# Process Safety in Design

## A Matter of Philosophy

BEYOND ZERO®
Our Culture of Caring

KIVI Kring Leiden/Rotterdam, Jan 2015,
Ton Jansen, Manager DHSE Jacobs NL

JACOBS®

www.jacobs.com | worldwide

# Disclaimer

**Important**

The material in this presentation has been prepared by Jacobs®.



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# Agenda

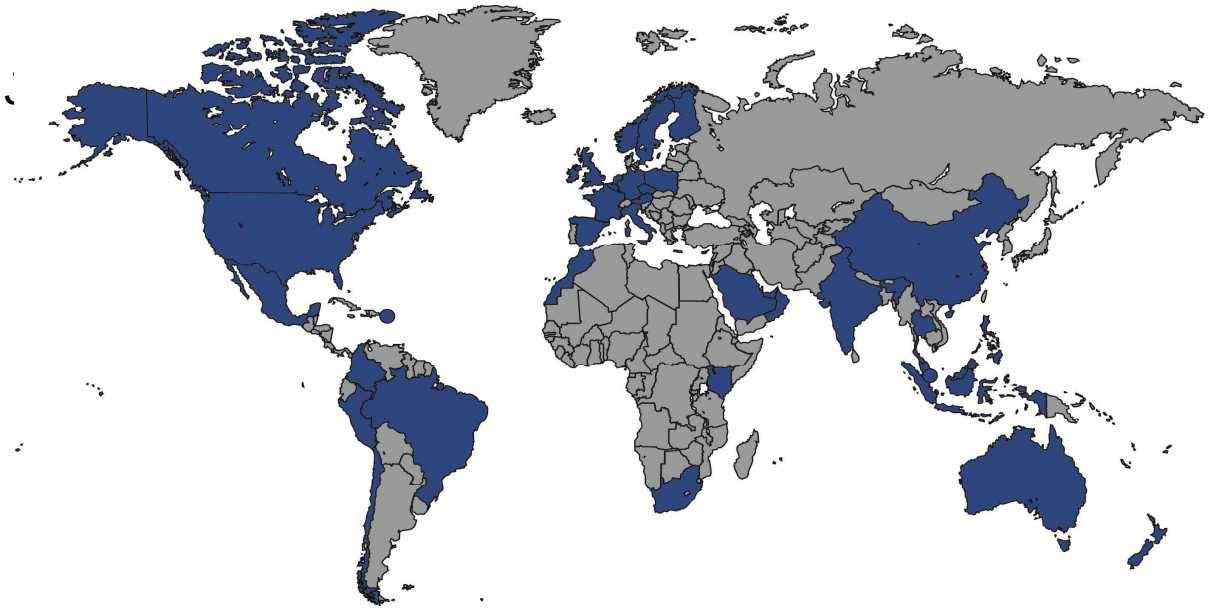
- Safety Topic
- Introduction Jacobs
- Major Incidents
- Process Safety in Design
- Design HSE with Jacobs
- Discussion/Questions

