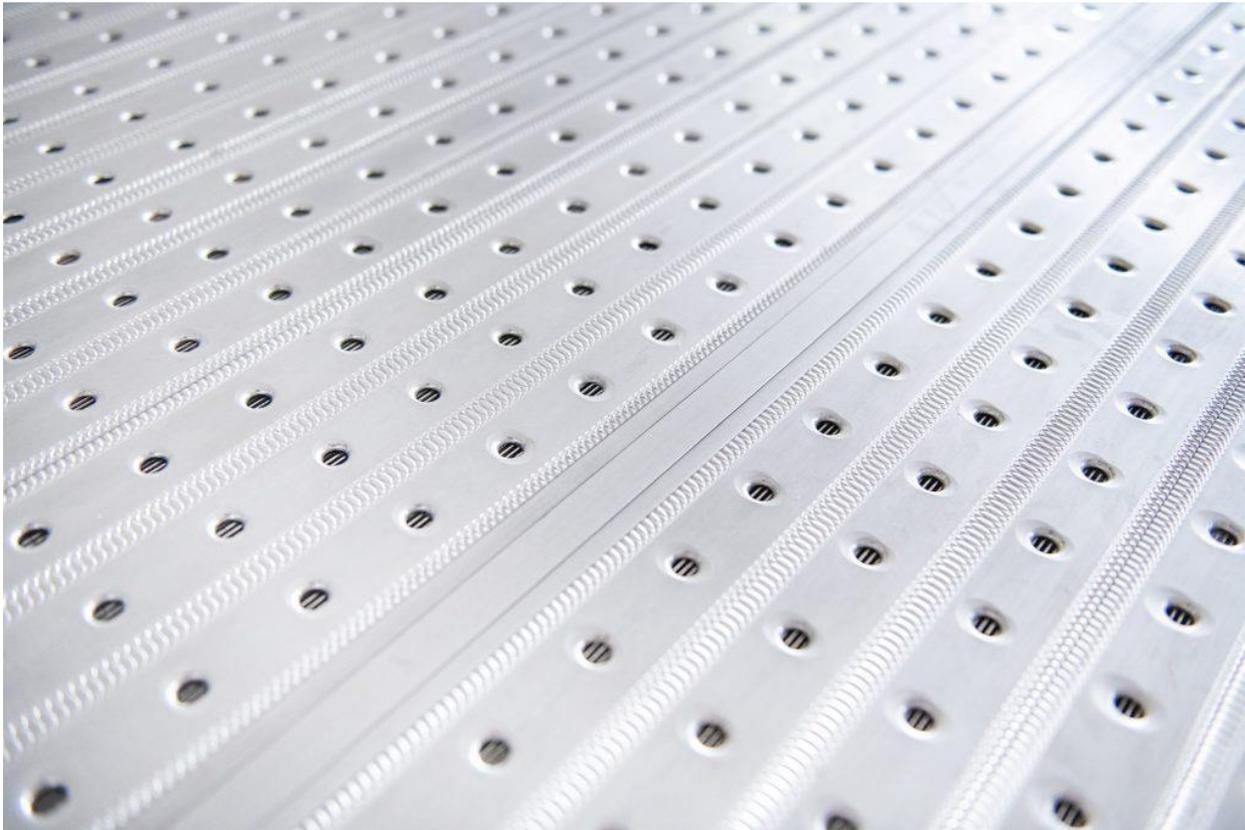
ILDFA Point Load Capacity:	96,000 lbs / (9 in * 16 in) = 666 psi (46 bar)
KC-135 Stratotanker load per tire*:	170 psi
<b>Safety Factor:</b>	<b>3.9</b>
F-35 load per tire*:	250 psi
<b>Safety Factor:</b>	<b>2.7</b>

\*Reference: Goodyear Aviation Data Book 2022. Section 6C Military Aircraft Application Charts

## 7.2. Profile Texture and Slip Resistance

The Safespill ILDFA consists of a polished aluminum top surface with shallow slopes to direct flow of liquid into drainage holes. The Safespill floor differs from traditional aircraft hangar flooring surfaces and has been rigorously tested to ensure a safe, functional, and durable work surface for contractors, maintainers, and other personnel working on or walking over the ILDFA.

Aircraft hangar floors are routinely exposed to hazards such as wet conditions, hydraulic fluid, and lubricant spills. To address these conditions, Safespill incorporates an anti-slip texture across the high points of the aluminum surface (see Figure 7-2). This design provides additional traction without compromising the ability of liquids to drain effectively.



*Figure 7-2: Safespill floor profile with anti-slip texture*

The U.S. Air Force Civil Engineer Center (AFCEC) evaluated the operational use of ILDFA in 2021 at Edwards AFB. Surveys of maintenance and operations personnel indicated that ease of use, visibility, FOD detection, and surface traction were all rated as neutral or positive when compared to traditional concrete hangar floors. The only negative feedback was related to equipment maneuverability and kneeling comfort—issues subsequently addressed through modifications to the top surface design.

These modifications are discussed in the following video:

<https://www.youtube.com/watch?v=BnpZZ3edwD0>

To ensure that slip resistance was not compromised by these design changes, independent testing was performed in accordance with ANSI/NFSI B101.1 using an ASM 825A tribometer.

Three surfaces were evaluated:

- 1) Safespill (ILDFA)
- 2) Polished Concrete
- 3) Epoxy Coated Concrete Sample from Hangar, 10-year age (VX-30 Point Mugu, Hangar 372)

A comparison of SCOF for each surface under dry, wet, and oily conditions is shown in Table 7-2.

*Table 7-2: SCOF of Concrete Surfaces vs Safespill (ILDFA) floor*

Conditions	Dry	Wet	Oily
Safespill (ILDFA)	0.72 – High Traction	0.78 – High Traction	0.25 – Minimal Traction
Polished Concrete	0.84 – High Traction	0.76 – High Traction	0.16 – Minimal Traction
Epoxy Coated Concrete Sample (PM-372)	0.73 – High Traction	0.56 – Moderate Traction	0.05 – Minimal Traction

Based on this testing, the Safespill floor provides slip resistance equivalent to polished concrete and epoxy-coated concrete under dry conditions, and superior slip resistance under both wet and oily conditions. The epoxy-coated concrete sample from Hangar 372 represents a typical surface condition after 10 years of continuous use. Multiple inspections confirmed that the tested sample was representative of aging hangar floors.

These results align with National Floor Safety Institute (NFSI) guidance for available traction and probability of slipping (Table 7-3: Available Traction and Probability of Slipping based on SCOF).

*Table 7-3: Available Traction and Probability of Slipping based on SCOF*

SCOF Value	Available Traction	Slip Probability
$\geq 0.6$	High Traction	Lower
$0.4 \leq \text{SCOF} < 0.6$	Moderate Traction	Increased
$< 0.4$	Minimal Traction	High

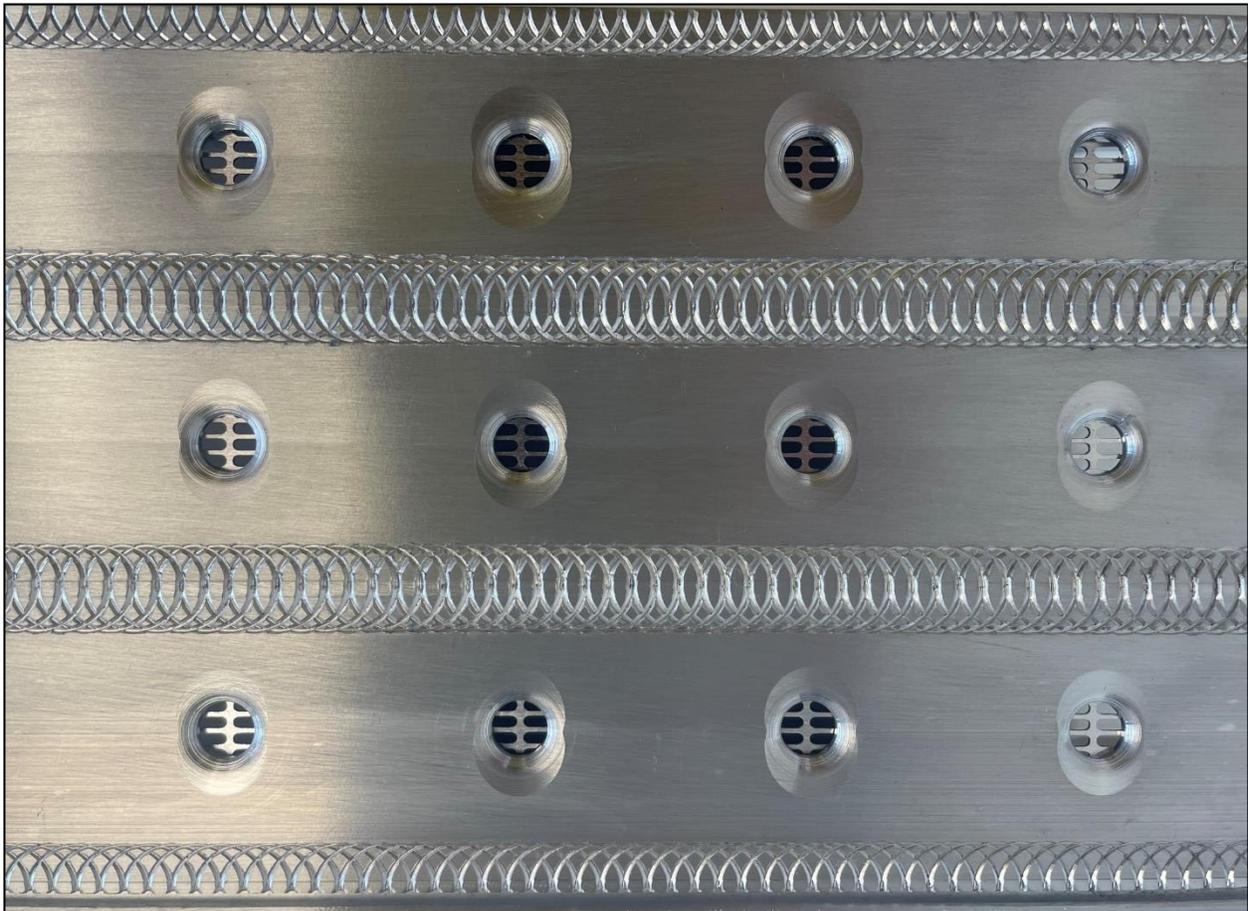
It is important to note that all hangar floor surfaces, whether concrete, epoxy-coated, or ILDFA, exhibit reduced traction under oily conditions. Industry best practice requires prompt cleaning of spills to mitigate slip hazards. In this context, the Safespill floor offers an operational advantage: its integrated drainage and flushing capability allows rapid removal of liquid spills, whereas conventional concrete relies solely on manual cleaning.

In summary, the Safespill ILDFA provides a work surface that is equal to or better than conventional hangar flooring in terms of slip resistance, visibility, and FOD detection, while offering unique safety and operational advantages through its engineered liquid drainage system.

## 7.3. FOD Screens

Below each perforation in the top surface of the ILDFA, a FOD screen is installed to prevent foreign object debris (FOD) from entering the channels of the ILDFA. This reduces the likelihood of blockages with the drainage system and prevents maintainers from losing key components when working atop the ILDFA.

The openings in the FOD screen are small enough to prevent washers as small as No. 5 or M4 from entering the ILDFA. However, the openings allow sand and dust to pass through so that these perforations are not blocked by debris. Inclusion of the FOD screen does not limit the drainage capacity of Safespill's ILDFA.



*Figure 7-3: ILDFA top surface with FOD screen installed below perforations*

## 7.4. Frictional Force in Stopping Conditions

Since ILDFA floor profiles are installed directly on the hangar slab, it is reasonable to consider whether aircraft movement on and off the floor could cause shifting. This section demonstrates that such movement does not present a concern.

The large surface area of contact between the aluminum profiles and the concrete slab provides sufficient static friction to resist displacement. In addition, the flooring assembly is always bounded by perimeter anchor points, as detailed in Sections 5.2 and 5.4.

To illustrate, consider an emergency scenario in which a large aircraft and tow tractor come to a sudden stop while positioned on the ILDFA. For the profiles to move, the horizontal force generated by the deceleration would need to exceed the static frictional resistance between the ILDFA and the slab. Calculations in the following discussion confirm that this condition is not achievable under realistic operating scenarios.



*Figure 7-4: Example of tug moving an aircraft onto ILDFA.*

The force generated by stopping of the tow tractor is described by the free body diagram below:

$F_v$  = Vertical force due to weight of the aircraft.

$F_h$  = Horizontal force motion of the aircraft.

$$F_v = (\text{mass of tow tractor} + \text{mass of aircraft} + \text{mass of ILDFA}) * \text{gravitational acceleration}$$



Figure 7-5: Free body diagram demonstrating forces on ILDFA under a moving aircraft

Therefore, the ratio of horizontal force to the normal force must exceed 0.73 to overcome static frictional forces and move the ILDFA relative to the hangar floor.

Static friction force is described by Equation 1.

$$(1) F_f = \mu * F_n$$

Where  $F_f$  is frictional force,  $\mu$  is the coefficient of friction, and  $F_n$  is the normal force of the aircraft and ILDFA in the vertical plane. Normal force is equal and opposite to the Vertical Force ( $F_v$ ) shown in the free body diagram above.

To overcome the static frictional force and move the ILDFA, the horizontal force generated by the decelerating aircraft must exceed the frictional force.

$$(2) F_h > F_f$$

Combining equations 1 and 2:

$$(3) F_h > 0.73 * F_v$$

The equations for the horizontal and vertical forces are given in equations 4 and 5:

$$(4) F_h = (m_{aircraft} + m_{tractor}) * a$$

$$(5) F_v = (m_{aircraft} + m_{tractor} + m_{floor}) * g$$

Since the mass of the ILDFA is much less than that of the tractor and aircraft, it is neglected, and the equation can be simplified to:

$$(6) (m_{aircraft} + m_{tractor}) * a > 0.73 * (m_{aircraft} + m_{tractor}) * g$$

Simplified further, the condition can be evaluated regardless of the weight of the tractor and the aircraft.

$$(7) a > 0.73 * g \text{ where } g = \text{acceleration due to gravity} = 9.8 \text{ m/s}^2$$

Deceleration can be represented as the product of initial velocity and stopping distance.

$$(8) a = V_i * d_s$$

Stopping distance can be calculated based on the following equation:

$$(9) d_s = \frac{V_i^2}{2 * \mu * g}$$

The coefficient of friction for a rubber tire on an aluminum surface can be approximated at 0.51. Based on an assumed initial velocity of 5 mph (8 km/h), the stopping distance is 1.74 ft (0.53 m) and the deceleration is approximately  $1.2 \text{ m/s}^2$ .

The frictional force, expressed as the product of acceleration due to gravity and the coefficient of friction between aluminum and the hangar floor, is much greater at  $7.2 \text{ m/s}^2$ .

Therefore, **the ILDFA will not move in this scenario.**

For additional information regarding alternative scenarios, please consult the ILDFA manufacturer.

# 8. Floor Openings

## 8.1. Tie Down Points

Openings in the ILDFA to access tie down points can be incorporated. The tie down points shown in Figures 8-1 through 8-4 carry a load rating of 10,000 lbs (4,536 kg). Using a core drill, a 6.5" (165 mm) diameter hole is cut in the concrete. The tie down is installed and then chemically anchored as shown in Figures 8-1 and 8-2.

The ILDFA access for the tie down point sits flush with the top surface (Figure 8-3) and allows the chain connection to secure the aircraft inside of the hangar as shown in Figure 8-4.

For new build projects, tie down points should not be included in the hangar slab design to allow the ILDFA manufacturer flexibility of installing the system.



Figure 8-1: Concrete core drilled out of hangar slab.

