



# HSE in Engineering Design

AIChE Seminar on Safety

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## CB&I Introduction

- CB&I designs, engineers and constructs some of the world's largest energy infrastructure projects
- Lummus part of CB&I since 2007
- Approximately 18,000 employees worldwide
- More than 700 projects a year
- Three business sectors:
  - Lummus Technology
  - Project Engineering and Construction
  - Steel Plate Structures



## HSE Introduction

- Chempack, 2010, fire, environmental damage, 41,5 million euro economical loss
- BP, Deep Water Horizon, 2010, Gulf of Mexico, USA. Fire, Explosion and large oil spillage. 11 people killed
- BP, Texas, 2005, Explosion in Isomerization Unit, 15 fatalities, 170 injuries and millions in losses





## HSE Introduction

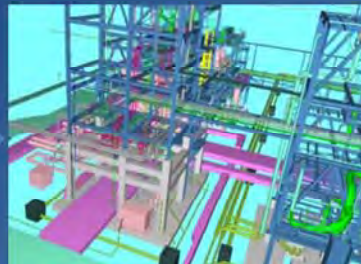
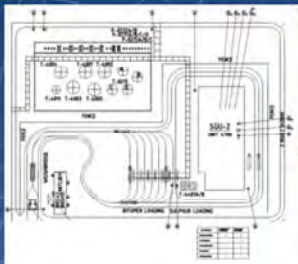
• FEED

EPC



Process  
Mechanical  
Civil  
Piping

Electrical  
Instrumentation  
HSE  
Project  
Management



## HSE Introduction

What is the role of HSE in Design and Engineering of a Facility?

- Identification, Assessment and Mitigation or Control of all HSE Risks which may impact People, Installation Integrity and Environment
- Ensure Design is in accordance with the latest Legislation and Regulations, Standards and Norms

