

MARSH SOLUTIONS...DEFINED, DESIGNED, AND DELIVERED.

## THREE PILLARS OF INDUSTRIAL (FIRE) SAFETY

Dr Jeanne van Buren  
sr. consultant




---

---

---

---

---

---

---

---

### THE PARADOX OF INDUSTRIAL SAFETY

- Conditions of industrial processes and the use of hazardous substances in industrial processes result in risks
- Risks can be controlled using suitable structural and instrumental provisions combined with organizational Lines of Defense (LoD)
- In practice, attuning these LoD categories (can) pose a problem due to lack of communication

MARSH 19 August 2015 1

---

---

---

---

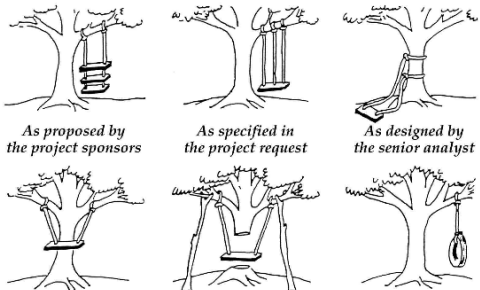
---

---

---

---

**"Problem solving is an art form not fully appreciated by some"**



As proposed by the project sponsors      As specified in the project request      As designed by the senior analyst

As produced by the programmers      As installed at the user's site      What the user wanted

With acknowledgements to S Heigh, who produced this very clear and elegant version of the tree swing pictures for teaching design in 1993

MARSH 19 August 2015 2

---

---

---

---

---

---

---

---

### INDUSTRIAL SAFETY

- Many stakeholders with very different interests and backgrounds
- An array of variables which can potentially affect industrial safety
- Codes and standards are very useful references, but practice always deviates from theory
- Industrial safety therefore requires an integrated approach with all stakeholders on board



<http://www.tmsdi.com/>

MARSH

19 August 2015

3

---

---

---

---

---

---

---

---

### THREE PILLARS INDUSTRIAL SAFETY (1)

Industrial safety is built on three pillars:

- **Structural provisions**
- **Installations & instrumentation**
- **Organizational aspects**

MARSH

19 August 2015

4

---

---

---

---

---

---

---

---

### THREE PILLARS INDUSTRIAL SAFETY (2)

#### **Structural provisions / Installations & instrumentation / Organizational aspects**

- The weakest link in the system determines the overall level of safety
- This is applicable to normal process conditions, startup, shutdown and during incidents
- Compliance with codes and standards alone is not sufficient

MARSH

19 August 2015

5

---

---

---

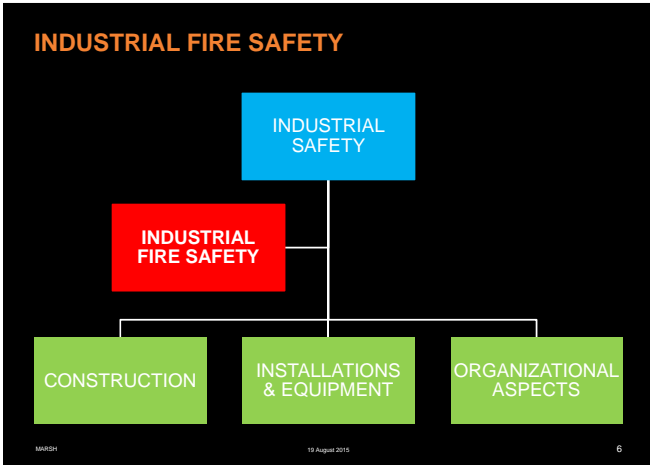
---

---

---

---

---




---

---

---

---

---

---

---

---

---

---

**EXAMPLE - MOBILE RESPONSE TO TANK FIRE**

<http://artofftroubleshooting.com/2013/02/18/storms-a-comin/>

- Tank complies with all relevant codes/standards
- Lightning strike causes full surface tank fire
- Pre-planned for mobile mutual aid response by off-site fire department

MARSH 19 August 2015 7

---

---

---

---

---

---

---

---

---

---

**NFPA 11 (1)**

**5.2 Outdoor Fixed Roof (Cone) Tanks**

Extinguishing methods - not considered to be in any order of preference:

- (1) Foam monitors and hand lines
- (2) Surface application with fixed foam discharge outlets
- (3) Subsurface application
- (4) Semi-subsurface injection methods

MARSH 19 August 2015 8

---

---

---

---

---

---

---

---

---

---

**NFPA 11 (2)**

**5.2.5.1.3** Fixed foam discharge outlets shall be attached at the top of the shell and shall be located or connected to preclude the possibility of the tank contents overflowing into the foam lines.

