



PROCESS SAFETY AS CORE WORK PROCESS

2024 Fall P2SAC Conference, Purdue University

Sanjay Ganjam, P.E.



AGENDA

Process Safety implementation in EPC projects

How PS is weaved into design of the facility

How other disciplines contribute

Value of Process Safety

KIEWIT OVERVIEW

**LEADER
IN SAFETY**

**0.15
TRIR**

Kiewit Energy Group Inc.

**EARNED
REVENUE**

**\$17.1 B
IN 2023**

**DIRECT-HIRE
MANHOURS**

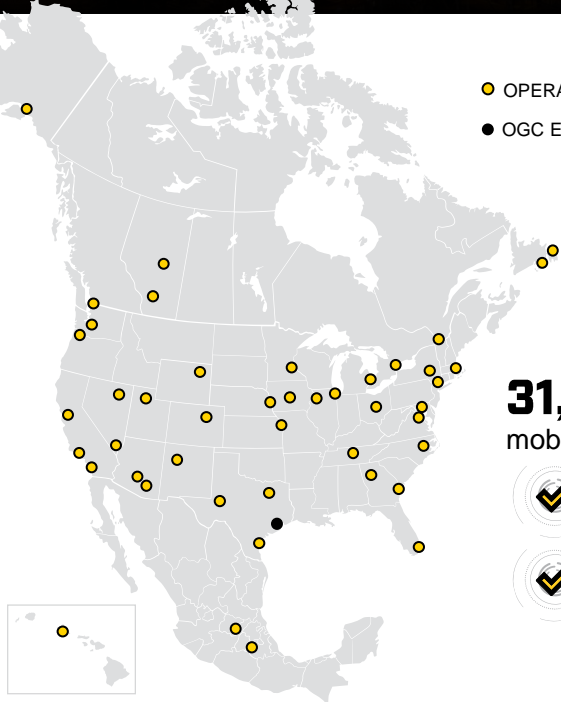
**60 M+
ANNUALLY**

Providing safety, quality
and schedule advantages

**KIEWIT-OWNED
EQUIPMENT**

**33,800
UNITS**

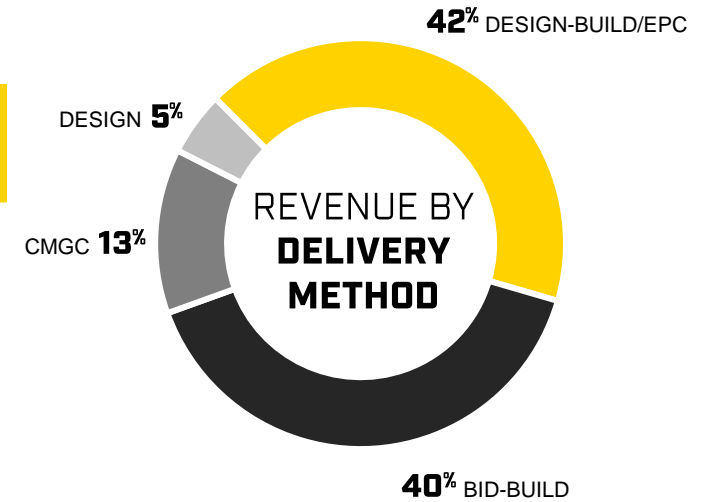
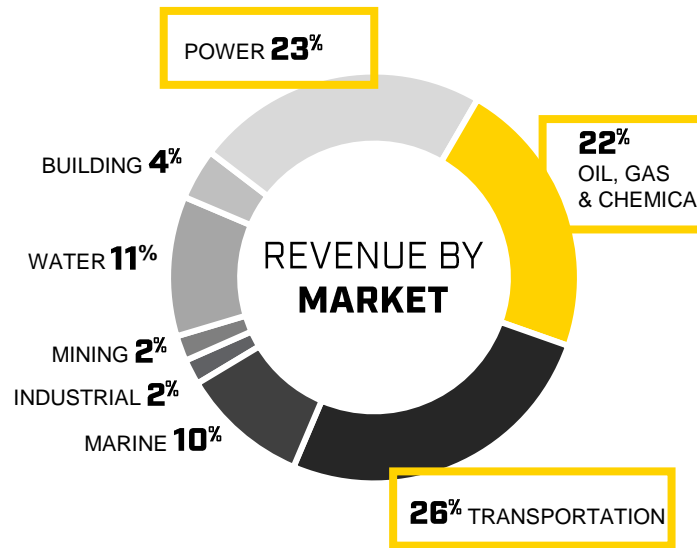
Totaling \$4.5 billion in value