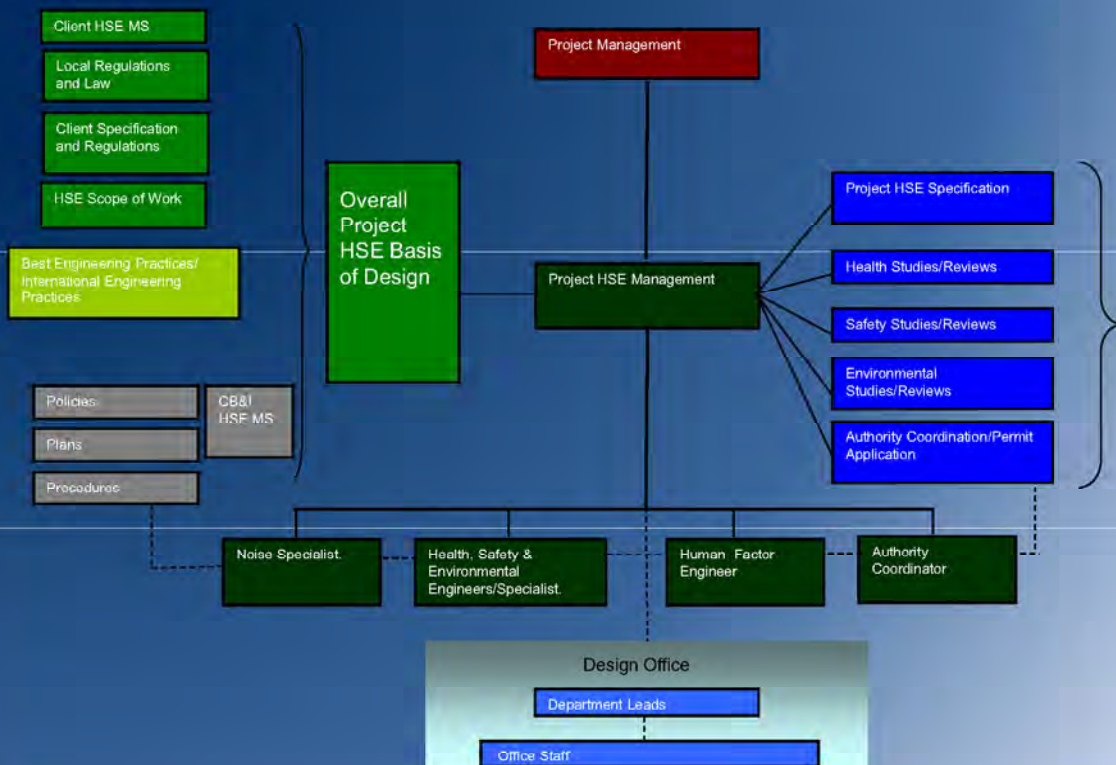


# HSE Management System

- HSE-MS
  - HSE Plan
  - HSE Policy
  - HSE Objectives and Targets
  - Roles and Responsibilities
  - Training
  - Procedures and Work Instructions
  - Communication
  - HSE Performance Indicators
  - Audits and Reviews
  - Follow-up/Stewardship



# HSE Organization in a Project





## HSE in Engineering

- Compliance to legal and other requirements
- HSE Reviews
- Fire Fighting
- Environmental Engineering
- Human Factor Engineering
- Health Engineering
- HSE related to Construction



## HSE Rules/Regulations/Standards/Norms

- Legislation, Regulations and Authorities Guidelines
  - Local regulations
  - European Directives
  - Occupational Safety and Health Administration (OSHA)
  - World Health Organization (WHO), Guidelines for Air Quality
- International Guidelines
  - API, NFPA, IEC, IP, ASME, NEN
- Insurance Company Loss Prevention Guidelines
  - GE GAP
- Client and CB&I Standards