**5.2.5.1.4** Fixed foam discharge outlets shall be attached so that displacement of the roof will not subject them to damage.



MARSH

19 August 2015

9

---

---

---

---

---

---

---

---

---

---

**NFPA 11 (3)**

**5.2.4 Design Criteria for Foam Monitors and Handlines**

**5.2.4.1 Limitations**

**5.2.4.1.1** Monitor nozzles shall not be used as the primary means of protection for fixed-roof tanks over 18 m (60 ft) in diameter.

**5.2.4.1.2** Foam handlines shall not be permitted to be used as the primary means of protection for fixed-roof tanks over 9 m (30 ft) in diameter or those over 6 m (20 ft) in height.

MARSH

19 August 2015

10

---

---

---

---

---

---

---

---

---

---

**NFPA 11 (4)**

**5.2.1 Supplementary Protection**

In addition to the primary means of protection, supplementary protection shall be provided in accordance with the requirements found in Section 5.9.

**5.9.1 Additional Protection**

In addition to the primary means of protection, some types of hazards shall require provisions for supplemental means of protection.

MARSH

19 August 2015

11

---

---

---

---

---

---

---

---

---

---

### NFPA 11 (5)

#### 5.9.2 Supplemental Foam Hose Stream Requirements

See NFPA 11 (page 24)

MARSH

19 August 2015

12

---

---

---

---

---

---

---

---

### CONSTRUCTION

- Tank design: weak seam, diameter tank, ERV, N<sub>2</sub>-purge
- Location of tank



MARSH

19 August 2015

13

---

---

---

---

---

---

---

---

### CONSTRUCTION & EMERGENCY RESPONSE (1)

- Site access & infrastructure
- Two options to access site to allow upwind approach of incident
  - Road width - can vehicles turn, manoeuvre around the corner, across train rails
  - Bearing capacity
  - Obstructions (pipe rack, rail track, ..)
- Location emergency control centre



MARSH

14

---

---

---

---

---

---

---

---

### CONSTRUCTION – BUND DESIGN (1)

- Bund floor – concrete, gravel, sand, clay, ..
- Bund wall – concrete, dike, metal sheeting (covered or not), brick wall



<http://www.rubis-terminal.nl/en/helicopter-view.html>



<http://adanoilandgas.com/page/details/specializatior/services/icon/>

MARSH

19 August 2015

15

---

---

---

---

---

---

---

---

---

---

### CONSTRUCTION – BUND DESIGN (2)

- Bund wall height
- Bund floor
- Bund wall penetrations
- Sloping floor
- Drainage

MARSH

19 August 2015

16

---

---

---

---

---

---

---

---

---

---

### INSTALLATIONS & INSTRUMENTATION (1)

Monitor conditions, intervention, adjustment, alarms, ...

- Required to assure safe operations
- Required levels of protection (redundancy)
- Incorporate and plan for impairment
- Distinct between technical and organizational Line(s) of Defense
- Alarm settings
- Suitability, reliability, and availability

MARSH

19 August 2015

17

---

---

---

---

---

---

---

---

---

---



### INSTALLATIONS & INSTRUMENTATION TANKS (5)

- Heating liquid in tank:
  - Hot water coil
  - Steam coil
  - Electrical heating coil
- Floating roof: water on roof, position of roof, leak in roof
- Flow restriction and static electricity

---

---

---

---

---

---

---

---

### ORGANISATIONAL ASPECTS

Extensive topic – non exhausting enumeration

- Staffing arrangements versus identified task for:
  - Standard operational conditions
  - During turnaround
  - Start-up shut down
  - Incidents
- Training and competency
- Inspection, testing, and maintenance (ITM)

---

---

---

---

---

---

---

---

## QUESTIONS

---

---

---

---

---

---

---

---





---

---

---

---

---

---

---

---