

Reducing Storage Tank Emissions Without Compromising Operational Performance

Jeff Eickhoff

Vice President of Sales & Marketing, HMT Inc.

Presentation Overview

- **Tank Emissions Mechanisms**
- **Tank & Floating Roof Types**
  - And their impacts on emissions
- **Design Strategies for Low Emissions**
  - (Floating roof tank options)
- **Other Minor Strategies**

Operational Performance Factors

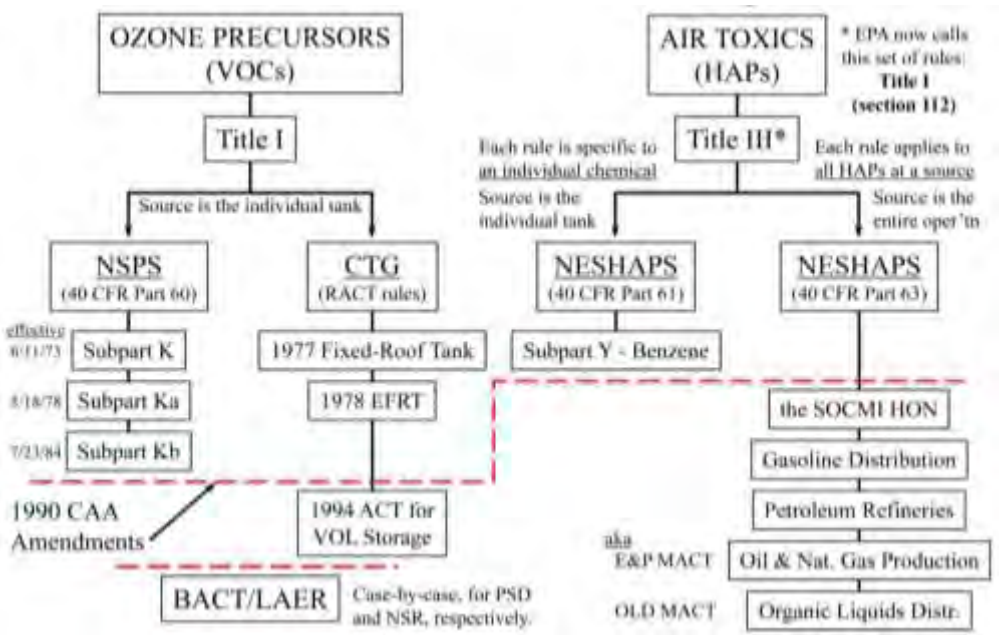
- **Working Capacity**
- **Heel Reduction**
- **Safety**
- **Accessibility**
- **Fire Protection**
- **Maintenance** (painting, drains, water removal, snow, etc.)
- **Durability & Useful Life**
- **Installation (ease, speed, cost)**
- **Ease of Cleaning and Inspection**
- **Initial Cost (project cost and cost per barrel of capacity)**

Regulatory Considerations

- **These are general design concepts presented here**
- **Your regulations and specific situation may vary**
- **Check with your environmental group to verify requirements**

The ever-changing regulatory world

(chart already obsolete…for illustration purposes only)



*** Chart courtesy of Rob Ferry, the TGB Partnership**

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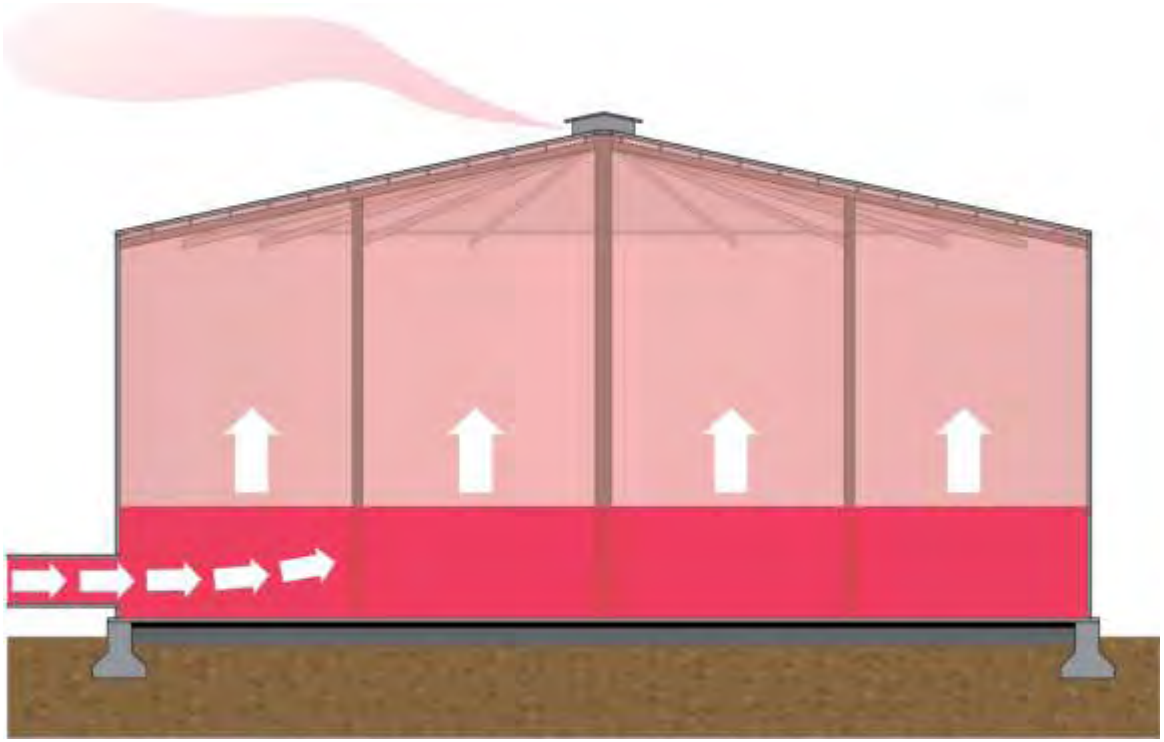
Tank Emissions Mechanisms