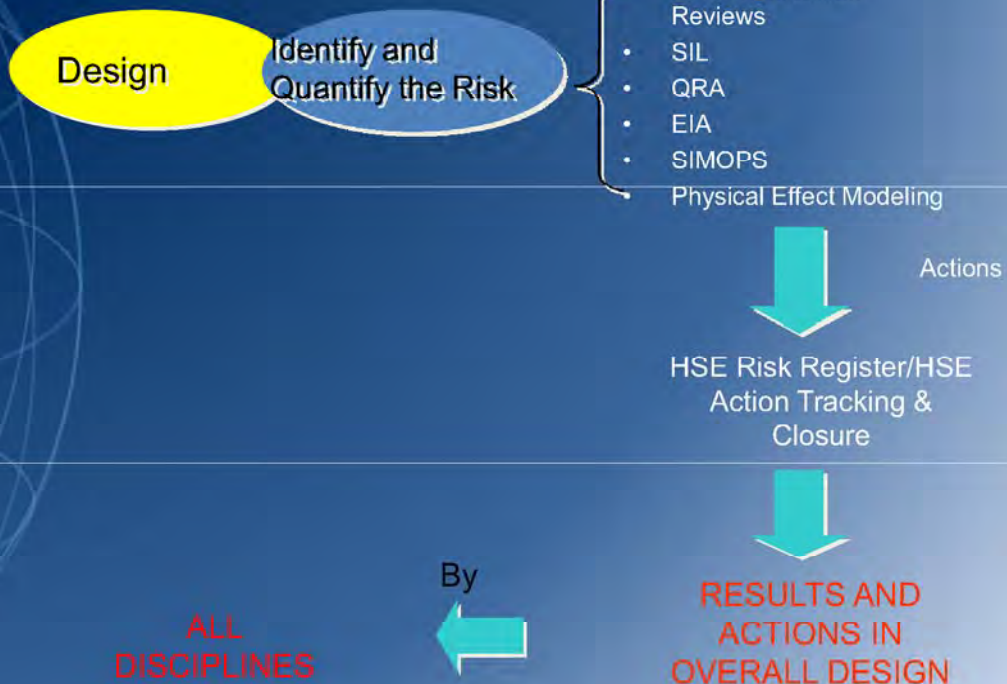


# Legal Compliance Register

Law/Regulation	Title	Applicable (Y/N)	Article	Requirement	Action to be taken	Responsible party	Status FEED
MD 9/97	Forms the Medical Commission and the Medical Appeal Commission relating to establishing differences between work-related injuries and non-work related injuries as well as establishing the degree and type of injury.			Might be applicable to Construction	EPC contractor to check if Medical Commission and medical appeal Committee of existing refinery is sufficient for the project.	Epic contractor	Closed
MD 17/93	Regulations for the Management of Solid Non-Hazardous Wastes	Y	2	Occupants of premises used for residential, commercial, industrial, agricultural or other purposes shall store and dispose solid non-hazardous waste in accordance with the provisions of these Regulations and the decision of the Concerned Authority to this effect, such that there is no nuisance or hazard to the public health.	Rules below shall be adhered to: No further action		Closed
			3	The Concerned Authority shall establish a suitable system for the collection, storage and transport of all solid non-hazardous waste arising within its specialized area towards all residential complexes, other than residential complexes of less than 200 inhabitants which can be excluded by a decision from the Minister, provided that no nuisance or hazard to the public health is risked thereby.	Not applicable as this is an action for the Concerned Authority		Closed
			4	Occupants or users of residential sites shall deliver all the waste produced from the use of this site to the system established for the collection of such waste.	This action has been made part of the Project Waste management Plan (S-000-5650-002)	HSE	Closed



# HSE Reviews



ALL DISCIPLINES

RESULTS AND ACTIONS IN OVERALL DESIGN

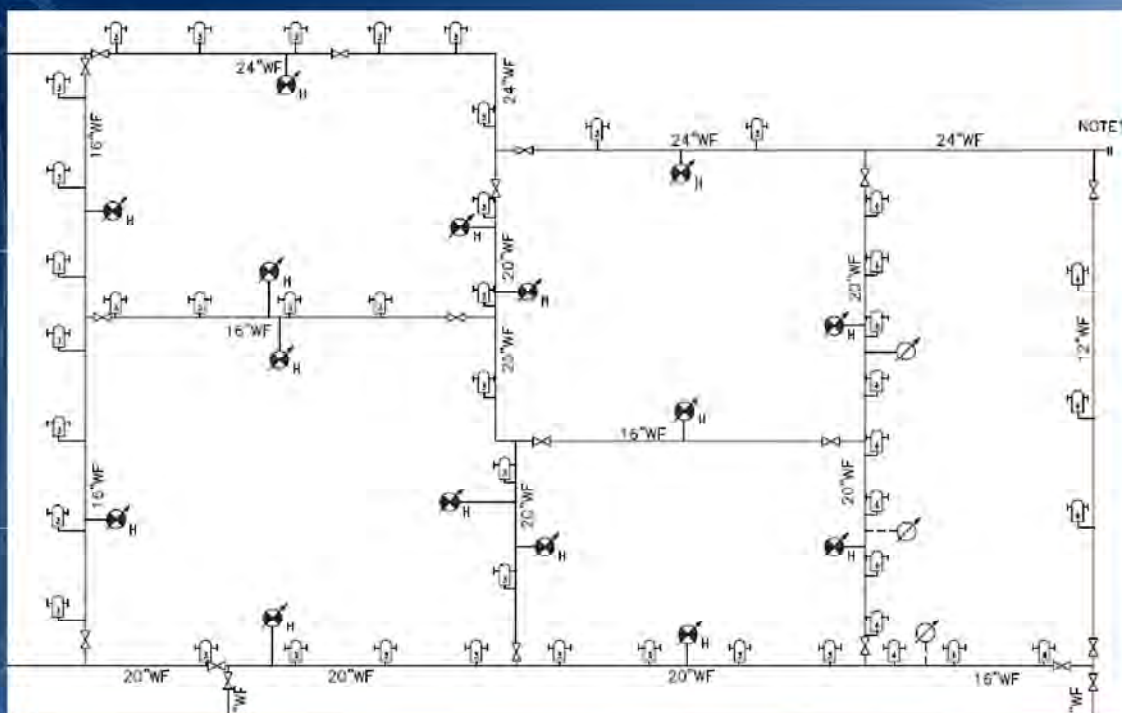


# Fire Fighting

- Fire Fighting Philosophy
  - Regulations
  - Fire Scenarios
  - Single or Double Fire
- Fire Water System
- Passive Fire Protection
- Fire and Gas Detection
- Fire Safety Equipment (Safety Showers, Portable fire extinguishers)