# About us

Headquartered in
Pasadena, California, USA

**1947**
Founded by Joseph J. Jacobs

**70,000+**
Employees



**$12.7**
Billion 2014 Revenues

**30+**
Countries

**$5.3**
Billion 2014 Client Savings

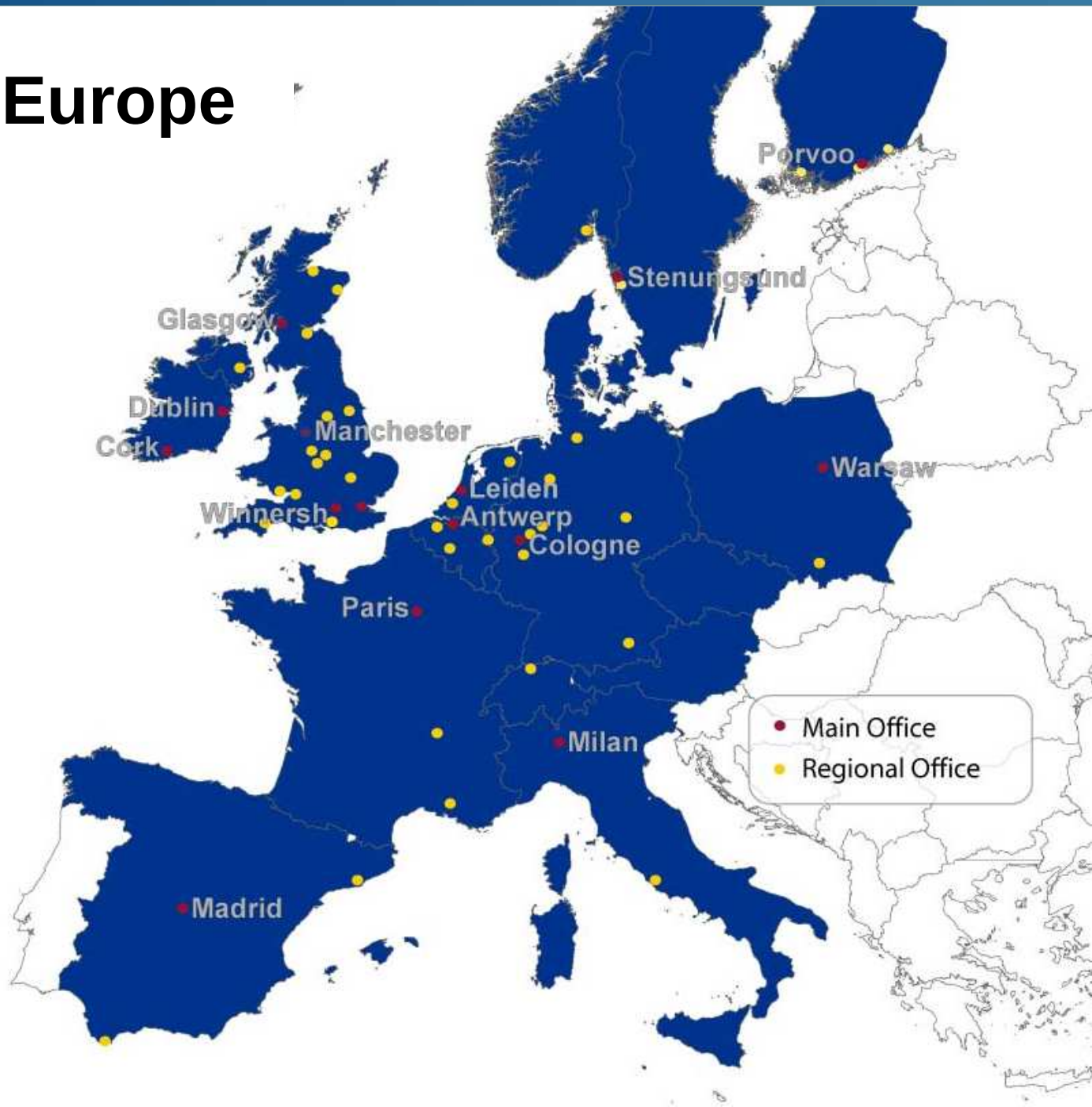
**JEC**
Publicly traded on NYSE

**250+**
Offices

# Jacobs - Offices in Europe

| Resources by Country | |
|---|---|
| **Offices** | **Resources** |
| Belgium | 585 |
| Finland* | 780 |
| France | 550 |
| Germany | 340 |
| Ireland | 744 |
| Italy | 248 |
| Netherlands | 1.508 |
| Poland | 142 |
| Spain | 111 |
| Sweden | 142 |
| United Kingdom | 9,494 |
| **Total** | **14,644** |

** Neste Jacobs Oy*



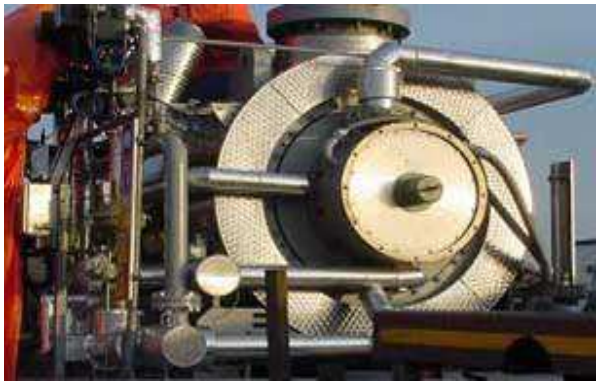
# Jacobs in The Netherlands

## Key Clients:

- ✓ Shell
- ✓ NAM
- ✓ DSM
- ✓ BP
- ✓ Sabic
- ✓ ExxonMobil
- ✓ DuPont
- ✓ KPE
- ✓ Vopak
- ✓ LyondellBasel
- ✓ Dow

## Industry Sectors Served:

- ✓ Upstream
- ✓ Refining
- ✓ Petrochemicals
- ✓ Sulfur
- ✓ Fine Chemicals
- ✓ Pharmaceuticals
- ✓ Light Industry
- ✓ Energy
- ✓ Consultancy Services



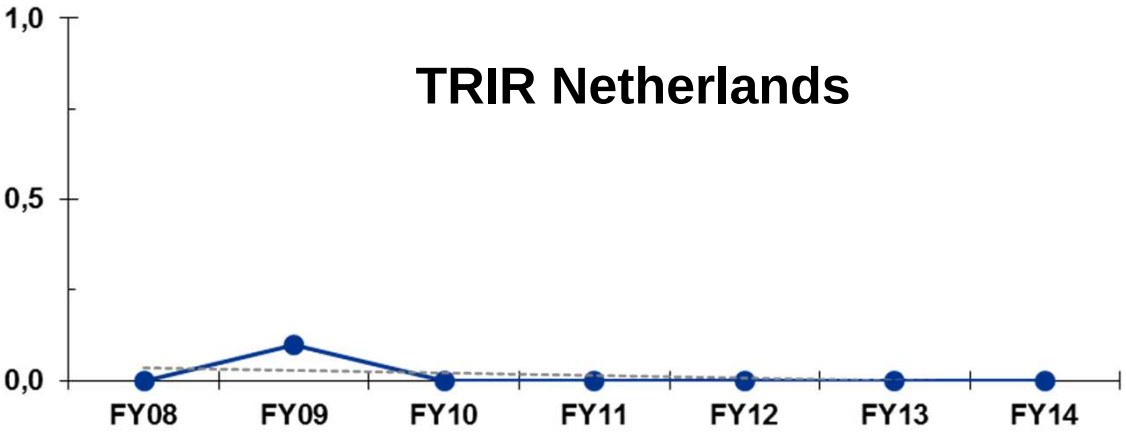
# The Netherlands – Disciplines & Expertise

| DISCIPLINES | TOTAL |
|---|---|
| (Design) HSE | 54 |
| Process | 189 |
| Civil / Structural | 84 |
| Instrumentation / Electrical | 275 |
| Mechanical / Piping | 259 |
| Project Management / Engineering | 158 |
| Project Services | 163 |
| Construction Management | 50 |
| Procurement / Contracting | 88 |
| General Management / H.O./Admin. | 126 |
| Others (QM/Consult./Authority) | 62 |
| **TOTAL** | **1508** |