31,100 EMPLOYEES
mobile workforce

16,200+ craft

14,900+ staff
> 3,600+ engineers



KIEWIT ENGINEERING LOCATIONS

3,600+
engineering &
design staff

950+
professional
engineers

2,900+
PE licenses
throughout
North America

INFRASTRUCTURE
Denver, CO

**POWER, INDUSTRIAL
AND WATER**
Lenexa, KS

**OIL, GAS &
CHEMICAL**
Houston, TX

KIEWIT MEXICO

- ENGINEERING HEADQUARTERS
- OPERATIONS OFFICES



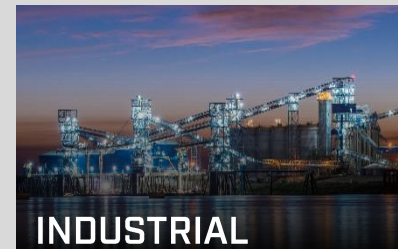
OIL, GAS & CHEMICAL

- Midstream
- LNG
- Petrochemical
- Refining
- Renewable / Alternative Fuels
- Hydrogen / Syngas / Ammonia



POWER

- Power Generation
- Transmission and Distribution
- Hydrogen
- Solar
- Carbon Capture
- Battery Storage



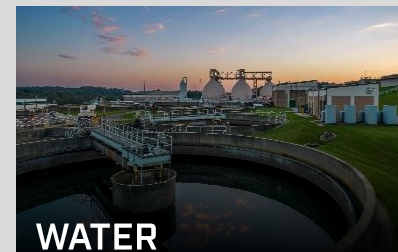
INDUSTRIAL

- Advanced Technologies
- Industrial Energy
- Mineral Processing
- Process Industries



INFRASTRUCTURE

- Roadways
- Bridge Structures
- Drainage
- Transit
- Water



WATER

- Water Treatment and Supply
- Wastewater, Biosolids and Reuse
- Conveyance Dams and Storage Desalination
- Industrial Water
- Energy and Efficiency

PRE-CONSTRUCTION

- Project development
- Capital studies
- Asset acquisition
- Owner's engineer
- Pre-detailed design / FEED
- Independent design reviews & assurance
- Performance modeling

PROJECT EXECUTION

- Detailed design
- EPC / design-build
- Temporary works
- Design management
- Design assurance