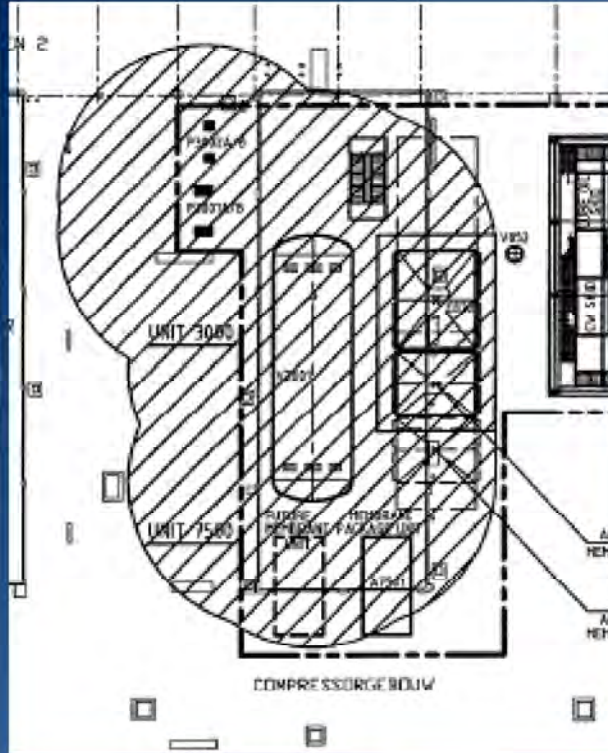


## Fire Fighting – Fire Water System



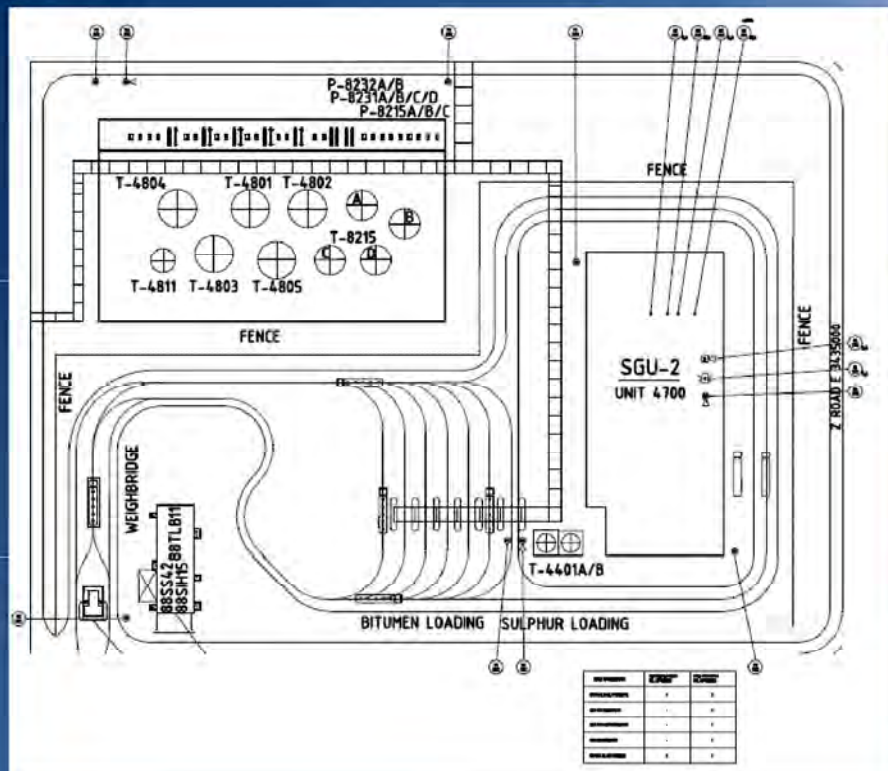


# Fire Fighting– Passive Fire Protection



# Fire Fighting– Fire and Gas detection

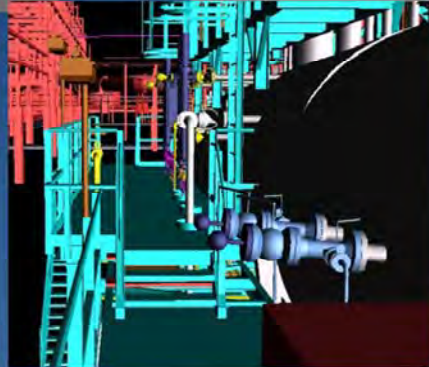
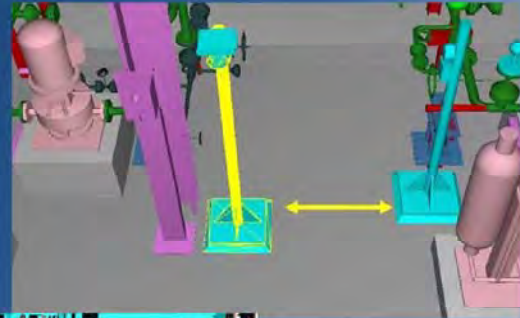
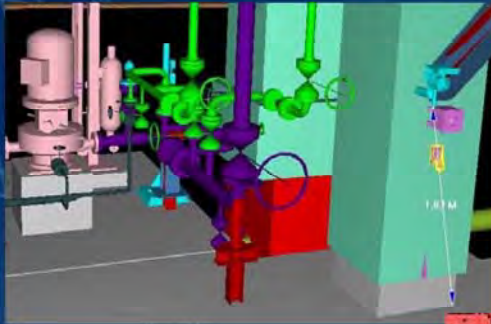
Toxic  
Flammable  
Fire  
detection







## Fire Fighting– Fire & Gas detection

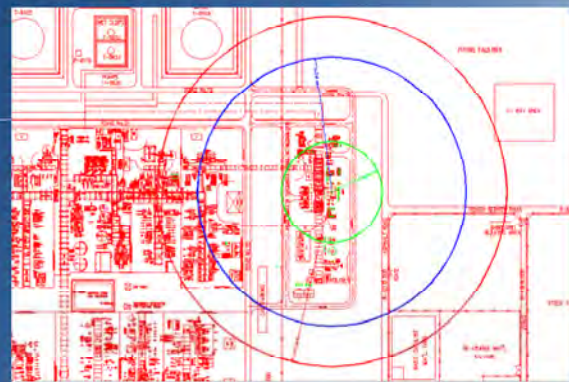
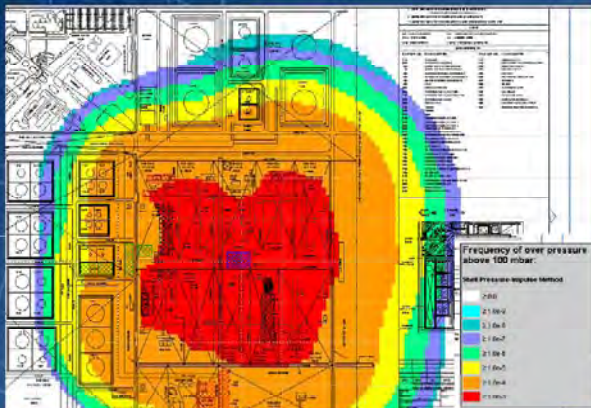