*European Hydrocarbon Center of Excellence*


| OFFICES | |
|---|---|
| Leiden | 1009 |
| Rotterdam Area | 144 |
| Meerssen | 152 |
| Sappemeer | 203 |

# BeyondZero




- ✓ 24x7 Culture of Caring
- ✓ NL winner of the 2014 President's BeyondZero® Excellence Award
- ✓ Recent Safety Campaigns
  - Gloves
  - Working at heights

## What is Unique About BeyondZero®

It is…

- A personal commitment to eliminate all incidents and injuries
- Conversation about possibility rather than probability
- Culture focused on creating a healthy and harm-free environment rather than avoiding incidents
- Organizational commitment to enable an existence free of incident and injury
- Built on leaders who act from deeply held core values

It is moving beyond:

- Numbers
- Compliance
- Quick, "off-the-shelf" technical fixes

**It is about us – Our employees, Our families, Our friends**

"Our commitment to safety never ends and we intend to set the pace for our industry. Our goal is zero accidents; we won't be satisfied until we achieve it."

*Noel Watson, Executive Chairman and CEO, Jacobs*

# Speaker Introduction

## Ton Jansen

- Tech. University Eindhoven (1989), Chemical Technology
- 2011- Present Jacobs
  - Since Aug 2011 Department Manager DHSE
- 2001-2010 Aker Kvaerner / Aker Solutions
- 1991-2001 Badger / Raytheon E&C / Washington Intl.

# "Tegelwijsheid"

# Major Incidents

## Lack of Process Safety > **Major Incidents**

- Jun 1974 > Flixborough (UK)
- July 1976 > Seveso (It)
- Nov 1984 > Mexico City (Mex)
- Dec 1984 > Bhopal (Ind)
- July 1988 > Piper Alpha (North Sea)
- Sep 2001 > Toulouse (Fr)
- Mar 2005 > Texas City (USA)
- Dec 2005 > Buncefield (UK)
- Apr 2010 > Deep Water Horizon (Gulf of Mexico)

# Major Incidents

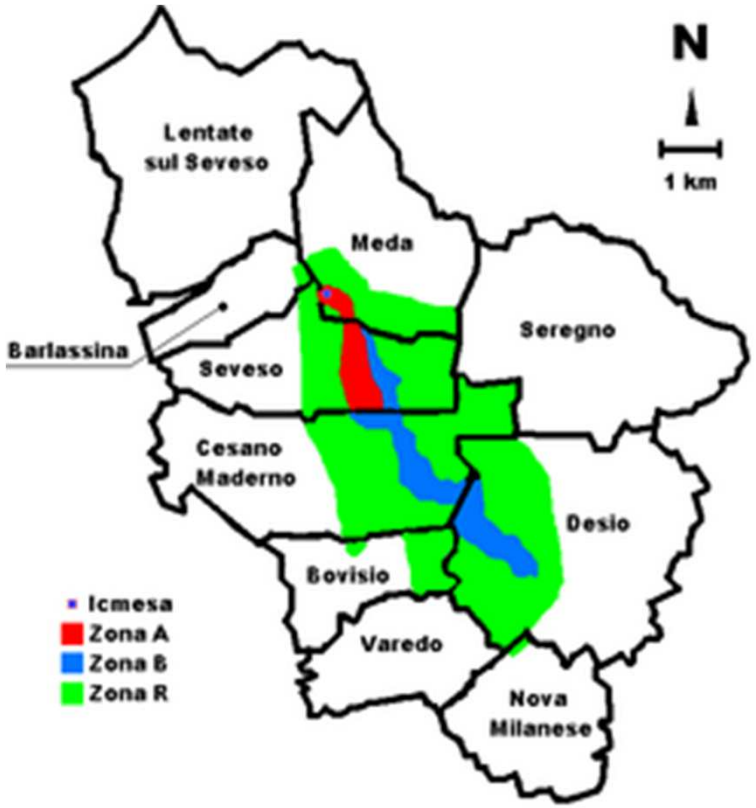
## Flixborough, UK (June 1974)

- Partial oxidation of cyclohexane
- Catastrophic failure of temporary piping
- 30 tonnes of hot cyclohexane released in 30 s
- Vapor cloud explosion
- 28 fatalities, 53 injuries; 1800+ houses damaged; plant destroyed
- 18 of those fatally injured were in control room
- Passing of UK “Health and Safety at Work” Act

# Major Incidents

## Seveso, Italy (July 1976)

- Runaway reaction
- 2 kg of dioxin release from relief system
- Over 17 km2 affected
- Locally grown food banned for several months
- Several inches of topsoil removed, incinerated
- 80,000 animals died or slaughtered
- Plant shut down and destroyed
- EU “Seveso Directive” prompted



# Major Incidents

## Mexico City, Mexico (November 1984)

- Large LPG / fuels storage facility
- Fires, vessel ruptures, boiling-liquid-expanding-vapor explosions (BLEVEs)
- Initiating cause unknown
- 600 fatalities, 7000 injuries
- Horizontal tanks rocketed as far as 1200 m away
- Fixed fire protection destroyed by blasts
- Fuels terminal destroyed

# Major Incidents

## Bhopal, India (December 1984)

- Pesticide production facility
- Water introduced into methyl isocyanate storage
- MIC toxic vapor release from vent system
- Total fatalities (1994): ~35,000
- Plant shut down; Union Carbide eventually sold
- Seveso II, EPA Risk Management Program prompted