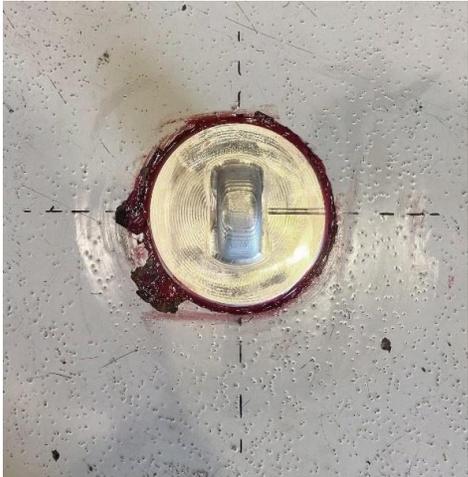


Figure 8-2: ILDFA tie down point chemically anchored into concrete slab

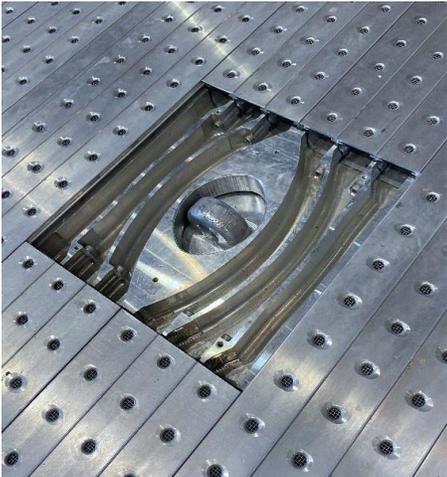


Figure 8-3: ILDFA tie down point without lid



Figure 8-4: ILDFA tie down point example with aircraft chain connection

## 8.2. Grounding Points

Grounding points for aircraft grounding are integrated into the ILDFA floor and are connected to a copper termination bus located within the ILDFA trench using a minimum of 6 AWG jacketed grounding wire. The termination bus is in turn connected to grounding rods or the building ground. An example of an ILDFA grounding point is shown in Figure 8-5.

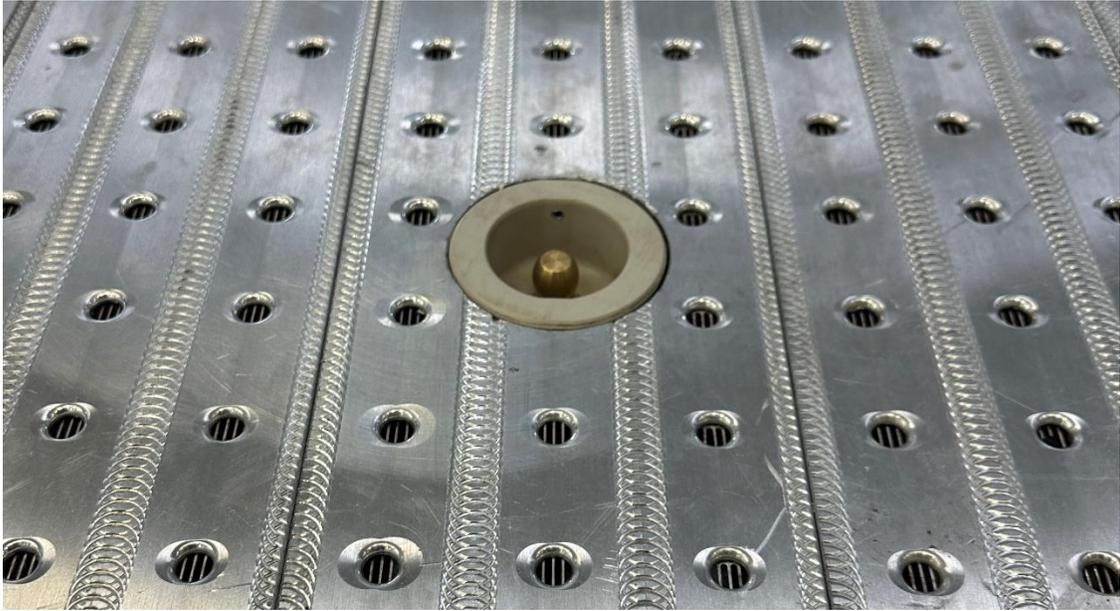


Figure 8-5: Example of ILDFA Grounding Point

Grounding points consist of a high-strength composite (PEEK) cup designed to exceed the point load capacity of the ILDFA floor profiles. A ball stud (ERICO B165R or equivalent) is fitted to the composite part, providing insulation from the aluminum ILDFA floor profiles.

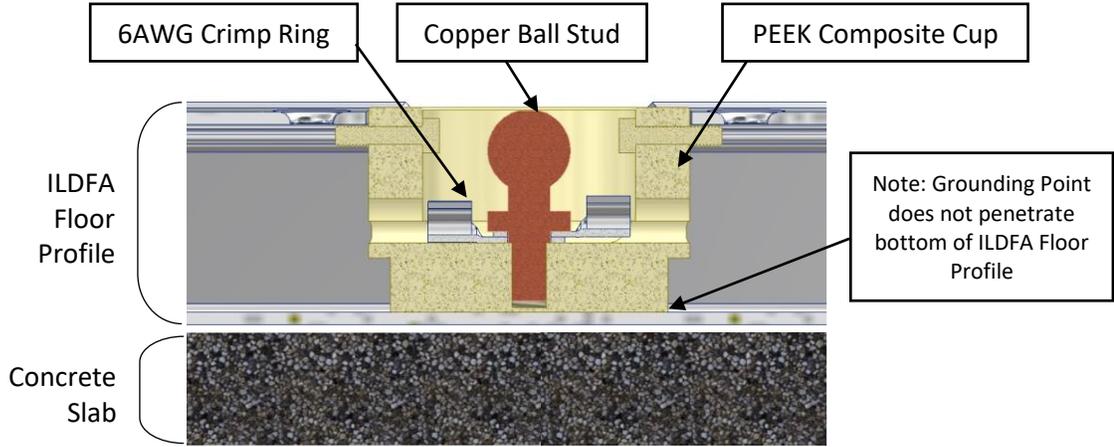


Figure 8-6: Cross section view of ILDFA grounding point embedded in profile

The grounding point is **not accessible** through the bottom of the floor, and all grounding wires are routed through the channels of the Safespill ILDFA floor profiles.

To install a grounding point, a 3" (76 mm) diameter hole is cut through the top surface of the ILDFA floor profile (Figure 8-7). The grounding point assembly is inserted into the opening and secured in place with set screws to prevent removal (Figure 8-8).

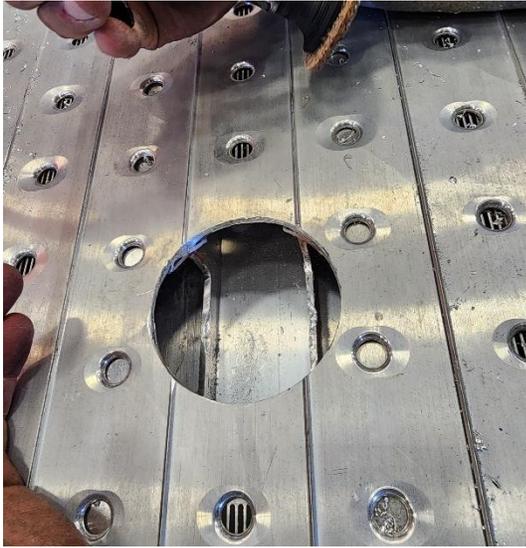


Figure 8-7: 3" Cutout in ILDFA Floor Profile

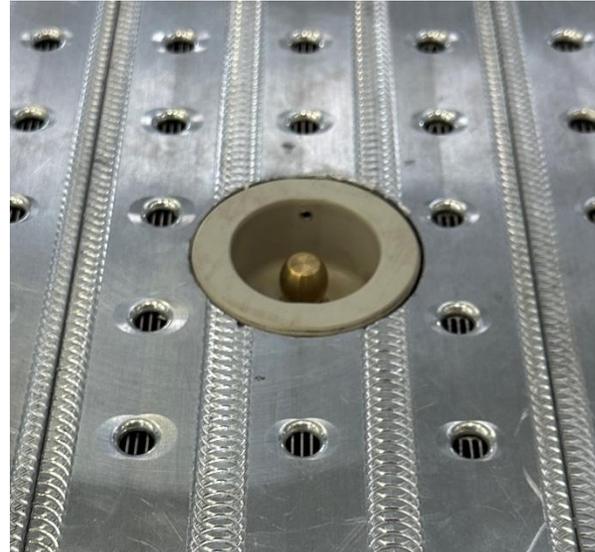


Figure 8-8: Grounding Point Inserted in ILDFA Floor Profile

Grounding points are connected in series with two independent paths to ground using 6 AWG grounding wire. The wire is routed through the ILDFA profiles to the trench, then through the trench to the edge of the floor assembly, and finally terminated on a grounding bus (Figure 8-9). The grounding bus is connected to a grounding rod or the building ground (Figure 8-10).

Grounding points may be placed at any location on the ILDFA except on top of trenches. Additional grounding points can be added retroactively if aircraft parking configurations or hangar operations change.

For new build projects, a dedicated grounding grid within the hangar slab is no longer required when ILDFA grounding points are used. In retrofit applications, the existing grounding grid and other utilities are not used.

It is important to note that these grounding points are designated for aircraft grounding only. Because the ILDFA is constructed entirely of aluminum, grounding of the floor assembly itself is also required. Just like with the aircraft grounding points, Safespill provides grounding connection points on ILDFA profile sections, a copper termination bus in the trenches, and the termination bus will need to be connected to building ground.

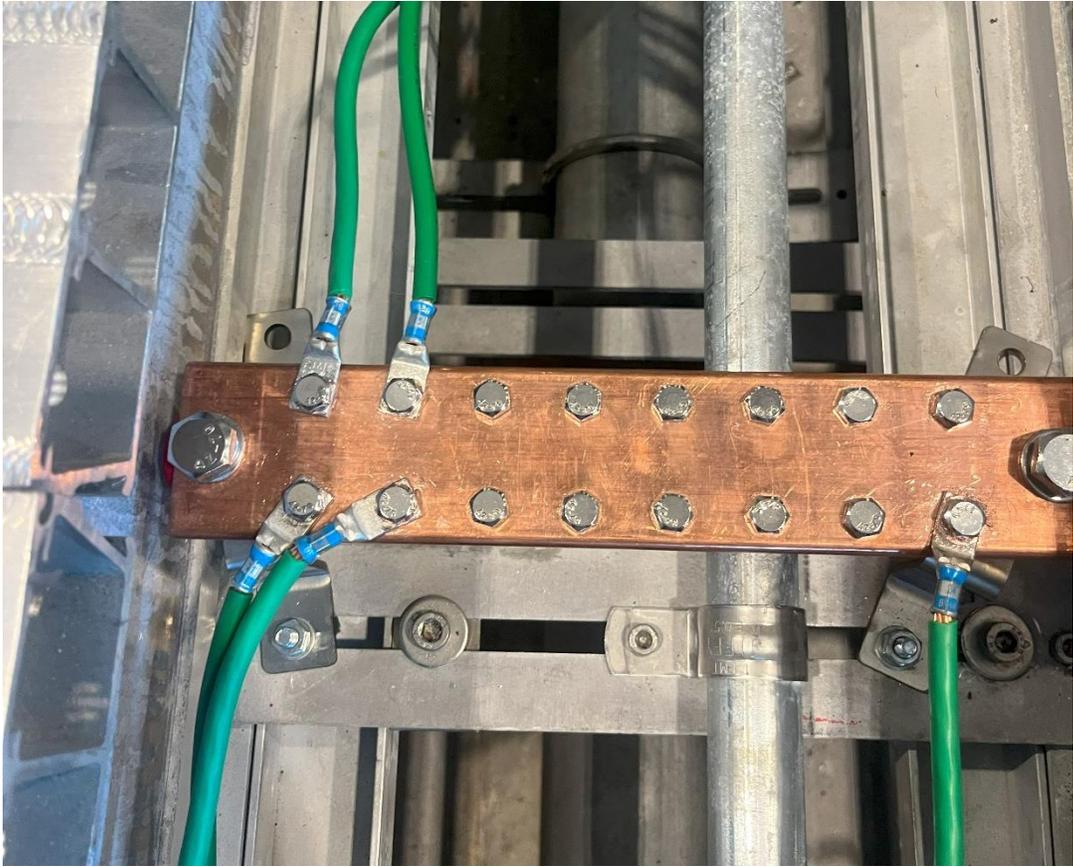


Figure 8-9: Grounding Bus installed in ILDFA prefabricated aluminum trench for termination of grounding points.

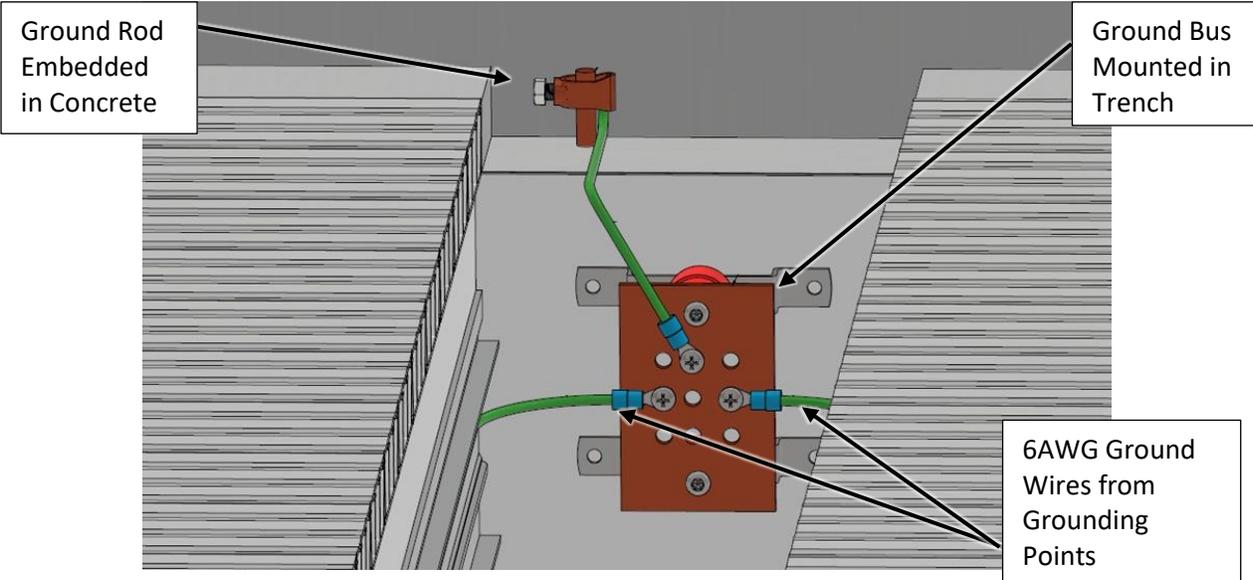


Figure 8-10: Grounding point termination at end of trench. Ground bar may vary in size depending on number of grounding points. Figure shows termination to grounding rod, but termination to building ground may be used in some cases.

### 8.3. Utilities Access

Openings in the ILDFA allow access to existing utilities in the slab that cannot be relocated, such as sewer drain cleanouts, electrical boxes, and pneumatic connections. The machined aluminum block is incorporated into the design of the floor and directs flow around the opening. Openings are rated for the same loading capacity as the ILDFA floor profiles when the lid is installed. For electrical box access, additional precautions may be necessary to prevent liquid from entering the electrical equipment.

Figures 8-11, 8-12, and 8-13 are examples of possible openings. Exact styles and dimensions needed for each project are determined during the design phase.