Mechanisms for Evaporative Loss

- **Working (or "filling") losses – Cone Roof Tanks**

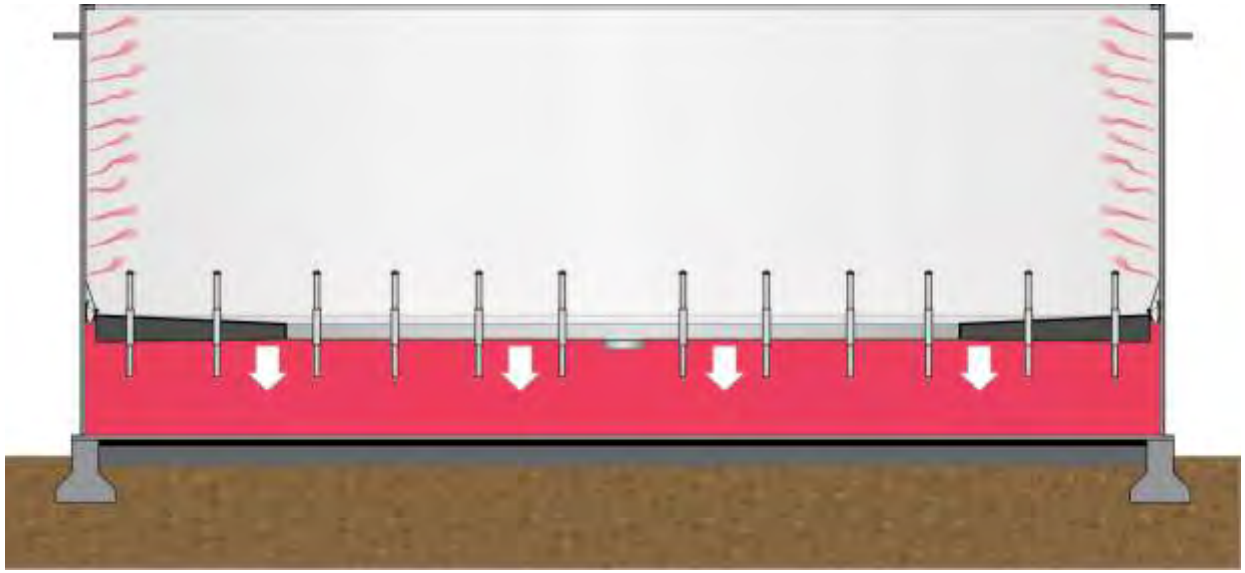


INFLUENCED BY

- Average temp
- Temperature changes
- Tank cycle frequency
- Vapor pressure
- Tank diameter and height
- Tank color

Mechanisms for Evaporative Loss, *continued*

- **Withdrawal losses – Floating Roof Tanks**

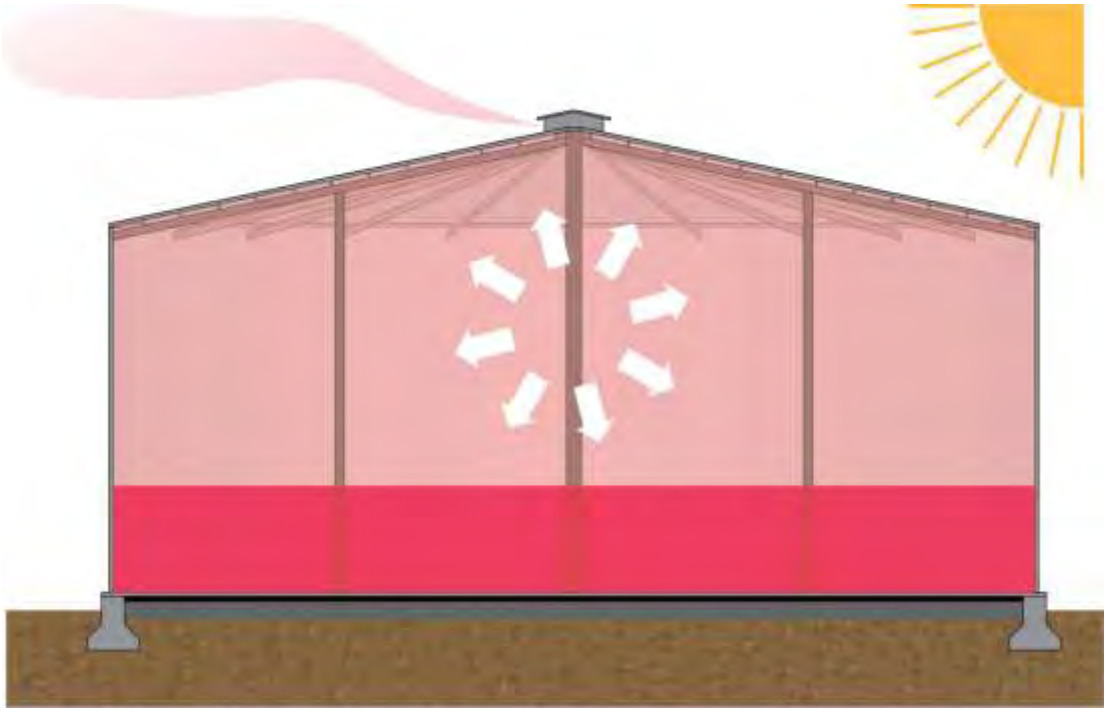


INFLUENCED BY

- Tank cycle frequency
- Tank shell condition
- Viscosity / clingage factors
- Floating roof seals
- Tank diameter and height