# Major Incidents

## Piper Alpha, North Sea (July 1988)

- Gas / Oil Platform, 170km NE of Aberdeen
- When platform was converted original safety concept was abandoned
- Simultaneous maintenance on pump and relief valves
- Condensate pump was started unaware that relief valve missed, replaced by hand tight blind, > Leak > Ignition > Explosion
- 167 fatalities

# Major Incidents

## Toulouse, France (Sept 2001)

- Ammonium nitrate storage at fertilizer plant
- Explosive decomposition initiated; cause unknown
- Equivalent blast energy 20-40 tons of TNT
- 30 fatalities; 2500+ injuries; US$ 2 billion in losses

# Major Incidents

## Buncefield, UK (December 2005)

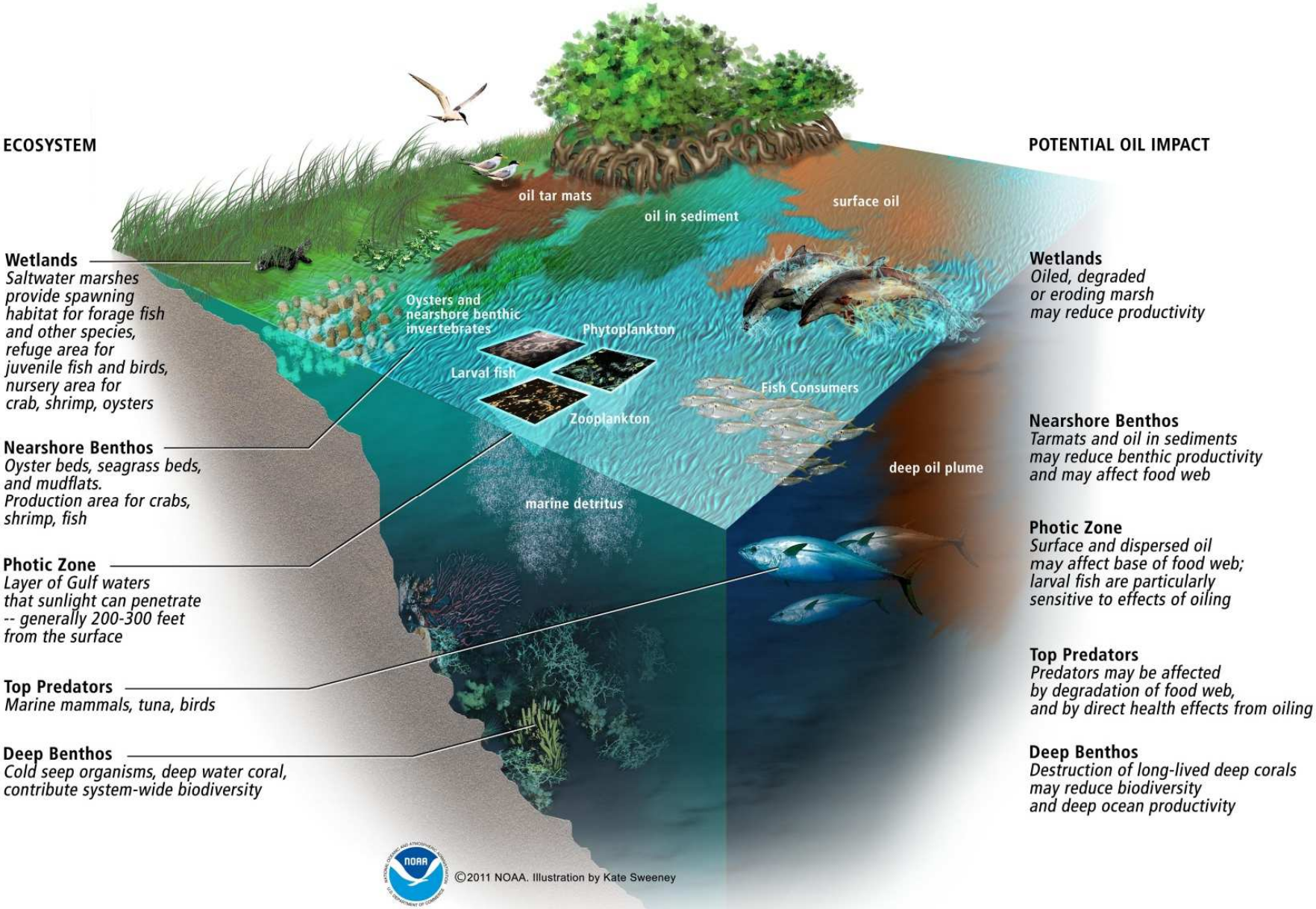
- Petrol (gasoline) tank farm
- Storage tank overflow
- Ignition, vapor cloud explosion and fires
- 40+ injuries; 20+ tanks destroyed
- Consequences could have been much worse

# Major Incidents

## Deep Water Horizon, Gulf of Mexico (April 2010)

- 11 fatalities, 17 injuries
- Biggest environmental disaster in US history
- Release of 800.000 – 6.400.000 liter/day crude oil
- 5 months to completely stop the oil flow
- Main cause improper design in order to save time and money

# Major Incidents



# Major Incidents

## Texas City, Texas (March 2005)

- Refinery isomerization unit
- Board operators on duty for 30 days
- One valve not opened during unit re-start
- Release of hot flammable material from vent stack
- Ignition and vapor cloud explosion
- 15 fatalities, 180 injuries
- Barker Report

# Major Incidents

# Major Incidents

## Texas City, Texas (March 2005)

Impact for Jacobs

- 15 fatalities
- All contractors, none direct BP
- 11 fatalities Jacobs (hired) contractors
- 127 Jacobs employees OSHA Recordable Injury
- Not involved in the Isomerisation Unit
- Enhanced Jacobs commitment to Safety > Never Again
- Beyond Zero® Program
- Own criteria for Facility Siting

# What is *Process Safety*?

1. The absence of loss and harm resulting from fires, explosions and hazardous material releases at process facilities
   [Event Focused]
2. The absence of loss and harm at process facilities by
   - Identifying Process Hazards
   - Containing and Controlling them
   - Countering abnormal situations with effective safeguards

   [Activity Focused]

# Process Safety in Design

For an engineering contractor SAFETY in all phases of a project shall be considered

- Engineering
- Construction
- Operation and Maintenance
- Demolition

# Process Safety in Design

In order to produce a Safe Design one should know:

- Why do loss events happen?
- How do loss events happen?
- What must be done to avoid them?