POST-CONSTRUCTION

- Commissioning
- Start-up
- Plant services
- Independent engineer

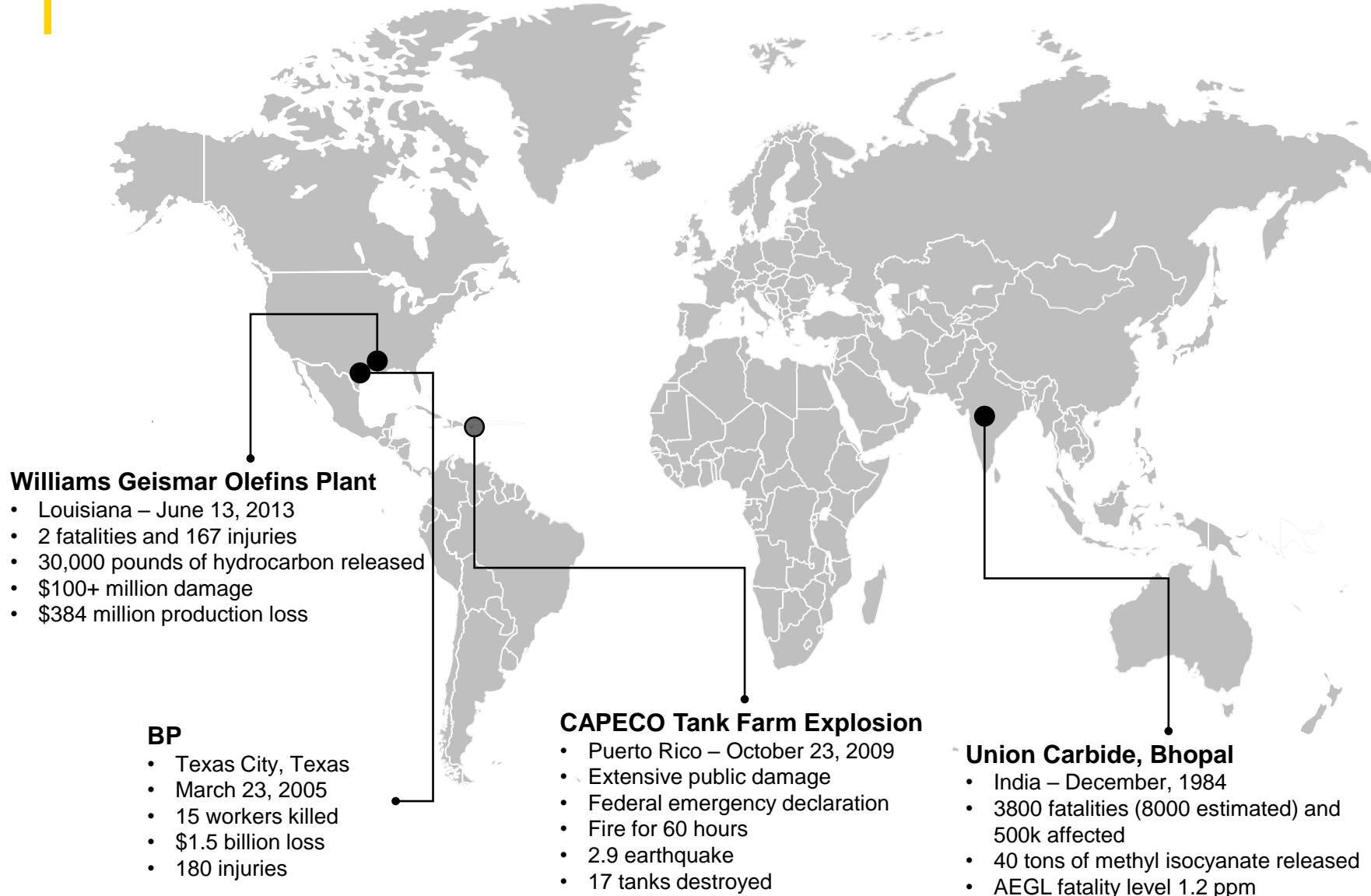


ENGINEERING SERVICES



PROCESS SAFETY

INCIDENTS



- These and many more incidents that cost companies lots of money and their reputation
- Mostly caused due to failure or shortcomings in Process Safety Management

Total loss of **\$33 BILLION** (2015 value) incurred in **100 LARGEST LOSSES**

- Marsh report 2016

WHAT IS PROCESS SAFETY?

- “A disciplined framework for managing the integrity of operating systems and processes handling hazardous substances by applying good design principles, engineering, and operating practices” (Center for Chemical Process Safety)
- Process Safety focuses on prevention and mitigation of process hazards like fire, explosion and chemical releases at process facilities
- Called different things at different times and in different companies
 - Loss prevention
 - HSE (Health, Safety and Environment)
 - Technical safety

