

SAFESPILL

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

**Version 5.0
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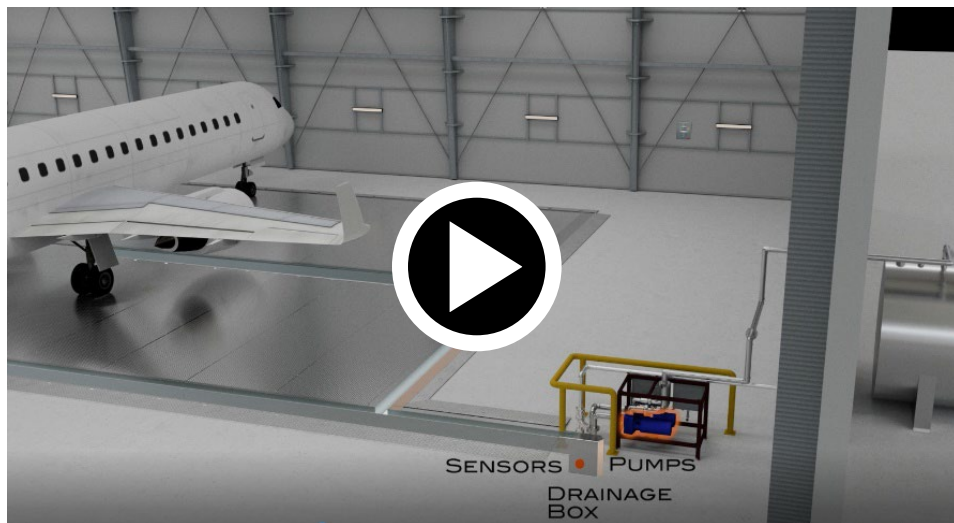
1. Scope of Document

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 of detailed input by the ILDFA manufacturer.

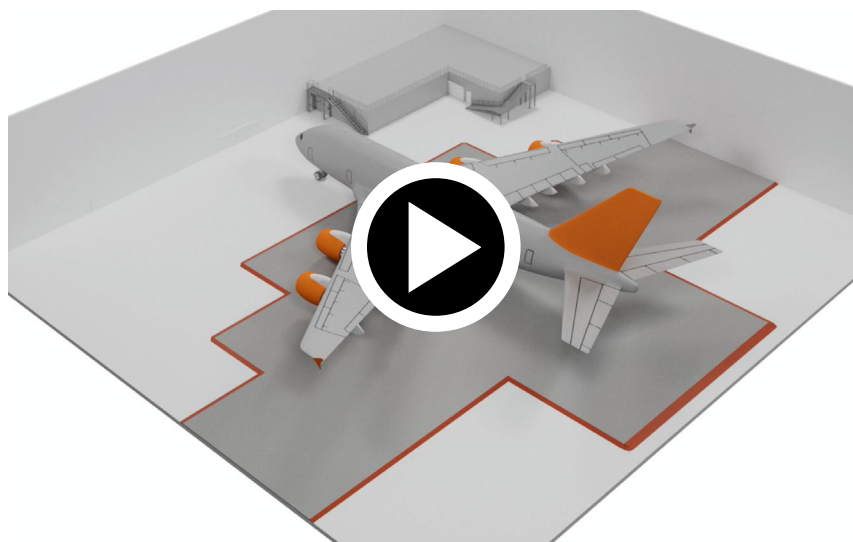
ILDFA is a new technology; therefore, best practices, installation, and manufacturing improvements continuously evolve. Please check for the latest version of the document at [Safespill.com/Safespill-Design-Guideline](https://safespill.com/Safespill-Design-Guideline).

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 directed by the local authority). In the event the spill is ignited, the ILDFA will rapidly control and extinguish the ignitable liquid fuel fire.

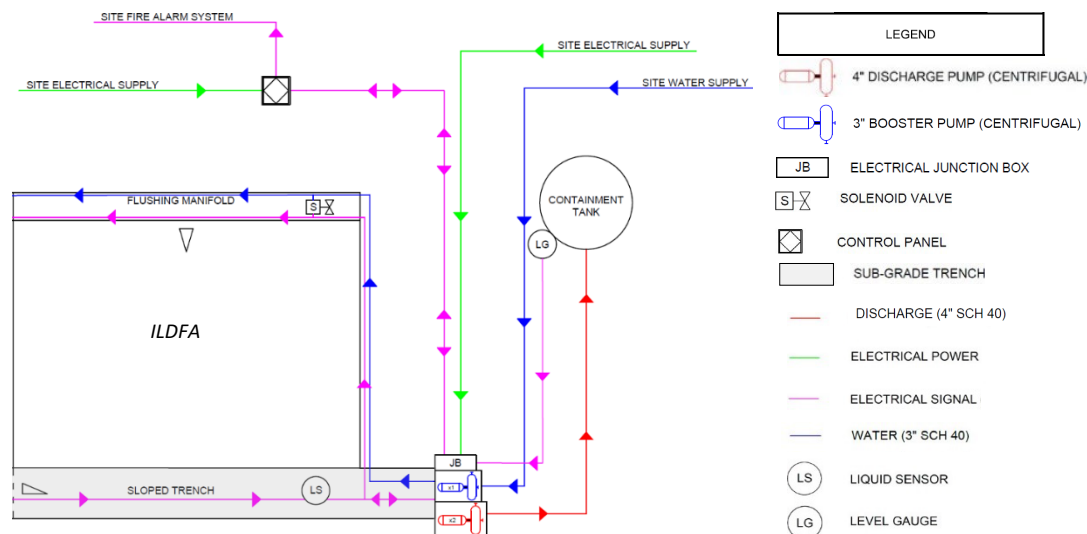
One application of an ILDFA is for Class B (fuel) fire protection inside an aircraft hangar, which is accepted under NFPA 409 2022 Edition for Group 1 & 2 hangars in combination with an overhead sprinkler system. ILDFAs are approved under FM Approval Standard 6090 and are the preferred method of fire 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 various ILDFAs in use today. In July 2023, NAVFAC released Interim Technical Guidance Fiscal Year 2023-02.1 (ITG FY23-02.1) to provide guidance on the installation of ILDFA in retrofit and new build hangars.

In additional, the U.S. Air Force Civil Engineer Center (AFCEC) has independently verified fire test performance of the ILDFA.

3. Piping and Instrumentation

An ILDFA is divided into zones with a maximum area of 1,240 ft² (115 m²) each. Each zone has its own solenoid valve, fiber optic liquid detector sensors, and flushing manifold, as shown in Figure 3-1.



When a spill occurs, only the flushing manifold dedicated to that zone will activate. Each flushing manifold requires 50 gallons per minute (GPM) (189 liters per minute) of flushing water. In a worst-case scenario, as shown in Figure 3-2, a spill may occur across multiple zones activating adjacent zones in both x and y direction. Up to 4 zones (Zones 1, 2, 6, and 7 in Figure 3-2) could detect a spill and activate all 4 flushing manifolds. In this case, 4 x 50 GPM (189 LPM) will require 200 GPM (757 LPM) as the worst-case scenario.

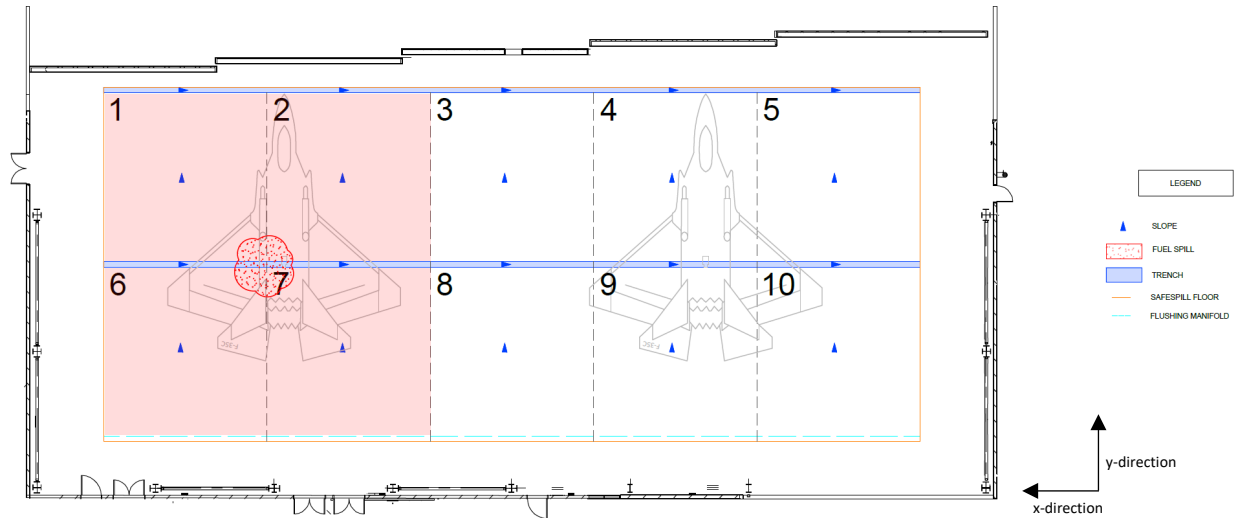


Figure 3-2: ILDFA layout drawing showing 4 zones activated by spill at intersection of 4 zones

The tie-in points represent what a third-party contractor will be responsible for in Figure 3-3. The ILDFA manufacturer can include this in the scope of supply upon request.

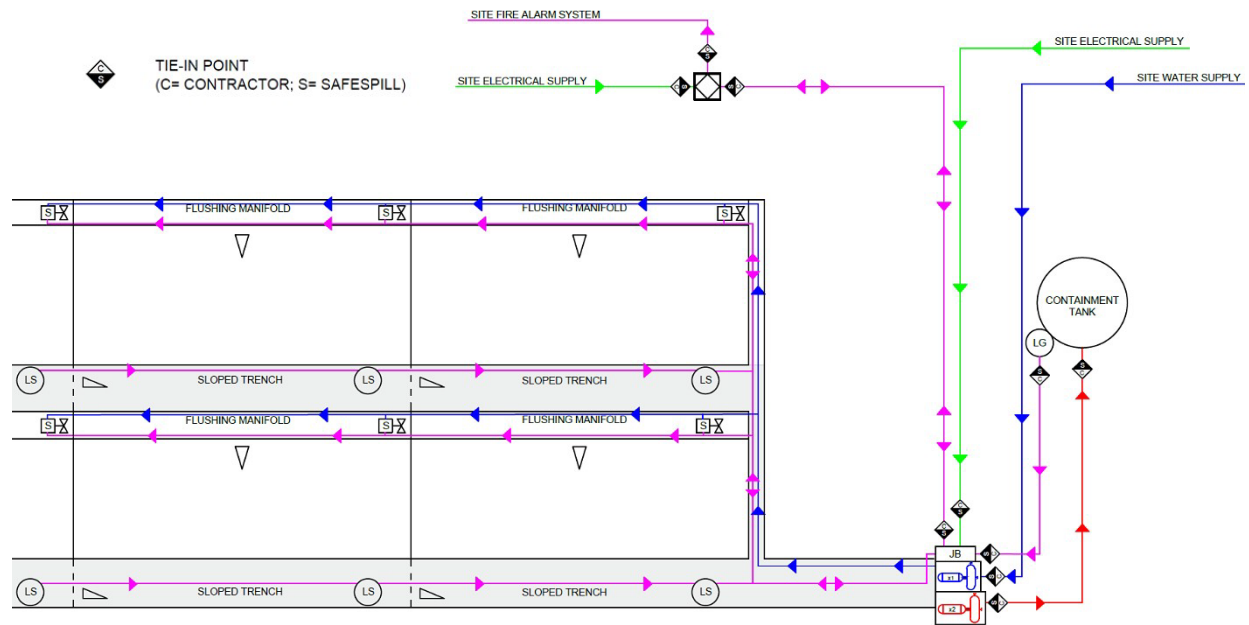


Figure 3-3: Simplified ILDFA P&ID of multiple zones

4. Hangar Coverage

A wall-to-wall coverage of the hangar floor will provide the greatest flexibility in an aircraft parking layout. For all ILDFA installations following NAVFAC ITGFY23-02.1, wall-to-wall layouts should be utilized to the maximum practical extent.

The ILDFA may be able to be offset from the wall if there are aircraft hangar bay clearance requirements established by the owner, i.e., 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.

In a designated aircraft parking scenario, a 16 ft (4.9 m) to 18 ft (5.5 m) radius should be drawn from the outer edge of any potential area containing fuel in the aircraft, such as fuel tanks and engines as shown in Figures 4-1 and 4-2. The spill radius requirement is based on the largest lateral distance of a potential spill set by the flow rate.

When considering a worst-case scenario spill for smaller aircraft, a 16 ft (4.9 m) lateral distance set by a flow rate of 200 GPM (757 LPM) is required. A worst-case scenario for larger aircraft requires an 18 ft (5.5 m) lateral distance set by a flow rate of 400 GPM (1,514 LPM). This ensures that all spilled liquid will land on the ILDFA. NFPA 409, Chapter 8.2.13.4.1 and FM Datasheet 7-93, Section 2.2.2.2 both explain the aircraft size to accurately determine whether a 200 GPM (757 LPM) or 400 GPM (1,514 LPM) spill rate needs to be used for calculations.

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

4.1. Flooring Layouts

Three examples of an ILDFA hangar coverage are shown. In Figure 4-1 a parking spot configuration with 200 GPM (757 LPM) spill. In Figure 4-2, a wall-to wall ILDFA for a 400 GPM (1,514 LPM) spill. In Figure 4-3, a parking spot configuration for a 400 GPM (1,514 LPM) spill.