Figure 8-11: Utility Opening with lid removed

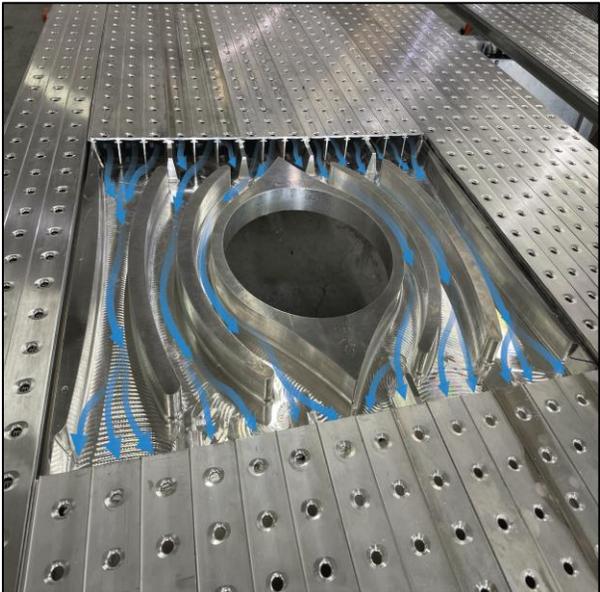


Figure 8-12: Utility Opening with example of flow through channels

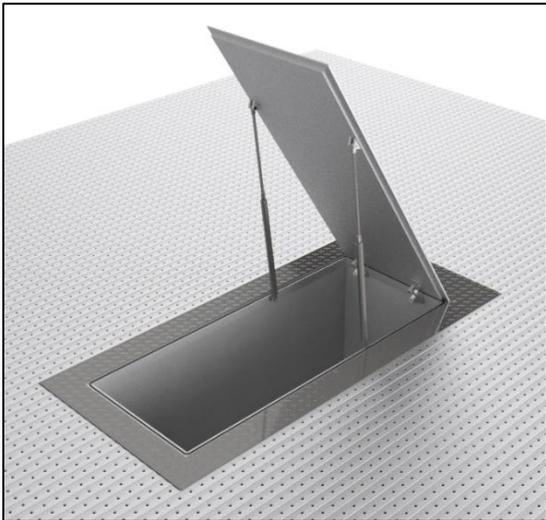


Figure 8-13: Utility Access Door Concept

## 9. Flushing Water Requirements

An ILDFA requires water to flush the internal drain channels. The ILDFA water requirement is 200 GPM (757 LPM). Each zone requires a water supply of 50 GPM (189 LPM). If a spill occurs on the corner of a zone, the 3 adjacent zones could activate as well.

Therefore, the total water supply required is  $4 \times 50 \text{ GPM} = 200 \text{ GPM}$  (757 LPM)

Three options are available for the ILDFA water supply:

1. Domestic Water Supply – Connect upstream of the facility water meter
2. Facility Sprinkler Water Supply – Connect upstream of the sprinkler backflow preventer and flow switch
3. Continuously maintained, dedicated non-potable source – Examples include a flushing supply tank or water recycle system

The flushing manifold operates at a minimum pressure of 60 psi (4.1 bar) and a maximum pressure of 120 psi (8.3 bar). Depending on the water pressure of the hangar, a booster pump or pressure reducer can ensure the correct pressure will be supplied to the ILDFA. See *Section 9.3, Booster Pump Design* for more details.

If providing a dedicated line to the hangar requires significant plumbing or if water availability is limited, a dedicated flushing water tank can be placed outside the hangar as an alternative. Typically, this would require a tank of 6,000 (34,070 L) to 12,000 gallons (45,425 L).

- UFC 4-211-01 requires 30 minutes of flushing water at 200 GPM (757 L/min)
- NFPA 409 (2022 Edition) requires 45 minutes of flushing water at 200 GPM (757 L/min).
- FM Datasheet 7-93 requires 60 minutes of flushing water at 200 GPM (757 L/min)

### 9.1. Reliability

When considering reliability and requirements for water supply, it is important to note that the ILDFA flushing water supply is **not subject to NFPA 20 requirements**.

If a booster pump is utilized, it does need to be listed. However, it is **not** required to have redundancy **nor** meet NFPA 20 requirements.

This is based on full-scale fire testing documented in the following report:

#### [Safespill ILDFA Failure Mode and Effects Analysis](#)

In this testing program, a fire test is conducted in which flushing water is intentionally disabled. In this test, the system successfully contains and controls the ignitable liquid spill fire, confirming that flushing water is not a critical component of suppression.

As a result, the booster pump does not need to meet NFPA 20 compliance, and the water supply does not need to meet NFPA 20 reliability requirements.

## 9.2. Water Supply Devices

When utilizing a domestic water supply, ensure that a backflow preventer is installed ahead of all ILDFA components.

For all water supplies, provide the following:

### **Valves**

Provide water control valves that are indicating type and comply with NFPA 13 requirements, around all components which need to be isolated for service. This includes upstream and downstream of booster pumps, upstream of each connection to the ILDFA, upstream of each strainer, and upstream of each water hammer arrestor or expansion tank.

### **Water Hammer Arrestor**

Provide a water hammer arrestor sized based on manufacturer's calculations and located as close as possible to the solenoid valve cabinet.

### **Strainers**

Provide a strainer, with opening size less than US Mesh 20 (1/32" or 0.8 mm), upstream of all ILDFA components. For applications following UFC 4-211-01, the strainer must be chrome-moly simplex basket conforming to ASTM A217/A217M, with a flanged connection, and stainless-steel strainer basket with mesh size 40.

### **Flow Meter**

Provide an ultrasonic flow meter for monitoring flushing manifold supply piping. The flow rate is monitored and tied into the ILDFA control panel. If flow rates are measured outside of typical parameters during operation, alarms will be displayed on the control panel, and a trouble signal will be sent to the FACP.

Figure 9-1 shows an example of a water supply arrangement when a booster pump is not utilized. In this case, a flow meter, water hammer arrestor, and basket strainer are installed upstream of the connection to the ILDFA and located on the back wall of a hangar.

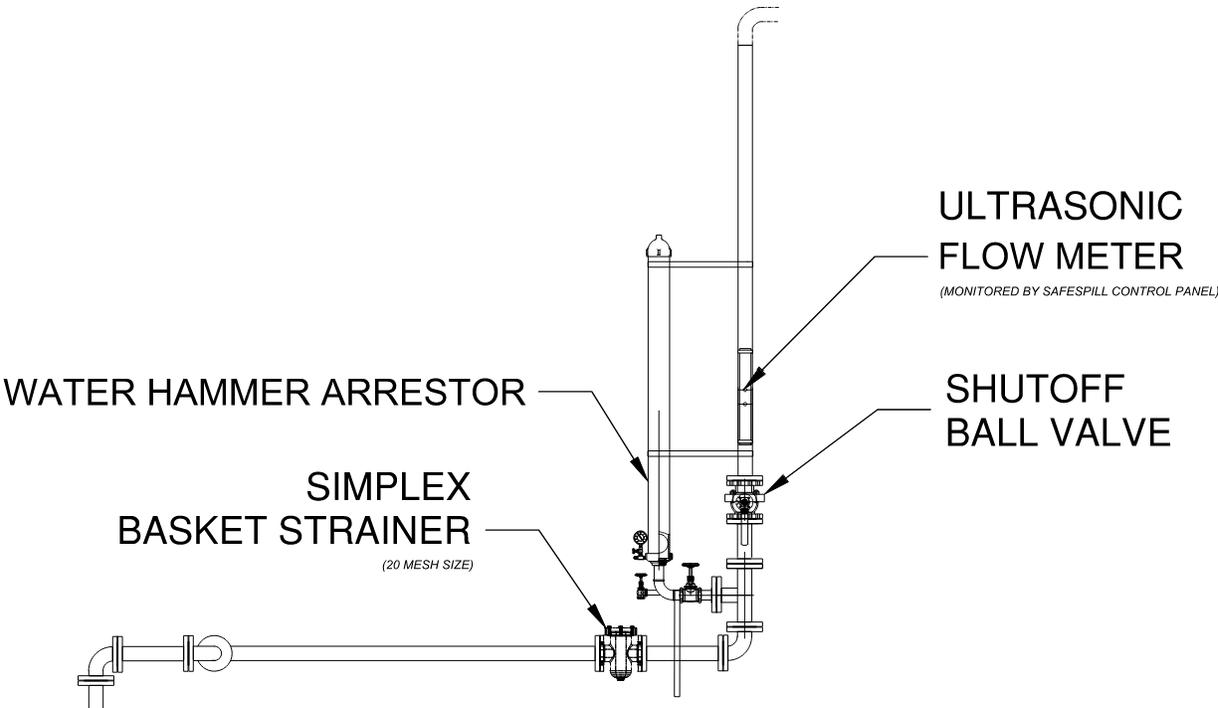


Figure 9-1: Example water supply arrangement with necessary devices.

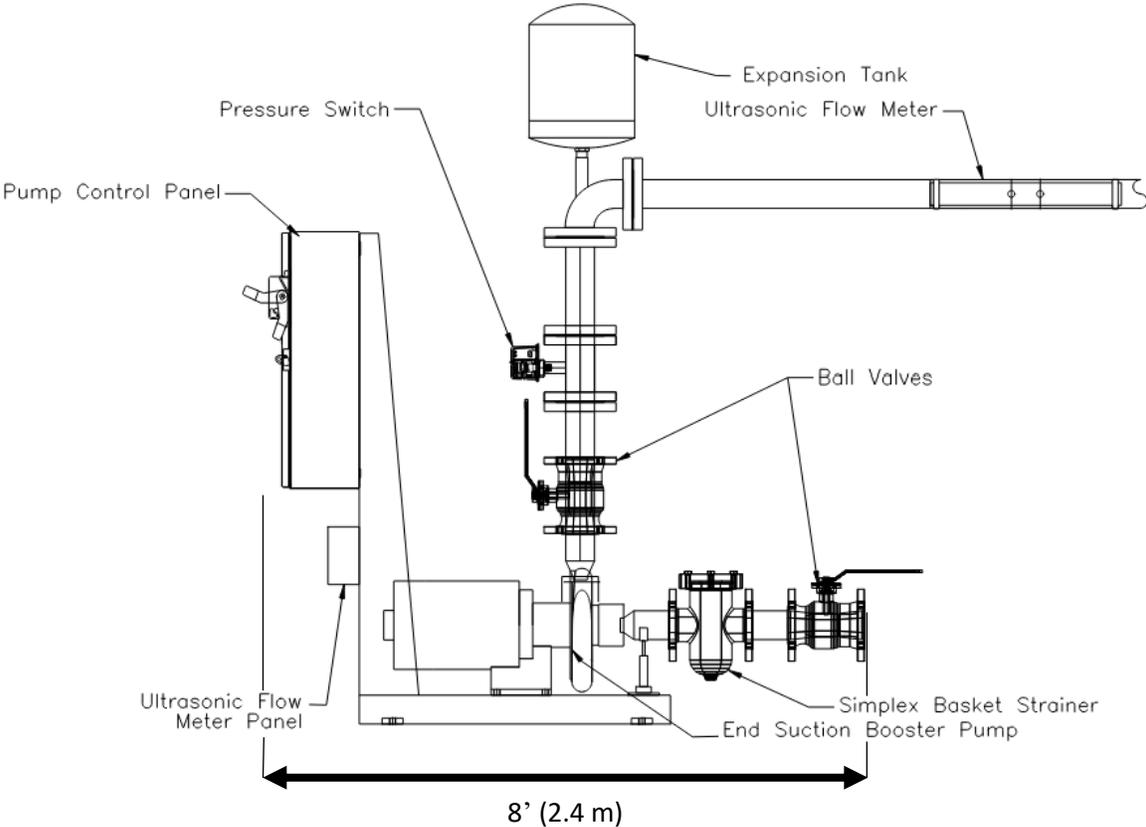


Figure 9-2: Example Booster Pump Skid

### 9.3. Booster Pump Design

An example of a typical booster pump skid is shown in Figure 9-2 on the previous page.

To determine whether a booster pump is required, friction loss through the ILDFA piping must be evaluated relative to the available incoming water supply pressure. At the tie-in point, the ILDFA requires a water supply of 200 gallons per minute (757 L/min) at 100 psi (6.9 bar). This ensures that the flushing system maintains a minimum operating pressure of 50 psi (3.5 bar) when up to four zones are activated simultaneously. If the available water supply cannot sustain this pressure at the required flow rate, a booster pump must be installed.

Water supply conditions and piping configurations vary by project, so an evaluation is needed on each installation to properly size the booster pump. However, a typical configuration is an end-suction centrifugal pump with a nominal 3" (DN 80) diameter inlet and outlet, powered by a 20 HP motor. Operating power for this pump is generally 480 VAC at 20 amps, though alternative motors can be provided to meet local voltage requirements.

Power is supplied directly from the building to a pump control panel equipped with a motor starter. The pump can be started by a signal from the main ILDFA control panel when a solenoid valve is opened, or by a pressure switch installed on the supply line downstream of the pump.

For ease of installation, the booster pump and all required components are typically integrated onto a skid. The standard skid has a footprint of 8 ft (2.4 m) by 4 ft (1.2 m) and weighs approximately 400 lbs (181 kg), though footprint and weight may vary depending on the required pump size.

The booster skid is normally installed in a pump room adjacent to the hangar bay; however, if it must be placed inside the hangar, care should be taken to ensure that it does not interfere with the ILDFA floor footprint.

## 10. Discharge Pump Skid

When designing the ILDFA, the pump skid system typically uses an FM Approved nominal 6" (DN 150), 50HP centrifugal pump with a maximum flow rate of 1,500 GPM (5,680 L/min). The discharge pump is controlled by a listed pump controller.

A 460/480VAC, 3 phase power supply with a 65A breaker is required for each pump skid. For hangars outside of the United States, pump motors can be modified to work with local 3 phase voltage supply.

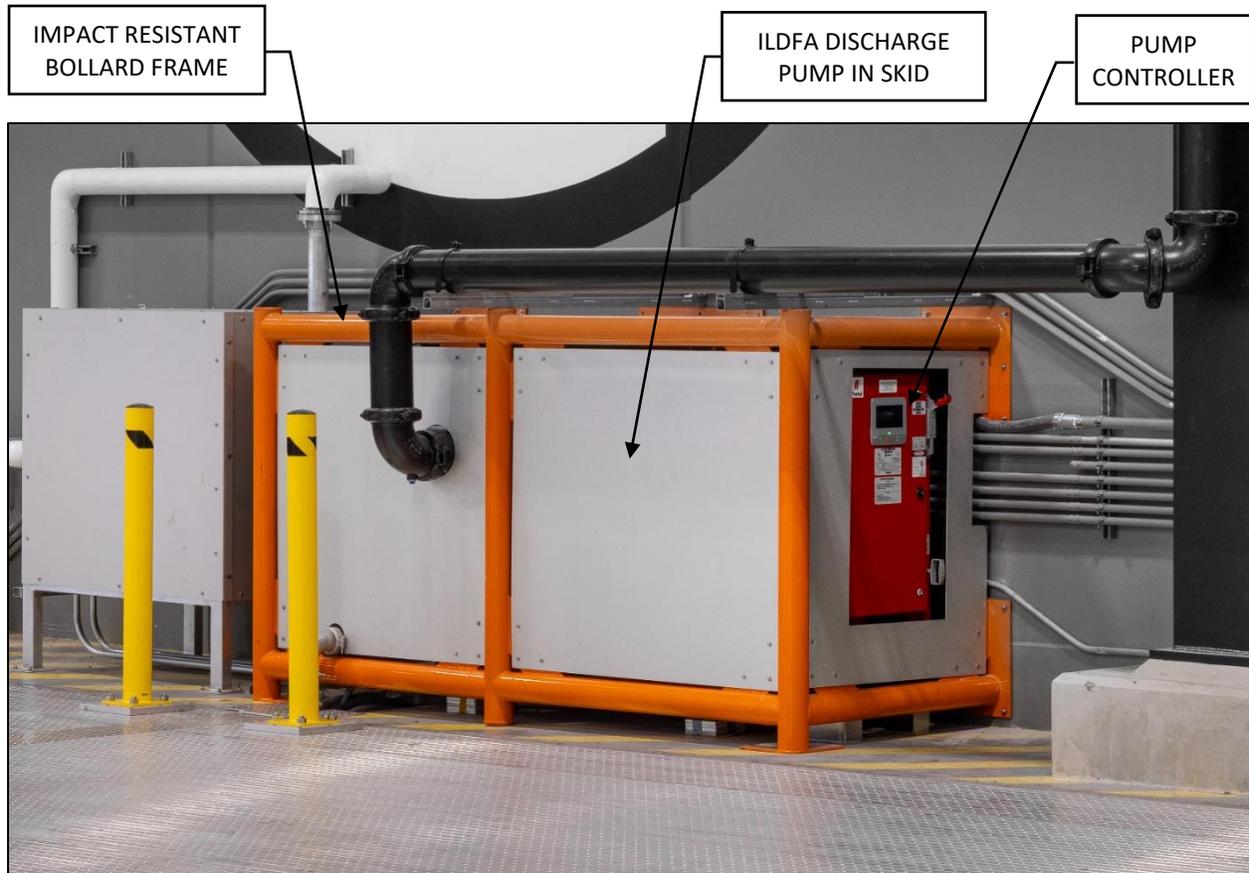


Figure 10-1: Typical pump skid enclosure in ILDFA hangar installation.