Detail location of Fire & Gas Detectors, Instruments



## Fire Fighting – Overpressure Contours

Overpressure Risk Contours using SAFETI



Gas Dispersion Contours



## Environmental Engineering

- Environmental/Waste Management Plan
- Emissions, Effluents and Waste Inventories Studies
- Environmental Hazard Identification (ENVID)
- Environmental Impact Assessment
- Air Dispersion Calculations
- BAT Analysis



## Environmental– Dispersion calculations

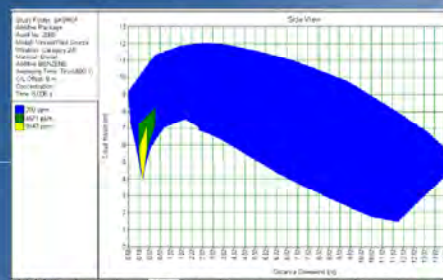
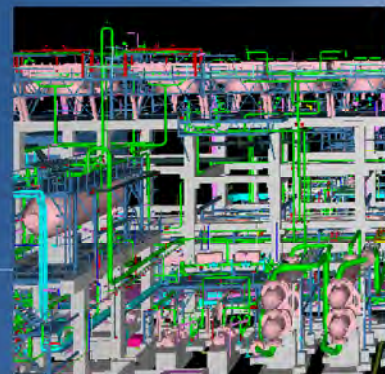