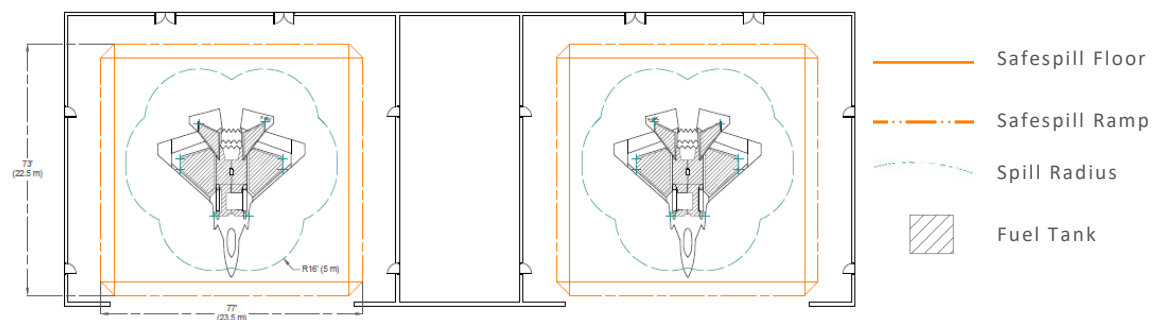


Figure 4-1: Example of a two-bay F-35C hangar with an ILDFA fixed to the spill radius

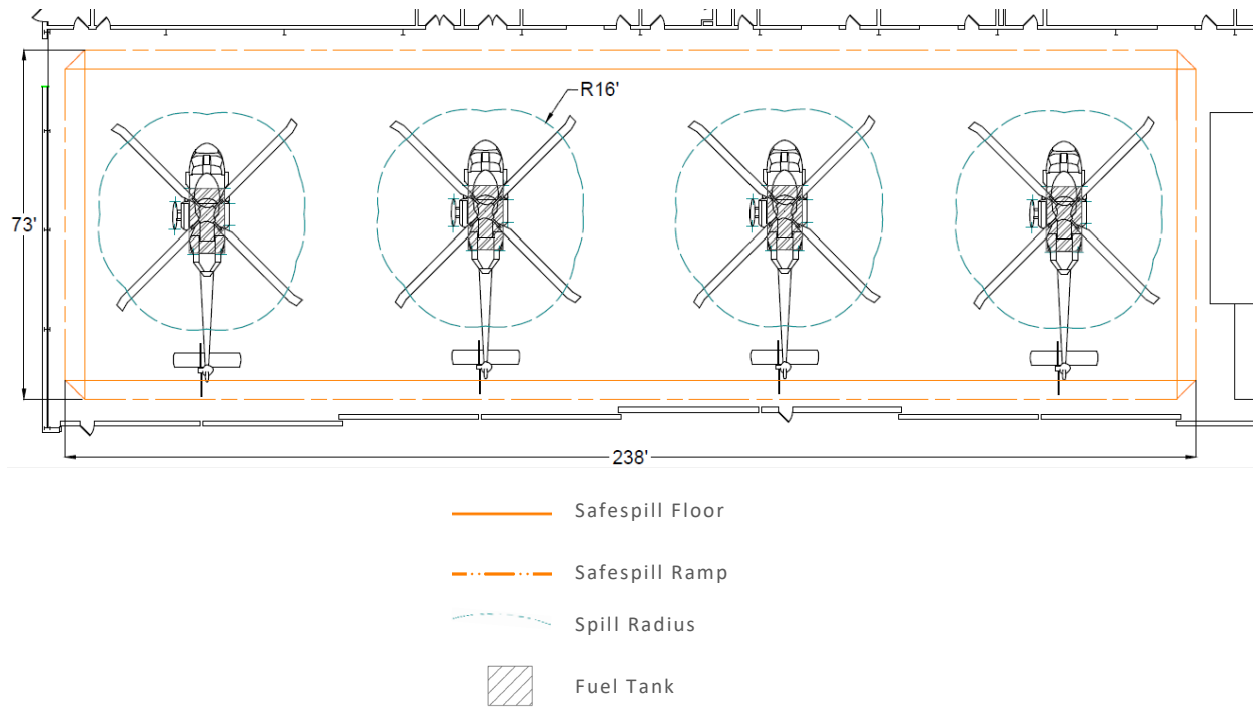


Figure 4-2: Example of a MH-60T Jayhawk hangar designed wall-to-wall, per NAVFAC ITGFI23-02.1

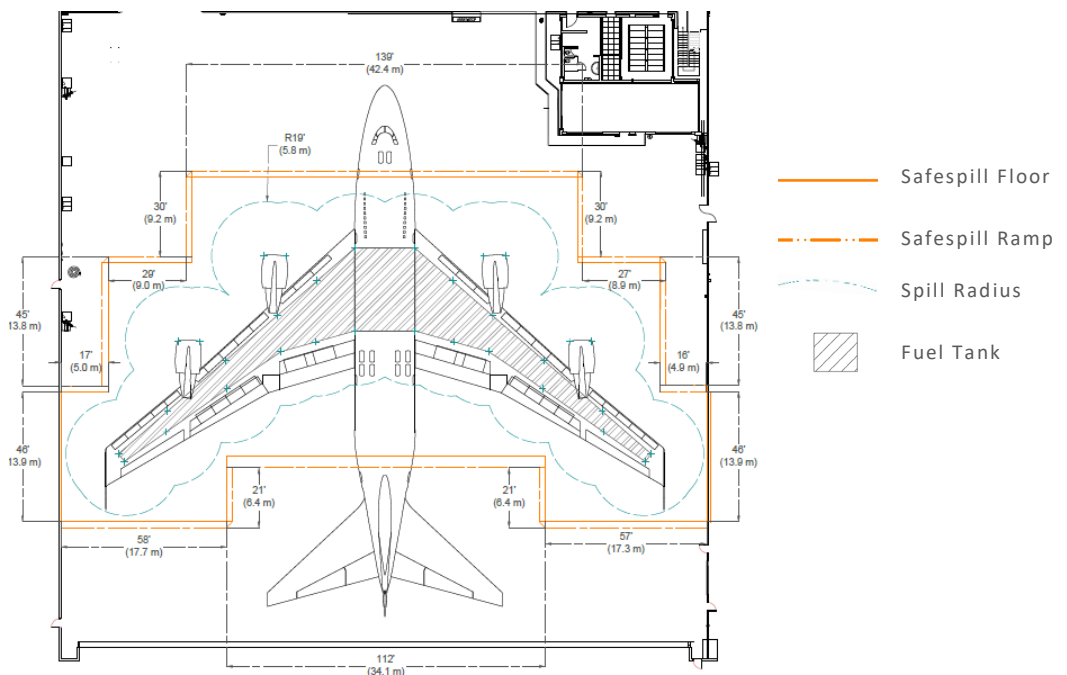


Figure 4-3: Example of a Boeing 747-SP hangar designed with a reduced ILDFA only covering potential spill areas

4.2. Trench Spacing

The spacing of trenches is based on the following:

ILDFA sections can be manufactured in lengths up to 39.37 ft (12 m). They are directly installed on the concrete slab and connected to a corresponding trench that is 12 inches (305 mm) wide. This means that the maximum spacing of the trenches needs to be 40.37 ft (12.3 m) from the center of each trench.

To reduce production costs, the number of trenches should be minimized and ILDFA sections can be manufactured at different lengths to achieve even spacing of trenches.

E.g., A 100 ft (30.5 m) deep hangar will require a minimum of three trenches.

These trenches should be evenly spaced at 33.33 ft (10.2 m) and a third trench at the remaining length of $(100.0' / 3) = 33.33'$.

In this case, all three rows of profile sections can be standardized to 32.3 ft (9.9 m), therefore reducing additional design and production cost.

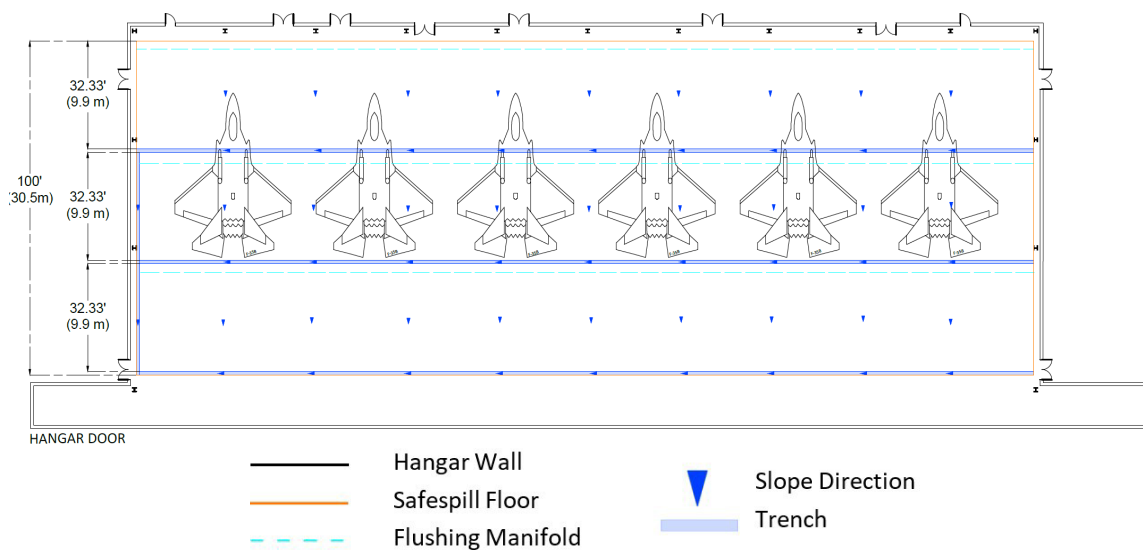


Figure 4-4: Trench spacing example for ILDFA design

5. Retrofit Hangar Applications

5.1. Concrete Slab Requirements

The ILDFA has been designed and tested to support the Maximum Takeoff Weight (MTOW) of any U.S. military or commercial aircraft under a compression load scenario. The slope of the concrete slab should comply with either the UFC code for military hangars or NFPA 409 for all other hangar applications.

NFPA 409 Chapter 7.12.2.5 requires a minimum of 0.5% (0.3°), while UFC 4-211-01 Aircraft Maintenance Hangars Chapter 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. Retrofit Hangar: Existing Slab

If the existing hangar slab meets the 0.5% to 1.5% slope but has a limited number of inconsistencies or low spots, a flat aluminum bar can be used to shim individual sections to meet the slope requirements. Figure 5-1 shows an example of shimming the ILDFA to match the 0.5% slope during an installation.



Figure 5-1: Aluminum flat bar used for shimming to proper slope requirements during installation

5.3. 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.

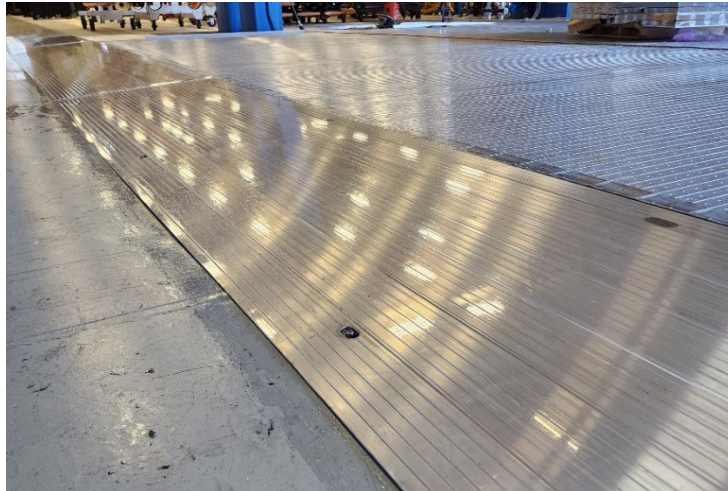


Figure 5-2: ILDFA Standard Sloped Access Ramps

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 all locations where aircraft will enter and exit the floor, standard ramps will be utilized. The ramp consists of multiple slopes to accommodate necessary anchoring features, but the average slope of the ramp is 1:24.

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 tug with a short elevation clearance, it is recommended to use a 1:48 sloped entrance ramp.



Figure 5-3: ILDFA with 1:48 sloped entrance ramp for helicopter with short elevation clearance

5.4. Retrofit Hangar: Milling Existing Slab

Small individual parking spots, such as for target drones or helicopters as shown in Figure 5-6, are possible by milling the existing slab. Towing, scaffolding, and maintenance can easily transition from the hangar slab to the ILDFA due to no change in elevation.

The concrete slab requirements listed in *Section 6.1. "New Build Hangar: Recessed Concrete Slab"* will be necessary for the individual recessed ILDFAs.

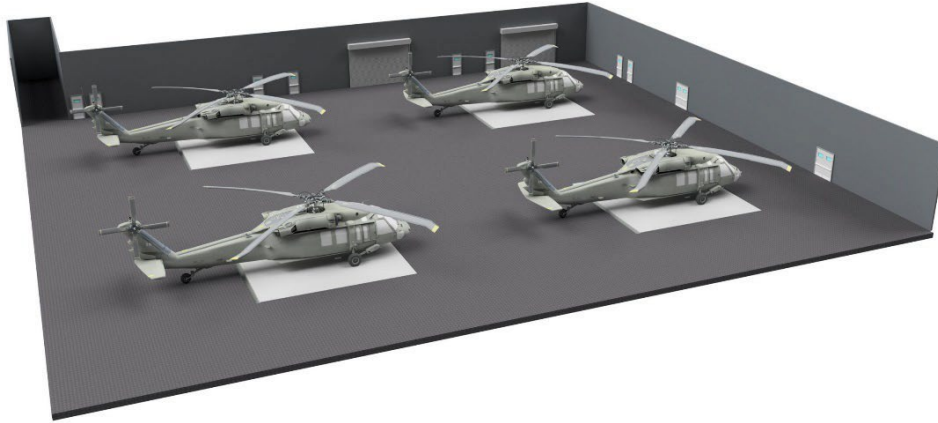


Figure 5-4: Render of helicopter ILDFAs recessed 2" (51 mm) by milling the concrete of the existing hangar slab

5.5. Retrofit Trench Installation

For all projects, Safespill requires the use of prefabricated aluminum trenches. Prefabricated trenches are used as plumbing conduits and include liquid sensor mounts, electrical conduits, flushing manifold supply piping, and solenoid valves. All electrical cables within the trench are routed in fireproof conduit and solenoid valves are housed in sub-grade enclosures mounted adjacent to the trench. Supplying prefabricated trenches with these components reduces production costs and installation time.

For retrofit projects, the existing hangar slab will need to be cut and prefabricated aluminum trenches will be installed in the void created by cutting concrete and back-filled with a high pressure, flowable, non-shrinking grout (Figure 5-7)

For large hangars, the necessary trench depth may exceed what is allowed by site conditions. In this case, two trench sections can be mirrored so that the shallowest point of the trench is at the center and the deepest end of the trenches are at the outer hangar walls. A structural engineering analysis will need to be conducted to determine if the depth and length can be extended without losing the structural integrity of the concrete slab.

The internal slope of the trench is required to be a minimum of 0.5% (0.3°) to ensure liquid drains to the lowest point. The minimum depth of a trench should be 16 inches (404 mm) to allow for proper flow of spilled liquid and piping conduit.