The pump and controller are housed inside of a welded aluminum bollard frame, with heavy duty aluminum panels to protect the equipment from collisions, such as forklifts, tugs, or tool carts. The bollard frame has an approximate footprint of 10 ft (2.9 m) by 5 ft (1.5 m) and an approximate height of 5.5 ft (1.6 m).

The hangar layout, width, and number of trenches will determine if one or more pump skids are required.

For a hangar layout that needs two pump skids, the skids will be located at each end of the ILDFA along the hangar wall to pump liquid from the trenches to above-ground external containment. Alternatively, the liquid can drain via gravity to an underground containment tank or underground Oil Water Separator (OWS). More details on containment and drainage options are provided in *Chapter 13, Containment and Drainage*.

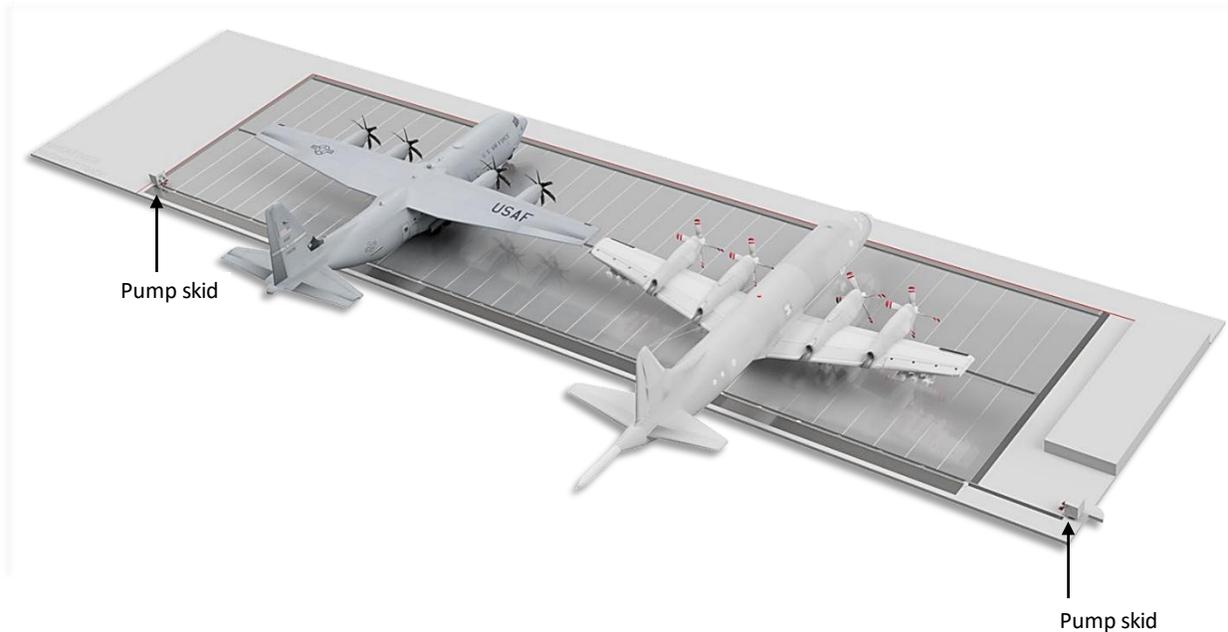


Figure 10-2: Render of ILDFA Layout with pump skids on opposite sides of the system

## 10.1. Discharge Pump Controller

To ensure reliability, all discharge pumps will be connected to a listed fire pump controller. The fire pump controller will be installed inside of the pump skid bollard frame with an opening in the enclosure panels for access. The pump controller will provide signaling to the main control panel to provide alerts when power is lost, pumps are running, or phase reversal occurs. A liquid detection sensor installed in the drainage box will send a signal to the pump controller to start the discharge pump whenever liquid is present in the drainage box of the ILDFA. The pump will start upon liquid detection and run for a pre-set duration after the liquid detection sensor is dry.

For most applications, the pump will run for (1) minute after the liquid detection sensor is dry as shown in the example logic tree in Figure 11-6. For applications following FM Datasheet 7-93, the pump will be required to run until it is manually shut off. Changes in runtime can be accommodated through on-site programming of the pump controller.

# 11. Controls System

For all ILDFA installations, a main control panel will be provided in each hangar bay. A controls junction box will be installed near the trenches and act as a cutoff between the main control panel and wiring entering the trench. One controls junction box can accommodate up to 16 ILDFA zones. All ILDFA control panels and junction boxes are UL-508A listed and FM approved, typically requiring a 2,400 watt supply. Control panels and junction boxes carrying Intrinsically Safe wiring are UL-698A listed.

## 11.1. Main Control Panel

The ILDFA control panel consists of a NEMA 4/IP66 enclosure, which should be mounted on a wall within the hangar, in a central location where it is visible to all hangar personnel.

In hangars with multiple bays, one main control panel will be provided for each hangar bay. Figure 11-1 shows an example of an ILDFA main control panel mounted on the inside wall of the hangar. Placement is within view of all ILDFA zones and is accessible to emergency responders and maintenance personnel.

The typical dimensions of the main control panel are 24" (0.61 m) wide by 30" (0.76 m) high by 12" (0.3 m) deep. The main control panel should be installed at least 18" (0.45 m) above the ground.

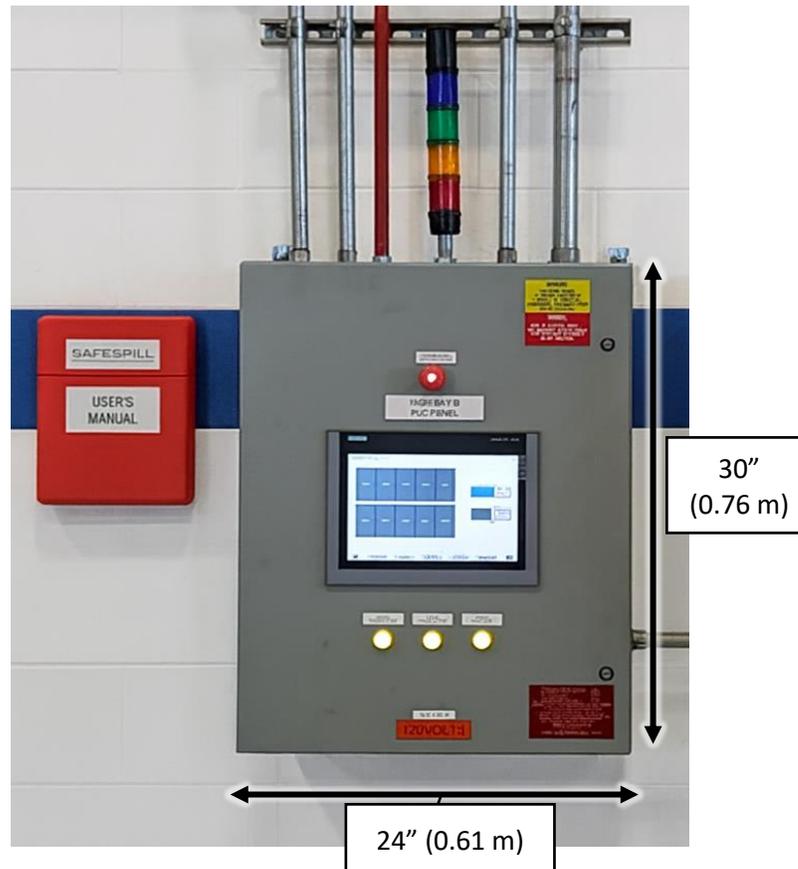


Figure 11-1: ILDFA Control Panel mounted on the interior hangar wall

The main control panel has indicating lights for power loss, system armed, and tank conditions. Audio-visual alarms are initiated at the main control panel. The main control panel has dry contacts for connection to the hangar’s Fire Alarm Control Panel (FACP) or Building Management System (BMS). A fire alarm sequence of operation is provided in *Section 11.4, Fire Alarm Sequence of Operation*. The ILDFA is designed to detect liquid spills only and does not detect fire. Therefore, the ILDFA control panel will not activate “alarm” for an FACP, and it is recommended that ILDFA should be installed alongside fire detection systems to activate alarm on the FACP.

UFC 4-211-01 requires the use of Triple Infrared (IR) Optical Flame Detectors in hangars with ILDFA installed. Additional information related to the use of Optical Flame Detectors with ILDFA is discussed in *Section 0, Optical Flame Detectors*.

A Human-Machine Interface (HMI) installed on the main control panel allows the user to activate cleaning cycles, manually activating the system if a spill occurs, observe current conditions of sensors and tank levels, and view alarm logs.

If remote monitoring is permitted, the ILDFA manufacturer can access the control panels’ PLC and HMI through a VPN connection to analyze the data and make continuous improvements. This allows the manufacturer to run diagnostic tests. One example is testing liquid detection sensors to diagnose errors within individual zones.

During standard operation, the system is armed and will activate upon three scenarios:

1. Automatic Operation – Activated by liquid detection sensors
2. Emergency Operation – Activated manually, when a spill is observed but not yet detected, via button on HMI
3. Manual Operation – Activated manually, for cleaning or flushing purposes, via button on HMI

More details on the system operations are provided in *Section 11.5, Logic Tree*.

The HMI displays the zone currently being activated by one of the three scenarios. The example below in Figure 11-2 shows the ILDFA Zone 3 activated for manual operation in green.



Figure 11-2: Example of the ILDFA HMI with Zone 3 cleaning mode activated

## 11.2. Controls Junction Box

The controls junction box is used as a cutoff point between wiring from the main control panel and wiring entering the trench. These junction boxes should be installed near the end of trenches, mounted to a nearby wall or column in the hangar bay, and connected to conduit runs in the trench. The typical dimensions of a controls junction box are 20" (0.79 m) wide by 20" (0.79 m) high by 8" (0.32 m) deep. The controls junction box should be installed at least 18" (0.45 m) above the ground.



*Figure 11-3: Typical Controls Junction Box mounted on wall near ILDFA trench*

The junction box sends input signals for liquid detection sensors to the main control panel and receives output signals for solenoid valves from the main control panel. Each junction box can be connected to up to 16 zones.

For most applications, the junction box includes a secondary logic controller to process local signals. This configuration minimizes wiring requirements between the main control panel and the junction box while maintaining identical safety and performance features.

### **The controls junction box typically contains:**

1. Intrinsically safe (IS) barriers for wiring liquid detection sensors
2. Terminal blocks for wiring to solenoid valves located in adjacent wall-mounted valve cabinets
3. A secondary logic controller for local signal processing

Input and output signals between the junction box and the main control panel are transmitted via Profinet (CAT6 Ethernet cable).

The following wiring is required between the main control panel and the controls junction box:

- 24VDC for power to IS Barriers and secondary logic controller: 6AWG, 2 conductors + 1 Ground
- 1 Profinet (CAT6) Ethernet cable for liquid detection and solenoid valve communication

Additional wiring for tank sensors, flow meters, or auxiliary devices may also be routed through the junction box depending on project layout.

### 11.2.1. UFC 4-211-01 (U.S. Military) Applications

For U.S. military projects following UFC 4-211-01, cybersecurity and network-segregation requirements typically prohibit Ethernet-based signal transmission. These applications generally require all circuits to be hardwired from the junction box terminals directly to the logic controller located in the main control panel.

Accordingly, the controls junction box includes:

1. Intrinsically safe (IS) barriers for wiring liquid detection sensors
2. Terminal blocks for wiring to solenoid valves in adjacent wall-mounted valve cabinets

Required wiring between main control panel and controls junction box:

- 24 VDC for power to IS barriers: 12 AWG, 2 conductors + 1 ground
- Liquid detection sensor signal: 22 AWG, 2 conductors per zone (32 conductors for 16 zones)
- Solenoid valve power: 14 AWG, 2 conductors per zone (32 conductors for 16 zones)

Additional conductors may be required for tank sensors, flow meters, or other auxiliary devices.

## 11.3. Backup Battery Power

Each main control panel will be connected to backup battery power providing 24VDC power for 48 hours of standby plus 30 minutes of operation. The batteries will be stored in a battery cabinet, which should be installed next to the main control panel, at least 18 inches above the ground.

The dimensions of the battery cabinet will be either:

For applications with **16 zones or less**: 19" (0.48 m) wide by 40" (1.02 m) high by 17" (0.43 m) deep.

For applications with **more than 16 zones**: 26" (0.66 m) wide by 40" (1.02 m) high by 17" (0.43 m) deep.

When building power is lost, the main control panel will automatically switch to battery power and continue to provide power supply to the logic controller, signaling devices, liquid detection sensors, solenoid valves, and tank sensor(s). When building power is lost, the main control panel will display power loss via an indicating light and transmit a supervisory signal to the FACP.

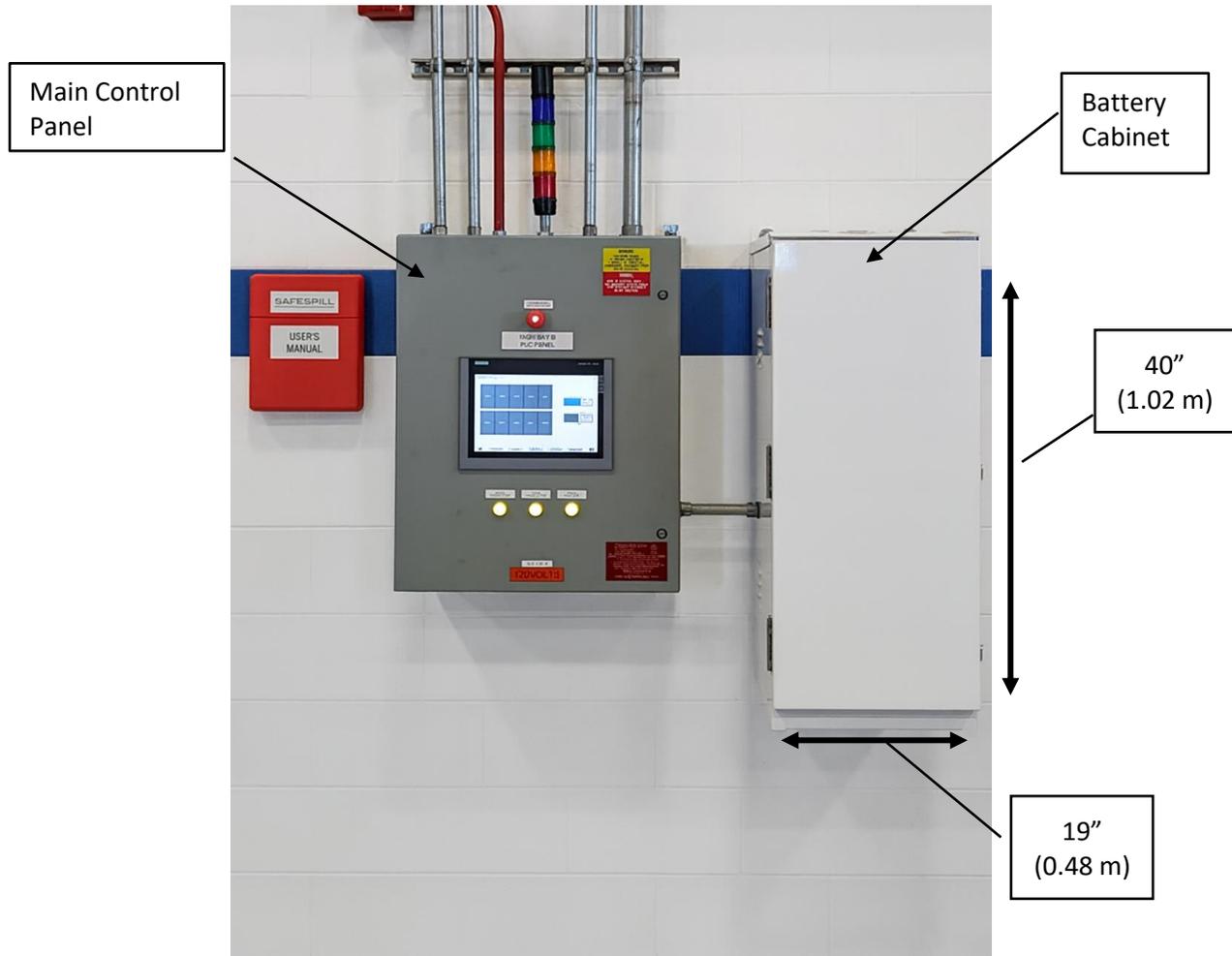


Figure 11-4: Battery cabinet mounted on wall near main control panel

## 11.4. Fire Alarm Sequence of Operation

Figure 11-5 shows a typical fire alarm sequence of operation meeting the minimum requirements for the sequence of operations in accordance with UFC 4-211-01. This includes signaling between the ILDFA Controls System and the hangar's FACP or BMS

