A Lifecycle Approach to Safety in PM Refineries

From Design to Continuous Improvement

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What is a PM Refinery

Best described as a non-financial banking institution that uses highly toxic, corrosive chemicals and gasses together with high temperature metal melting operations to convert scrap precious metal bearing materials and often dangerous impurities into pure precious metal.

All of this typically happens in a highly secure bubble and for the most part with a relatively unskilled work force.

Refining is a hazardous business.

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The art of refining precious metals still uses age old techniques that are hazardous but have been engineered over the years to make them safer.

- Miller process - Melting impure gold and injecting chlorine to vaporize noxious metal impurities
- Graining Metals - Melting and pouring molten metals into water
- Aqua Regia or Chlorine - Dissolving metals in highly corrosive environments at elevated temperatures generating noxious gasses as byproducts (NoX, Chlorine etc)
- Selective Gold reduction - Injecting noxious gasses (e.g SO_2) or chemicals into highly acidic solutions to reduce PM's.

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An inherent property of a substance, situation or environment which has the potential to cause harm to people, equipment or our environment

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Many useful things in this world have multiple hazardous properties:

- Automobiles
  - Driven by humans at 30-100mph (sometimes intoxicated)
  - Loaded with flammable fuel
  - Hot exhaust gasses
  - Hot surfaces
  - Pressurized cooling systems
  - Thin metal bodies
  - Etc

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Many useful things in this world have multiple hazardous properties:

- Chemical process or products
  - Acute or chronic toxicity
  - Flammability
  - Corrosiveness
  - Reactive
  - Explosive

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- The properties of a technology or material that makes it hazardous is often the property that makes it useful
  - Nuclear Material - power generation
  - Gasoline is flammable - transportation
  - Chlorine is toxic - water purification
- Conscious Control of hazards is critical in deriving the benefits of the technology in a safe manner.

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What is safety?

Safety can mean different things to different people

- *“To be free from risk of physical harm” – a site supervisor*
- *“Something that protects you – a barrier – from harm” – a tradesman*
- *“A sense that nothing (or no one) will intentionally hurt me” – a customer service consultant*
- *“It’s about people – looking after each other, keeping an eye out for my mates” – an underground mine worker*

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What is safety?

Safety is a state in which hazards and conditions that can lead to physical, psychological or material harm are **controlled** in order to preserve the health and well being of individuals, our communities and our equipment.

"Safety is not the absence of accidents or injuries, but rather the application of effective defenses and appropriate human performance tools to control hazards in a quest to prevent accidents, injury or death"

“A safe environment is one in which we have considered everything in our power to identify and control hazards in our quest to prevent accidents, injury or death"

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How do we build a sustainably safe PM refinery?

1. Safety Conscious Design
2. Continuous Improvement
3. Cultivation of a safety driven culture

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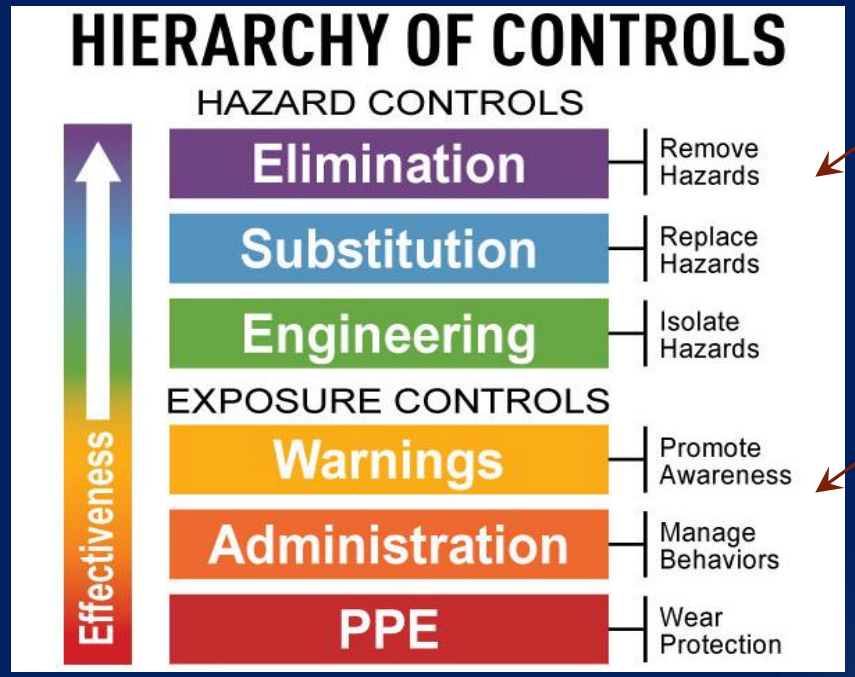
Safety Conscious Design



Physical Hazard Control

(limit occurrence of unwanted event)

Human Management

(limit probability or consequence of an accident)

Lesson from the Titanic disaster:

Improvement of Hazard Controls (hull divided into watertight compartments) is not a reason for reducing Exposure Controls (lifeboats)

We all know how that turned out.