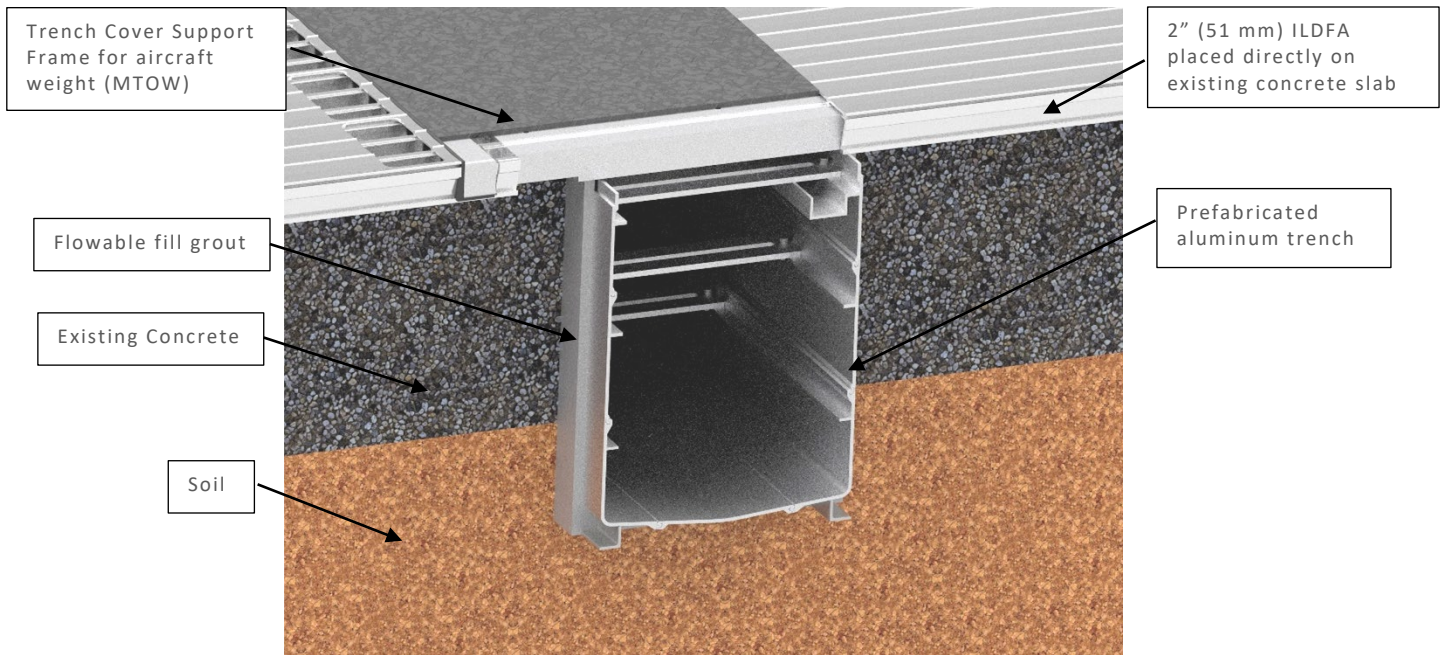


Figure 5-5: Render of ILDFA installed directly on hangar slab with prefabricated trench for retrofit projects

A step-by-step process is shown in Figure 5-8 on the following page of how the ILDFA prefabricated trenches are installed. The ILDFA trench covers are designed with a girder frame that supports the Maximum Takeoff Weight (MTOW) of the largest airframe. The ILDFA trench covers and support frames are included within the manufacturer's scope. More details on the structural considerations of the ILDFA trench covers and support frame is discussed in *Section 7.3, Structural Considerations for Trenches*.

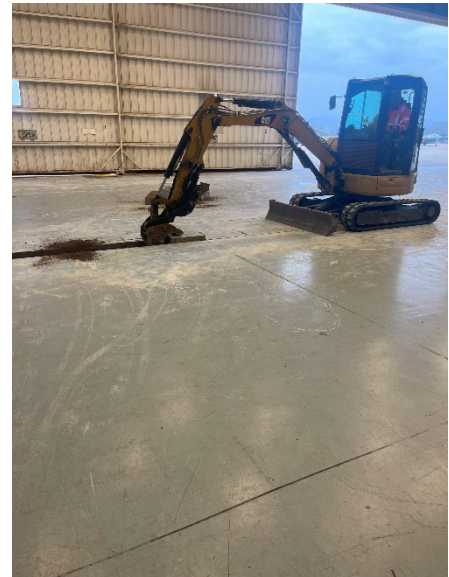
Where a potential exists for aluminum ILDFA components to be in contact with metals such as cast-iron grates, steel rebar, or carbon steel angle, non-conductive isolation materials need to be used to prevent galvanic corrosion. Fluoroelastomer (FKM, Viton™) or bituminous coatings can be applied to isolate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

STEP 1



Cutting through existing concrete slab

STEP 2



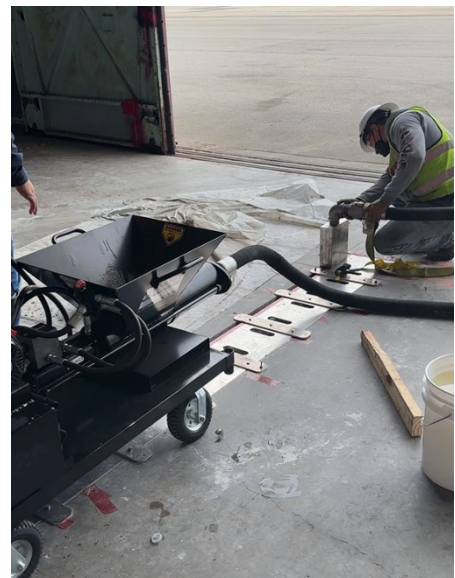
Excavate and compact soil

STEP 3



Place prefabricated aluminum trenches

STEP 4



Backfill trench with flowable grout

Figure 5-6: Step-by-step process of installing ILDFA prefabricated trenches for a retrofit hangar

6. New Build Hangar Applications

6.1. Recessed Concrete Slab

When designing an ILDFA for a new build hangar, recessing the slab by 2 inches (51mm) will provide a flush transition between the concrete floor and the ILDFA. In this scenario, no ramps will be required.

To reinforce the corners of cut concrete, it is recommended that steel or aluminum angle is used as shown in Figure 6-1. Where dissimilar metals are used, fluoroelastomer (FKM, Viton™) seals will be installed to isolate metals and prevent galvanic corrosion.

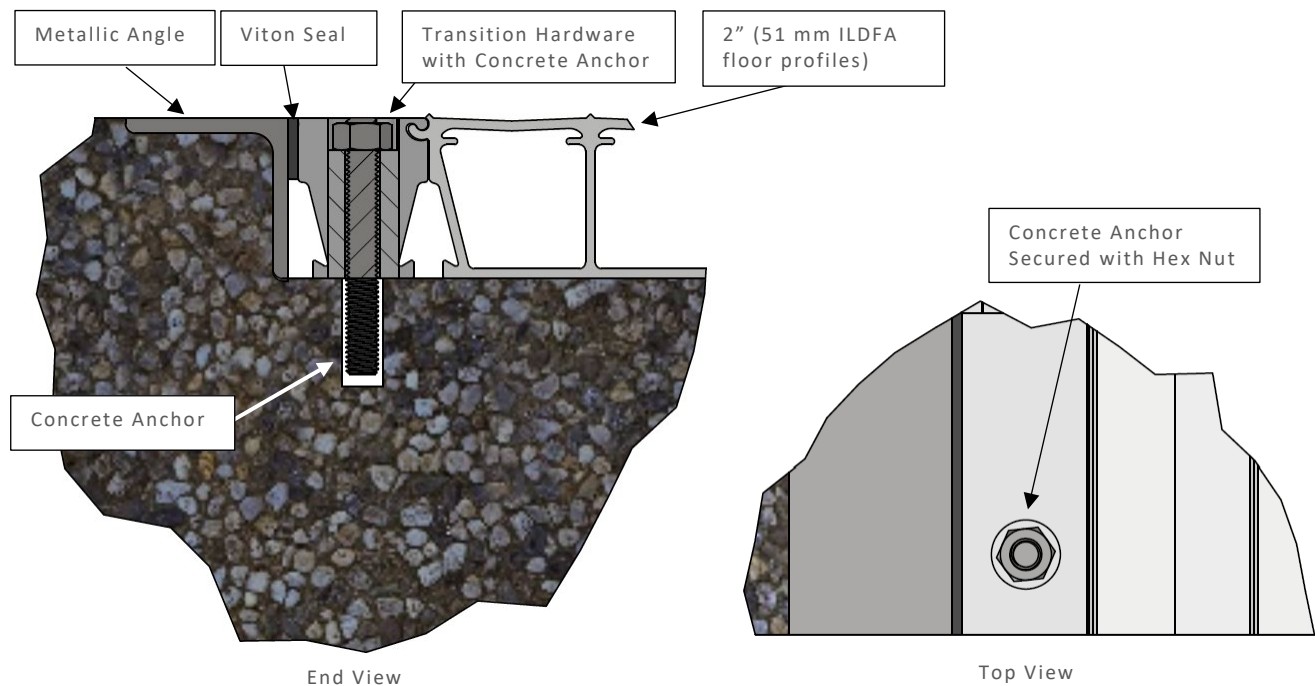


Figure 6-1: Transition from Hangar Slab to ILDFA with Recessed Concrete

Although some corrosion may occur when aluminum is exposed to concrete, the total corrosion is minimal and occurs only while concrete is wet. Corrosion of aluminum when embedded in dry concrete is non-significant.

(Reference: [“Aluminum in Concrete, Linberg”](#))

When designing, 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 12" (305 mm) slab thickness requirement for a hangar cannot be reduced to 10" (254mm) with an ILDFA (the height of the ILDFA is 2" (51mm)); the slab needs to remain 12" (305mm) thick. The slab plus the ILDFA will be 14" (356mm), as shown in Figure 6-2.

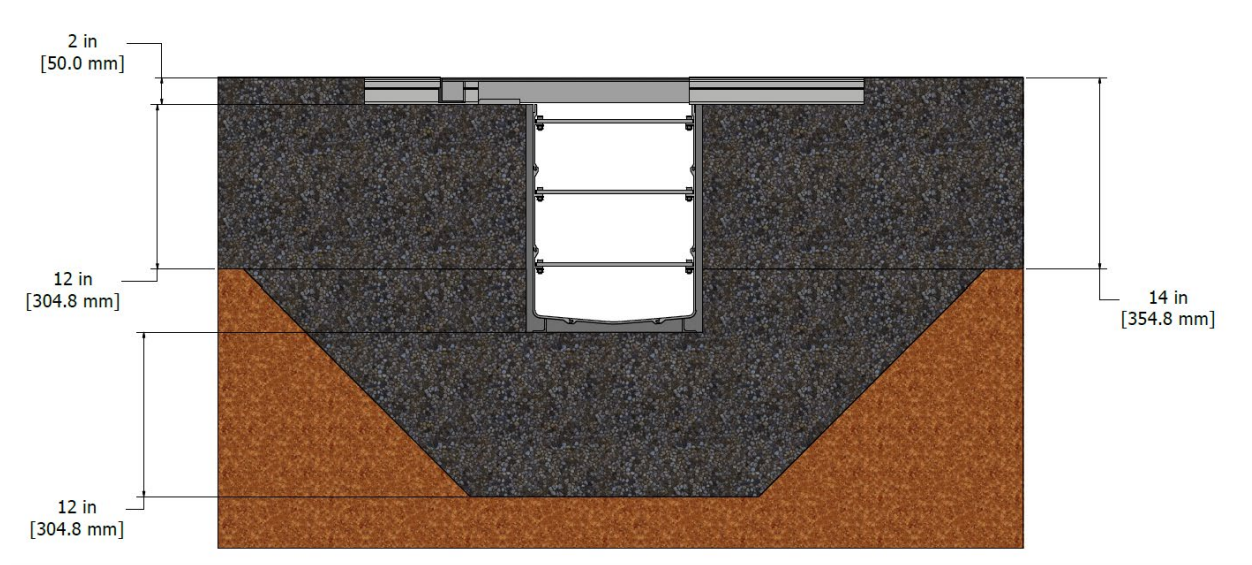


Figure 6-2: Recessed ILDFA with prefabricated aluminum trenches

6.2. Cast-In Place Trenches

For all projects, Safespill requires the use of prefabricated aluminum trenches. Prefabricated trenches are used as plumbing conduits and include liquid sensor mounts, electrical conduits, flushing manifold supply piping, and solenoid valves. All electrical cables within the trench are routed in fireproof conduit and solenoid valves are housed in sub-grade enclosures mounted adjacent to the trench.

In a new build construction, the trenches should be designed into the hangar slab as cast-in-place concrete using Safespill's prefabricated aluminum trench shell as formwork. The ILDFA manufacturer requires prefabricated trenches to be installed for existing hangar scenarios when a structural analysis confirms the hangar slab retains sufficient strength. For both retrofit and new build scenarios, supplying trenches with all the components mentioned above reduces production costs and installation time.

Cast-in-place trenches are not limited to a certain depth and length when concerning the ILDFA. A structural engineer should determine the maximum dimensions of the cast-in-place trenches that the existing soil conditions allow.

The internal slope of the trench is required to be a minimum of 0.5% (0.3°) to ensure liquid drains to the lowest point. The minimum depth of a trench should be 16 inches (404 mm) to allow for proper flow of spilled liquid and piping conduit.