MISSION OF PROCESS SAFETY

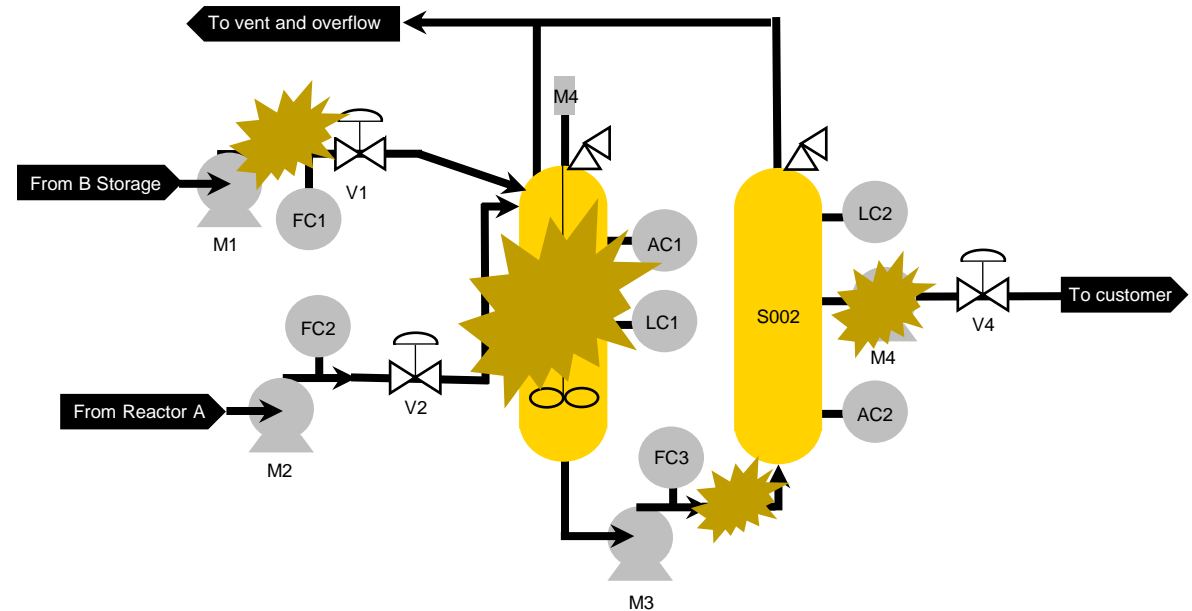
Our mission is to serve our Kiewit projects and our clients in building **SAFER PROCESS PLANTS**

Realized by following codes, standards and **PROCESS SAFETY MANAGEMENT** (PSM) practices

We proactively seek to **expose** hidden hazards and find ways to **PREVENT OR MITIGATE THEM**