# Why do loss events happen?

- Handling dangerous process materials and energies
- As we do so the potential for loss events is always existing

# High Level Analyses:

Loss Event  Impact

Point of time in an abnormal situation when an irreversible physical event occurs that has the potential for loss and harm impacts

*[release, ignition, rupture……]*

# How do loss events happen?

- (HAZARD)
- Initiating Cause
  - Failure, Wrong Feedstock,…..
- Deviation
  - No flow, High Pressure,….
- Loss Event
  - Release, Fire , Explosion,…
- Impact
  - Injury, Fatality, Damage,…

# What must be done to avoid loss events?

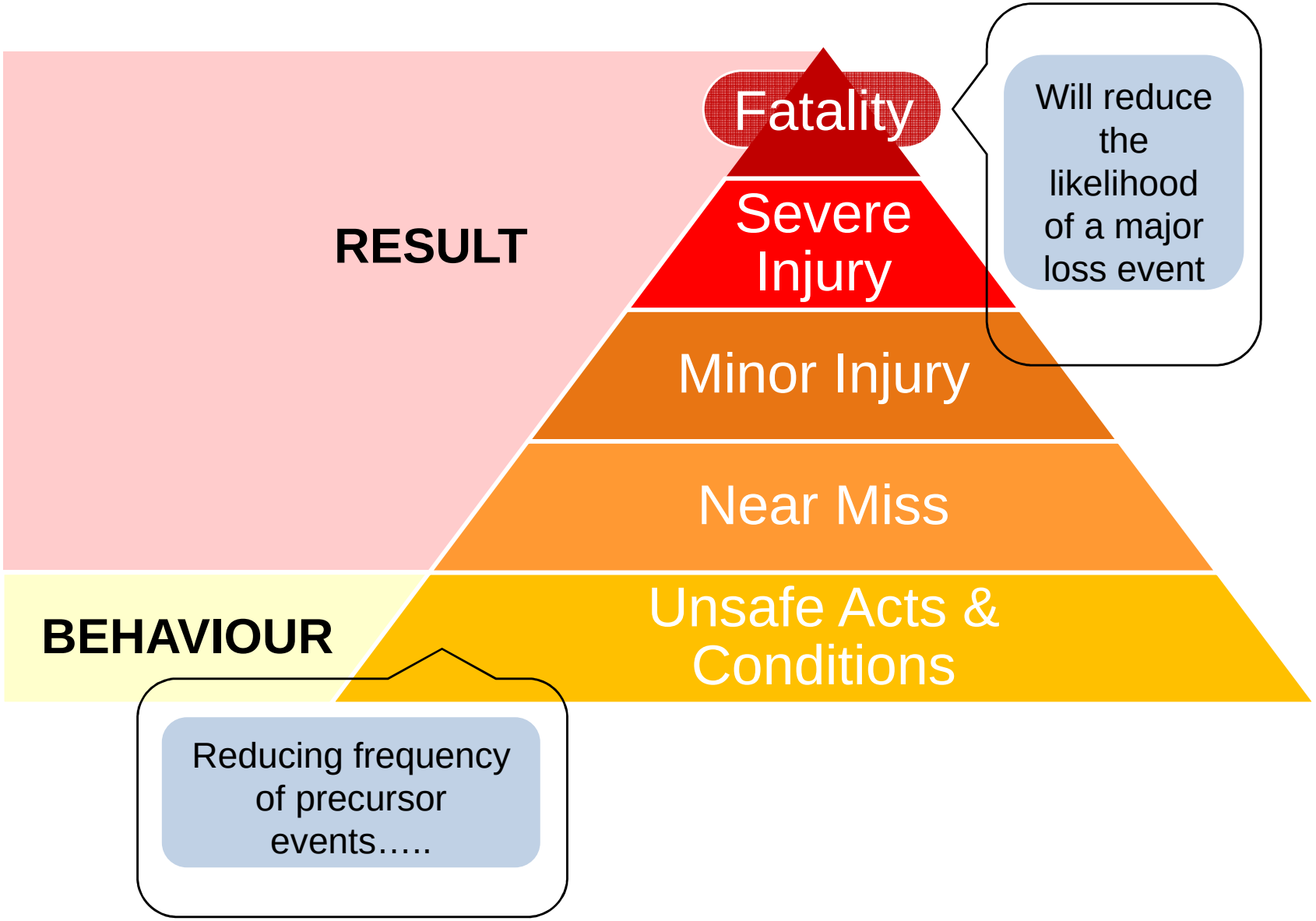
- Most engineering focuses on designing a process to ***work:***

  "**normal situation**"

- We must also consider how a process can ***fail,*** starting with an

  "**abnormal situation**"

# Process Safety in Design



# Process Safety in Design

Always apply proper safety strategies during engineering:

1. Inherent Safe Design – Hazard Reduction
2. Passive Safeguards – Design features that reduce risk without active functioning of any device
3. Active Safeguards – Engineering Controls
4. Procedural Safeguards

# Process Safety in Design

Process Safety is **not** a Single Discipline responsibility

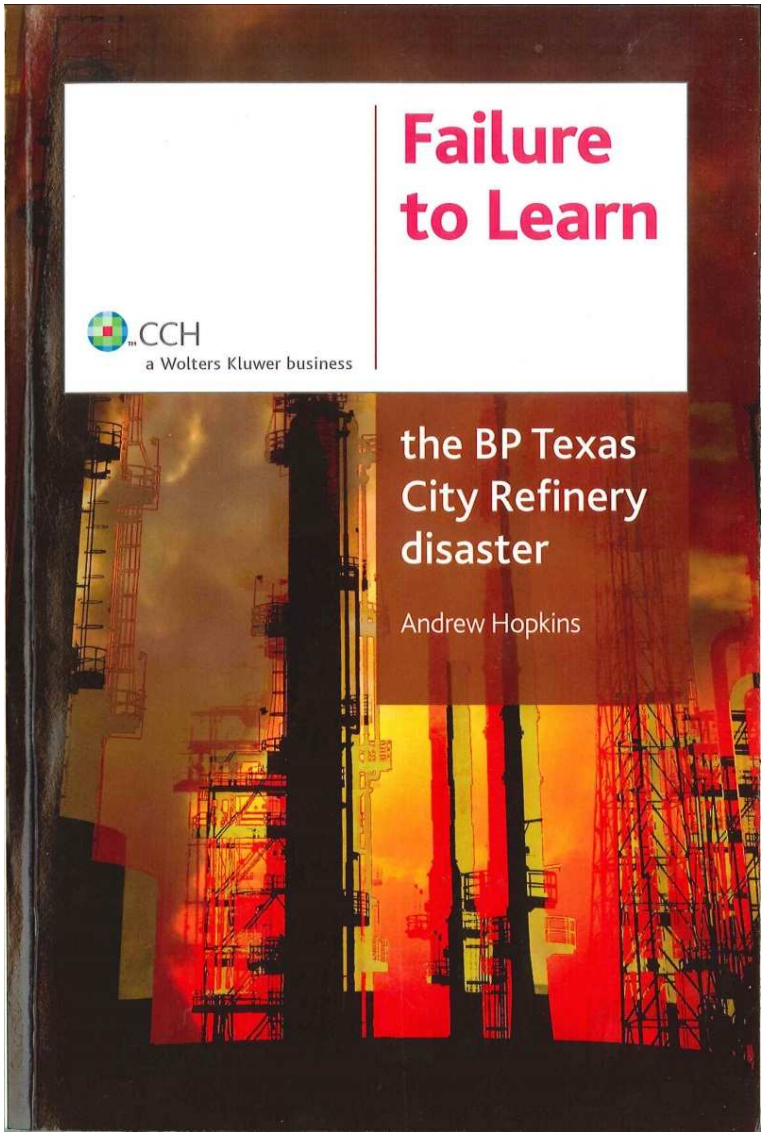
- Full involvement of:
  - Client Engineering
  - Client Operation
  - Client Safety Specialists
  - Contractor Engineering and (D)HSE
- Full commitment of Management

# Process Safety in Design

Interesting reading material:

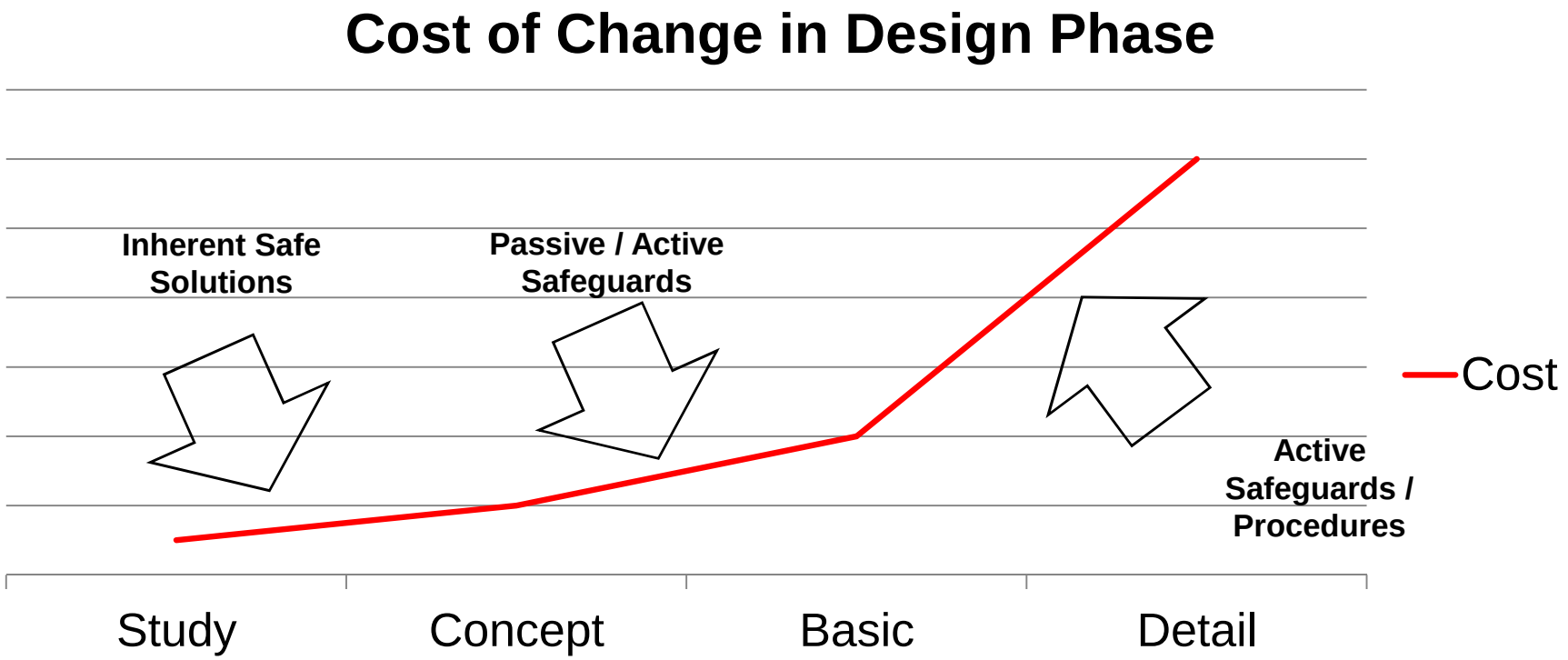
“Failure to Learn”