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Safety Conscious Design

- Keys to success
  - A human centered approach to all technical design, taking into account the reality of activities and the constraints workers face daily.
  - Always design with the final operator in mind (KISS)
  - Involve multi-disciplinary teams
    - Experts in field (experienced engineers, consultants and others)
    - Active Management (all levels)
    - Operational staff
      - Operators
      - Maintenance personnel

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Safety Conscious Design

- Keys to success
  - Design safety features into the process vs trying to bolt on after
  - Consider safety features early in design

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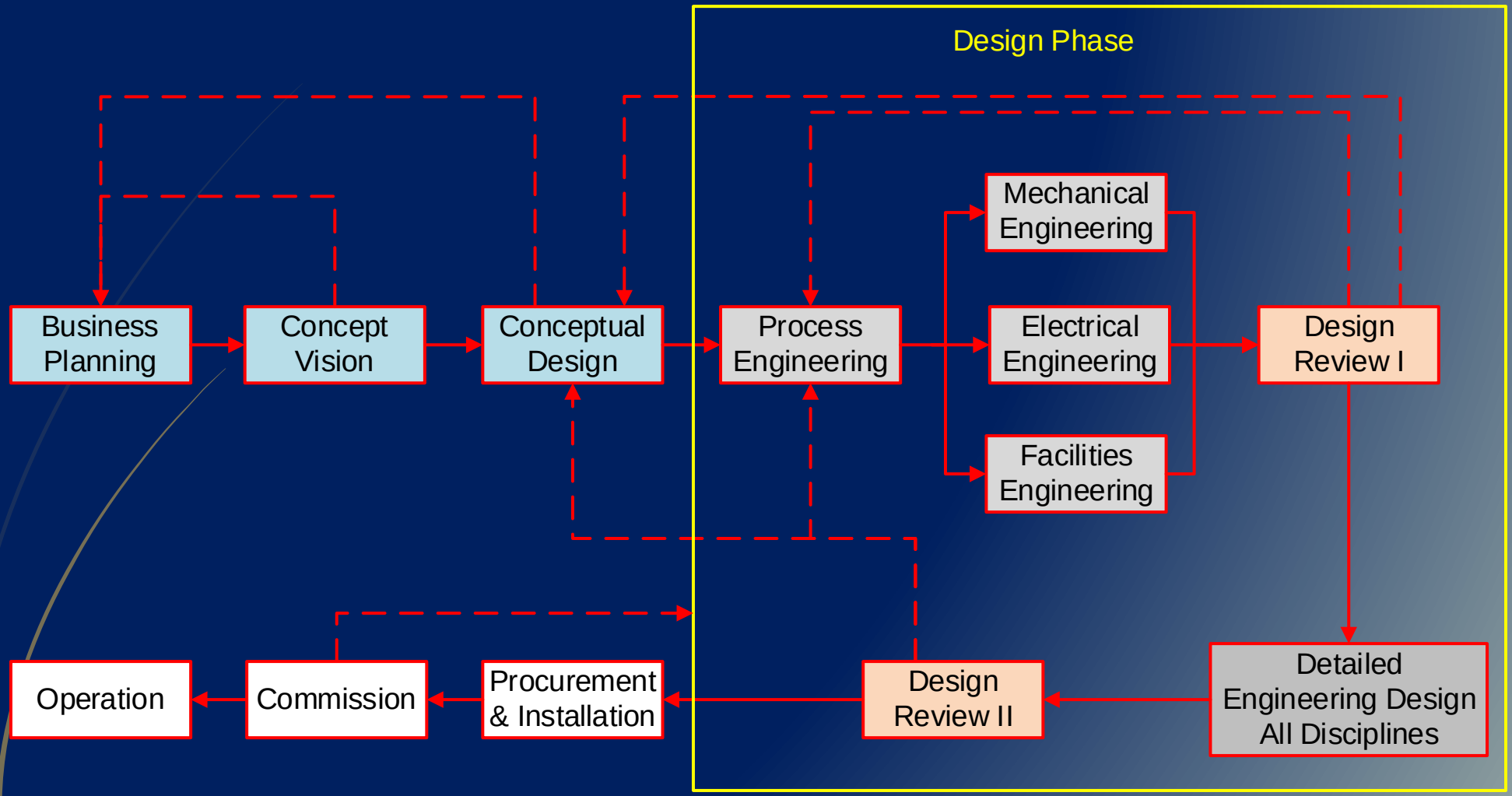
Typical Project Life Cycle