LEARN from past industrial incidents

PERSONAL SAFETY VS. PROCESS SAFETY



SLIPS, FALLS, CUTS, WORKPLACE INCIDENTS

Protect personnel – prevent injury and fatality

LOSS OF CONTAINMENT: SPILLS, LEAKS, FIRE, TOXIC

Protect assets, environment and prevent multiple fatalities

Source: The Safety Association for Canada's Upstream OGC

PERSONAL SAFETY VS. PROCESS SAFETY

PREVENT SERIES OF EVENTS

Low to high severity – high frequency

Good visibility at bottom of pyramid

PREVENT CATASTROPHIC EVENTS

High severity – low frequency

Less visible and complex to measure

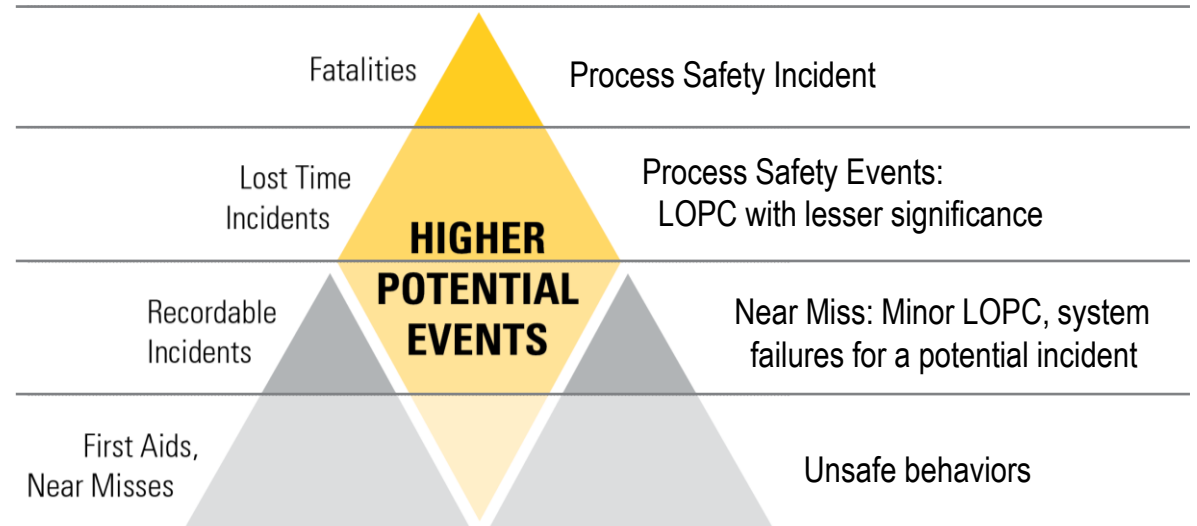
CONSTRUCTION SAFETY

Address ‘Nobody Gets Hurt’ during construction
Life-Saving Actions®



SAFETY IN DESIGN

Address process safety risk, protect employees, asset, community and reputation
Process Safety Management

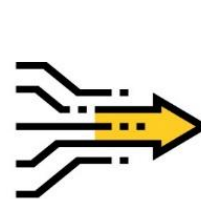


PROCESS SAFETY AT KIEWIT

- Part of Kiewit Oil, Gas & Chemical Engineering provide company wide support
Responsible for 3 areas
- Process Safety
 - Identify process hazards, estimate consequence and risk
 - Find ways to eliminate, reduce or mitigate
- Functional Safety
 - Effectiveness of safety shutdown system to prevent or mitigate hazards in response to inputs
- Fire Protection
 - Use fire water, foam, dry chemical etc. to protect from hazards of fire

AN INTEGRATED APPROACH

- Prevention (process safety and functional safety)
- Mitigation (fire protection)