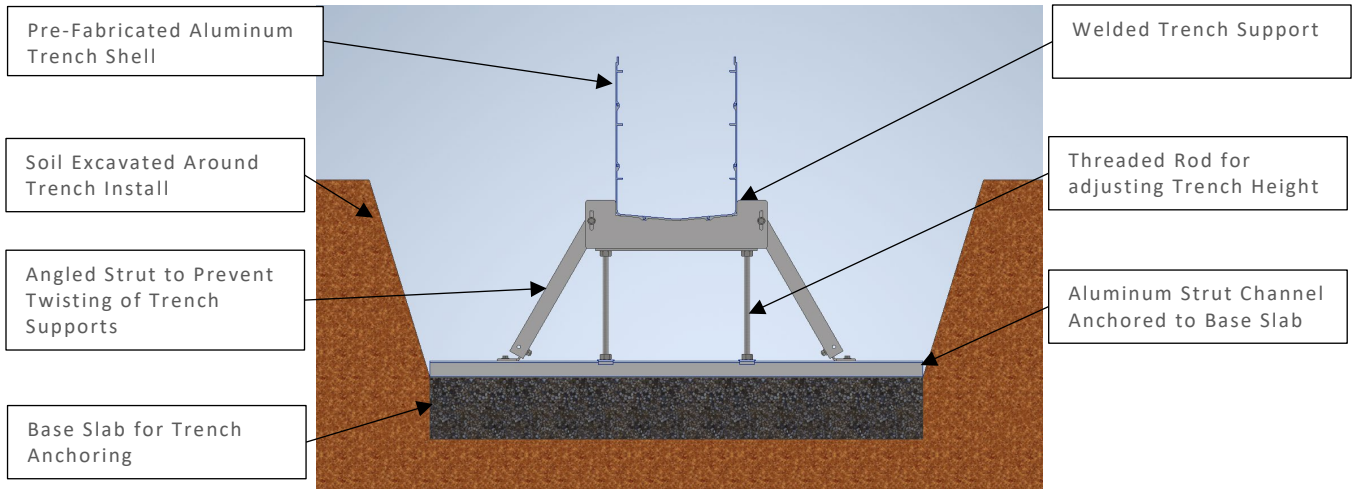


Figure 6-3: New Build Trench Anchoring Features

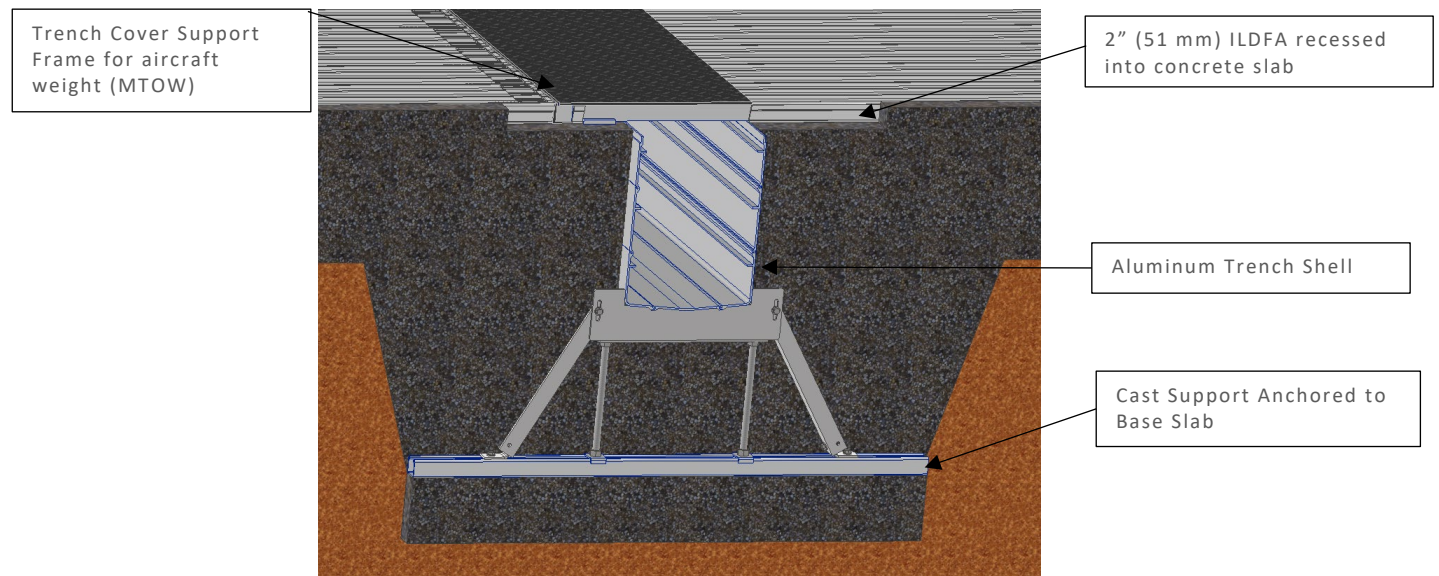


Figure 6-4: Post-slab pour render of ILDFA cast-in-place trenches for new build projects

All cast-in-place aluminum trench shells are supplied with a welded trench support. This hardware includes threaded rods which can be adjusted to raise or lower the trench to meet the required trench slope. In addition, angled struts are installed once the required height is reached to prevent the trench shell from moving and twisting during the slab pour. Threaded rods and angled struts are connected from the welded trench support to a standard 1-5/8" (41 mm) aluminum strut channel which is anchored to the base slab.

A step-by-step process is shown in Figure 6-5 on the following page of how the ILDFA prefabricated trenches are installed.

STEP 1



POUR BASE SLAB

STEP 2



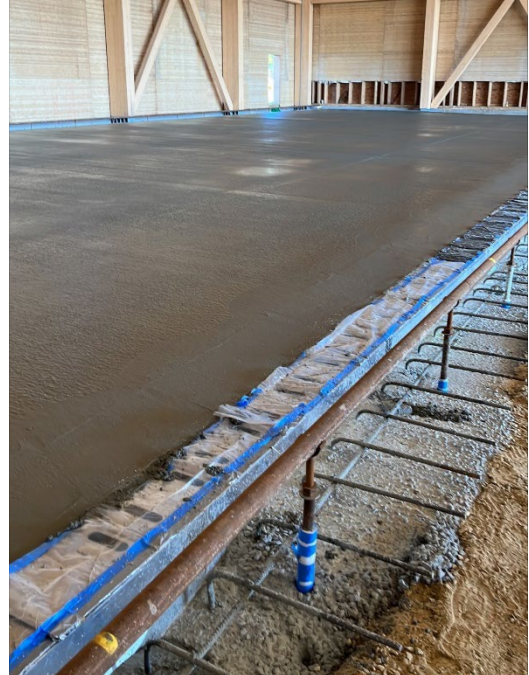
ANCHOR ADJUSTABLE FEET

STEP 3



PLACE TRENCHES

STEP 4



POUR SLAB

Figure 6-5: Step-by-step process of installing ILDFA prefabricated trenches for a retrofit hangar

7. Structural Specifications

7.1. Point Load Capacity

The ILDFA floor profiles are manufactured out of 6000 series Marine-Grade Aluminum because of the corrosion resistance and high strength, pushing the life span of the ILDFA to 50 years. Testing was conducted for the point load capacity of the ILDFA floor profiles. Taking a 9" x 16" (229mm x 406mm) area, which represents the contact area of a fighter jet tire, the ILDFA withstood up to 48 tons (44 MT) of pressure.

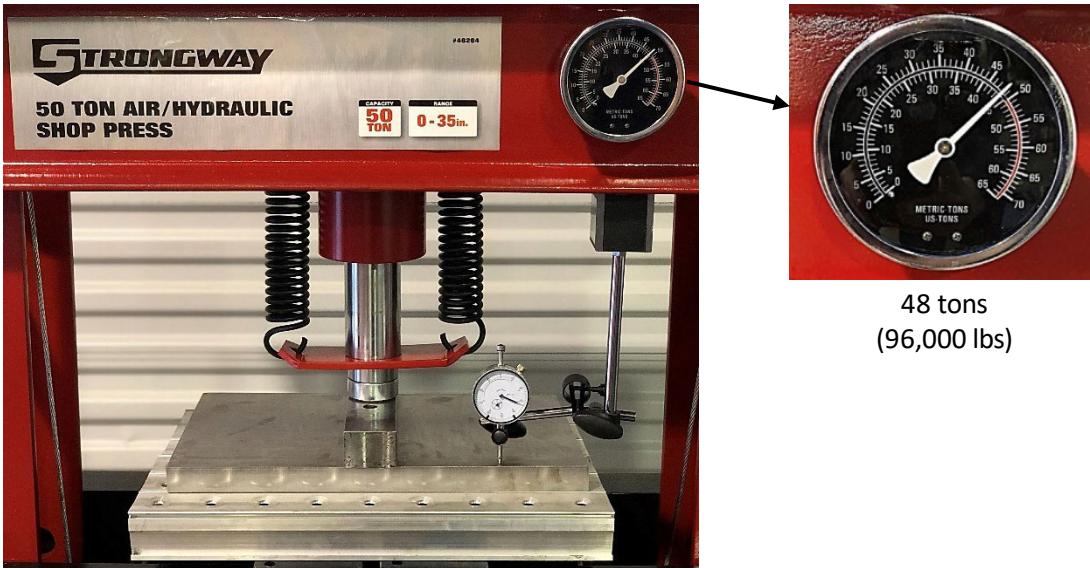


Figure 7-1: Point load capacity of a 9" x 16" ILDFA area can handle 96,000 lbs (46 bar)

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: Safety factor calculations for the ILDFA point load capacity are as follows:

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

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

7.2. Frictional Force in Stopping Conditions

Since ILDFA floor profiles are placed directly on the hangar slab, movement of aircraft onto and off the floor could cause the profiles to shift. However, in most situations the profiles are bounded either by a recessed slab (as described in Sections 5.4 and 6.1) or by anchored ramps (as described in Section 5.3).

In addition, the surface area in contact between the aluminum floor profiles and the concrete slab provide sufficient static friction to prevent movement.

For example, consider the following scenario in which an emergency causes a large aircraft and a tow tractor suddenly stop while on top of the ILDFA:

To move the ILDFA, the horizontal force generated during deceleration of the tow tractor and aircraft must exceed the static frictional force that exists between the ILDFA and the hangar floor.

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 = (mass of tow tractor + mass of aircraft + mass of ILDFA) * gravitational acceleration

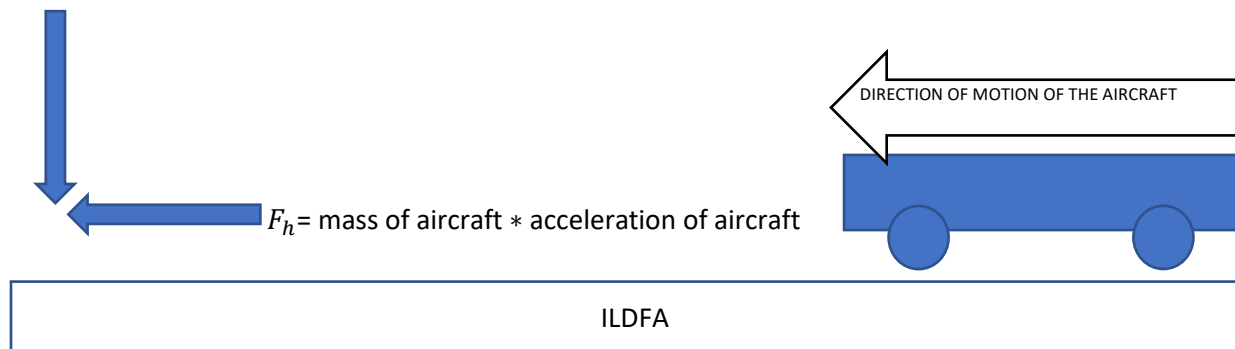


Figure 7-2: Free body diagram demonstrating forces on ILDFA under a moving aircraft

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, μ 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 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 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 m/s^2 .

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

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

7.3. Structural Considerations for Trenches

Due to the design of the trenches and trench cover support, the aluminum trench shells due not experience loading from aircraft moving over the trench supports.

All force generated by aircraft movement is distributed through the trench cover support and into the concrete slab as shown in Figure 7-3.

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

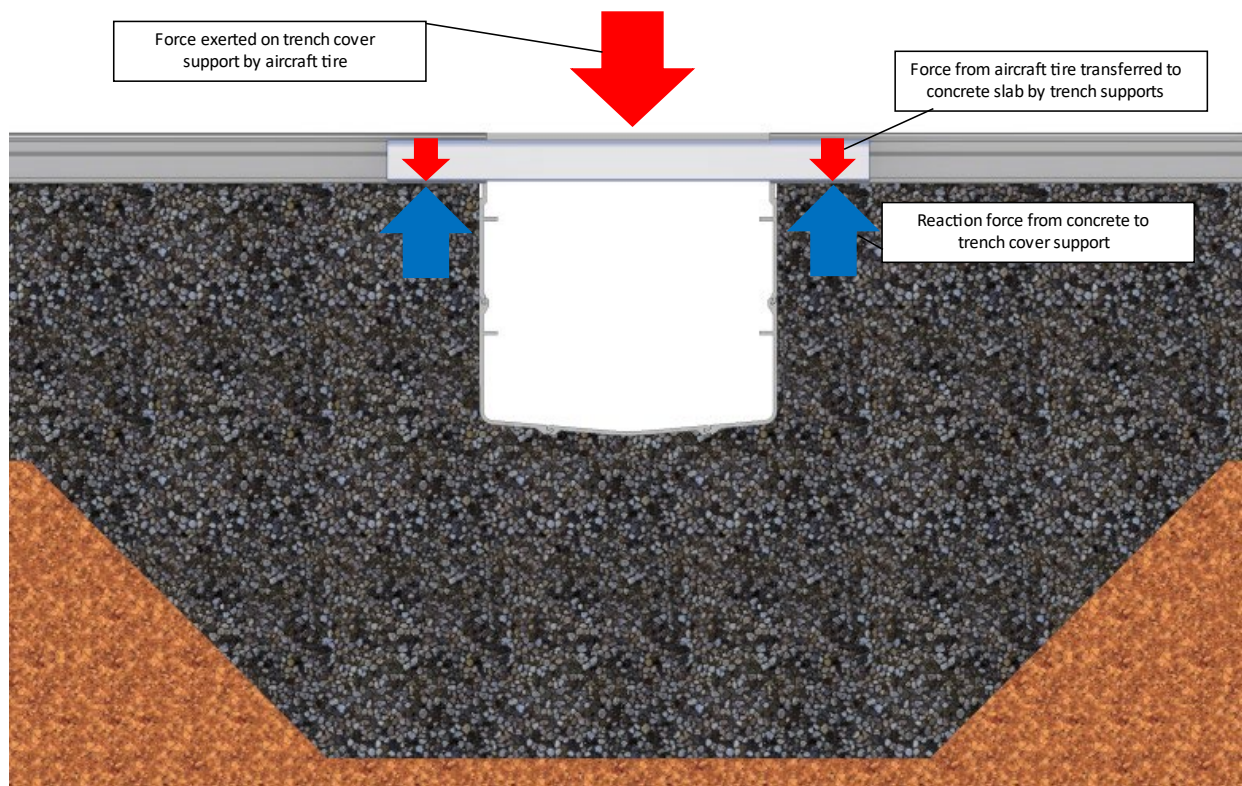


Figure 7-3: Rendering of aluminum trench and concrete slab showing force transferred from aircraft tire to concrete. First profile removed to show girder which spans beyond the width of the trench.

Trench cover supports have been designed using finite element analysis to ensure that supports can handle point load capacity of aircraft tires as described in Section 7.1.

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

Figure 7-4 shows the girders fit into the profile channels, with the trench cover lid removed and the first profiles removed.