ILDFA SEQUENCE OF OPERATION						
		SYSTEM OUTPUT				SUPERVISORY ANNUNCIATION AT LOCAL PANEL (BMS or FACP)
		ANNUNCIATION AT SAFESPILL CONTROL PANEL				
		CONTINUOUS AUDIBLE NOTIFICATION AT SAFESPILL CONTROL PANEL	CONTINUOUS STROBE AT SAFESPILL CONTROL PANEL	CONTINUOUS INDICATING LIGHT AT SAFESPILL CONTROL PANEL	SILENCABLE AUDIBLE NOTIFICATION AT SAFESPILL CONTROL PANEL	
SYSTEM INPUTS		A	B	C	D	E
1	AUTOMATIC ACTIVATION OF ILDFA (SPILL DETECTED)	X	X			X
2	EMERGENCY ACTIVATION OF ILDFA	X	X			X
3	ACTIVATION OF SAFESPILL EMERGENCY STOP			X	X	
4	LOW FLOW DETECTED DURING SOLENOID OPERATION, SAFESPILL FLUSHING SUPPLY				X	
5	SIGNAL FROM SAFESPILL CONTROL PANEL, DISCHARGE TANK IS ≥95% FULL	X	X	X		X
6	SIGNAL FROM SAFESPILL CONTROL PANEL, DISCHARGE TANK IS 30 - 94% FULL	X	X	X		X
7	SIGNAL FROM SAFESPILL CONTROL PANEL, DISCHARGE TANK IS 20 - 29% FULL		X	X	X	
8	SIGNAL FROM SAFESPILL CONTROL PANEL, 120 VOLTAGE SUPPLY IS INTERRUPTED			X	X	
9	SIGNAL FROM SAFESPILL CONTROL PANEL, 480 VOLTAGE SUPPLY IS INTERRUPTED	X	X	X		

SYSTEM OUTPUT DETAILS	
AUDIBLE CONTINUOUS NOTIFICATION AT SAFESPILL CONTROL PANEL = CONTINUOUS HORN AT SAFESPILL CONTROL PANEL	
CONTINUOUS STROBE AT SAFESPILL CONTROL PANEL = CONTINUOUS STROBE AT SAFESPILL CONTROL PANEL	
CONTINUOUS INDICATING LIGHT AT SAFESPILL CONTROL PANEL = CONTINUOUS INDICATING LIGHT AT SAFESPILL CONTROL PANEL	
SILENCABLE AUDIBLE NOTIFICATION AT SAFESPILL CONTROL PANEL = INTERMITTENT HORN AT SAFESPILL CONTROL PANEL (SILENCABLE)	

Figure 11-5: Sequence of Operations for FACP in accordance with UFC 4-211-01

11.5. Logic Tree

Figure 11-6 and Figure 11-7 are examples of the ILDFA logic tree that explains the flow of operations for all typical and atypical scenarios.

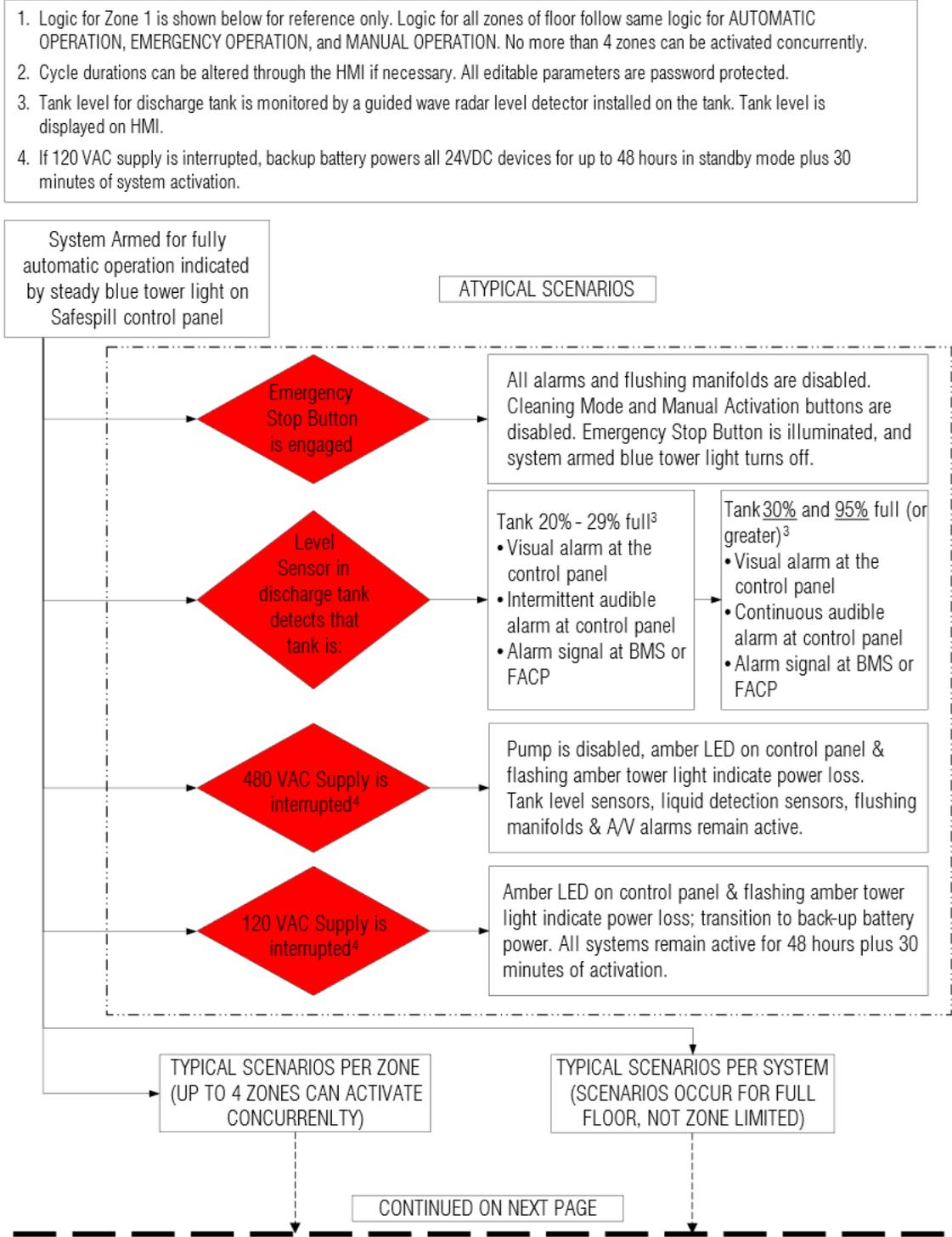


Figure 11-6: ILDFA Logic Tree

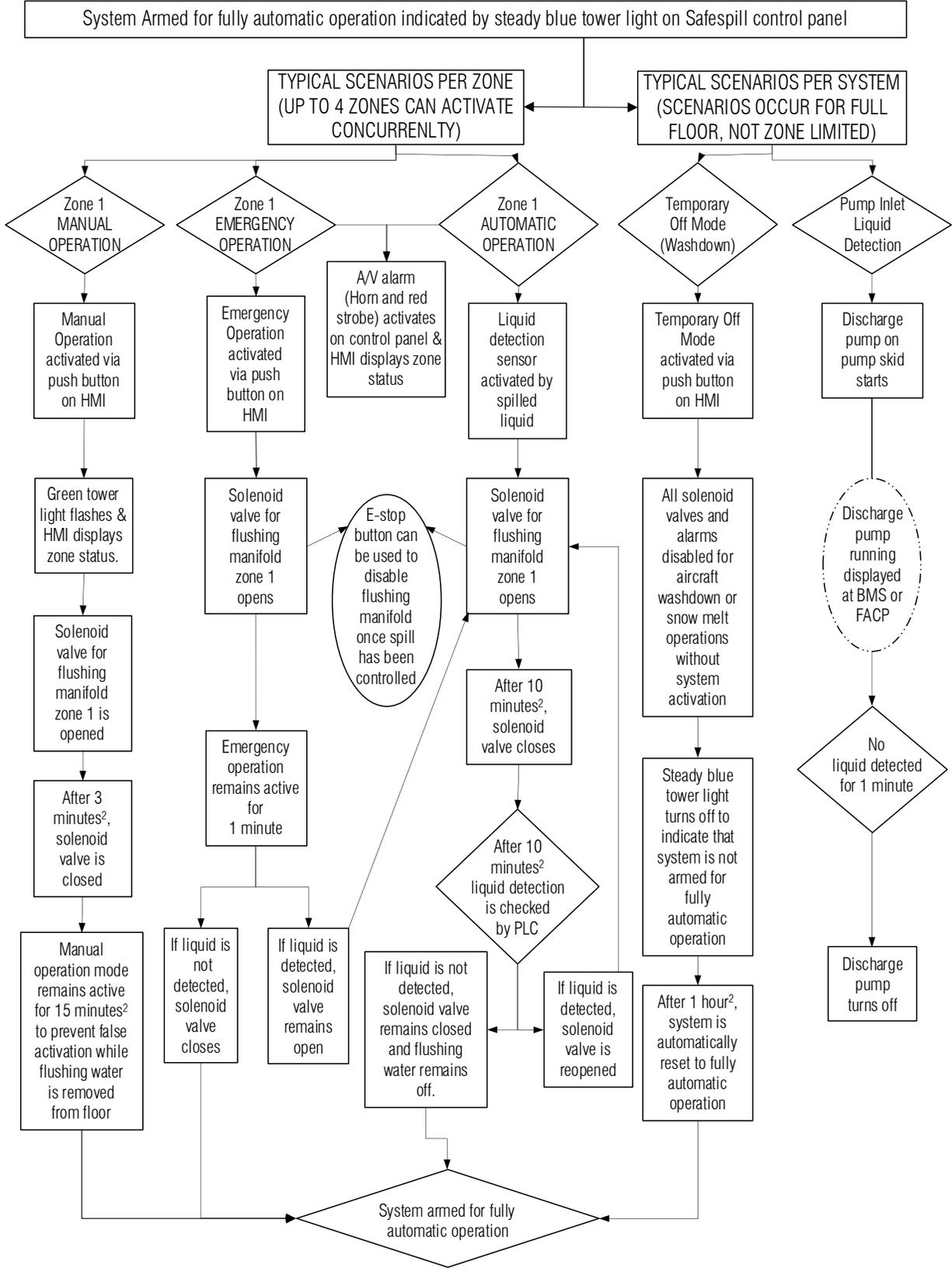


Figure 11-7: ILDFA Logic Tree (Continued)

## 12. Electrical Components in Trench

Liquid detection sensors, solenoid valves, and wiring for these devices are installed within the trench of the ILDFA and are provided by Safespill.

### 12.1. Liquid Detection Sensors

For each zone of the ILDFA, (1) liquid detection sensor is installed. The liquid detection sensor is intrinsically safe and FM Approved for use in Class 1, Division 1 locations. The liquid detection sensor consists of a two-wire amplifier which converts intrinsically safe voltages to a visible red light.

Figure 12-1 provides a visual explanation of liquid detection sensor components and operations.

The visible red-light travels through a fiber optic cable to a glass prism and returns via fiber optic cable to a receiver on the sensor. When the glass prism is not submerged in liquid, the red light returns to the sensor uninterrupted. When the glass prism is submerged in liquid, the red light is scattered and does not return to the sensor. The sensor transmits a “light” or “dark” condition to an intrinsically safe barrier located in the controls junction box.

Each liquid detection sensor is connected to the intrinsically safe barrier via (2) 18AWG conductors, with a 4-pin, M12 quick disconnect fitting on the device side.

Liquid detection sensor wiring is routed through the trench in a rigid metallic conduit to prevent abrasion and crushing. Table 12-1 provides recommended conduit sizing based on the number of zones in each conduit run. Please note, conduit sizing remains constant from the controls junction box to each liquid detection sensor on the conduit run.

If a liquid detection sensor component or wiring is damaged, the device registers as activated and signals the control panel that a spill has occurred.

Table 12-1: *Recommended Conduit Size for Liquid Detection Sensor Wiring*

<b>Number of Zones</b>	<b>Recommended Conduit Size</b>
12 Zones or Less	1" (27 mm)
13 to 20 Zones	1-1/4" (35 mm)
More than 20 zones	1-1/2" (41 mm)

*Glass Prism at end of fiber optic cable*



*Sensor amplifier and fiber optic cable*



*DRY fiber optic cable*



*WET fiber optic cable*



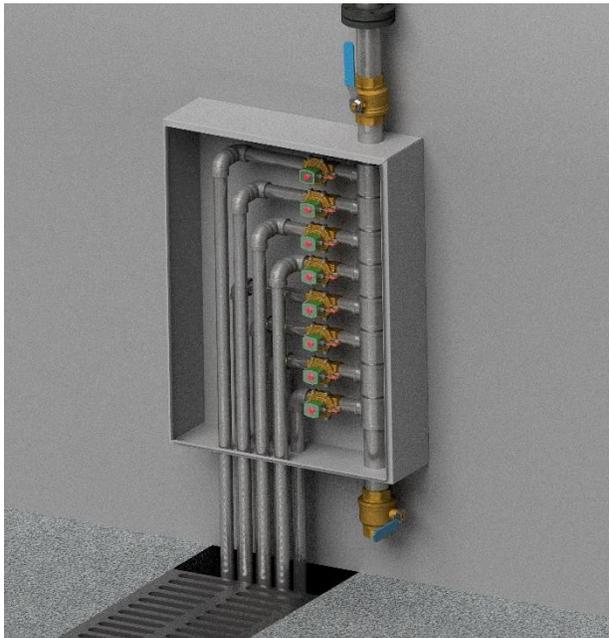
*Figure 12-1: Liquid detection sensor components and operations*

## 12.2. Solenoid Valves

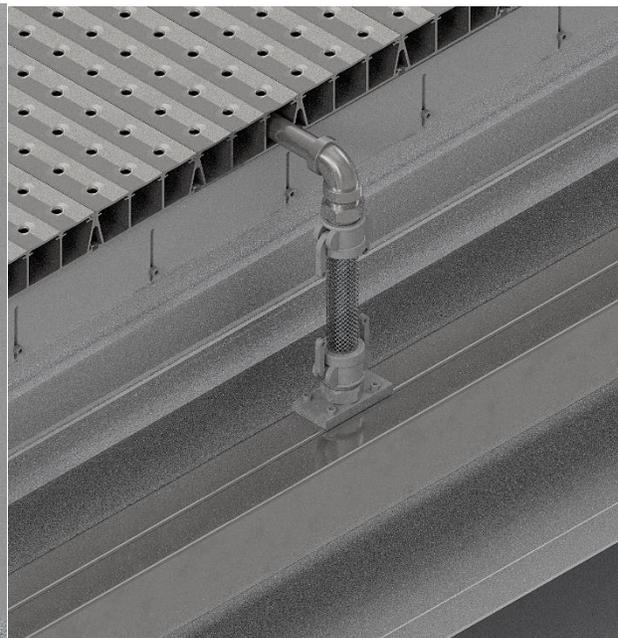
For each zone of the ILDFA, (1) solenoid valve is installed in a wall mounted valve cabinet near the end of a trench. A nominal 3" (DN80) water supply line is required to each valve cabinet. Within the valve cabinet, this water supply line branches off to each valve, and a nominal 1-1/2" (DN 40), schedule 40 pipe is routed from each valve to a pipe assembly within the ILDFA trench. Piping from the wall mounted cabinet to the ILDFA trench will typically require routing in a utility trench to prevent obstructions in the hangar.

Downstream of each valve, piping remains empty under normal conditions and is filled with water and pressurized only upon activation of the solenoid valve. Once the solenoid valve is closed, an automatic drain valve installed within the trench allows the piping run to drain for freeze protection. Solenoid valves fail-closed, so if a loss of power occurs, water is not supplied to all zones of the floor.