Mechanisms for Evaporative Loss, *continued*

- **Breathing losses – Cone Roof Tanks**

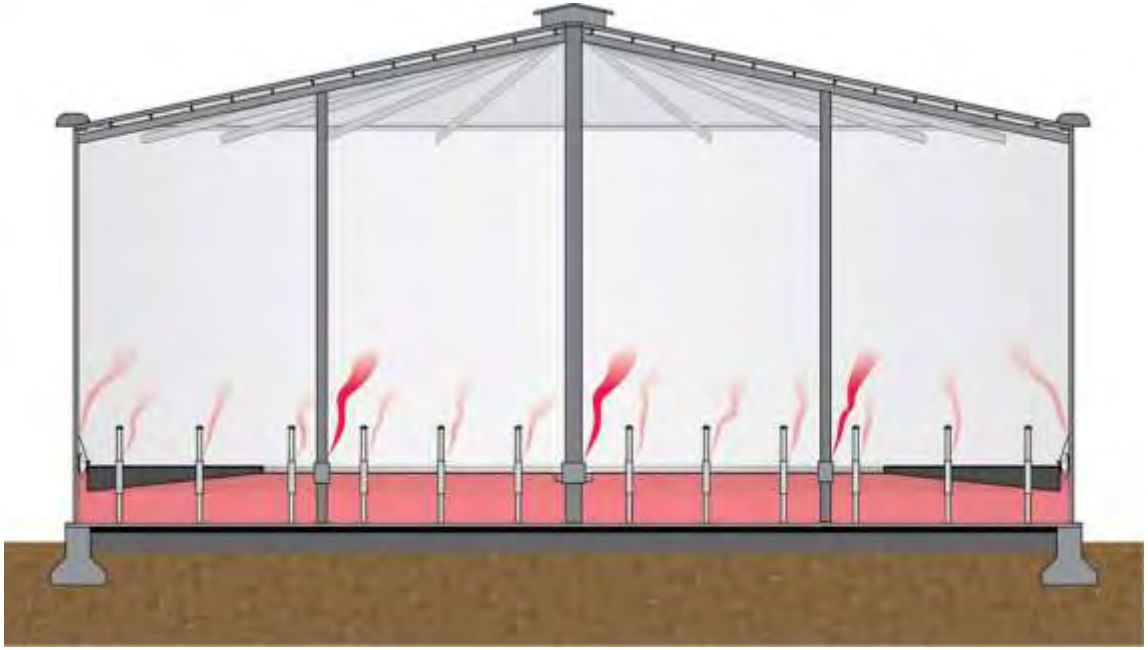


INFLUENCED BY

- Average temp
- Temperature changes (especially from sunshine and cloud patterns)
- Vapor pressure
- Tank diameter and height
- Tank color

Mechanisms for Evaporative Loss, *continued*

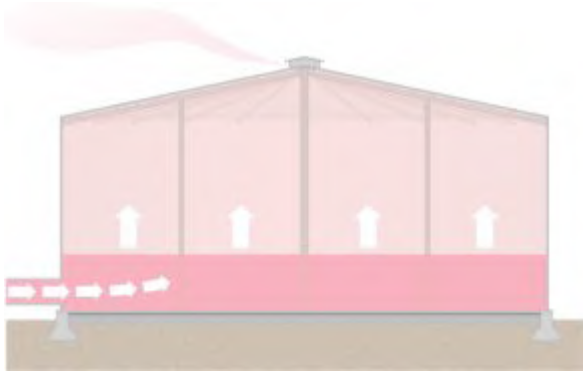
- **Standing losses – Floating Roof Tanks**
  - From rim seals, deck appurtenances and deck seams



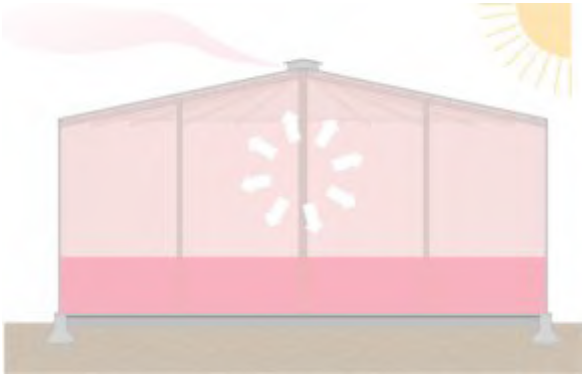
INFLUENCED BY

- Average wind speed (for EFRTs)
- Average temp
- Temperature changes
- Vapor pressure
- Fixed roof (IFRT) vs. none (EFRT)
- Floating roof type
- Deck penetrations
- Floating roof seals
- Tank color

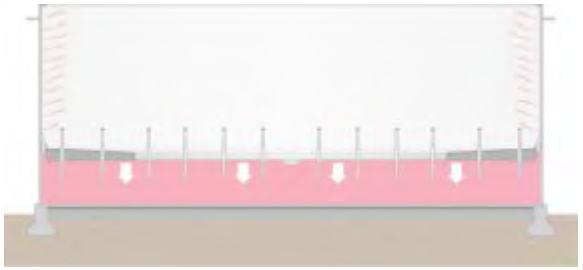
Where can we make an impact?