**PROCESS
SAFETY**



**FIRE
PROTECTION**

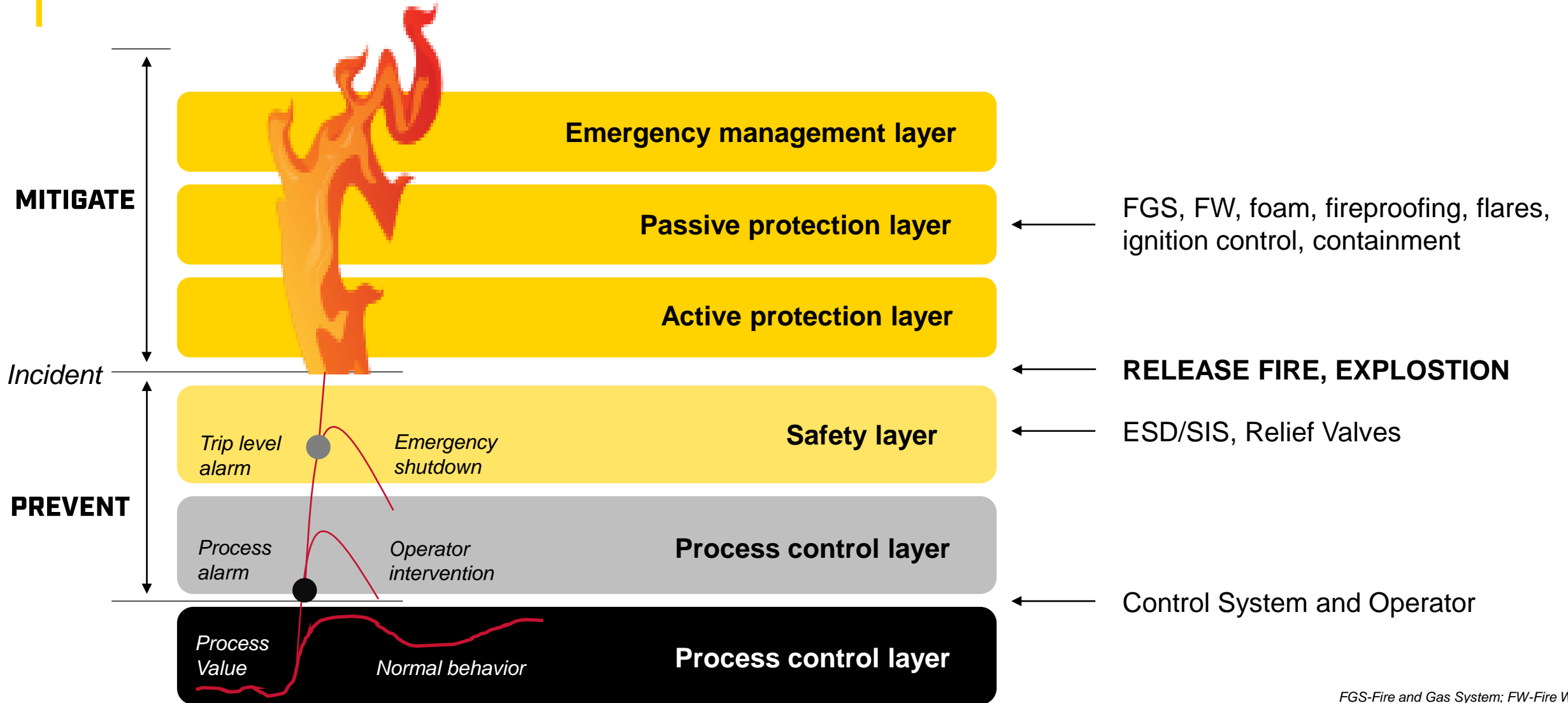


**FUNCTIONAL
SAFETY**



SAFETY IN DESIGN

LAYERS OF PROTECTION – SAFEGUARDS – BARRIERS



FGS-Fire and Gas System; FW-Fire Water;
 ESD-Emergency Shutdown; SIS-Safety Instrumented System
 Source | Emerson Safety Lifecycle Seminar

GENERAL METHODOLOGY

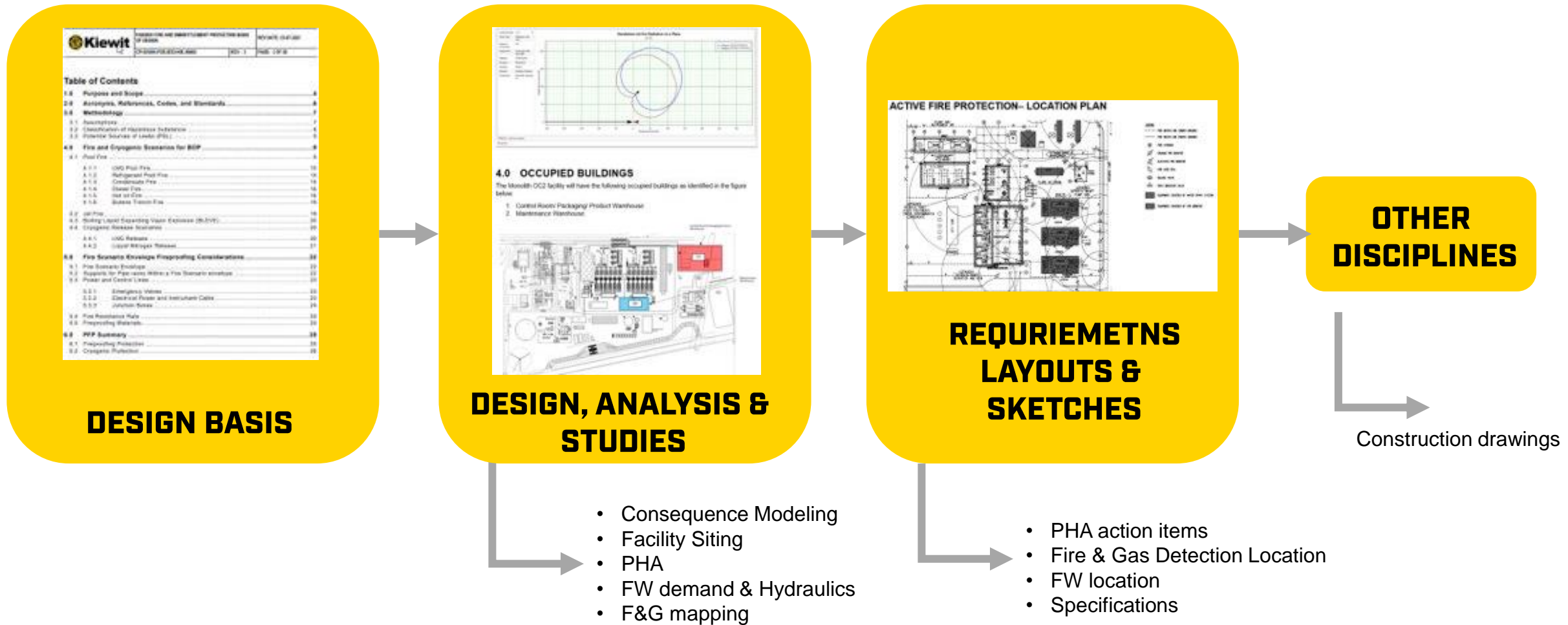
- Process Safety Management
- Identify hazards, define extent of consequences and design safeguards
- Layers of protection or safeguards or barriers
- Strategies for safeguards
 - Inherently safer
 - Eliminate or minimize process hazards instead of “add-on” controls
 - Active controls
 - Safety shutdown system, relief system
 - Passive controls
 - Fireproofing, dikes and sumps
 - Procedural and administrative
 - Operating procedures