Figure 12-2 shows an example of a wall mounted valve cabinet with 8 zones. In this example the dimensions of the cabinet are 24" W (0.6 m) x 48" H (1.2 m) by 10" D (0.25 m). A utility trench with open grating is shown as an example for connection of piping from the cabinet to the ILDFA trench.



*Figure 12-3: Wall mounted valve cabinet serving 8 zones of ILDFA*



*Figure 12-2: Connection of in-trench piping to flushing manifold supply*

After entering the ILDFA trench, piping continues to the designated zone, where connections are made between the 1-1/2" (DN 40) pipe and additional piping that travels through the profile and supplies the flushing manifold installed at the opposite end of the floor.

## 13. Containment & Drainage

NFPA 409 (proposed 2026 Edition), FM Datasheet 7-93 (July 2022), and UFC 4-211-01 (Change 4) all provide guidance on the style of containment and drainage; however, each standard varies in its requirements. Regardless of style or size of tank, liquid containment must be located **outside** of the hangar.

A variety of options for containment are available and detailed further in *Section 13.3, Containment and Oil Water Separator Options*

### 13.1. Sizing Considerations – Containment Tank

When calculating the required size for a **containment tank**, first determine two critical criteria:

1. What is the applicable code or standard?
2. Are aircraft in the hangar considered large or small?

Applicable codes define small aircraft up to 78 ft (24 m) in length with a fuselage width of less than 13 ft (4 m).

For small aircraft, consider the total inboard fuel capacity as the largest potential spill volume.

For large aircraft, consider the single largest internal fuel cell size for the largest potential spill volume.

Table 13-1 provides containment tank sizing requirements based on UFC 4-211-01 (Change 4), NFPA 409 (proposed 2026 Edition), and FM Datasheet 7-93 (July 2022).

*Table 13-1: Containment Sizing Requirements*

	UFC 4-211-01	NFPA 409	FM 7-93
Worst-Case Scenario (WCS) Spill Volume	For small <sup>1</sup> aircraft: Total inboard fuel capacity For larger aircraft: Single largest internal fuel cell		
WCS Flushing Water	200 GPM (757 L/min)		
Sprinkler Water	N/A	Up to 600 GPM <sup>2</sup> (2,271 L/min)	600 GPM (2,271 L/min)
Event Duration	30 minutes	45 minutes	60 minutes
Safety Factor	10%	10%	N/A
Redundancy	100%	N/A	N/A

1. NFPA 409 Chapter 8.2.13.4.1 and FM Datasheet 7-93, Chapter 2.2.2.2 define small aircraft up to 78 ft (24 m) in length with a fuselage width of less than 13 ft (4 m)
2. See Section 13.4, Commentary on Sprinkler Flow Requirements

Figures 13-1, 13-2, and 13-3 provide example calculations for containment sizing following each code.

# EXAMPLE CALCULATION

USING UFC 4-211-01

<b>Largest Potential Spill</b>	Total Fuel Volume	2,750 gallons
<b>WCS Flushing Water</b>	200 GPM * 30 min	6,000 gallons
<b>Safety Factor</b>	8,750 gallons * 10%	875 gallons
<b>Redundancy</b>	9,625 gallons * 100%	9,625 gallons
<b>Containment Tank Volume</b>		<b>19,250 gallons</b>



Figure 13-1: Example calculation for containment sizing using UFC 4-211-01 (Change 4) for a hangar housing F-35 aircraft

# EXAMPLE CALCULATION

USING NFPA 409, 2026 Edition

<b>Largest Potential Spill</b>	Largest internal fuel cell	12,190 gallons
<b>WCS Flushing Water</b>	200 GPM * 45 min	9,000 gallons
<b>Sprinkler Water</b>	600 GPM * 45 min	27,000 gallons
<b>Safety Factor</b>	48,190 gallons * 10%	4,819 gallons
<b>Containment Tank Volume</b>		<b>53,009 gallons</b>

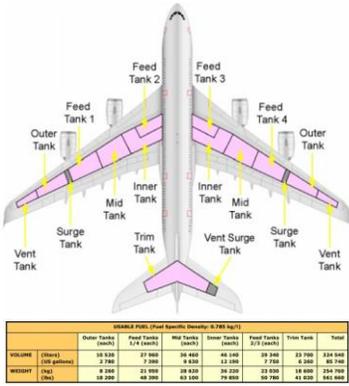


Figure 13-2: Example calculation for containment sizing using NFPA 409 (proposed 2026 Edition) for a hangar housing Airbus A380

# EXAMPLE CALCULATION

USING FM 7-93

<b>Largest Potential Spill</b>	Largest internal fuel cell	7,271 gallons
<b>WCS Flushing Water</b>	200 GPM * 60 min	12,000 gallons
<b>Sprinkler Water</b>	600 GPM * 60 min	36,000 gallons
<b>Safety Factor</b>	N/A	N/A
<b>Containment Tank Volume</b>		<b>55,300 gallons</b>

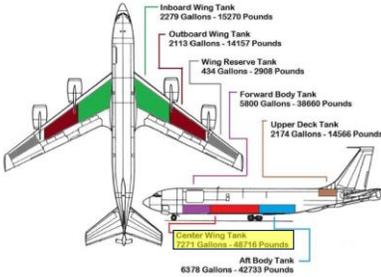


Figure 13-3: Example calculation for containment sizing using FM Datasheet 7-93 (July 2022) for a hangar housing KC-135 Stratotanker

### 13.2. Sizing Considerations – Oil Water Separator

When calculating the required flow rate for an **oil water separator**, first determine two critical criteria:

1. What is the applicable code or standard?
2. Are aircraft in the hangar considered large or small?

Applicable codes define small aircraft up to 78 ft (24 m) in length with a fuselage width of less than 13 ft (4 m).

For small aircraft, consider a fuel flow rate of 200 gpm (757 L/min).

For large aircraft, consider a fuel flow rate of 400 gpm (1514 L/min).

*Table 13-2: Oil Water Separator Sizing Requirements*

	UFC 4-211-01	NFPA 409	FM 7-93
Worst-Case Scenario (WCS) Spill Volume	For small <sup>1</sup> aircraft: 200 GPM (757 L/min) For larger aircraft: 400 GPM (1,514 L/min)		
WCS Flushing Water	200 GPM (757 L/min)		
Sprinkler Water	N/A	Up to 600 GPM (2,271 L/min)	600 GPM (2,271 L/min)

For sizing oil water separators, the calculation is simple. There are 4 possible sizes required:

*Table 13-3: Oil Water Separator Required Flow Rates*

	UFC 4-211-01	NFPA 409 or FM 7-93
Small Aircraft	400 GPM (1,514 L/min)	1,000 GPM (3,785 L/min)
Large Aircraft	600 GPM (2,271 L/min)	1,200 GPM (4,542 L/min)

## 13.3. Containment and Oil Water Separator Options

This section provides details on 7 different options for handling fuel water mixtures discharged from ILDFA installed in hangars. For all options, it is still necessary to follow the sizing considerations provided in Sections 13.1 and 13.2. For aboveground containment tanks, provide UL 142 compliant tanks. For underground containment tanks provide UL 1316 compliant tanks

### 13.3.1. Underground Containment Tank

**Overview:**

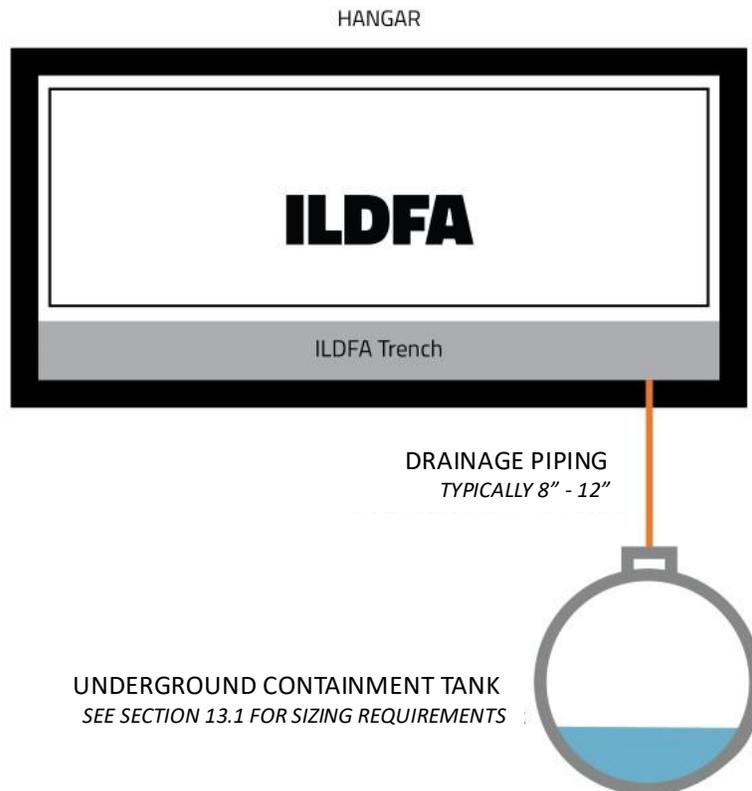
Drainage is routed underground from ILDFA in the hangar to an underground, UL 1316 compliant containment tank. Flow is driven by gravity and containment tank is sized for the full volume calculated in Section 13.1.

**Pros:**

- Straightforward hydraulic design and flow management
- ILDFA not dependent on discharge pump

**Cons:**

- Additional excavation and installation costs
- Requires regular emptying and hauling
- PFAS-contaminated soil from legacy AFFF use may require expensive remediation
- High groundwater or unstable soils may prevent underground tank installation



## 13.3.2. Underground Oil-Water Separator

### Overview:

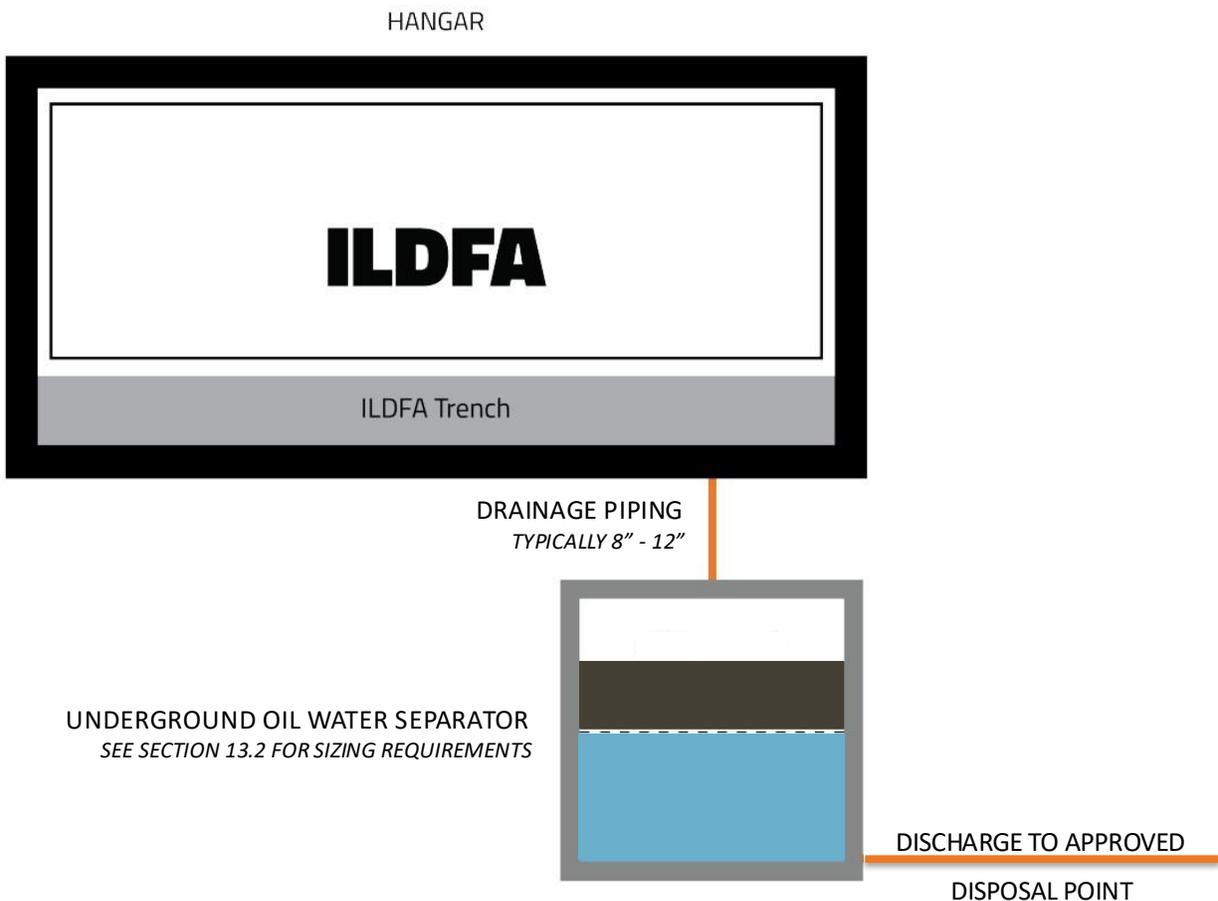
Drainage is routed underground from ILDFA in the hangar to an underground Oil Water Separator. Flow is driven by gravity and OWS is sized for flow rates calculated in Section 13.2.

### Pros:

- No haul off of contaminated water required
- ILDFA not dependent on discharge pump

### Cons:

- Increased cost and complexity of underground install (excavation, PFAS, site conditions)
- System reliability depends heavily on proactive maintenance
- Requires ongoing compliance testing



## 13.3.3. Hybrid System – Small OWS + Overflow Tank

### Overview:

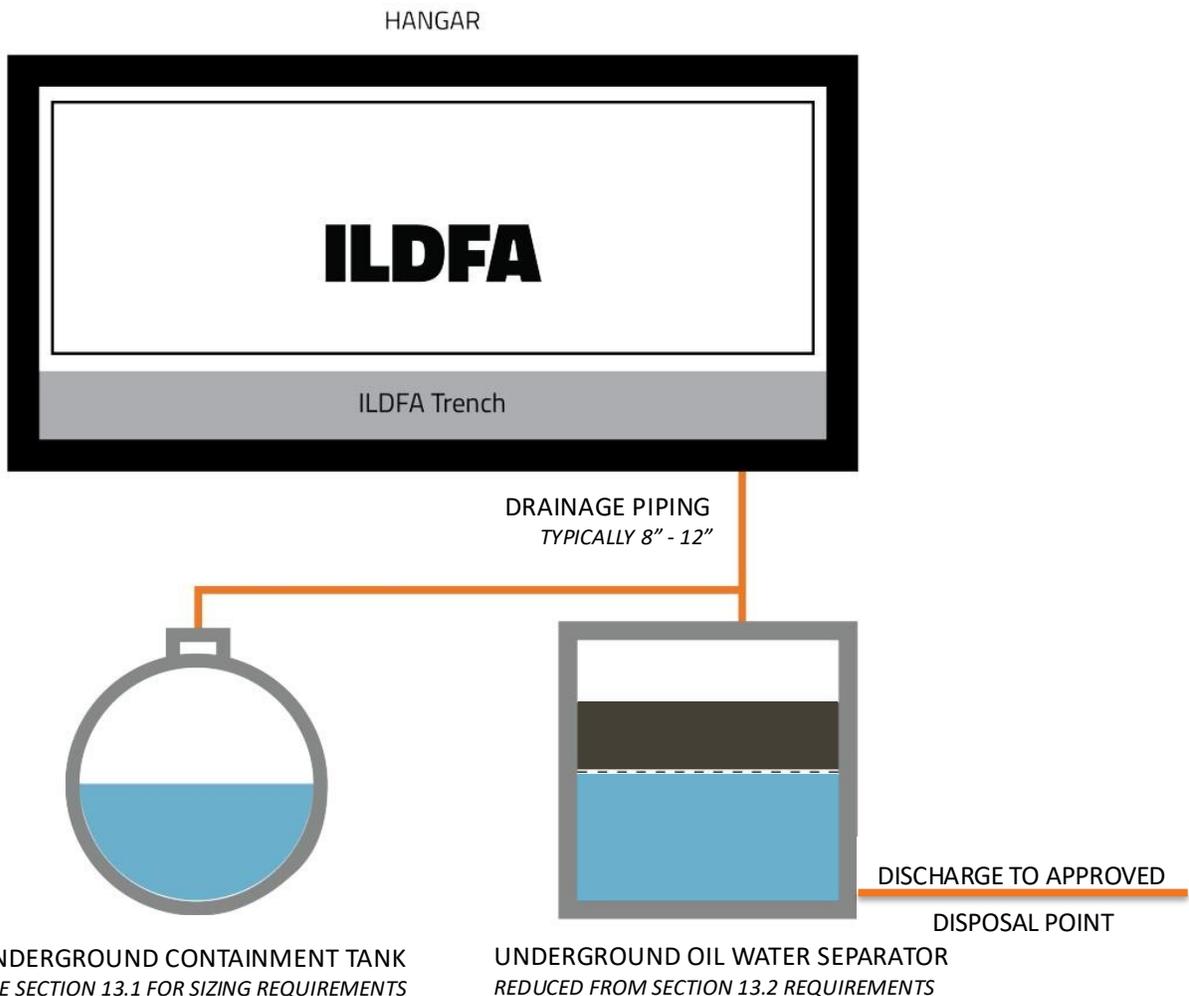
Day-to-day discharge from ILDFA flows through underground piping to a small Oil Water Separator. Overflow from large spills are routed to an underground containment tank. OWS is a low-cost unit, sized for routine activity, while Overflow Tank is sized for major spill events.