Working losses



Breathing losses



Withdrawal losses

Standing losses

Standing Losses – Design / Selection Factors

- **Fixed roof over the floating roof**
- **Floating roof penetrations and features**
  - Perimeter seal types
  - Deck seams (for bolted construction IFRs)
  - Appurtenances
    - **Columns penetrations**
    - **Adjustable leg penetrations**
    - **Gauge pole / ladder penetrations**
    - **Manways**
    - **Pressure / vacuum release vents**

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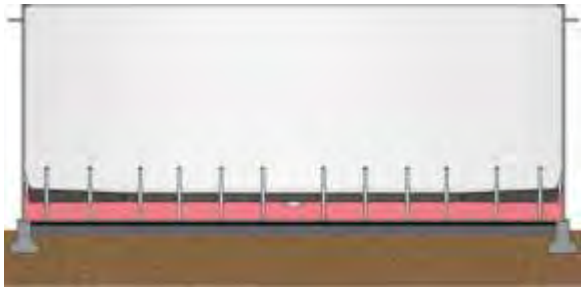
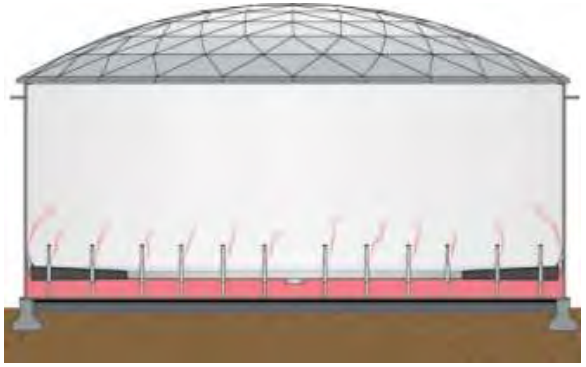
Tank & Floating Roof Types and Impact on Emissions

Floating Roof Tank Types



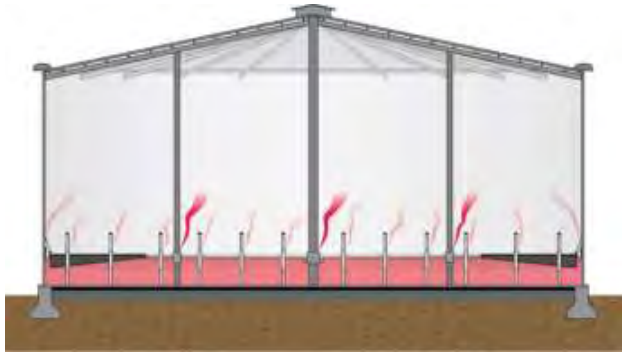
Traditional EFRT

Leg-supported Pontoon EFR



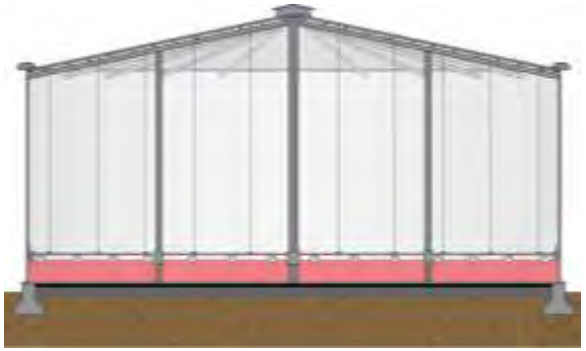
Domed EFRT

Leg-supported Pontoon EFR,
Retrofitted w/Geodesic Dome



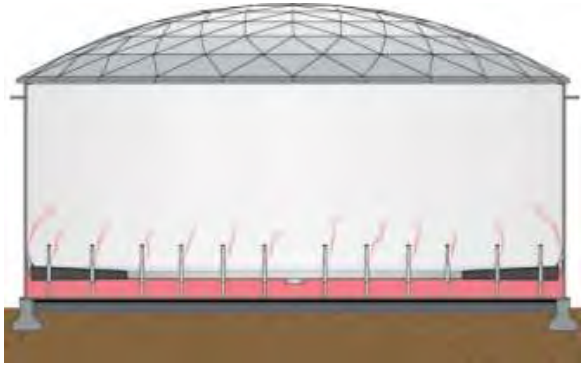
Traditional IFRT

Leg-supported IFR
under Steel Cone Roof



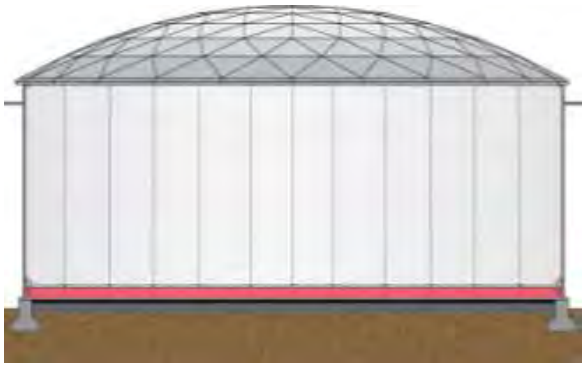
Suspended IFR

Suspended IFR under
Steel Cone Roof



IFRT with Dome

Leg-supported IFR under
Aluminum Geodesic Dome

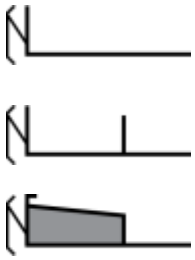


Suspended IFR + Dome

Suspended IFR under
Aluminum Geodesic Dome

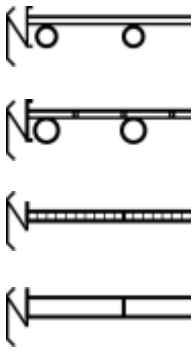
Internal Floating Roof Types

STEEL



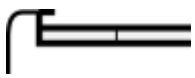
- Steel Pan
- Steel Bulkhead
- Steel Pontoon

ALUMINUM



- Conventional Skin & Pontoon
- Heavy Duty Skin & Pontoon
- Bolted-seam Panel Construction Full Contact
- Welded-seam Panel Construction Full Contact