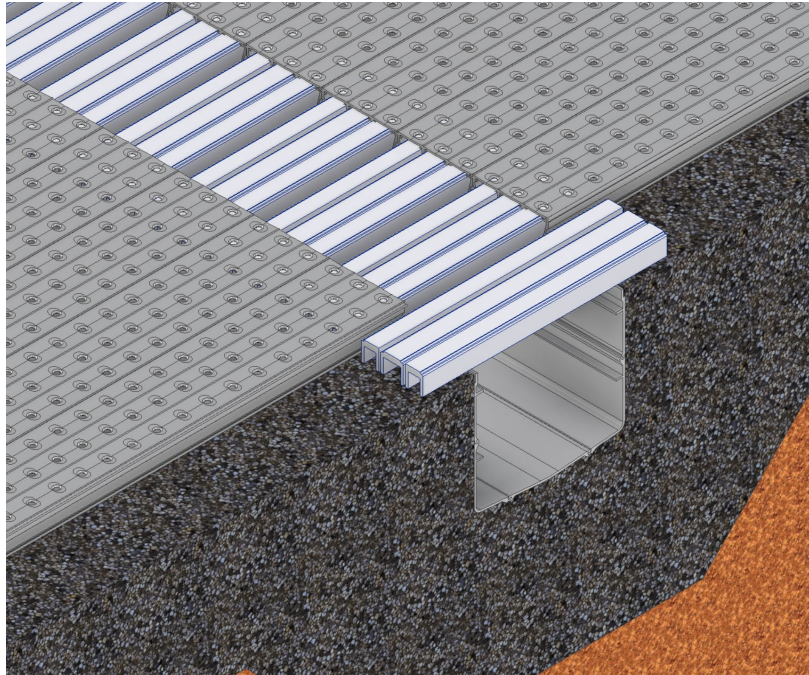


Figure 7-4: Render showing Trench cover support girders. First profiles and trench lid removed to show girder supports.

Figure 7-5 shows the same arrangement as Figure 7-4 with the trench cover lid and first profiles restored. This figure demonstrates the final installation of the trench cover support.

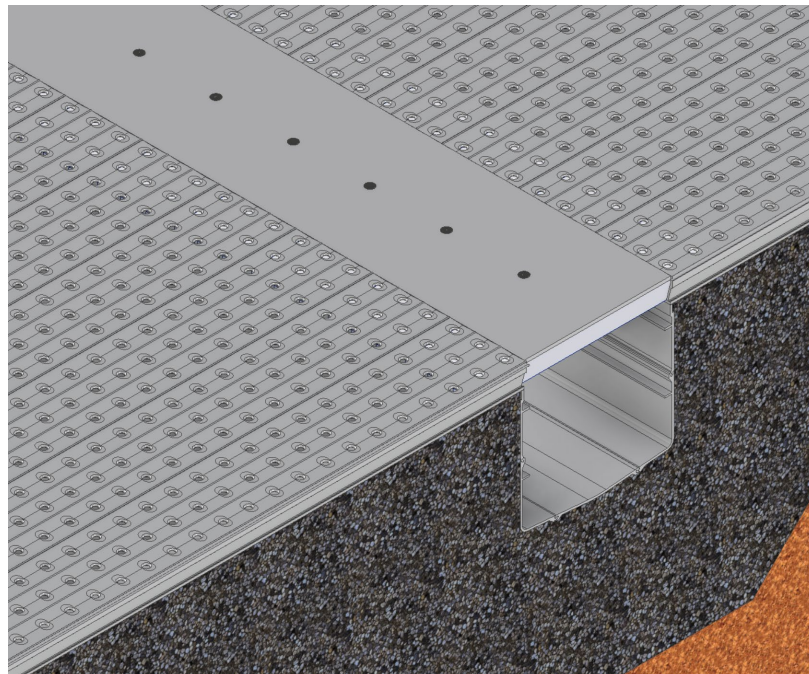


Figure 7-5: Render showing fully assembled trench cover support.

8. 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" Ø hole in the concrete is cut. 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 to allow the ILDFA tie down point to be chemically anchored

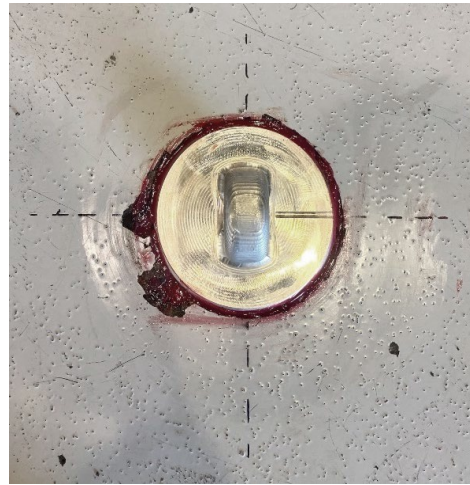


Figure 8-2: ILDFA tie down point chemically anchored into concrete slab

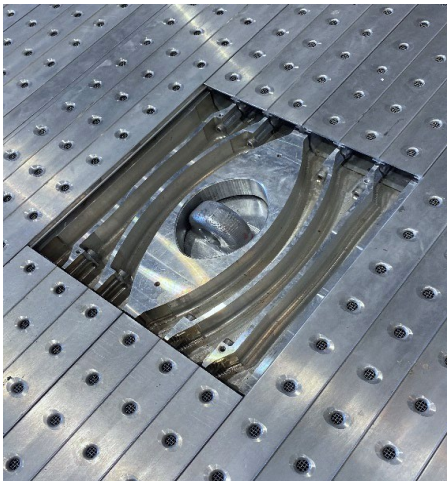


Figure 8-3: ILDFA tie down point without lid



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

9. Grounding Points

Grounding points for aircraft grounding are integrated in the ILDFA and connected to the ILDFAs grounding grid using a minimum of 6 AWG jacketed grounding wire. The ILDFA grounding grid will be connected to ground rods or building ground. An example of an ILDFA grounding point is shown below in Figure 9-1.

For new build projects, a grounding grid is no longer necessary within the hangar slab when utilizing the ILDFA grounding. For retrofit projects, the existing grounding grid and other utilities will not be used.

Grounding points may be placed at any location on the ILDFA, except on top of the trenches. Additional grounding points can be added to the ILDFA retroactively if parking configuration or other changes are made to hangar operations.

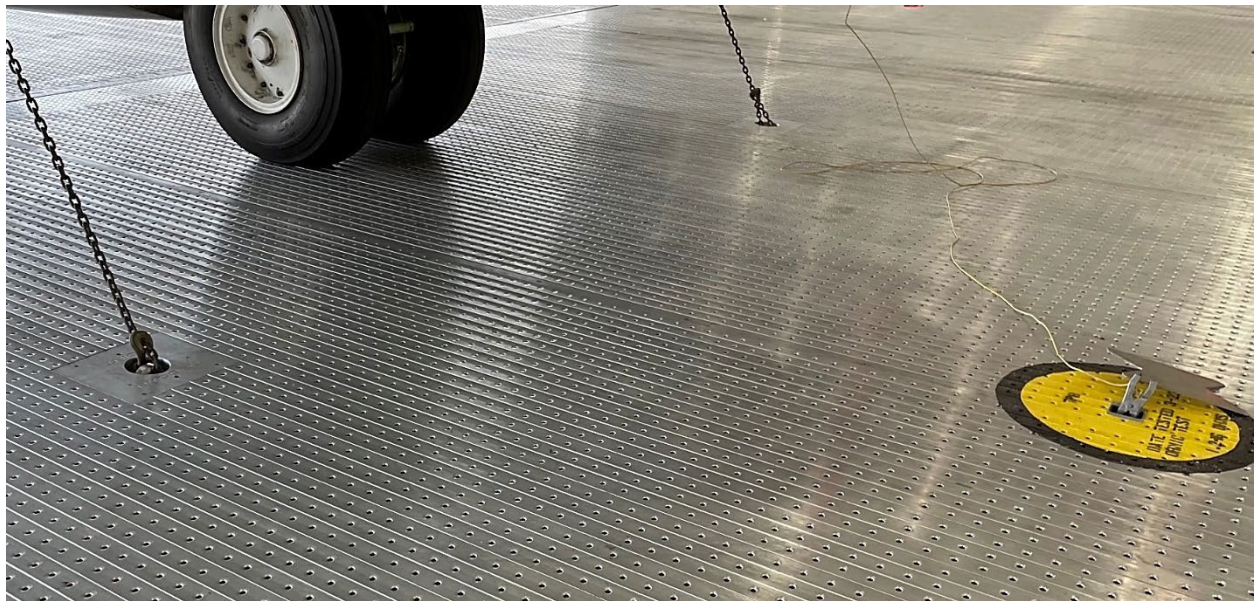


Figure 9-1: ILDFA grounding point example

Grounding points consist of a high-strength composite cup and machined aluminum support. When installed in the ILDFA floor profile, these components exceed the point load capacity of the floor profiles. A ball stud (ERICO B165R or equivalent) is fitted to the composite part and insulated from the aluminum support and the ILDFA floor profiles (Figure 9-2).

A 3" (76 mm) diameter hole is cut through the top surface of the ILDFA floor profile and the grounding point assembly is inserted into the opening (Figure 9-3). Once inserted, set screws hold the grounding point in place and prevent removal.

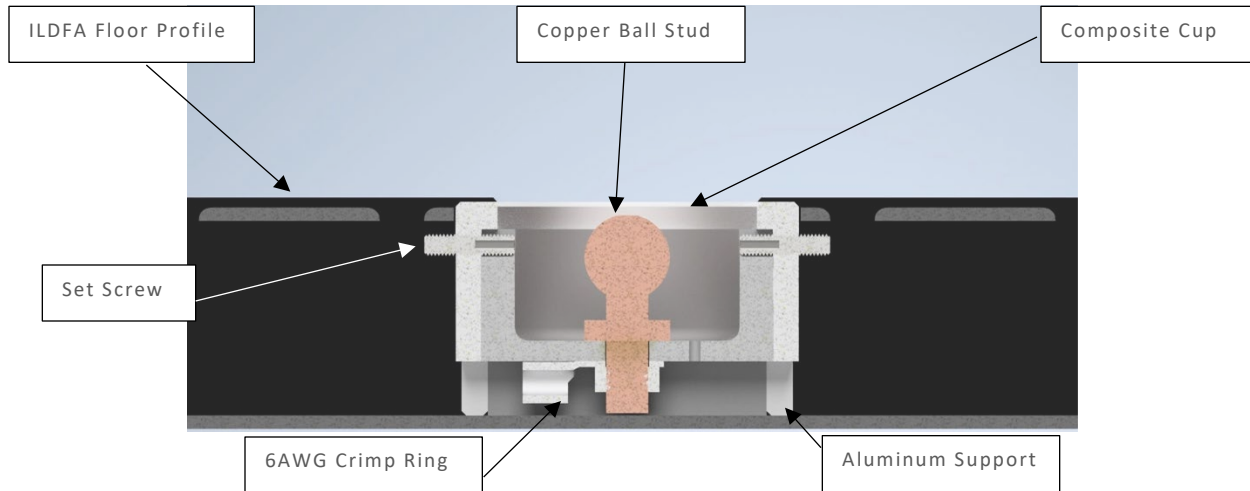


Figure 9-2: Cross section view of ILDFA grounding point embedded in profile

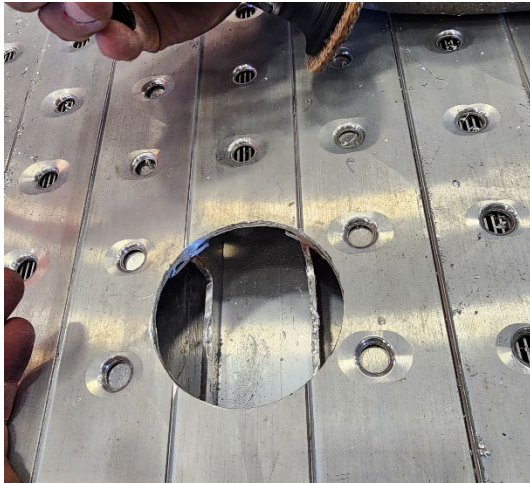


Figure 9-3: 3" Cutout in ILDFA Floor Profile



Figure 9-4: Grounding Point Inserted in ILDFA Floor Profile.

Grounding points are connected in series using 6 AWG grounding wire which runs through ILDFA profiles to the trench. Grounding wires are routed through the trench to the edge of the floor assembly and terminated on a grounding bar, which is connected to a grounding rod or building ground (Figure 9-5).

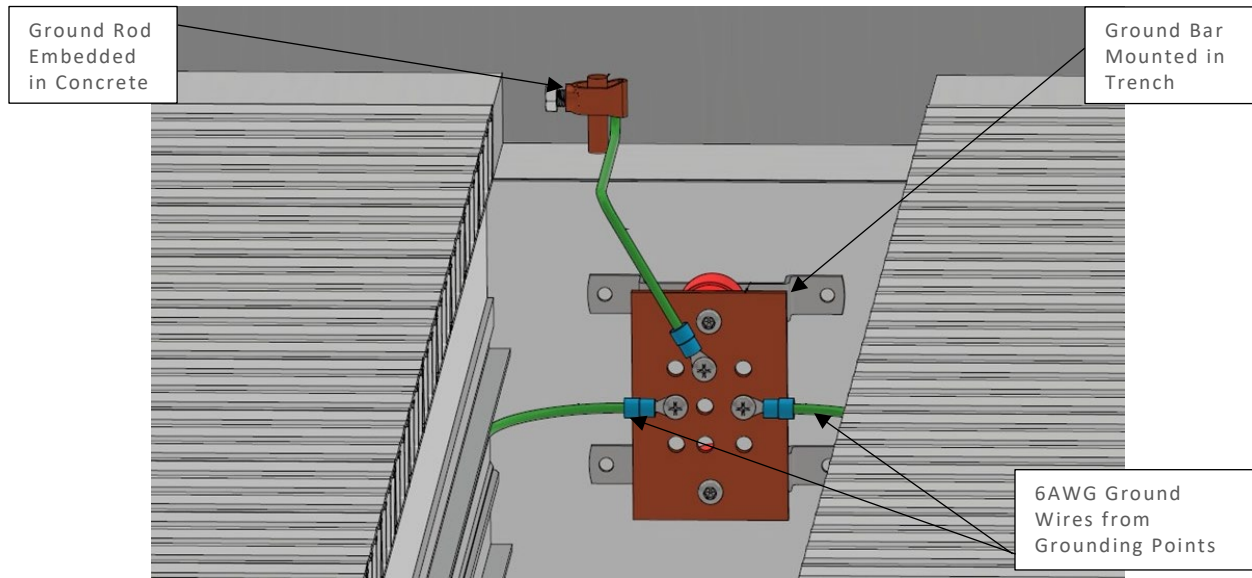


Figure 9-5: Grounding point termination at end of trench. Ground bar may vary in size depending on number of grounding points. Figure shows termination to grounding rod, but termination to building ground may be used in some cases.

10. Water Requirements

An ILDFA requires water to flush the internal drain channels. The ILDFA water requirement is 200 GPM (756 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 should be $4 \times 50 \text{ GPM} = 200 \text{ GPM}$ (756 LPM)

The flushing manifold will require a minimum of 2" water main connection. For ILDFAs larger than 10,000 ft² (929 m²), the water main connection will need to be increased to 3" due to friction losses created by longer pipe runs. If providing a dedicated line to the hangar requires significant plumbing or 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 (22,710L) to 12,000 gallons (45,420 L). NAVFAC ITG FY23-02.1 and NFPA 409 require 30 minutes of flushing water at 200 GPM (681 LPM), while FM Datasheet 7-93 requires 60 minutes of flushing water at 200 GPM (681 LPM).