### Pros:

- Reduced cost for smaller OWS
- Reduces likelihood of filling tank and causing delays to operations
- Reduces required haul-off of contaminated water

### Cons:

- Increased cost and complexity of underground install (excavation, PFAS, site conditions)
- Requires both OWS and containment tank
- Requires additional design for overflow/diverter valve



## 13.3.4. Above-Ground Containment Tank Only

### Overview:

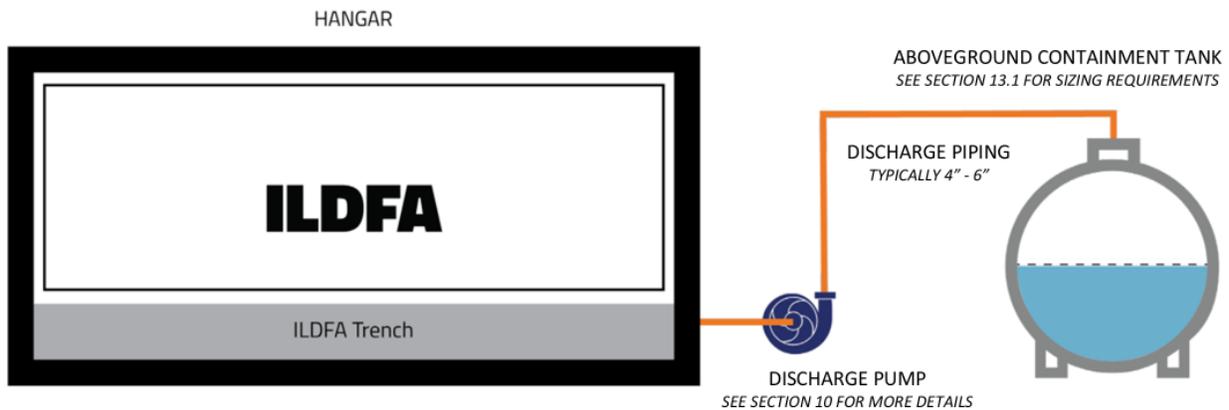
ILDFA discharge is pumped to a dedicated above-ground containment tank, which holds the entire volume as calculated in Section 13.1. No treatment occurs during the event, only containment.

### Pros:

- Simplified system
- No excavation required
- Accessible for visual inspection and regular maintenance
- Can be modular and relocated if needed

### Cons:

- Dependent on haul off or testing for disposal
- Occupies additional space outside hangar
- Hangar use may be delayed while containment tanks are emptied/tested



## 13.3.5. Above-Ground Containment Tank + Safespill OWS Package

### Overview:

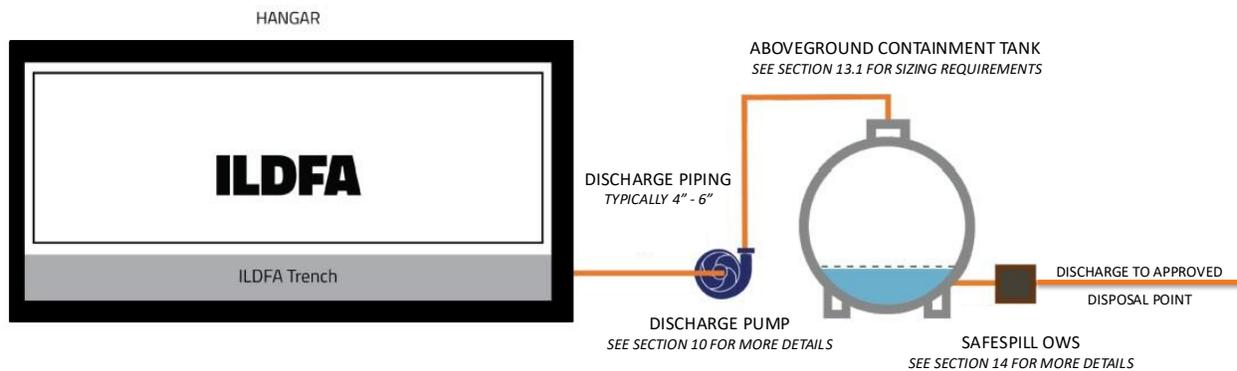
ILDFA discharge is pumped to a dedicated above-ground containment tank, which holds the entire volume as calculated in Section 13.1. After a spill, a Safespill OWS skid treats the collected fluid. For more details on the Safespill OWS, see Section 14.

### Pros:

- Maintenance-friendly above-ground layout
- Effective low-flow rate treatment for post-spill operations
- No treatment required during peak flow
- Water discharged from Safespill OWS contains <10 ppm hydrocarbons, meeting most regulatory thresholds for direct disposal

### Cons:

- Occupies additional space outside hangar
- Requires OWS maintenance



## 13.3.6. Closed-Loop Recycle Tank Integration

### Overview:

Enhances Option 5 by recycling water from Safespill OWS to a flushing water recycle tank, enabling 100% reuse of discharged water.

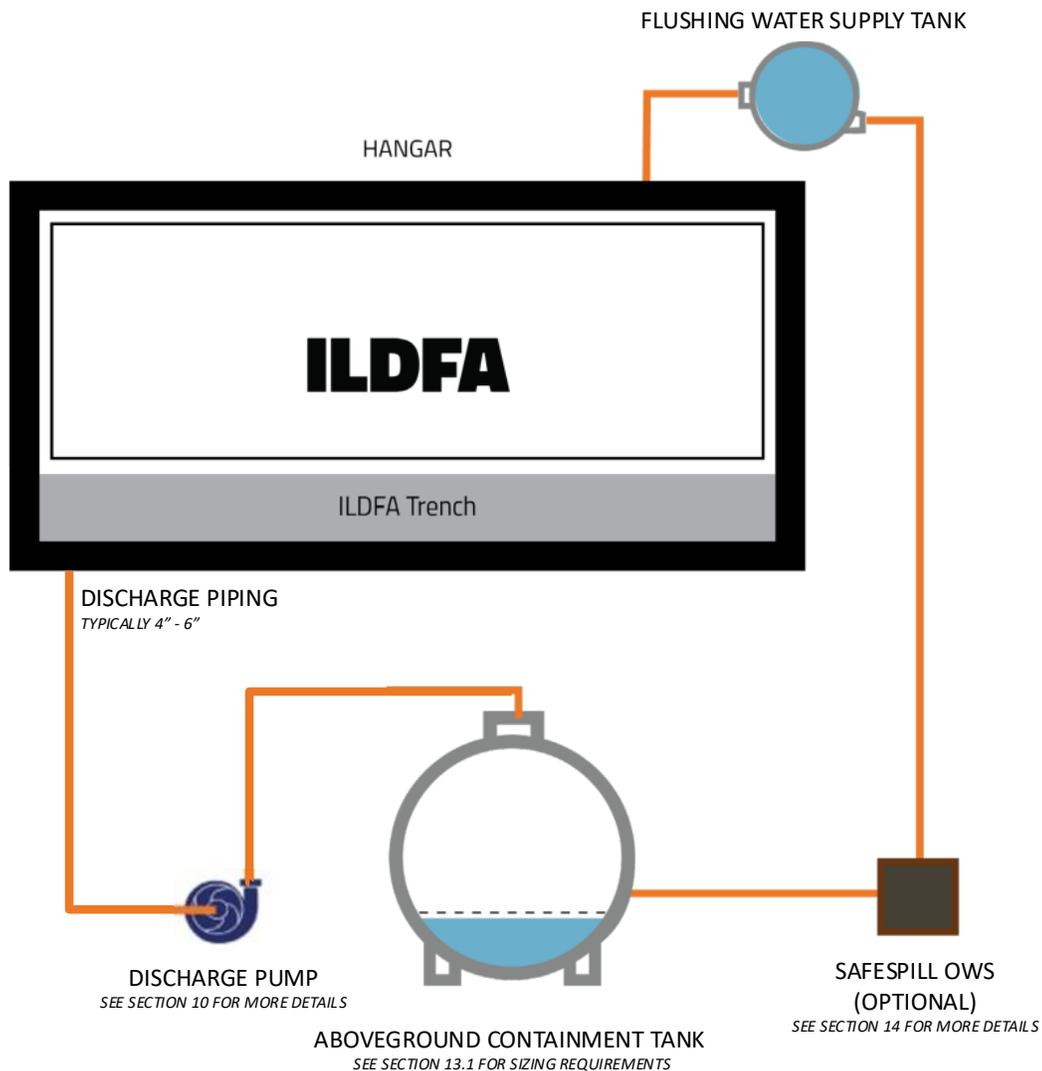
Flushing water tank sizes: UFC 4-211-01 (6,000 gal), NFPA 409 (9,000 gal), FM 7-93 (12,000 gal).

### Pros:

- Supports sustainability goals and may contribute to LEED certification
- Reduces long-term water use

### Cons:

- Higher complexity and installation cost
- Requires ongoing maintenance and compliance testing



## 13.3.7. Hybrid Above-Ground Tank + Overflow Containment

### Overview:

Minimum sized, 15,000 gallons (57,000 liters), above-ground containment tank captures day-to-day ILDFA discharge. Optional Safespill OWS package can treat tank contents.

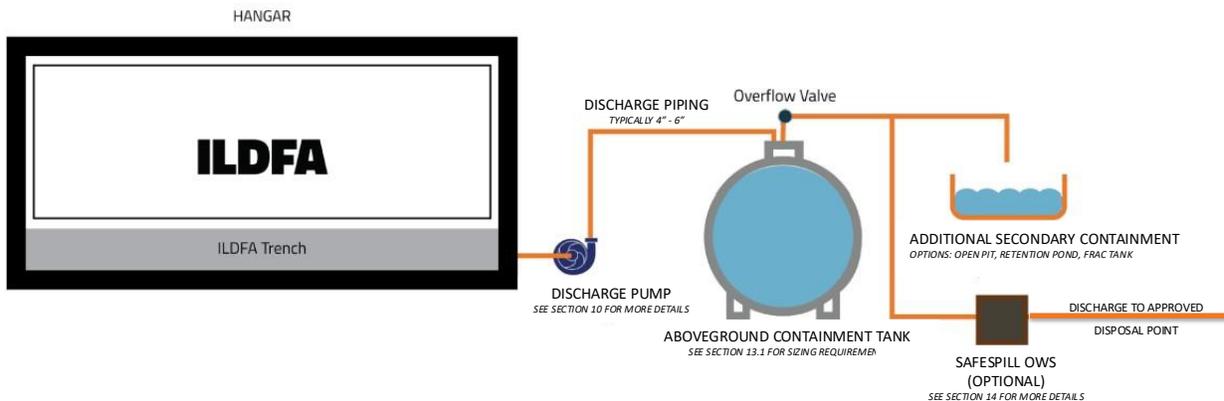
Overflow from above-ground containment tank is routed to additional external containment, such as an open pit, pond, or frac tanks. Overflow valve diverts flow when tank reaches capacity.

### Pros:

- Cost-effective balance between routine and worst-case containment
- Eliminates need for large-capacity primary tank or underground systems
- Leverages existing pumping infrastructure
- Modular and adaptable for various site layouts
- Optional OWS unit improves compliance for recurring spills

### Cons:

- Multiple components require coordination and space
- Overflow areas must be protected, engineered, and inspected regularly
- Dependent on multiple mechanical systems (discharge pumps and valves)
- OWS unit still requires maintenance and monitoring



## 13.4. Commentary on Sprinkler Flow Requirements

In the NFPA 409 (2022 edition), the required drainage rate capacity of ILDFA was written as follows:

### **“8.2.13.4**

The floor assembly shall have a drainage rate that is greater than 110 percent of the total anticipated fuel discharge rate, plus an allowance for the required sprinkler flow.”

This language was considered vague as “an allowance for the required sprinkler flow” does not clearly specify whether the allowance is meant to consider the entire area of the hangar, the entire area of the ILDFA, or the design fire size.

During the 2026 revision cycle for NFPA 409, the technical committee agreed to modify this section to clarify that the ILDFA must account for flushing water, sprinkler water, and fuel flow. However, the committee agreed that only a portion of the required sprinkler water flow is intended to be included in the calculation and chose to align requirements in NFPA 409 with the requirements of FM Datasheet 7-93 which limits the maximum required sprinkler flow rate to 600 gpm (2,271 L/min). The revised language, to be included in the 2026 edition of NFPA 409 is provided below:

### **“7.5.14.4**

The floor assembly shall have a drainage rate that is greater than 110 percent of the total expected flow and includes all of the following:

- (1) The total anticipated fuel discharge rate
- (2) The anticipated flushing water rate
- (3) An allowance for the required sprinkler flow rate not to exceed 600 gpm (2,271 L/min)”

## 14. Safespill OWS (Oil Water Separator) Skid

Due to the use of water as a flushing medium, water will mix with spilled fuel within the containment tank. To minimize the frequency of tank emptying and reduce remediation costs, an Oil Water Separator (OWS) Skid can be included with the ILDFA package.

The OWS Skid operates independently from the ILDFA hangar control panel and can process the containment tank's liquid contents either manually or automatically following a spill event. The system separates hydrocarbons from water, discharging treated water to an approved disposal point and collecting recovered oil for proper disposal.

Each OWS Skid is fully enclosed with a footprint of 8 ft × 10 ft (2.5 m × 3.0 m). The maximum operating weight is 15,000 lb (6,800 kg) when all internal tanks are filled. Electrical power requirements include a 120 VAC, 25 A connection to the OWS control panel, which provides power to onboard pumps and motor starters.

The standard configuration includes all of the following:

- **Oil Water Separator:** Maximum inlet flow rate of 10 GPM (40 L/min).
- **Activated Carbon Filter:** Removes residual hydrocarbons to achieve treated water quality of <5 mg/L total petroleum hydrocarbons (TPH).
- **Oil Storage Tank:**
  - Capacity: 500 gal (1,900 L)
  - Fitted with a level sensor to alert the operator when full.
  - Includes a tank-mounted fuel pump for emptying to a disposal vessel.
- **Control Panel:**
  - Houses motor starters for onboard pumps
  - Displays oil tank level, inlet flow rate, and outlet flow rate
  - Designed for local control, independent from the ILDFA system.

### Optional Components and Configurations

Depending on project scope, environmental requirements, or end-user preference, the OWS Skid can be provided with additional or alternative features such as:

- **Automated fluid transfer** from the containment tank (continuous or on-demand mode).
- **Remote monitoring capability** or integration with facility supervisory systems.
- **Secondary containment basin** for additional environmental protection.
- **Heaters or insulation** for cold-weather installations.
- **Sample ports** for water-quality verification.

The end user, Authority Having Jurisdiction (AHJ), or local environmental authority is responsible for determining whether the treated water can be discharged to the sanitary or storm system, or recycled back to the ILDFA water supply tank. The hangar operator is responsible for periodic emptying of the oil storage tank and replacement of the carbon filter as needed.