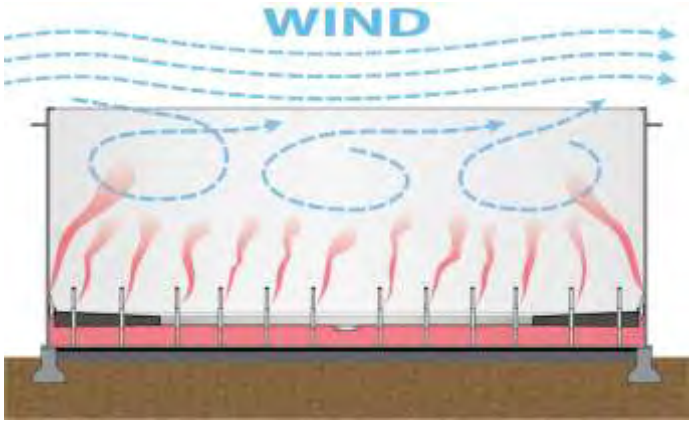
GRP

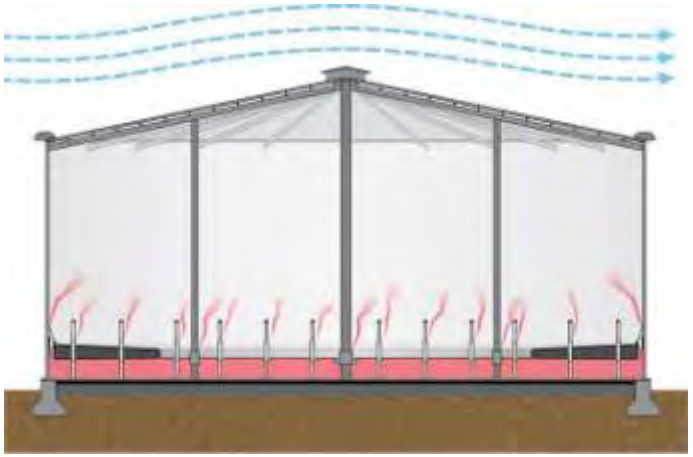


- Composite (GRP) Full Contact

Impact on emissions:

Presence of a fixed roof





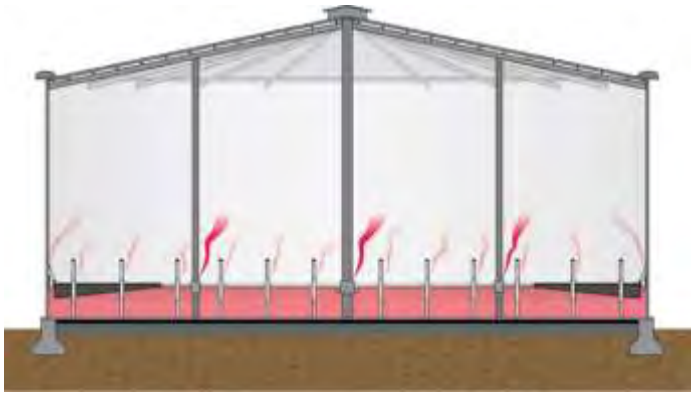
- **Eliminates wind effect**
- **Also reduces liquid surface temp**

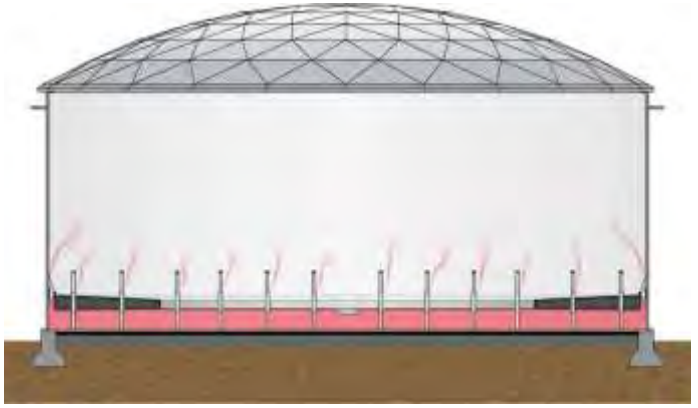
Difference of 12,859 lbs per year

Based on 120’ diameter tank in Houston storing RVP 10 Gasoline; 24 cycles/year

Impact on emissions:

Cone roof vs. self-supported fixed roof





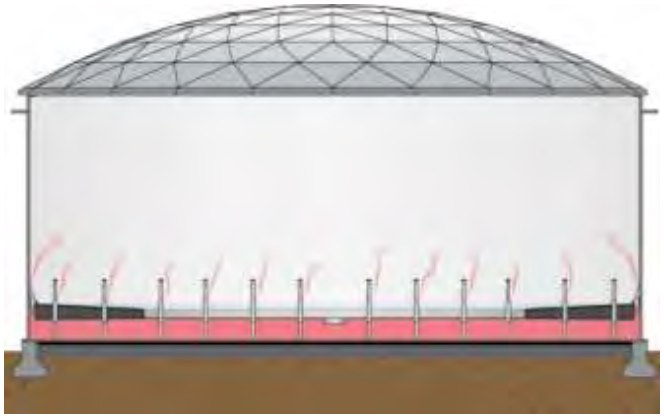
- **Column penetrations vs. none**

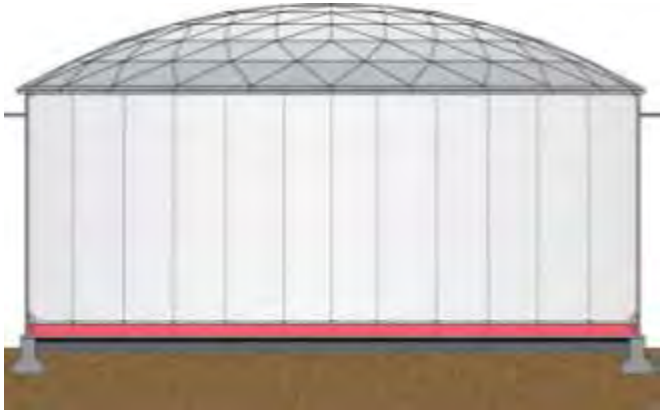
Difference of 2,986 lbs per year

Based on 120’ diameter tank in Houston storing RVP 10 Gasoline; 24 cycles/year

Impact on emissions:

Leg-supported vs. suspended IFR





- **Adjustable leg penetrations vs. none**

Difference of 2,940 lbs per year

Based on 120’ diameter tank in Houston storing RVP 10 Gasoline; 24 cycles/year

Impact on emissions:

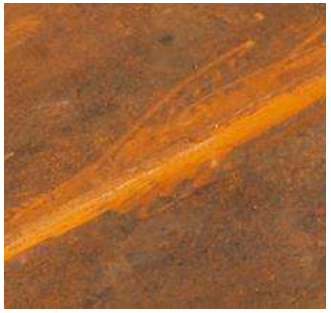
Bolted vs. Welded Construction

Bolted Construction

Skin & Pontoon AIFR
Bolted sheet Construction

Bolted Full Contact AIFR
Bolted panel Construction

Welded Construction



Steel IFR or EFR
Welded Construction

Welded Full Contact AIFR
Welded Construction

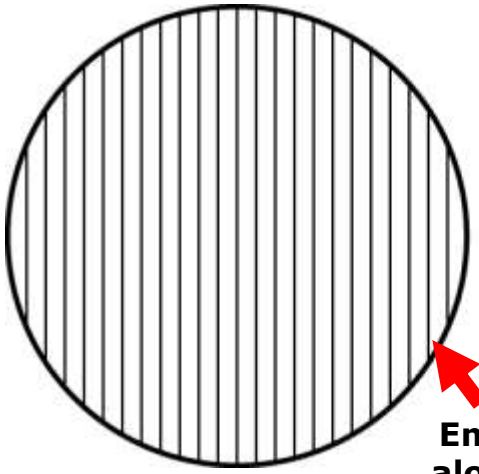
Composite (GRP)
One-piece Construction

- **Welded (one-piece) construction eliminates deck seam emissions**

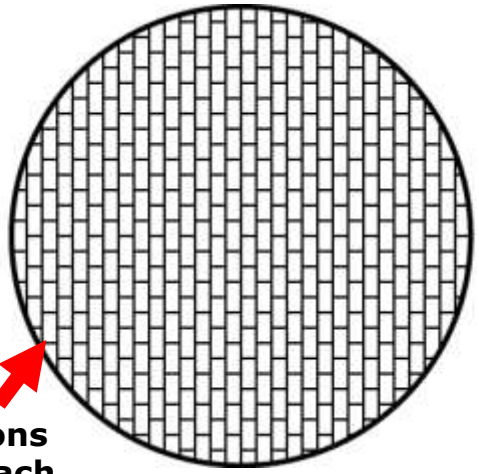
Impact on emissions:

Bolted vs. welded (one-piece) IFR construction

Skin & Pontoon
Sheet-construction
(Bolted)

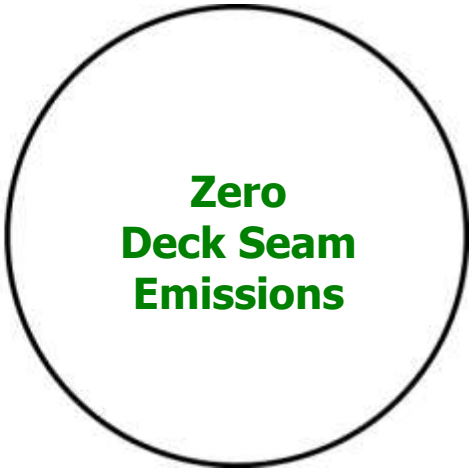


Full Contact
Panel-construction
(Bolted)



Emissions along each deck seam

Any Welded or One-piece IFR



5,136 lbs/yr

8,475 lbs/yr

0 lbs/yr

Assumptions: 120’ x 48’ tank, 2’ freeboard, Gasoline RVP 13, Houston, 24 turnovers/year.

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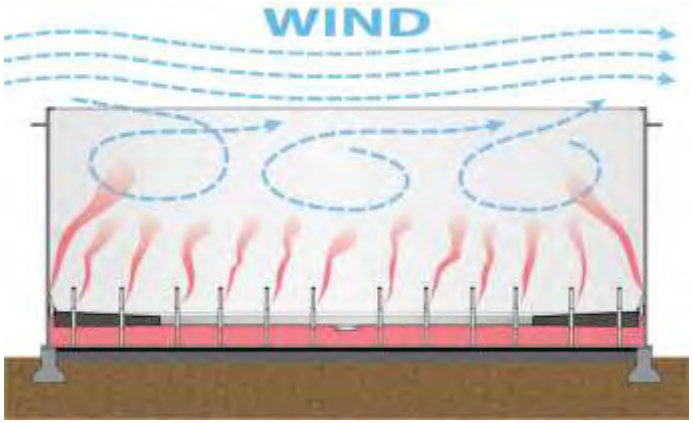
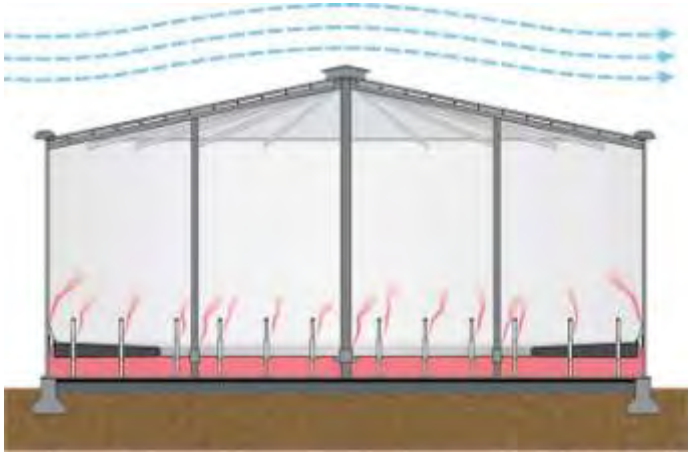
Design Strategies for Low Emissions

First design choice: EFRT or IFRT?