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Safety Conscious Design

- Keys to success
  - Be prepared to use multiple design iterations
  - Process Hazard Analysis Tools
    - Design Reviews
    - HAZOP
    - Structured what if with checklists
    - FMEA
    - Other appropriate methodology
  - Involve multi-disciplinary teams
  - Effective Communication

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Tools to Design Safety Into Process

- Automation
  - Reliability of instrumentation, sensors, alarms and PLC equipment
  - Redundancy – pH, ORP, Pressure, Level, Temp devices
  - Automatic and Manual Safety Interlocks
  - Managing Power Loss (Emergency Generation)

- Maintainability
  - Access to equipment
  - Equipment layout
  - Critical preventative maintenance

- Mechanical Integrity
  - Reactors and Tanks
  - Piping Systems Support
  - Pressure Relief and Ventilation systems
  - Emergency Shut Down Systems

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Continuous Improvement

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Why Continuous Improvement?

- Just because it been here for 30 years does not mean it was or is still safe
- Operators turnover (tribal knowledge)
- Provides Opportunities to continuously design safety into the process
  - Introduction of new equipment or technology
  - Introduction of Robust Automation
  - Facility improvements
  - Monitoring systems and preventative maintenance
  - Address Un-controlled changes made with time

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Continuous Improvement

- Keys to success Part 1
  - Learn from operator suggestions, mistakes, accidents and near misses
    - Always Investigate and get to root cause of accidents and near misses
    - Do not simply file findings away…… always take action

"Improvement ideas without positive action remain Improvement ideas"

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Continuous Improvement

- Keys to success Part 2 – The human factor
  - Accident and incidents most often result from poor training, ignorance, arrogance, fatigue, distracted or disgruntled employees
  - Work with and encourage people constantly to look for ways to improve their work environment hence safety
  - Provide effective and continuous personnel training and development
  - Hands on engineers - communication

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Continuous Improvement

- Keys to success Part 2 – The human factor
  - Implement procedures for change control
  - Strong management to ensure all SOP's, guidelines and designed safety features and interlocks are observed and respected
    - Policy without consequences recipe for disaster

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THIS
WORK CENTER
HAS BEEN
ACCIDENT-FREE
SINCE
JOE LEFT
Safety - Quality - Excellence

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“The best safety programs in the world did not get there overnight.

It was years of small incremental improvements that they continue to make”.

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Safety culture

Safety culture is the way in which safety (the barriers, procedures) are designed into a process are managed in the workplace.

It reflects the attitudes, beliefs, perceptions and values that management and employees at all levels share in relation to keep everyone safe.

It can also be described as:

“How an organization as a whole behaves when no one is watching”.

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Safety culture

Basic principles for integrating safety culture into the workplace.

- There should be a process for managing organizational change or technical projects which grant significant importance to safety (on a par with production)
  - Safety should naturally be how work is done
  - Safety should be part of every discussion and decision
  - Safety should be discussed upfront , early and continuously
  - Safety by design is a collaborative opportunity in the workplace

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Safety culture

Some questions we should ask ourselves are:

- How do we instill a safety culture at all levels of the organization?
- How do we ensure importance is granted to safety in all decisions and compromises?
- Will it work? Is it safe? If it's not safe how do we re-engineer it or what barriers need to be implemented to make it safe.

The goal is to create a workplace where all players work together all the time contributing to safety, taking action, and achieving resolution by communication.

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Safety In PM Refineries

"A safe PM refinery is one in which we have considered everything in our power to identify and control hazards in a quest to prevent accidents, injury or death"

This can be effectively achieved by:

1. Incorporating Safety Conscious Design to all processes and infrastructure
2. Development of a robust Continuous Improvement Program
3. Cultivating a culture where all players have a vested interest in creating a safe working environment

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