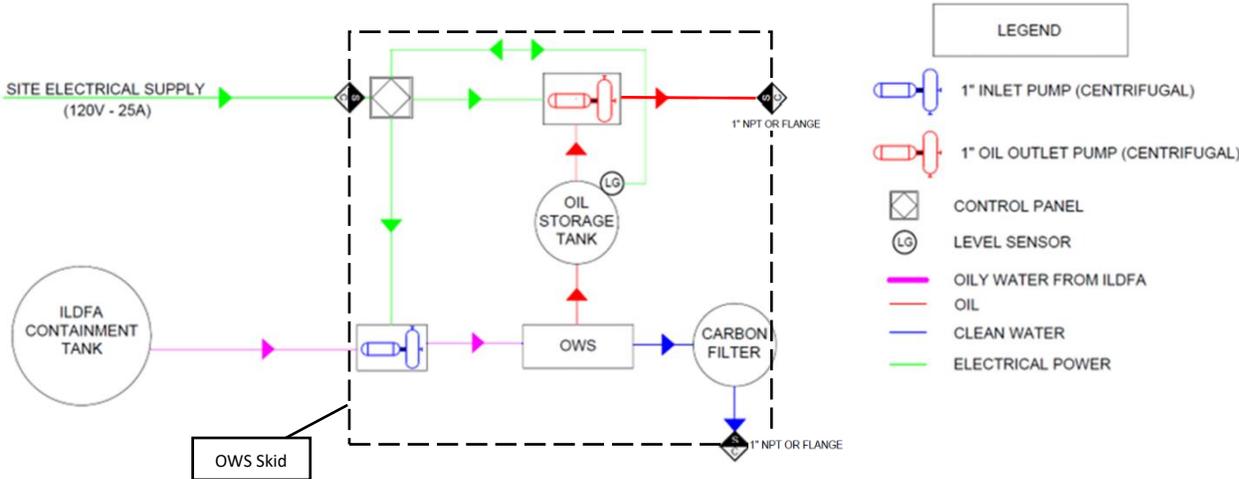


Figure 14-1: P&ID of Safespill OWS (Oil Water Separator) Skid



Figure 14-2: OWS skid external side view next to containment tank (left) and end view with control panel (right)

# 15. Pre-Conditioned Air (PCA)

The installation of the Safespill ILDFA is compatible with hangars using pre-conditioned air (PCA) trenches. The following design has been submitted and approved by NAVFAC.

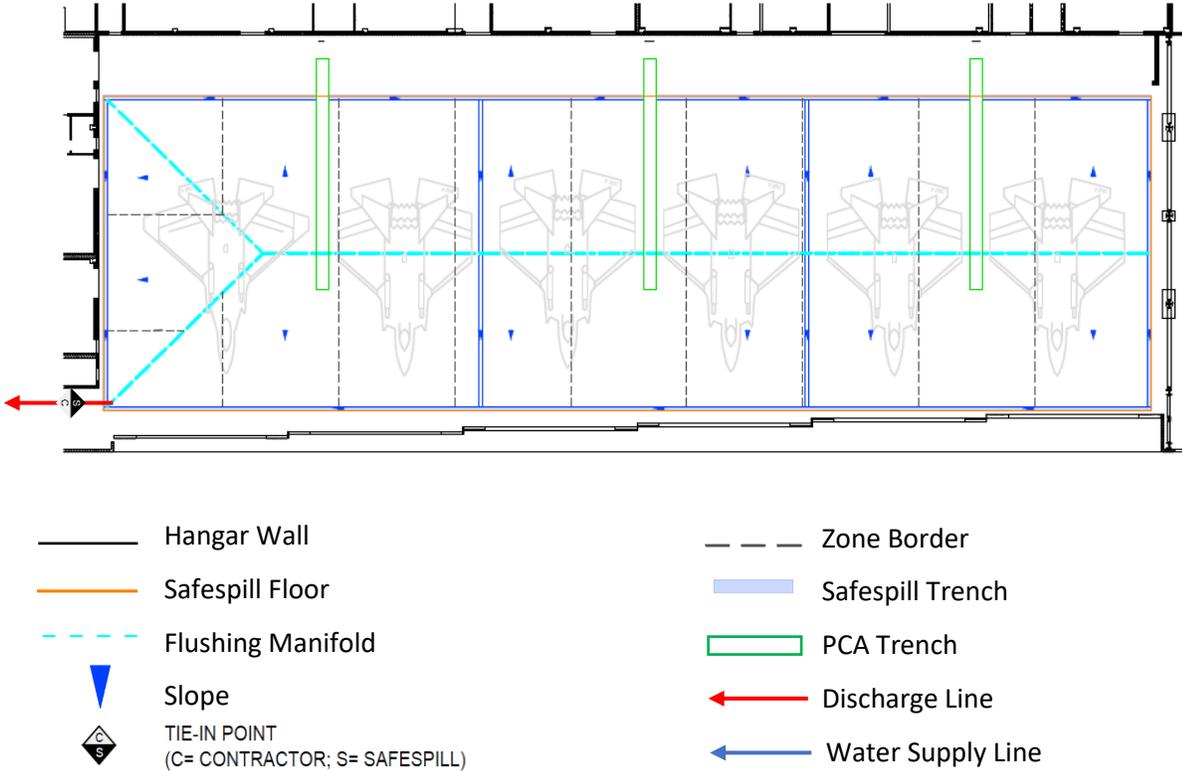


Figure 15-1: Approved layout for ILDFA in hangars using PCA trenches

In this design, there is no intersection between PCA trenches and ILDFA trenches. Air ducts do not enter the ILDFA trenches and no liquid from the ILDFA will enter PCA trenches. PCA trenches are fully isolated from ILDFA trenches.

PCA trenches begin near the back wall of the hangar and travel below the floor profiles of the ILDFA. ILDFA trenches always slope away from PCA trenches.

## 16. Overhead Sprinkler System

When an ILDFA is installed, it is still necessary to provide a sprinkler system in the hangar as required by NFPA 409, FM Datasheet 7-93, UFC 4-211-01, or local authority. The sprinkler system is necessary to protect the hangar against fires other than hydrocarbon-based fires.

Live, full-scale fire testing indicates that if an ignitable liquid fire occurs in a hangar with an ILDFA installed, it is extremely unlikely that closed head sprinklers will activate based on reductions in spill size and heat release rate.

See the test report here: [https://safespill.com/wp-content/uploads/2023/11/NFPA\\_409-Test-Report\\_Safespill\\_Web.pdf](https://safespill.com/wp-content/uploads/2023/11/NFPA_409-Test-Report_Safespill_Web.pdf)

An excerpt from the attached report:

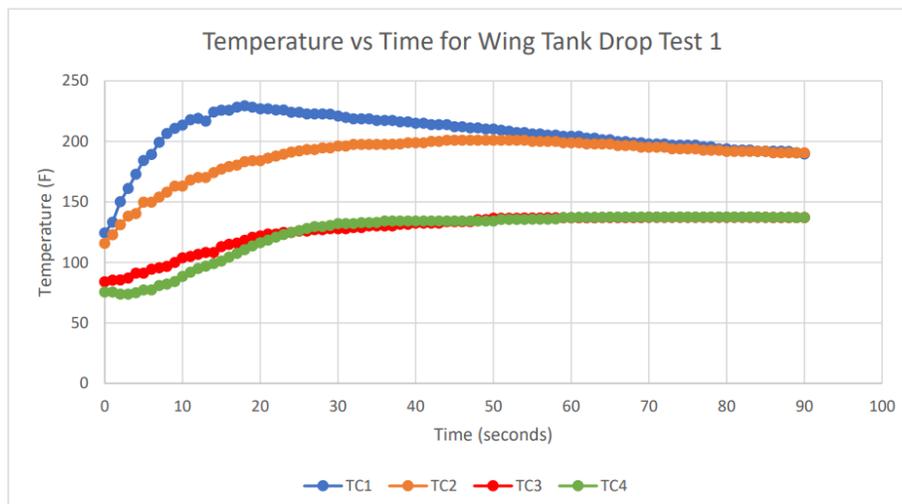
“When closed-head water sprinkler systems are used, NFPA 409 requires the use of quick-response sprinklers with a temperature rating of 175°F for Group I hangars, with equivalent or higher temperature sprinklers required for other hangar groups and areas with high ambient temperatures.

Although ceiling height may vary depending on the aircraft housed in the facility, typical hangar ceilings are more than 12 meters (40 feet) high, which is much higher than the (7.5 meter) 25-foot ceiling in the Safespill testing facility. NFPA 409 requires a maximum sprinkler spacing of 3.7 meters (12 feet).

During testing, adjacent thermocouples were placed 2 meters (6.5 feet) from the origin of the fire and temperatures observed, even at just 4 meters from the floor assembly surface, rarely exceeded 175°F.

Based on results from testing, it is reasonable to conclude the following:

- (1) Only sprinklers installed in hangars with ceilings lower than 9 meters (30 feet) are likely to activate
- (2) In hangars that meet criteria (1), only sprinklers directly above the origin of the fire are likely to activate. Adjacent sprinklers are unlikely to activate.”



## 17. Optical Flame Detectors

UFC 4-211-01 requires the installation of Triple Infrared (IR) Optical Flame Detectors in hangars where ILDFA is installed. Optical flame detectors are utilized to detect fires within the hangar, while ILDFA detects liquid spills. Flame detection activates the FACP alarm, while ILDFA liquid detection activates the FACP supervisory.

Due to concerns related to the reflectiveness of ILDFA, Det-Tronics conducted flame detector testing on an ILDFA on December 13, 2021 at the ILDFA manufacturing facility in Houston, TX on a sunny day. The results concluded that the flame detector is not affected by the matte finish of the ILDFA and exhibits less reflection than a typical gloss-finish epoxy floor. The Det-Tronics Flame Detector Testing report can be found [Safespill.com/Det-Tronics-Flame-Detector-Safespill-Testing](https://safespill.com/Det-Tronics-Flame-Detector-Safespill-Testing).



Figure 17-1: Flame detector testing was conducted on the ILDFA shown.

## 18. Water Supply for Cold-Weather Environments

The ILDFA’s flushing manifolds require water supply, which is typically wet pipe up to the wall mounted valves as described in 12.2. While the piping within the ILDFA trenches remains empty under normal conditions, the supply piping from the pump room to the valve cabinets inside the hangar may, in some installations, be routed through areas subject to freezing temperatures. In such cases, additional design measures should be incorporated to ensure the water supply remains freeze-protected.

Where piping cannot be located entirely within a conditioned space, a motor-operated, electrically controlled supply valve may be installed upstream of the solenoid valve cabinet to isolate the supply during standby conditions. As described in 12.2, each zone includes an automatic drain valve located at the lowest point of the line, which allows residual water to discharge into the ILDFA trench and be removed in the same manner as any other collected liquid.

Automatic drain valves are intended to provide freeze protection by allowing the supply piping to drain after operation; however, small amounts of residual water may remain in low points or fittings. These traces of water do not compromise freeze protection.

If a spill occurs, the upstream supply valve and the solenoid valve(s) for the affected zone(s) open simultaneously to provide flushing water to the ILDFA.

As an alternative to the use of an additional upstream supply valve and drain configuration, heat tracing may be used to maintain freeze protection along exposed sections of supply piping.

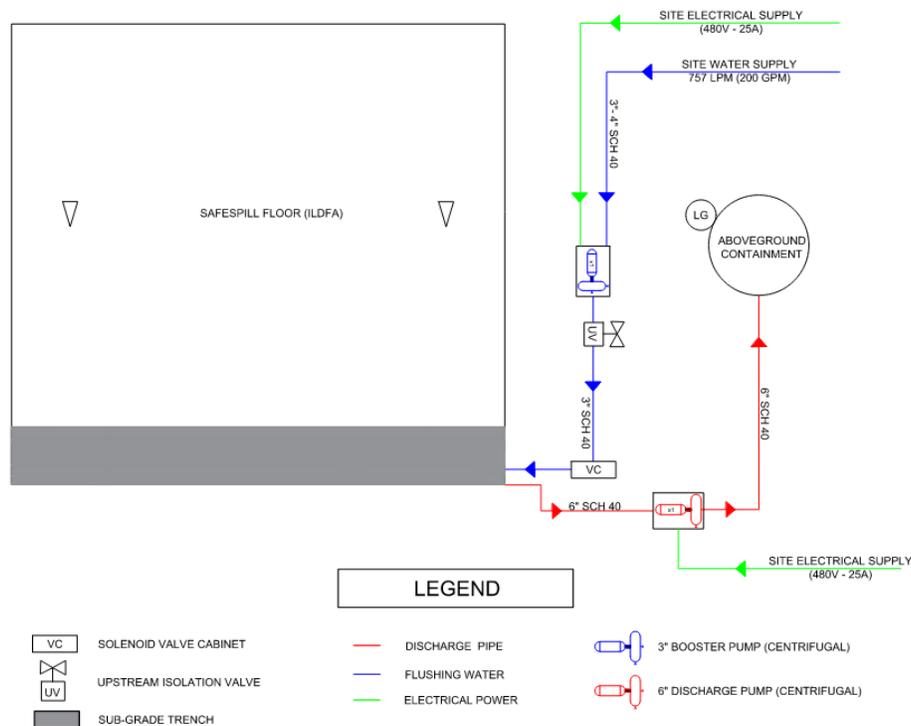


Figure 18-1: Simplified P&ID of ILDFA with addition of upstream isolation valve for freeze protection

## 19. In-Slab Heating Compatibility

ILDFA has been successfully installed in multiple hangars incorporating in-slab radiant heating systems with glycol or water tubing. This heating method is commonly employed in cold climates to prevent freezing within hangars and to maintain a comfortable working environment for personnel.



*Figure 19-1: Radiant in-slab heating system for hangar utilizing ILDFA*

In these systems, heated fluid circulates through piping embedded in the concrete slab beneath the ILDFA. Heat is conducted through the concrete and emerges at the surface, where it radiates into the occupied space.

When ILDFA profiles, constructed from highly conductive aluminum, are placed on top of the heated slab, they act as an extended thermal surface. The aluminum rapidly absorbs heat from the underlying concrete and redistributes it laterally, evening out surface temperature variations caused by discrete tubing locations. This effect provides a more uniform radiant output across the floor area, reducing cold spots and creating a more consistent thermal environment for aircraft and personnel.

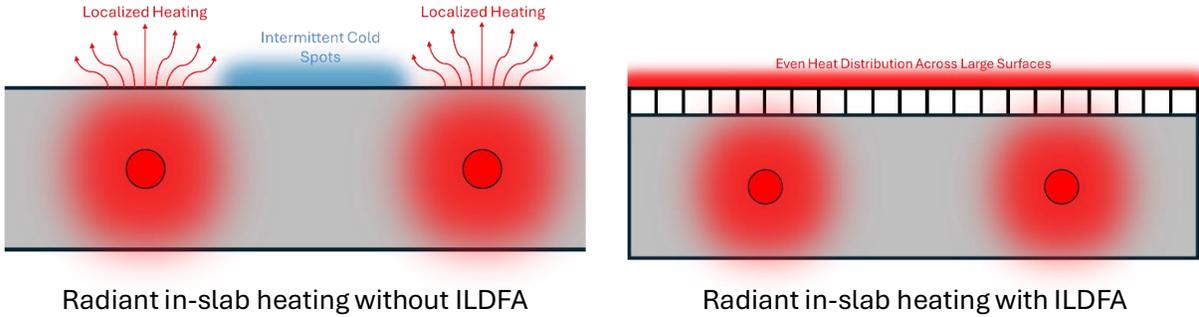


Figure 19-2: Comparing radiant in-slab heating with and without ILDFA

Although the aluminum introduces an additional layer above the slab, which may slightly delay the initial response time of the heating system, the overall outcome is improved heat transfer efficiency and better comfort conditions. The aluminum profiles effectively function as heat-spreading fins, increasing the effective heat exchange surface area and smoothing the delivery of radiant energy into the hangar.

## 20. Conclusion

This document is intended to serve as a reference guide for the preliminary design of Ignitable Liquid Drainage Floor Assemblies (ILDFA) in aircraft hangars. While it provides general guidance to assist Architects and Engineers during early project stages, it should not be used as a substitute for project-specific consultation. Each hangar presents unique challenges, and final design decisions must be coordinated directly with Safespill to ensure compliance with applicable codes, best practices, and the most current installation standards.

For the most recent version of this document and additional technical resources, please visit:

<https://safespill.com/technical-specs-resources/>.

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