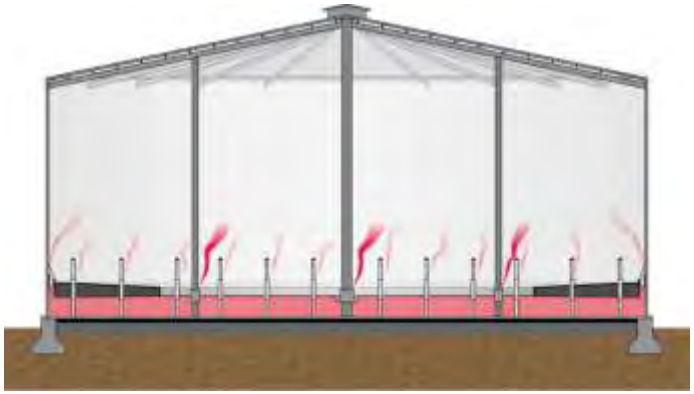




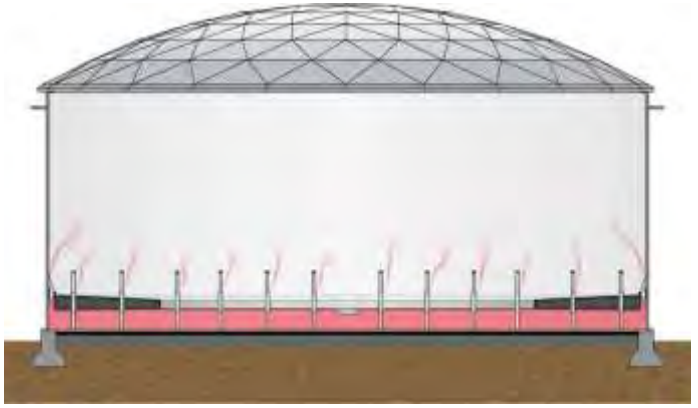
Advantages	Disadvantages
Cost	Higher emissions
Easier to achieve longer out-of-service inspection intervals	Bulky EFR profile doesn't optimize capacity
	Painting/coating required
	Drain maintenance
	Limited material choices
	Snow / ice hazards
	Rainwater gets in product

Advantages	Disadvantages
Lower emissions due to elimination of wind	Cost
More IFR type and material choices	10-year seal inspection
No drain maintenance	
Low-profile IFRs can gain significant capacity	
No snow / ice hazards	
No rainwater in product	

Second design choice: cone roof or dome?

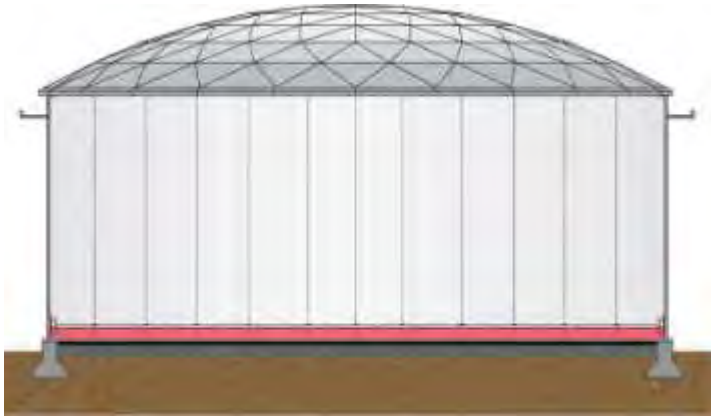


Advantages	Disadvantages
Good for sealed / pressurized applications	Higher emissions (from column penetrations)
Shallower pitch is easier to walk on	Columns create other issues (corrosion, settlement, out-of-plumbness)
	Painting/coating required

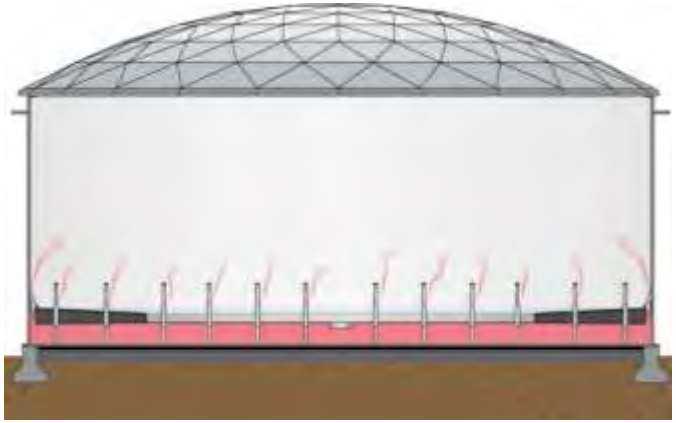


Advantages	Disadvantages
Lower emissions	Visually taller profile
No columns to maintain	Steeper pitch at perimeter more difficult to walk on
No paint to apply or maintain	
Capacity gain at top (foam chambers or rafter clips)	

Third design choice: suspended or legs?