Grade/Platform Level



Steam  
Cold water, hot water  
Flue gases,  
N<sub>2</sub>  
Flow  
Pressure

**Safe Location ?**



Elevation and Location based on Consequences Modeling (Dispersion Calculation and/or Jet fire) by HSE



## Human Factor Engineering

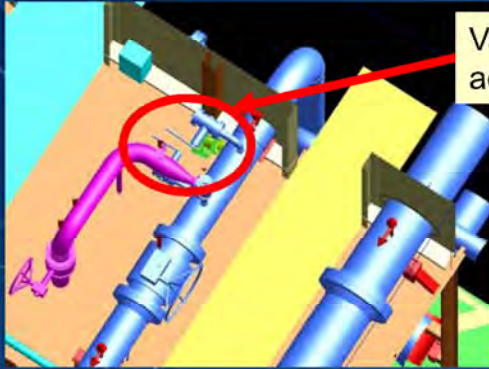
- Human Factor Engineering Plan
- Implementation of Regulations and Standards
- HFE Training
- Identification of Valves Analysis (IVA)
- 3D Model Reviews
- HFE reviews on Vendor Packages



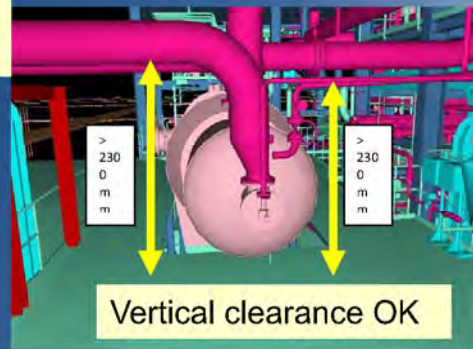
## Human Factor Engineering

- Aim is to prevent rework!

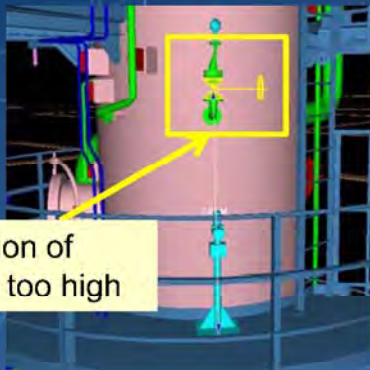




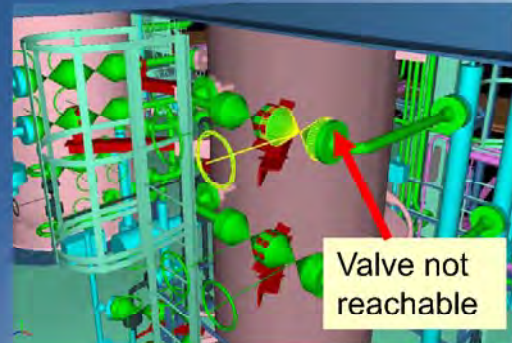
Valve is not accessible



Vertical clearance OK



Position of valve too high



Valve not reachable

– Ergonomics Bulletin nr 04 – November 2009

## Foreword

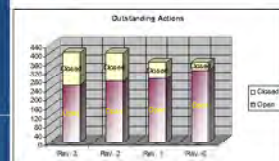
Welcome back ladies and gents! A lot of things have happened during the last two months. HFE health checks, 30% Model Reviews, 30% HFE Model Reviews, updates, new actions, etc. A lot of excitement indeed, but also a lot of (good) work has been done and more is expected in the following months.

## Model Reviews

After the 30% Model Review, the Project Ergonomic Team has met several times to consider and evaluate the status of design against the requirements listed in the HFE Register (see the updated progress in the next section). One of the objectives of these focused sessions is to arrive at the 60% Model Review (around the third week of January, i.e. almost around the corner!) with all 30% issues closed and in a very good shape for the 60% check.

## HFE Register Progress

As a matter of fact, the number of actions in the HFE Register is growing, but fortunately the action close-out rate is running faster, so everything is under control.



Since the last bulletin issued in September, the HFE Register has been updated and issued twice, the total number of issues increases from 361 to 405 (rev. 3), while the number of closed actions also rises from 74 (rev.1, ca. 20.5%) to 146 (rev. 3, ca. 36.5%), a lot of work is still to be done, but it is a remarkable result. Go keep going folks!

