INTERNAL FLOATING ROOF
Brick Style Honeycomb Type with Full Contact Liquid Surface
From Taiwan to the World

Founded in 2005, Full Most Co. Ltd. is a Taipei-based company. Our spectrum of products and services cover: Internal Floating Roof (IFR) for oil storage tanks, Pipeline Services.

Full Most provides complete services that cover consultation, technical designs, fabrication and installation of Internal Floating Roofs (IFR) – Brick Style Honeycomb Type with Full Contact for aboveground storage tanks, for petrochemical industry, refineries, oil terminals and other related firms. Our IFR products are designed to isolate more effectively the honeycomb core and the stored liquid, and its lifetime and structural strength is higher than Skin & Pontoon type IFR or Sandwich type honeycomb IFR.

Our IFR complies with API 650H and NFPA standards. To survive and develop in a competitive market, every company must insist on standards for its products and services. Full Most stands out due to its high quality, its technological expertise, its capacity to manage complex projects and responsibility for the surrounding environment.

At the same time, Full Most is also engaged in close cooperation with different companies around the world. Full Most is the authorized partner in Taiwan of Dacon Inspection Services for its inspection and pipeline services: Ultrasonic Intelligent (UT) Pigging, Magnetic Flux Leakage (MFL) Pigging.

Moreover, we offer Hot Tapping services, which can be done without stopping the operation lines (e.g. pipelines in petrochemical industry, refineries, steelworks, power plants, semiconductor industry and others).

Our Vision and Mission

As with every successful company, we are also looking for new business opportunities and new ideas to complement our existing portfolio.

Our vision is to be the preferred partner in IFR and Pipeline Services field. To achieve this, we provide our partners with tailor-made solutions ensuring high quality and safe operations. Our priorities are fostering highest product and service quality, customer focus with long-term partnerships, and leveraging internal synergies.

Business Platform for Oil Industry

Right Products + Service + People + Channel

Responsible for the Environment

We strive to integrate the principles of sustainable business practices in all our activities and are committed to the environment. Safety is the top priority and shapes our technical, organizational and behavioral standards.

Interested in Our Products and Technology?

Let’s talk!
Internal Floating Roofs - Different Types of Problems

\[ \text{Steel Pontoon Roof Type} \]

**Advantages**
- Strong structure, long life span
- Because the steel plates are completely welded, the sealing efficiency is the best
- The full contact design can reach over 90% of VOC emissions reduction

**Disadvantages**
- It can be installed only in new storage tanks. In old operational storage tanks the IFR installation takes longer because the domes need to be removed and the steel plates need to be welded with open-flame.
- It is bulky, and because the height is 600-1000mm and the rim space is 150-250mm, it can cause unbalance and it can get stuck inside the storage tank.
- It has a strong structure, and during extreme shaking it can cause damage to the tank shell.

\[ \text{Skin and Pontoon Roof Type} \]

**Advantages**
- Light weight and low cost
- All the parts can be put into the tank through the manhole
- Easy to install in a short time

**Disadvantages**
- Because it’s vapor mounted, it cannot reach the VOC reduction requirements and meet the environmental standards.
- During filling and withdrawal operations it can become unstable, suffer deformations and it can sink to the tank bottom.
- The VOC level is high and over the safety levels because of the emissions accumulated and concentrated in the space between the deck and the liquid.
- The storage capacity will be less because of the VOC high levels.

\[ \text{Sandwich Panel Roof Type} \]

**Advantages**
- High buoyancy and strong structure because of the honeycomb core inside the floating panels
- Easy to install in a short time
- All the parts can be put in the tank through the manhole
- The full contact liquid design can reach emission reduction of VOC exceeding 90%

**Disadvantages**
- The sandwich type panels, the honeycomb and aluminum skin are in direct contact with the stored liquid, therefore the glue used to stick all the parts together can be easily soaked and peeled off, causing the floating roof to sink to the tank bottom.
IFR Design Features

- Brick Style Honeycomb Type floating panel with high-strength structure: 1.2t/ft² plane compression

- The stored liquid will not infiltrate to the honeycomb core because the 4 corners of the floating panels are fully welded. Gas leaking test is used in all 4 corners to ensure 100% sealing.

- The frame-linked design forms a stable structure.
  - All floating plates are bolt-free, puncture-free, and every single unit can be replaced individually.

- Two-way automatic vent design to balance the pressure during filling and withdrawal operations, and to prevent the floating roof from severely shaking.

- All the parts can be put into the tank through the manhole.

- Easy to install in a short time.

- The structure is very strong, supporting more than 12 persons walking anywhere on the roof, exceeding API 650H requirements.

- The Full Contact design can reach over 90% of VOC emissions reduction.

- The related tests are measured and certified by third party: SGS.

- Meets NFPA 11 requirements.