Advantages	Disadvantages
No tank entry required to change IFR positions	Not practical with steel IFRs
Lower emissions due to elimination of leg penetrations	Evaluation of designs recommended
Eliminates maintenance, inspection, repair issues associated with legs	Suspension from existing dome may not be possible
Multiple positions can be set for flexibility	



Advantages	Disadvantages
	Tank entry required to set IFR positions
	Higher emissions (from leg penetrations)
	Legs create additional inspection / corrosion points

Fourth design choice: IFR Type

Skin & Pontoon AIFR

Bolted Full Contact AIFR

Steel IFR

Welded Full Contact AIFR

Composite (GRP)

Emissions	Fair	Poor	Good	Best	Best
Capacity	Best	Best	Fair	Best	Best
Speed of Install	Best	Fair	Fair	Fair	Good
Durability	Fair [1]	Fair/Good [2]	Best	Good	Best
Corrosion Resistance	Poor to Good [3]	Poor to Good [3]	Poor to Good [3]	Poor to Good [3]	Best
Can be Suspended	Yes	Yes	No	Yes	Yes
Cost	$$ / $$$	$$ / $$$	$$$$	$$$$	$$$$$

[1] Skin & Pontoon IFRs come in a wide range of weights and qualities; heavy duty skin & pontoon IFRs with bi-directional structure and connections designed to handle high cycles, high flow rates, and dynamic loading can last longer than the tank without major maintenance required

[2] Bolted full-contact IFRs also come in a wide range of qualities and designs; consult manufacturers for more information

[3] Depends on product and whether steel roof is painted / coated

Alternate technologies have made significant advancements

- **Talk to your IFR suppliers to learn more**

Emissions Comparison (lbs/year)

for Various Tank Configurations and Various Major Markets

	Common Tank Configurations				
Location	**EFRT**	**Cone Roof Steel IFR Adj Legs**	**Cone Roof, Aluminum Skin & Pontoon IFR, Adj Legs**	**Cone Roof, Aluminum Bolted Panel AIFR, Adj Legs**	**Dome Roof, Welded Panel AIFR Suspended (no legs)**
Houston	20,896	8,037	12,960	14,423	**1,464**
Los Angeles	17,701	7,196	11,594	12,902	**1,327**
New Jersey	20,653	5,834	9,383	10,438	**1,090**
Chicago	18,975	5,245	8,426	9,372	**991**
Tulsa	24,597	6,887	11,092	12,343	**1,271**
New Orleans	21,808	8,040	12,965	14,430	**1,465**
Singapore	18,837	10,553	17,046	18,977	**1,891**
Saudi Arabia	41,181	11,445	18,495	20,591	**2,058**

Assumptions

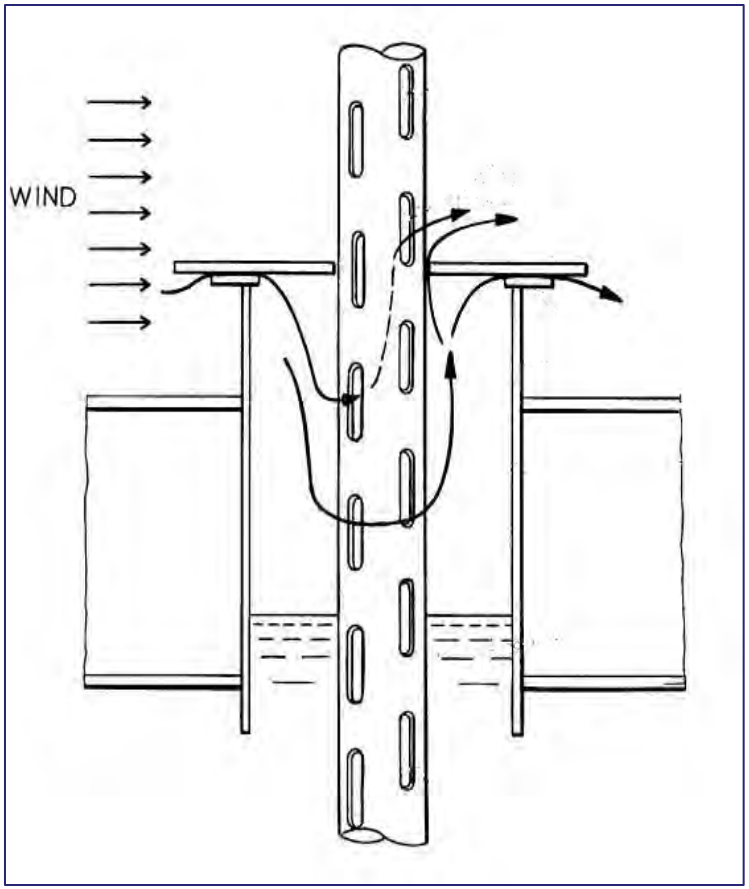
- **All tanks are 120’ diameter x 48’ tall with 44’ of working capacity (3,722,518 gal)**
- **Stored product is gasoline, RVP 10**
- **Each IFR equipped with primary mechanical shoe seal and rim-mounted secondary seal**
- **Each IFR with the exception of the welded IFR is equipped with adjustable deck legs**
- **Emissions based on 24 tank turnovers per year**
- **Bolted panel based on a 5’ x 12’ panel; bolted sheet is 5’ wide**
- **All deck fittings “Typical” except the suspended IFR, which has no leg penetrations**
- **Cone roofs have 7 columns**

4

Other minor strategies

Gauge Pole Sleeves

- **Gauge Pole Wells are often overlooked as large sources of emissions and product loss**
- **Large liquid surface area**
- **An improperly sealed gauge pole can emit more than 25 times the VOCs as the entire primary and secondary seal systems combined**
- **Wind makes the problem worse**



Gauge Pole Sleeves, continued

Roof Leg Socks

Tank Diameter

- **Smaller diameter = less emissions**
- **Strategy:**
  - Get soil analysis done early in the game to see if you can go up in height and reduce diameter

Summary of Strategies

- **Major design strategies**
  - Eliminate wind effect (cover the tank)
  - Eliminate columns (use a self-supported fixed roof)
  - Eliminate leg penetrations (suspend the IFR)
  - Eliminate deck seams (use welded or one-piece construction)
- **Other minor strategies**
  - Gauge pole sleeves
  - Leg socks
  - Tank diameter (early in design process)

Thank You

Questions: jeickhoff@hmttank.com

www.hmttank.com