by Prof Andrew Hopkins



# Process Safety in Design

Process Safety starts at the beginning of the design effort (Front End Loading)



# Process Safety in Design

- Design with Safety in your Mind
- Timely Risk Assessments (HAZID, HAZOP, QRA, SIL)
  - Use proper assessment for each phase
- Follow up based on:
  - Inherent Safer Design
  - Passive Safeguards
  - Active Safeguards
  - Operational Procedures

Common pitfalls in a design environment:

1. Technical challenges are addressed in silo's
2. Technical standards are considered to be known
3. Impact of changes is under estimated (outside scope)
4. Working on "out-dated" documents (as-builts)
5. Multiple projects using the same documents
6. Copy existing designs without challenge

How do we address these at Jacobs:

Common pitfalls in a design environment:

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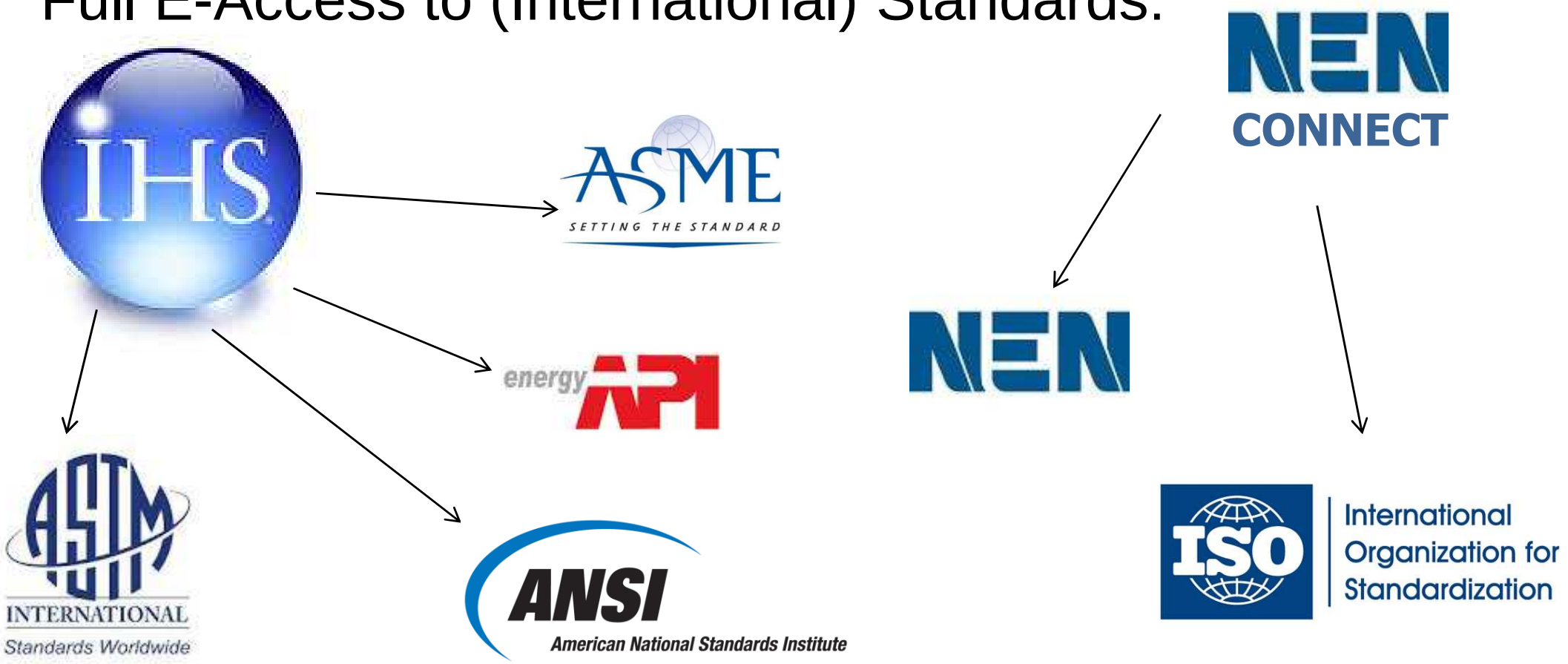
# Full E-Access to (International) Standards:




And others !

Access to Client Standards & Specifications:


ExxonMobil

**Shell DEPs**

And others !