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 12, Booster Pump* for more details.

A domestic water line or a fire water line can provide flushing water for an ILDFA. If a fire water line is providing the water, the tie in point should be upstream of the flow alarm so that flushing activation for cleaning cycles or unignited spill removal will not activate the fire alarm.

Flushing manifold supply piping is monitored by a flow meter, which is 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.

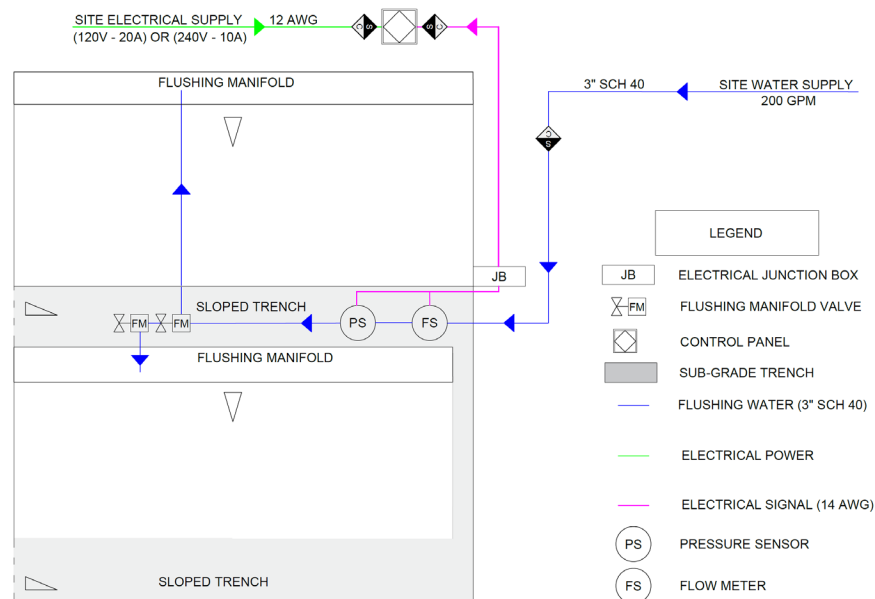


Figure 10-1: P&ID showing flow meter and pressure sensor located sub-grade within ILDFA trench

11. Discharge Pump Skid

When designing the ILDFA, the pump skid system typically uses one FM Approved 4", 20HP centrifugal pump with a maximum flow rate of 750 GPM (2840 L/min) for the trench discharge. For applications requiring higher flow rates, an FM Approved 6", 40HP centrifugal pump with a maximum flow rate of 1,500 GPM (5,680 L/min) is recommended. In both cases, the discharge pump is controlled by a listed pump controller.

Table 11-1: Required Amperage and Breaker Size for Common Discharge Pumps

Pump Inlet/Outlet	Motor HP	Required Amperage at 460VAC	Recommended Breaker Size (Amps)
4" Flanged	20	24.1	30
4" Flanged	30	36.2	40
6" Flanged	40	47.1	55
6" Flanged	50	59.2	65

A 460/480VAC, 3 phase power supply is recommended for each pump skid. Pump motors can be modified to work with local 3 phase voltage supply.

Figure 11-1 shows an example of a standard pump skid with a 4" centrifugal pump and pump controller.

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).

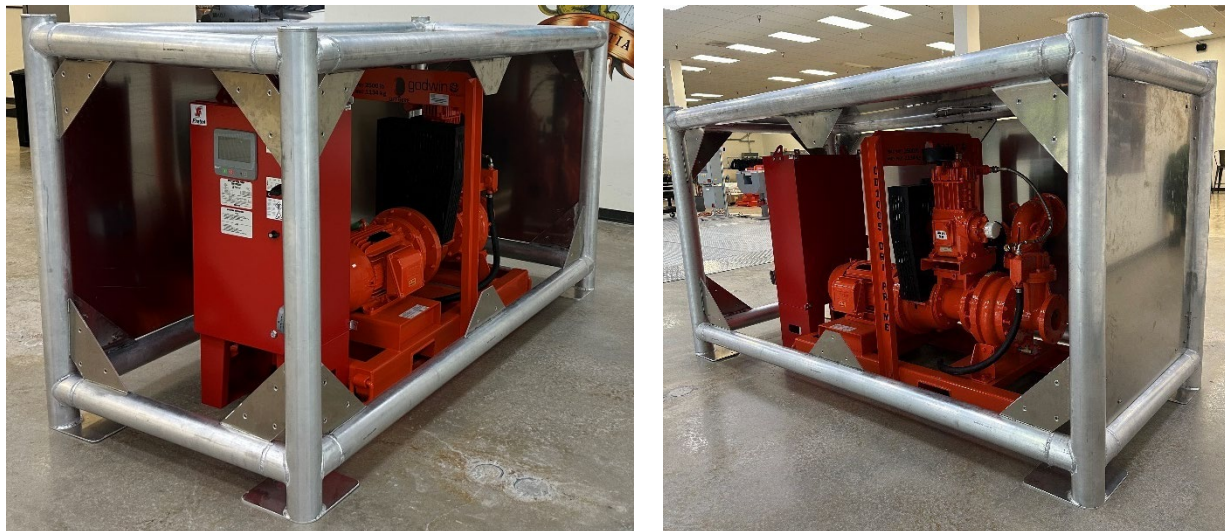


Figure 11-1: Pump skid with 4", 20 HP centrifugal pump and pump controller enclosed in welded aluminum bollard (Exterior panels removed to shown internal components)

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 gravity drain by individual drain connection points to external containment such as an underground Oil Water Separator (OWS). Please review *Section 15, Liquid Containment Sizing* for more details.



Figure 11-2: Render of ILDFA Layout with pump skids on opposite sides of the system

11.1. Discharge Pump Controller

To ensure reliability, all installed 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 signal to the pump controller to start the discharge pump whenever liquid is present in the trench 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 some applications, the pump will run for (1) minute after the liquid detection sensor is dry as shown in the example logic tree in Figure 13-5. For other applications, the pump will be required to run until it is manually shut-off. Changes in run time can be accommodated through on-site programming of the pump controller.

12. Booster Pump

In applications where insufficient water pressure is available, a booster pump may be installed to boost water pressure supplied to the ILDFA flushing system.

12.1. Pump Specifications

In most cases, a standard centrifugal pump capable of providing 39 psi (2.7 bar) at 200 GPM will be used for the booster pump. As discussed in *Section 10, Water Requirements*, 200 GPM (757 LPM) is the maximum flushing water flow required for a worst-case scenario. The typical specification for a pump that meets these requirements is a 3" diameter inlet and outlet fitted with a 7.5 HP motor. This pump should be provided with 480 VAC at 10 amps. Alternative motors can be supplied to meet local voltage requirements.

At this time, there is not a satisfactory, listed pump that meets the specifications described above. However, Safespill is in the process of certification for an FM Approved pump to be used for applications requiring a booster pump.

12.2. Pump Location

The booster pump should be in an area near the ILDFA installation but should not interrupt the footprint of the ILDFA system. When placed in the hangar bay, the booster pump will be mounted on a skid with a footprint of 4 ft (1.2 m) by 2 ft (0.6 m). Alternatively, the pump may be placed in a nearby pump room and mounted to a 4 ft (1.2 m) by 2 ft (0.6 m) housekeeping pad. Power may be supplied through the main control panel, controls junction box, or directly from the building. When supplied directly from the building, a motor starter will be required at the pump and 24VDC start signal will be sent from the main control panel.

13. 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 and typically requires a 2,400 watt (120 VAC, 480 VAC, or other local voltages can be used) power supply. Control panels and junction boxes carrying Intrinsically Safe wiring are UL-698A listed.

13.1. Main Control Panel

The ILDFA control panel 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 13-1 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 in (0.6 m) wide by 30 in (0.76 m) high by 12 in (0.3 m) deep. The main control panel should be installed at least 18 in (0.45 m) above the ground.



Figure 13-1: 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). A fire alarm sequence of operation is provided in *Section 13.4, 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.

NAVFAC ITG FY23-02.1 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 19*.

A Human-Machine Interface (HMI) installed on the main control panel allows the user to activate cleaning cycles, manually activate 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. Liquid detection recognized as a spill
2. Manual system activation by button on HMI
3. Cleaning cycle activation by button on HMI

More details on the system operations are provided in *Section 13.5, Logic Tree*.

The HMI displays the zone currently being activated by one of the three scenarios. The example below in Figure 13-2 shows the ILDFA Zone 3 activated by cleaning mode in green.

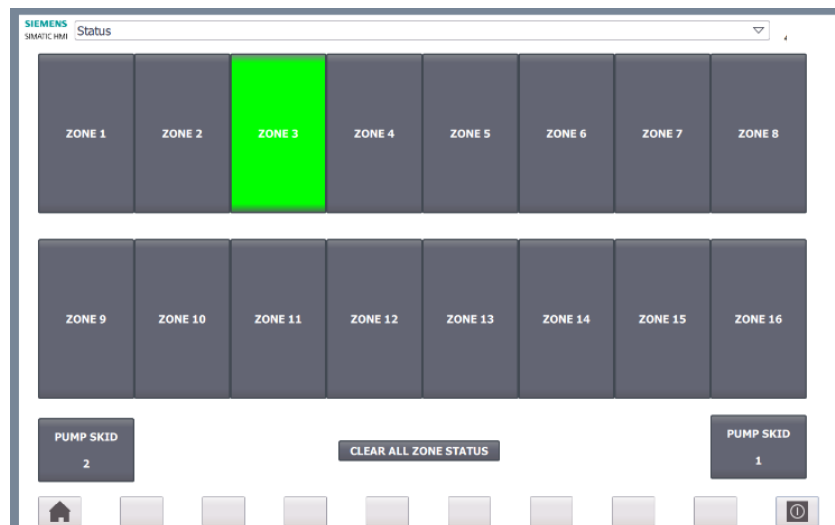


Figure 13-2: Example of the ILDFA HMI with Zone 3 cleaning mode activated

13.2. 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 are installed near the end of trenches and connect to conduit runs in the trench. Each junction box can be connected to up to 16 zones. The junction box sends input signals for liquid detection sensors and receives output signals for solenoid valves from the main control panel. The method of communication varies based on whether the ILDFA is installed on a military or non-military hangar.

13.2.1. Military Applications

For military applications, the controls junction box will contain intrinsically safe barriers for wiring liquid detection sensors and terminal blocks for wiring to solenoid valves in the trench. Due to cybersecurity concerns, all circuits are hardwired from the junction box terminals to the logic controller located in the main control panel.

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

- 24VDC for power to IS Barriers: 6AWG, 2 conductors + 1 ground
- Liquid Detection Sensor Signal: 22AWG, 2 conductors per zone (i.e. for 16 zones, 32 conductors are required)
- Solenoid Valve Power: 14AWG, 2 conductors per zone (i.e. for 16 zones, 32 conductors are required)

Additional wiring for tank sensor, flow meter, and other auxiliary devices may be required on a project-by-project basis.

13.2.2. Non-Military Applications

For non-military applications, a secondary logic controller will be installed in the controls junction box. The same intrinsically safe barriers and terminal blocks will be used as in military applications. However, the use of a secondary logic controller greatly reduces the required wiring between the main control panel and controls junction box. Input signals for liquid detection sensors and output signals for solenoid valves are transmitted via 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
- Liquid Detection Sensor Signal and Solenoid Valve Power: 1 Cat6 Ethernet cable

13.3. Backup Battery Power

Each main control panel will be connected to backup battery power providing 24VDC power for 48 hours of standby plus 15 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 typical dimensions of the battery cabinet are 16 in (0.4 m) wide by 40 in (1.0 m) high by 20 in (0.5 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. When building power is lost, the main control panel will display a power loss via an indicating light and transmit a supervisory signal to the FACP.



Figure 13-3: Battery cabinet mounted on wall near main control panel

13.4. Fire Alarm Sequence of Operation

Figure 13-4 shows a typical fire alarm sequence of operation for signaling between the ILDFA Controls System and the hangar's FACP.

FIRE ALARM SEQUENCE OF OPERATION				SYSTEM OUTPUT				
				ANNUNCIATION AT FIRE ALARM CONTROL PANEL (FACP)			ANNUNCIATION AT SAFESPILL CONTROL PANEL	
				AUDIO-VISUAL FIRE ALARM NOTIFICATION AT FACP	AUDIO-VISUAL SUPERVISORY ALARM INDICATION AT FACP	AUDIO-VISUAL TROUBLE ALARM INDICATION AT FACP	CONTINUOUS AUDIBLE NOTIFICATION AT SAFESPILL CONTROL PANEL	SILENCABLE AUDIBLE NOTIFICATION AT SAFESPILL CONTROL PANEL
SYSTEM INPUT				A	B	C	D	G
SUPERVISORY CONDITIONS	1	ACTIVATION OF SAFESPILL LIQUID DETECTION SYSTEM (SPILL DETECTED)			X		X	
	2	ACTIVATION OF SAFESPILL MANUAL BUTTON			X		X	
	3	ACTIVATION OF SAFESPILL EMERGENCY STOP				X		X
	4	LOW FLOW DETECTED DURING SOLENOID OPERATION, SAFESPILL FLUSHING SUPPLY				X		X
	5	SIGNAL FROM SAFESPILL CONTROL PANEL, DISCHARGE TANK IS ≥95% FULL				X	X	X
	6	SIGNAL FROM SAFESPILL CONTROL PANEL, DISCHARGE TANK IS 30-94% FULL				X	X	X
	7	SIGNAL FROM SAFESPILL CONTROL PANEL, DISCHARGE TANK IS 20-29% FULL				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	
AUDIO-VISUAL FIRE ALARM NOTIFICATION AT FACP =	HORNS AND STROBES THROUGH OUT HANGAR
AUDIO-VISUAL SUPERVISORY ALARM INDICATION AT FACP =	BEEPING AND FLASHING AT FIRE PANEL
AUDIO-VISUAL TROUBLE ALARM INDICATION AT FACP =	BEEPING AND FLASHING AT FIRE PANEL
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 THROUGH HMI)

Figure 13-4: Typical Fire Alarm Sequence of Operation

13.5. Logic Tree

Figure 13-5 is an example of the ILDFA logic tree that explains the flow of operations once one of the three activation scenarios occurs.