EPC PROCESS SAFETY IMPLEMENTATION

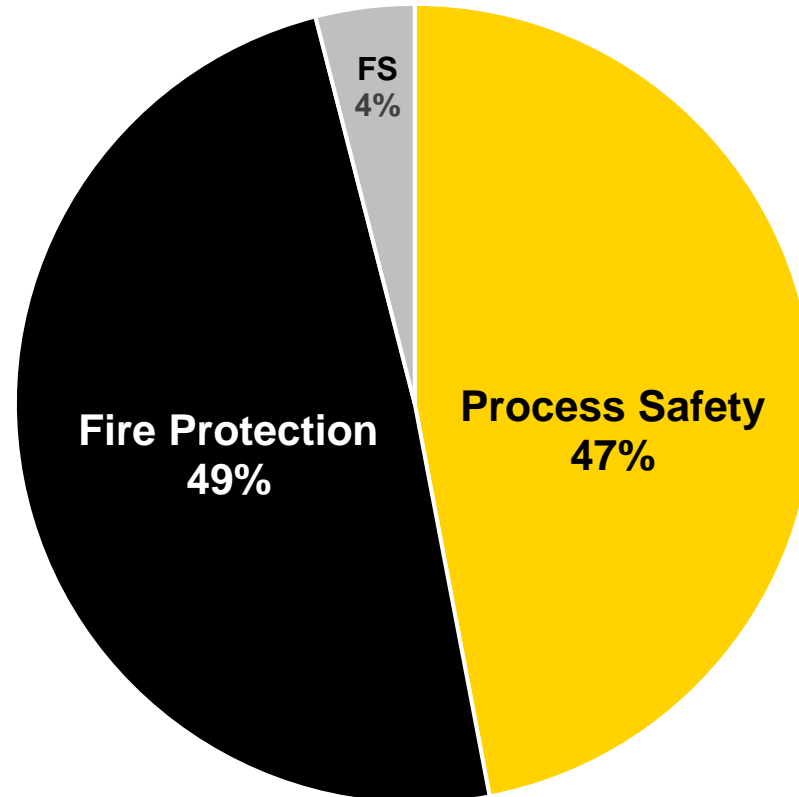
- Achieve Safety in Design thorough various tasks and design documents
- Process safety does the analysis and sets the requirements
- Process Safety requirements are documented in various design basis and drawings
- Other disciplines implement these requirements into detailed design drawings
- Detailed design drawings are used for construction

PROCESS SAFETY DELIVERABLES – SIMPLIFIED WORKFLOW



PS DELIVERABLES – BY AREA

DESIGN DOCUMENTS



■ Process Safety ■ Fire Protection ■ Functional Safety

PROCESS SAFETY – DESIGN BASIS DESCRIPTIONS

PROCESS SAFETY DESIGN BASIS

Provides overall guidance of the intent and basis of process safety design for a project.



ACTIVE FIRE PROTECTION DESIGN BASIS

Provides overall guidance of the intent and basis of active fire protection for a project.

FIRE, GAS AND TOXIC DETECTION SYSTEM DESIGN BASIS

Basis design for the Fire & Gas Detection System of a project.



PASSIVE FIRE & CRYOGENIC PROTECTION DESIGN BASIS

Provides basis of design for Passive Fire Protection (PFP) and Cryogenic Protection for the project. The goal for PFP is to protect process equipment, process equipment supports, and structural steel member supports from heat influx from a pool or jet fire.