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# Process Safety in Design

Imperial Sugar 2008 (USA)

(Sugar) Dust Explosion

# Process Safety in Design

- Conveyor belt corridor
- Transporting sugar from Silo's to packaging
- Corridor filled with sugar dust
- Ventilated corridor
- *Contamination of sugar*

# Process Safety in Design

- Solution > cover the conveyor belt
- Clean corridor
- No contamination of sugar
- *No ventilation in cover*

# Process Safety in Design

- Obstruction of conveyor belt
- Sugar dust inside the cover
  ignited by hot bearing
- Primary explosion sets of secondary explosion throughout the sugar plant
- *14 Fatalities, 36 injuries*

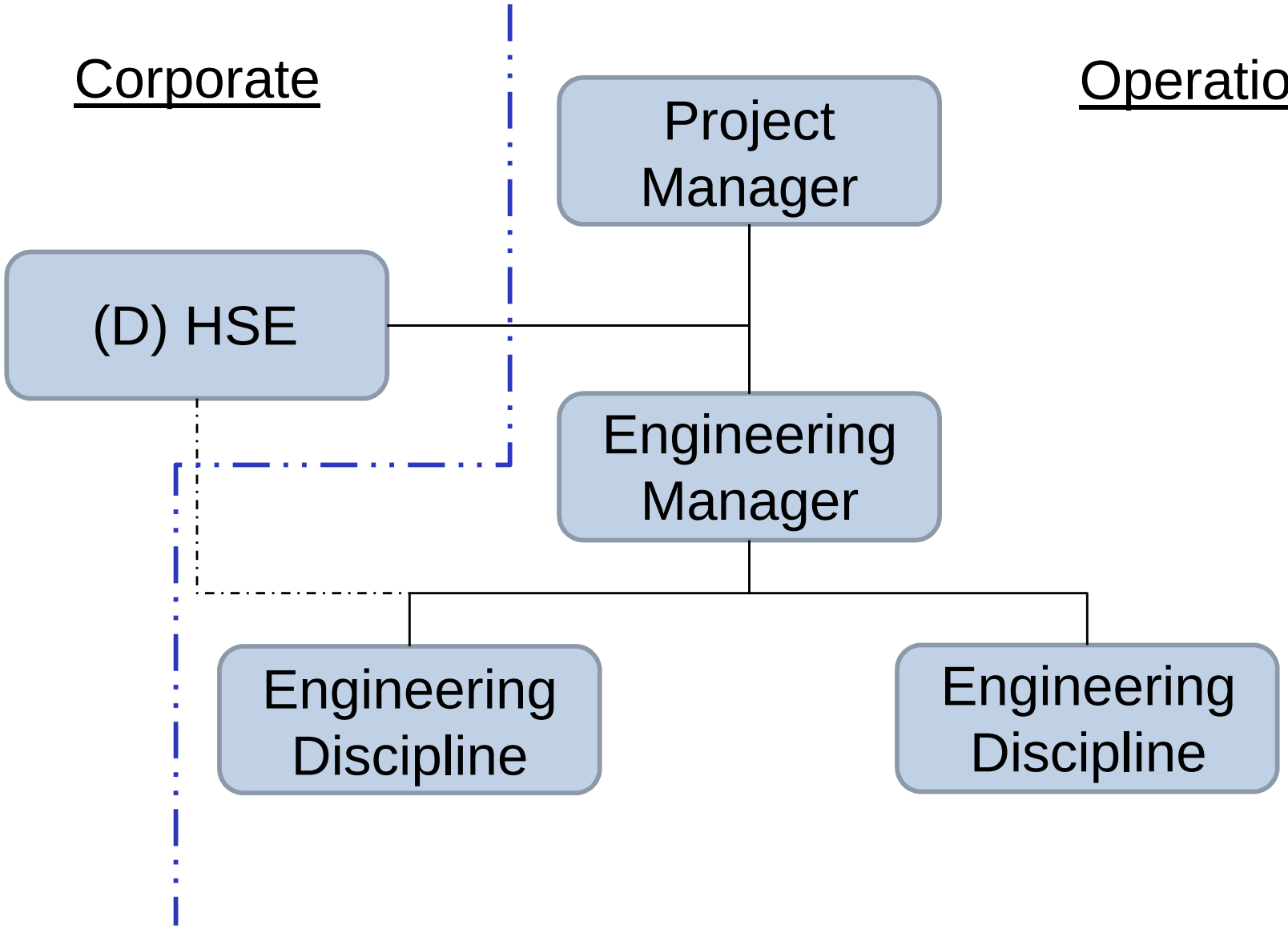
*Video: US Chemical Safety Board.*
*www.csb.gov*

# Design HSE in Jacobs

## (D)HSE

- Various roles on a project
  - Advisor
  - Engineering
  - Challenger
- How to keep an “Independent” eye/attitude

# Design HSE in Jacobs



# Design HSE in Jacobs

What do we do on our projects?

- HSE Plan, HSE File and HSE Action List
- HSE Awareness Sessions
- Conducting (timely) the proper Safety Reviews
  (HAZID, HAZOP, SIL)
- Hazardous Area Classification
- Fire & Gas Detection Philosophy and Layout

# Design HSE in Jacobs

- Fire Fighting and Fireproofing Philosophy and Layout
- Fire, Toxic and Explosion Modeling
- Noise Prediction, Ergonomics, Health Risk Assessments
- Advise / Challenge other disciplines
- Constructability Safety Reviews
- Facility Siting Analysis

# Design HSE in Jacobs

Constructability & Safety Reviews:

- Common effort of Construction, Design HSE and Field HSE
- To be held in all project phases (multi disciplinary review)
- Focus on reducing construction risk by improving design

# Design HSE in Jacobs

Ultimate Goal:

"Evolve" to a state of

**chronical discomfort**

# Questions?

# Thank you!

JACOBS®