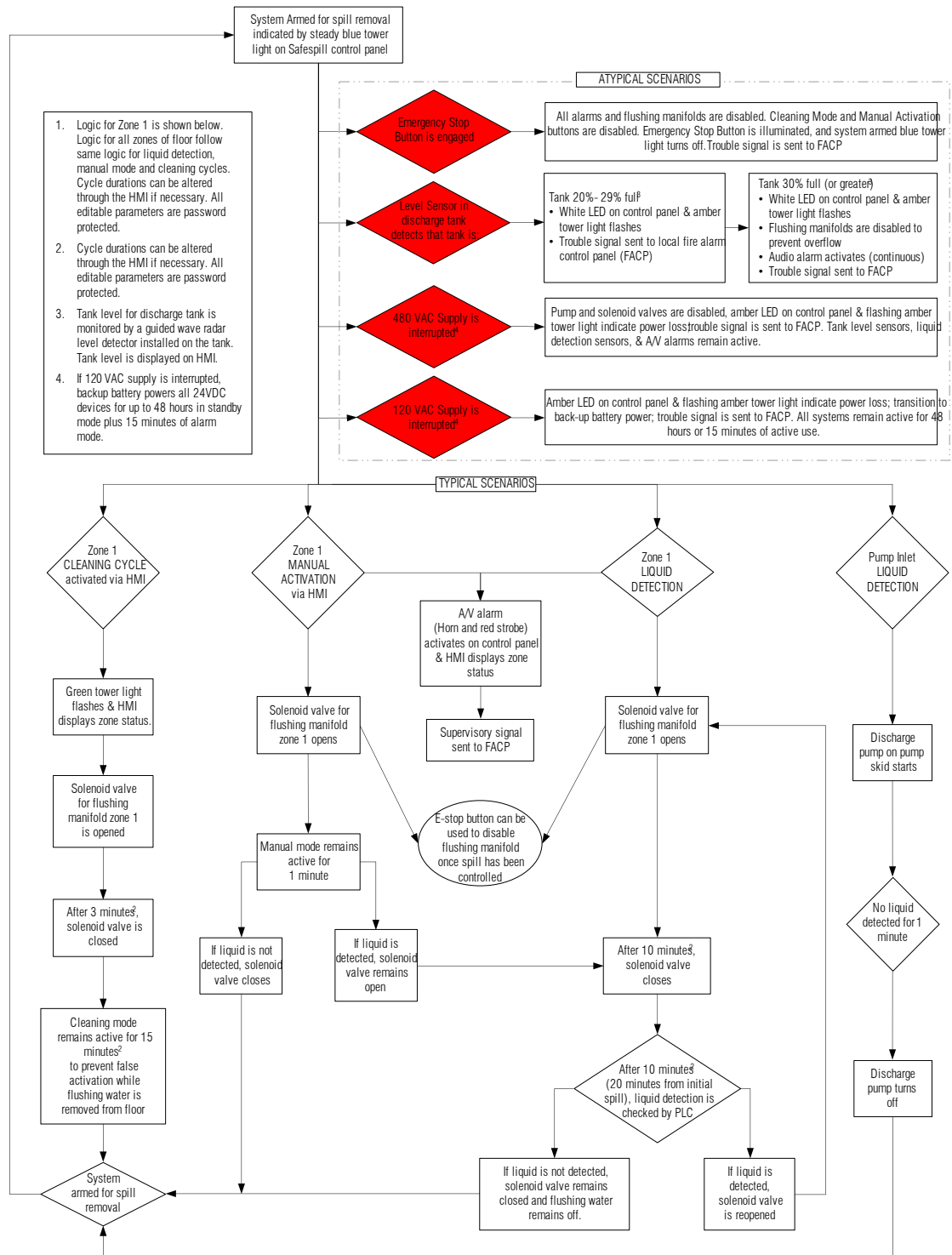


Figure 13-5: ILDFA Logic Tree

14. Electrical Components in Trench

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

14.1. 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.

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 (1) 22AWG/4 conductor fuel resistant jacketed cable, with a 4-pin, M12 quick disconnect fitting on the device side. The cable may be connected to (1) sensor or connected to (2) adjacent sensors using a splitter cordset.

Liquid detection sensor wiring is routed through the trench in EMT conduit to prevent abrasion and crushing, however, explosion proof conduit and fittings are not required due to the intrinsically safe nature of the wiring.

Table 14-1: Required Conduit Size for Liquid Detection Sensor Wiring

Number of Zones (w/o splitter)	Number of Zones (w/ splitter)	Minimum Conduit Size
1	N/A	¾"
2	1	¾"
3	N/A	¾"
4	2	¾"
5	N/A	¾"
6	3	¾"
7	N/A	¾"
8	4	¾"
9	N/A	1"
10	5	1"
11	N/A	1"
12	6	1"
13	N/A	1"
14	7	1"
15	N/A	1-1/4"
16	8	1-1/4"

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.

Glass Prism at end of fiber optic cable



Sensor amplifier and fiber optic cable



DRY fiber optic cable



WET fiber optic cable



Figure 14-1: Liquid detection sensor components and operations

14.2. Solenoid Valves

For each zone of the ILDFA, (1) solenoid valve is installed in a fire-rated aluminum enclosure mounted adjacent to the trench. The solenoid valve is FM Approved for use in Class 1, Division 1 locations. When liquid is detected in a zone, the solenoid valve for that zone opens to provide water flow to the flushing manifold in that zone.

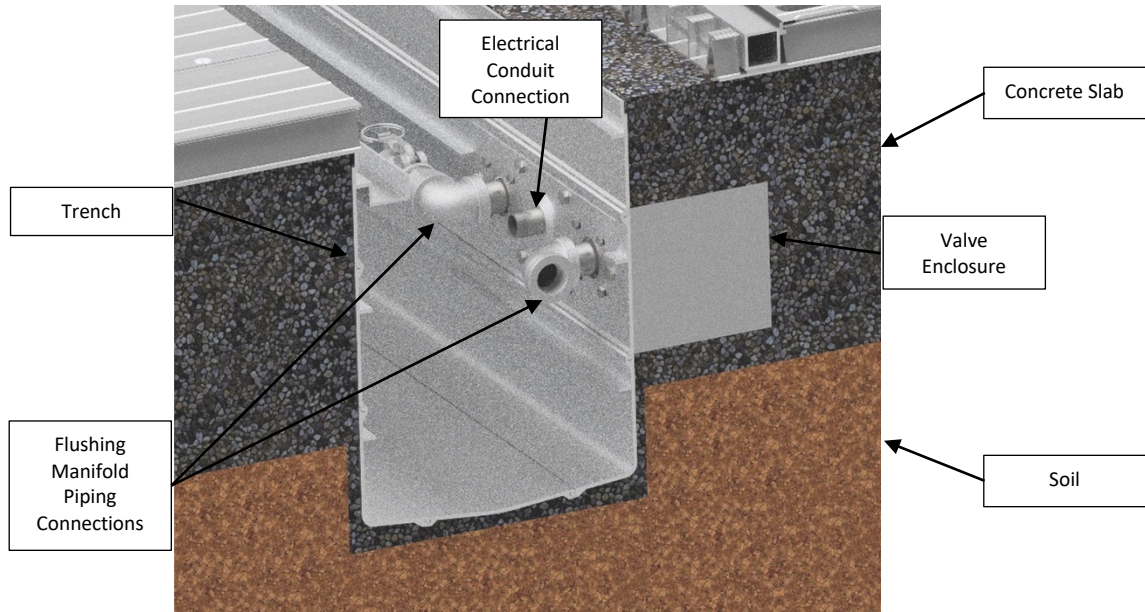


Figure 14-2: Solenoid valve enclosure installed on external wall of trench, embedded in concrete

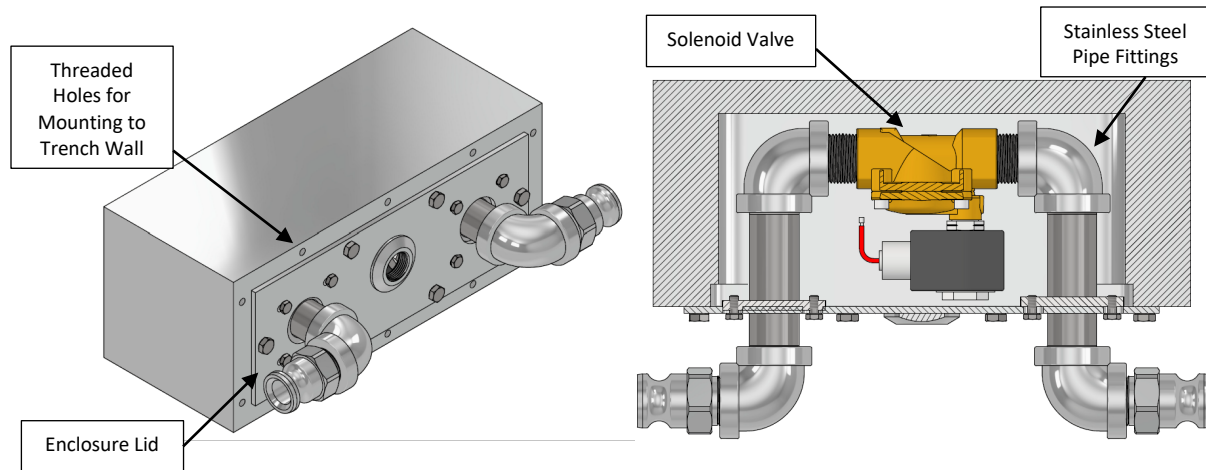


Figure 14-3: Detailed view of solenoid valve enclosure

Solenoid valves fail-closed, so that in the event of a power loss condition, water is not supplied to all zones of the floor. This also means that electrical supply in the event of a fire is critical. Therefore, all wiring and conduit used in the trench is 2-hour fire-rated according to UL FHIT standard for fire-resistive circuit integrity systems.

The wiring consists of a 14AWG/3 conductor cable with a fire-retardant, insulated jacket. Wiring is routed through metallic conduit with explosion proof fittings.

Table 14-2: Required Conduit Size for Solenoid Valve Wiring

Number of Zones (w/o splitter)	Minimum Conduit Size
1	¾"
2	1"
3	1"
4	1-1/4"
5	1-1/4"
6	1-1/2"
7	1-1/2"
8	2"
9	2"
10	2"
11	2"
12	2"
13	N/A, use multiple conduits
14	N/A, use multiple conduits
15	N/A, use multiple conduits
16	N/A, use multiple conduits

15. Liquid Containment Sizing

Containment of spilled hydrocarbons is required; there are two typical liquid containment solutions. The first is using gravity-fed drainage to an underground containment tank. In this case, a civil engineer will be responsible for designing the system, which is beyond the scope of this document.

In the event an underground containment tank is not preferred due to cost or environmental concerns, an above ground containment system can be used. This option can be included in the scope of the ILDFA manufacturer. The ILDFA will need to be equipped with pumps to remove spilled liquid and flushing water from the lowest points in the trench system. The discharge pumps (refer to *Section 11.1 Pump Skid* for details) will direct the liquid to above ground containment.

Regardless of style or size of tank, liquid containment must be located **outside** of the hangar.

15.1. Tank Styles and Sizing

NFPA 409 (2022 Edition), FM Datasheet 7-93 (July 2022), and US NAVFAC ITG FY23-02.1 all provide requirements on the style of containment and size requirements; however, each standard varies in its requirements.

A breakdown of style of containment allowed is provided in Table 13-1.

Table 15-1: Style of Liquid Containment

	NAVFAC ITG FY23-02.1	NFPA 409	FM 7-93
Above Ground Tank	✓	✓	✓
Underground Tank	✓	✓	✓
Underground OWS	✓	✓	✓
Open Pit	X	✓	✓



Figure 15-1: Example of 15,000 gallon (56,781 L) UL-142 steel aboveground tank; shown for reference only

15.2. Sizing Considerations

When calculating required sizing of the spill containment tank for a larger aircraft, the largest internal fuel cell size for the largest potential spill (LPS) is used. Figure 15-2 shows the fuel tank layout for a large aircraft (KC-135 Stratotanker).

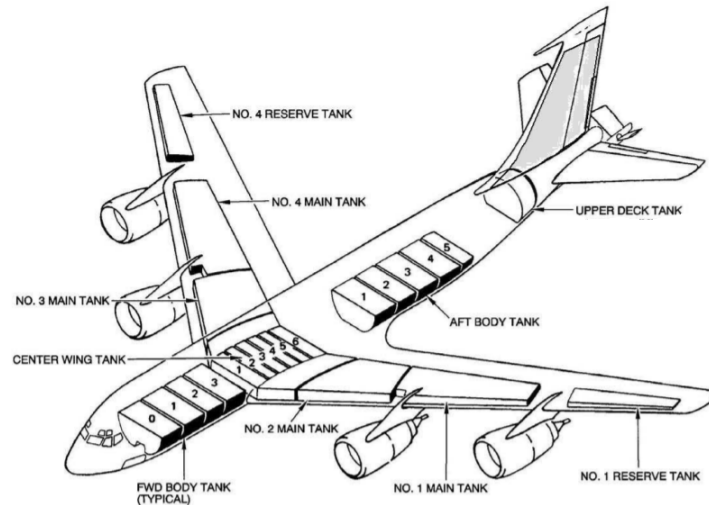


Figure 15-2: KC-135 Stratotanker fuel cell locations

Based on [heat flux data](#) from fire tests and the elimination of a pool fire, it is extremely unlikely that an ignited spill on an ILDFA produces enough heat to activate an overhead sprinkler head.

However, based on the relatively low amount of water produced by sprinkler activation and the incremental increase in tank size needed to account for sprinkler water, it could be considered that 1,240 ft² (115 m²) (WCS of one ILDFA zone) would have sprinkler activation. Total sprinkler water amount is calculated by using the sprinkler water density in NFPA 409 Chapter 9.2.5 at 0.17 GPM/ft² (6.94 LPM/m²).

$$\begin{aligned} \text{E.g., } 0.17 \text{ GPM/ft}^2 * \text{max spill area } 1,240 \text{ ft}^2 * 30 \text{ mins} &= 6,324 \text{ gallons} \\ 6.94 \text{ LPM/m}^2 * \text{max spill area } 115 \text{ m}^2 * 30 \text{ mins} &= 23,943 \text{ liters} \end{aligned}$$

15.3. Example Calculations

Table 15-2 provides containment tank sizing requirements based on NAVFAC ITG FY23-02.1, NFPA 409, and FM 7-93.

Table 15-2: Containment Sizing Requirements

	NAVFAC ITG FY23-02.1	NFPA 409	FM 7-93
Worst-Case Scenario (WCS) Spill Flow Rate	200 GPM (681 LPM) for small* aircraft, 400 GPM (1,514 LPM) for larger aircraft		
WCS Flushing Water	200 GPM (681 LPM)		
Event Duration	30 minutes	Largest potential spill/WCS Spill Flow Rate	60 minutes
Sprinkler Density	N/A	0.17 gal/min/ft ²	600 gal/min
Sprinkler Coverage Area		15,000 ft ²	

*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)

Table 15-3 provides example calculations for containment tank sizing for a hangar housing one KC-135 Stratotanker (Figure 15-2) using requirements from NAVFAC ITG FY23-02, NFPA 409, and FM 7-93.