- Meets API 650H requirements.
VOC Calculation

Formula’s Source
- EPA-AP 42 Chapter 7
Calculation parameters:
- Diameter: 20 m
- Capacity: 5000 m³
- Stored liquid: naphtha
- Cycle: every 7 days
- Temperature difference (est.): avg. high 15 °C; avg. low 3°C
- Average daily solar radiation energy: 1135 btu/ft² day

With No IFR
Calculation types:
1. standing storage loss
2. working loss
Based on the calculation from the formula, the annual vapor loss is around 205.3 t/yr

With Skin and Pontoon Type IFR
There is no calculation formula for Skin & Pontoon IFR type under EPA-AP 42
- Float tube diameter: 0.24 m
- Length: 2.9 m
- Quantity: 56
- Supposing the coverage area is \( D\times L\times Q = 0.24\times 2.9\times 56 = 38.976 \) m²
- A 20m diameter tank with total measure area = 314.159 m²
- Float tube cover area percentage is \( 38.976/314.159 = 12.4 \)%

- Non-covered area is ≈85%
- Skin & Pontoon IFR annual vapor loss 174 t/yr
  (annual vapor loss without any IFR = 205 ton/yr)

  - Daily vapor loss = \( 0.47 \) t/day (=174 t/yr ÷ 365 day/yr)
  - If product gravity = 1
  - Daily liquid height loss = \( 0.47 \div (10\times 10\times 3.1416) \)
    = 1.5 mm per day

With Full Most IFR - Brick Style Honeycomb Type with Full Contact
There are two working conditions: normal operation and roof standing
- Four categories of loss under normal operation:
  - rim seal loss
  - deck fitting loss
  - withdrawal loss
  - deck seam loss
- Two categories of loss under roof standing:
  - standing idle loss
  - filling loss

Full Most’s IFR annual vapor loss is only ≈2.2 t/yr
Case 1: Stored Liquid Test Under No Operations

Environmental conditions
- Location: NE China (Panjin)
- Diameter: 20 m
- Capacity: 5000 m³
- Stored liquid: naphtha
- Test period: every 8 days
- Temperature difference (est.): avg. high 15 °C; avg. low 3 °C
- Avg. daily solar radiation energy: 1135btu/ft² day

Test result datasheet
- Testing under no filling or withdrawal operations

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March total loss
- height (m): 0.054
- weight (T): 11.647

November total loss
- height (m): 0.068
- weight (T): 12.623

Tank #1412 with Skin & Pontoon Type IFR

Tank #1414 with Full Most IFR - Brick Style Honeycomb Type with Full Contact

- March total loss
  - height (m): 0.009
  - weight (T): 1.819

- November total loss
  - height (m): 0.01
  - weight (T): 2.06

Full Most IFR - Brick Style Honeycomb Type with Full Contact - can reduce 116t/year (138t - 22t) more than Skin & Pontoon IFR type does. Our IFR not only decreases VOC emissions and reduces environmental pollution, but it also lowers the explosion hazards.

Case 2: VOC Concentration Test

Environmental Conditions
- Location: Taiwan, Yilan (Taiwan Petrochemical Plant)
- Date: 2015/03/19
- Diameter: 17.38 m  
  Capacity: 3000 m³
- Liquid stored: M-xylene
- Design stored height: 12.127m
- Tank height at time of measurement: 9.5m
- The test is conducted after the liquid was stored for 9 days
- Testing instrument: Thermo Environmental Instruments TVA-1000

Through the calculation formula and field result, it is proven that using Full Most IFR - Brick Style Honeycomb Type with Full Contact, the VOC emissions are reduced dramatically and it can meet the environmental requirements 100%. Also the safety will be increased due to VOC emissions reduction.
IFR Honeycomb Floating Panel

- Hi-tech aerospace technology is used to design the honeycomb floating panels with high-strength, making it a highly reliable product.
- 3rd party SGS test result: it can stand up to 1267 kgf
  Sample size: 200x200mm, hydraulic machine is used to apply uniform pressure
- Discontinuous honeycomb floating panel, light weight and high buoyancy:
  API 650 gravity standard 0.7 ÷ floating panel gravity (panel weight 12500g ÷ panel volume (5x 58 x 290 )cm³)
  This calculation is based on standard panel buoyancy and reaches 4.7 times its dead weight.
- The liquid will not infiltrate the honeycomb core because the 4 corners of the floating panel are fully welded. Gas leaking test is used in all 4 corners to ensure 100% sealing.
  Afterwards, the panels are marked with the coding numbers, and delivered to the customers.

IFR Support Leg

- The support legs work independently from the floating roof and will not damage the whole structure.
- 3rd party SGS stress test result for support leg’s structure shows that it can support 2988 kgf.
- The support leg, support leg well and support leg pad can automatically adjust by themselves when resting on the tank bottom.
- The upper part of the support legs have socks to prevent the VOC emissions. The socks materials depend on the stored liquid.

IFR Structure

- The floating roof and the support legs are joint by beams to form one continuous strong structure.
  This structure is tested by SGS, and can support 1200 kgf (more than 12 persons can safely walk anywhere on the roof).
- 3rd party SGS oscillation test:
  The test frequency range: from 60-110 times/min and lasted for 1h. There were 5,100 shakings.