## F&G Check

Along with the various HFE checks, in the first days of November several reviews of the F&G system design have been performed both from a HSE (i.e.

effective position of the detectors) and HFE (i.e. maintainability and, when relevant, reachability) point of view.

Here below some examples of detector design



We can see here that the highlighted H2S detector is correctly positioned around pump P8003A. The position is correct because the equipment is located according to the indication of the F&G layout, it is accessible and reachable and it does not obstruct maintenance operations around the pump.



In this case, the beam and the beacon installed in front of the K-5001/2 compressor shed are shown. The design is ok, because even if these items are not accessible from grade, there is sufficient space around them for maintenance.

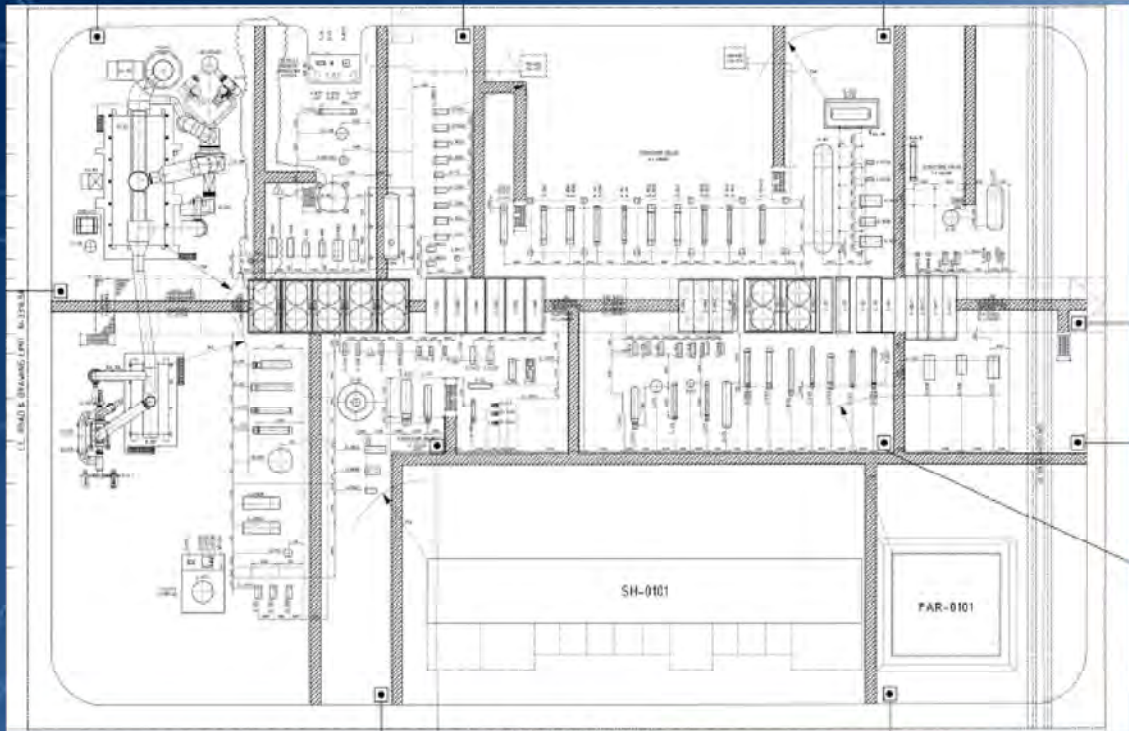
In the last example shown below, we can see the location of a Manual Call Point within HDS-B Substation. The button appears to be perfectly reachable (1.4 m from grade) and positioned adjacent to the exit door.

Besides some detectors still to be designed and optimized, a very good job has been done by the instrumentation department. Chapeau!