Table 15-3: KC-135 Spill Containment Sizing Calculation

	NAVFAC ITG FY23-02.1	NFPA 409	FM 7-93
Largest Aircraft Fuel Cell	7,270 gal (27,519 L)	7,270 gal (27,519 L)	7,270 gal (27,519 L)
WCS Flushing Water	6,000 gal (22,712 L)	6,000 gal (22,712 L)	12,000 gal (45,420 L)
Sprinkler Water	N/A	76,500 gal (289,552 L) ¹	36,000 gal (136,260 L)
Required Containment Size	15,000 gal (56,775 L) ²	89,770 gal (339,780 L)	55,270 gal (209,197 L)

1: NFPA 409 Chapter 8.2.4.5 requires a sprinkler density of 0.17 gpm/ft² (6.9 LPM/m²) over 15,000 ft² (1,394 m²)

2: NAVFAC ITG FY23-02.1 requires a minimum tank size of 15,000 gallons

16. Safespill Oil Water Separator Package

Due to the use of water as a flushing medium, water will be mixed in the spilled volume within the containment tank. To reduce the frequency of emptying the containment tank and to reduce remediation cost, an Oil Water Separator (OWS) Skid can be included in the tank package of the ILDFA manufacturer's scope.

The OWS Skid will be controlled locally, independent of the ILDFA hangar control panel and will manually or automatically process the tank's liquid content after a spill has occurred.

The OWS Skid consists of an 8' x 10' (2.5m x 3m) fully enclosed skid (Figure 16-1) with an oil water separator, activated carbon filter, and 500 gal (1900L) oil storage tank (Figure 16-2).

The OWS Skid is connected to the containment tank and can be configured to draw contaminated fluid manually or automatically from the tank, discharging clean water (<5 mg/L TPH) and sending hydrocarbons to the skid-mounted storage tank.

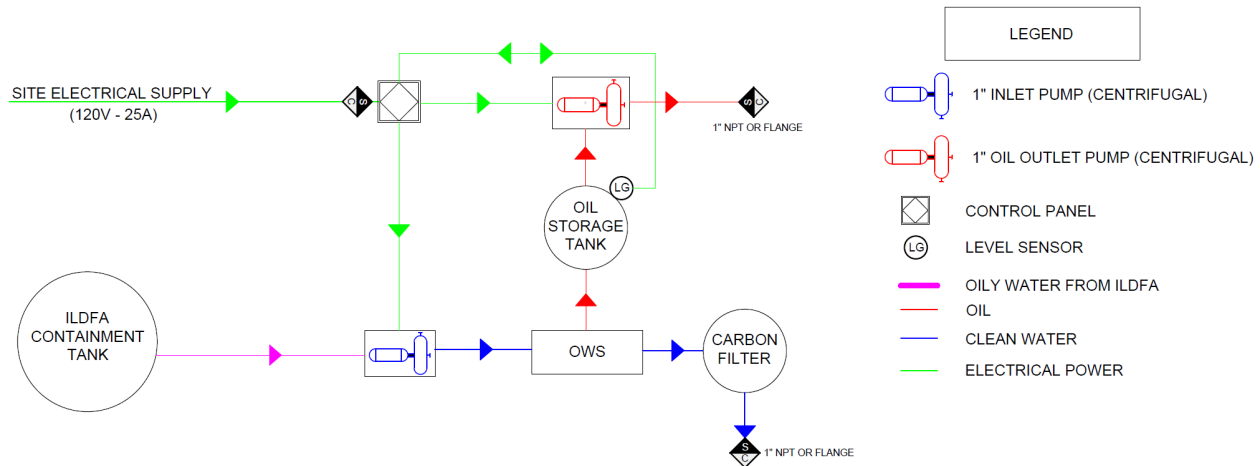


Figure 16-1: P&ID of Oil Water Separator Skid



Figure 16-2: OWS Skid External View



Figure 16-3: OWS Skid Internal (panels removed)

Clean water can be discharged via gravity to a storm drain or retention pond based on local environmental requirements (Figure 16-4) or be recycled via pump to a water supply tank for the ILDFA (Figure 16-5).

The oil storage tank is fitted with a level sensor which alerts the operator when the tank is full. When the tank is full, it can be emptied using a tank mounted fuel pump to the desired disposal vessel.

The OWS Skid requires 120VAC, 25A electrical connection to power the control panel and pumps. No other utilities are required. The operator will be responsible for determining the clean water disposal location or reuse to water supply tank, emptying the oil storage tank, and replacing the carbon filter when needed.

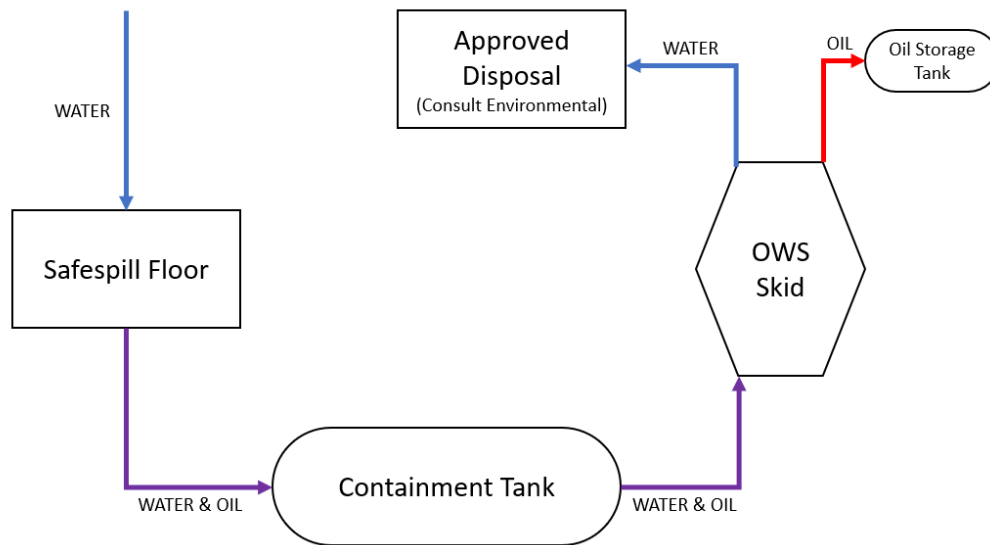


Figure 16-4: Flow Diagram of OWS Skid when discharging clean water

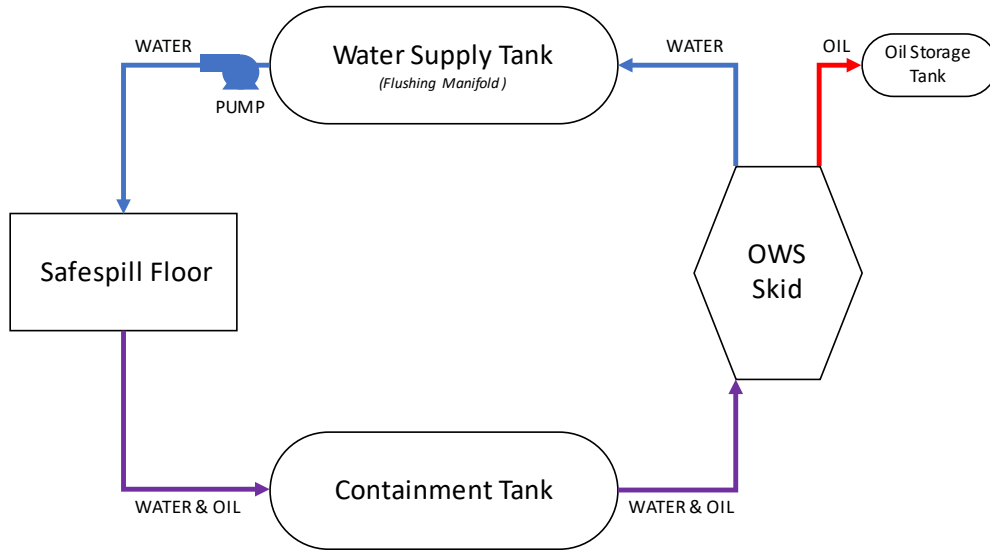


Figure 16-5: Flow Diagram of OWS when reusing water for ILDFA

17. Pre-Conditioned Air (PCA) Trenches

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.

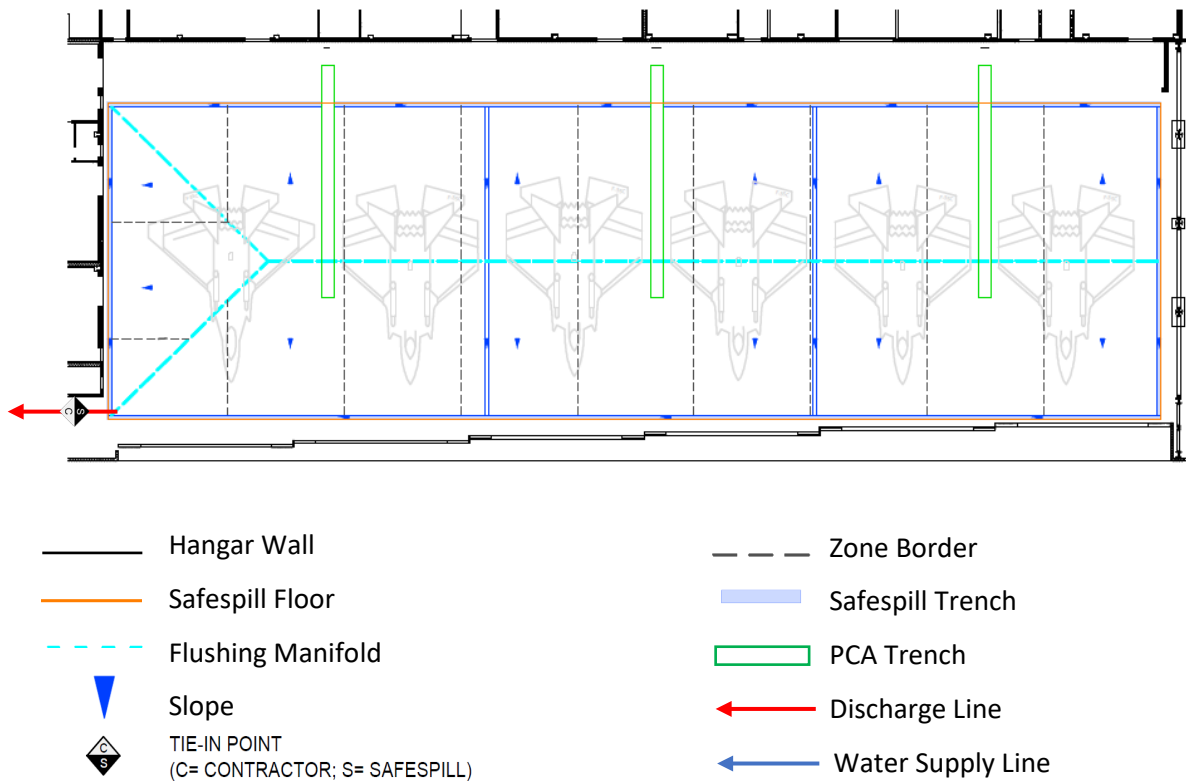


Figure 17-1: Proposed layout for ILDFA in hangars using PCA trenches

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.

18. Overhead Sprinkler System

Provide a sprinkler system as required by NFPA 409, FM Datasheet 7-93, NAVFAC FY23-02.1, or local authority. The sprinkler system is required to protect the hangar against fires other than hydrocarbon-based fires.

Please note that if an ignitable liquid fire occurs with an ILDFA installed, it is extremely unlikely that closed head sprinklers will activate based on reductions in spill size, elimination of a pool fire, and heat release rate.

19. Optical Flame Detectors

NAVFAC ITG FY23-02.1 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 19-1: Flame detector testing was conducted on the ILDFA shown.

20. Cold Weather Environments

The ILDFA flushing manifold requires water supply, which is typically wet pipe and pressurized in all conditions. When ILDFA is used in cold weather environments, the flushing manifold supply piping can be designed as a dry pipe system.

Additional electrically controlled valves are added upstream of the ILDFA (supply valve) near the supply header and at the lowest point in the flushing manifold supply piping (drain valve). When temperatures drop to freezing conditions, the supply valve is closed and the drain valve is opened to remove all water from the system. The water is drained directly into the trench of the ILDFA and removed like any other spill.

If a spill occurs while the piping is dry, the drain valve closes and the supply valve opens along with the solenoid valve(s) for the appropriate zones to provide flushing water.

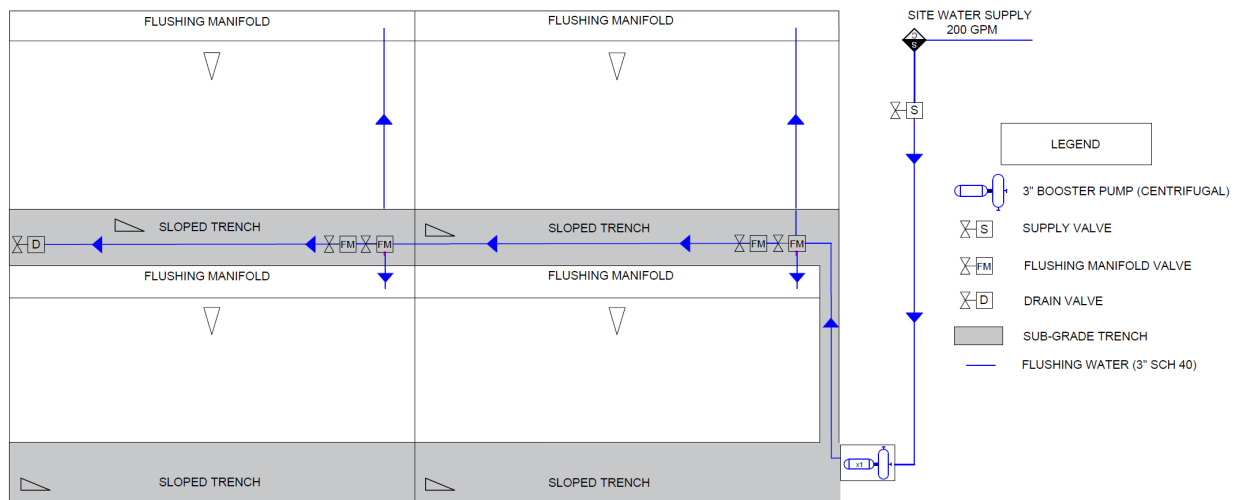


Figure 20-1: P&ID of ILDFA with addition of supply valve and drain valve for dry pipe capability