## Human Factor Engineering – Escape Routes



## Health Engineering

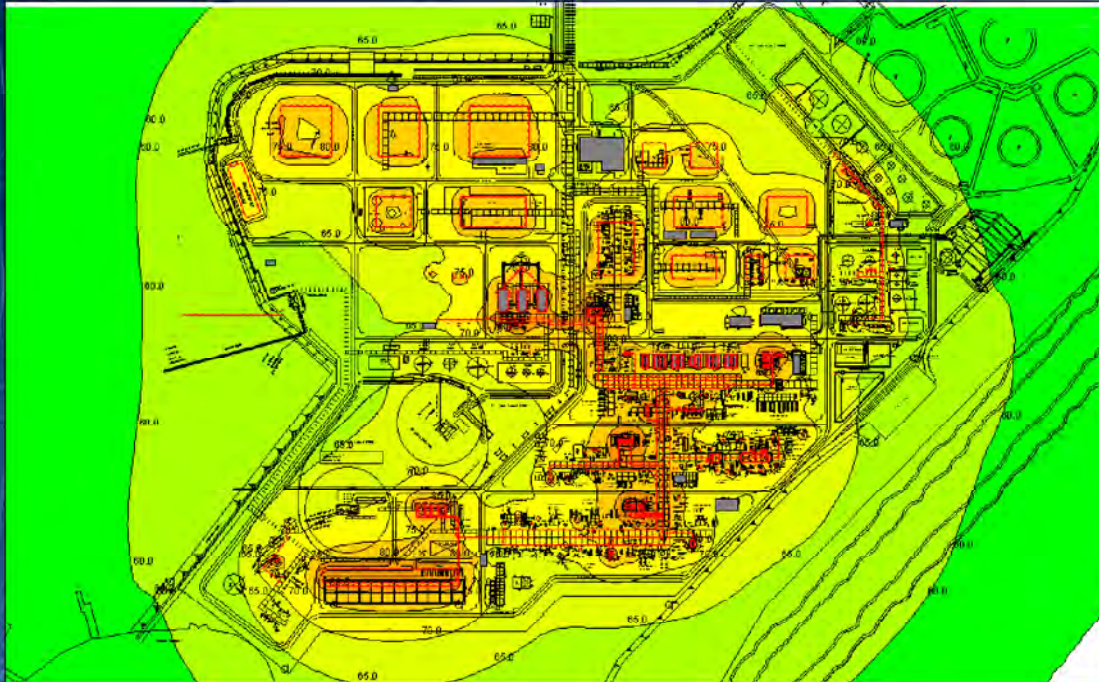
- Health Risk Assessment
- Materials Safety Data Sheet Analysis
- Noise Allocation Studies





## HSE in Engineering - Noise

### Noise Allocation Study



## HSE related to Construction

### Assistance to Construction:

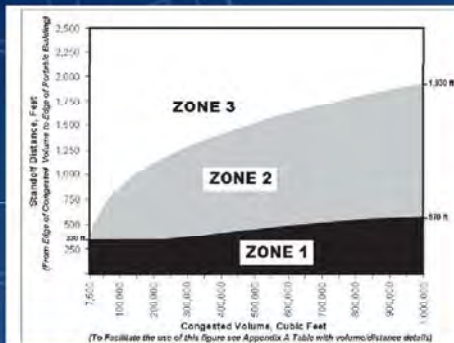
- HSE Construction Plan
- Setting/Location of Construction Temporary Facilities
- Support for application of Environmental Permit and Building Permit
- Subcontracting
  - Tender Package Preparation
  - Subcontractor HSE program reviews during bids
  - Subcontractor HSE execution Strategy/Plan Review
- Activities during Construction
  - Owner of overall HSSE Project Risk Register
  - Construction Emergency Response Plan
  - HFE (Ergonomics) Site reviews
  - HFE training to subcontractor
  - Authority requirements





# HSE in Construction - temporary facilities

- Location of temporary facilities



## Conclusion

### The role of HSE during Design and Engineering of a Facility

- Identification, Assessment and Mitigation or Control of all HSE Risks which may impact People, Installation Integrity and Environment
- Ensure Design is in accordance with the latest Legislation and Regulations, Standards and Norms
- Design and Engineering of Fire Safety Facilities

## Why is this important?

- Chempack, 2010, fire, environmental damage, 41,5 miljoen euro economical loss – no environmental permit for storage and handling of flammable liquids in IBC's
- BP, Deep Water Horizon, 2010, Gulf of Mexico, USA. Fire, Explosion and large oil spillage. 11 people killed – Design and Construction
- BP, Texas, 2005, Explosion in Isomerization Unit, 15 fatalities, 170 injuries and millions in losses – facility siting