PS DELIVERABLES – BASIS

DELIVERABLE DESCRIPTION	DELIVERABLE TYPE	REMARKS
Process Safety Design Basis	Design Criteria	
Active Fire Protection Design Basis	Design Criteria	For fire water and non-water systems
Fire, Gas, Toxic Detector Design Basis	Design Criteria	
Passive Fire Protection Design Basis	Design Criteria	

In some projects we combine all design basis into one basis

PS DELIVERABLES – STUDY AND CALCULATIONS

DELIVERABLE DESCRIPTION	DELIVERABLE TYPE	REMARKS
Facility and Building Siting Study	Study	Using either consequence only basis or using Quantitative Risk Analysis (QRA) basis Typically fire and explosion risk analysis (FERA) for blast overpressure profiles and impacts on occupied buildings.
Facility Hazard Analysis (FHA) and PHMSA Siting Analysis Report	Study	Required for FERC and PHMSA for Liquefied Natural Gas (LNG) projects
Fire Water Demand Calculation Report	Report	Calculates the maximum fire water needed for each fire zone
Fire Water Hydraulics Calculation Report	Report	Make sure adequate flow and pressure of fire water available
Fire Protection Analysis per NFPA	Report	For LNG NFPA59A, Chapter 9, Different zones on plot plan, access hazards within the zone and recommend detection/mitigation/protection



PS DELIVERABLES – DRAWINGS AND SPECIFICATIONS

DELIVERABLE DESCRIPTION	DELIVERABLE TYPE	REMARKS
Fire, Gas, Toxic Detector Location Drawings	Drawing	
Fire Water Process Flow Diagram (PFD & P&IDs)	Drawing	Process Flow Diagrams, Piping & Instrumentation Diagrams
Eye wash/Safety shower Location Drawings	Drawing	
Fire Water Location and Coverage Drawings	Drawing	
Fire Extinguisher Location Drawings	Drawing	
Passive Fire Protection Layouts	Drawing	
Escape and Evacuation Route Sketch	Drawing	
Fire, Gas, Toxic Detector Requirements	Specification	
Active Fire Protection Requirements	Specification	
Fire and Safety Equipment Requirements	Specification	Dry chemical, hand held extinguishers etc.
Passive Fire Protection Requirements	Specification	
Safety Requirement Specification (SRS)	Specification	

PS DELIVERABLES – LISTS

DELIVERABLE DESCRIPTION	DELIVERABLE TYPE	
Hazardous Area Classification Schedule	List	By equipment list the electrical classification for ignition control
Passive Fire Protection Schedule	List	By equipment lists where fire proofing applied
Hazard Detection List/Matrix	List	Mostly for LNG FERC jobs or if client asks
Fire and Safety Equipment List/Matrix	List	Mostly for LNG FERC jobs or if client asks

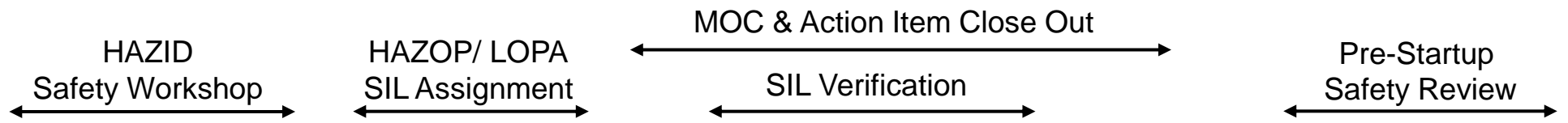
PS DELIVERABLES – PHA

DELIVERABLE DESCRIPTION	DELIVERABLE TYPE	REMARKS
Process Hazard Analysis (HAZID) Report	PHA Documentation	
Process Hazard Analysis (HAZOP, LOPA) Report	PHA Documentation	PHA review includes HAZOP, What if, Checklist, etc. per OSHA 1910.119
PHA Action Item Closeout Sheet	PHA Documentation	PHA Closeout Report with listing of PHA/HAZOP action items.
Management of Change (MOC) Safety Review	PHA Documentation	
Safety Integrity Level (SIL) Verification Analysis	Report	
Reliability, Availability & Maintainability (RAM) analysis	Report	

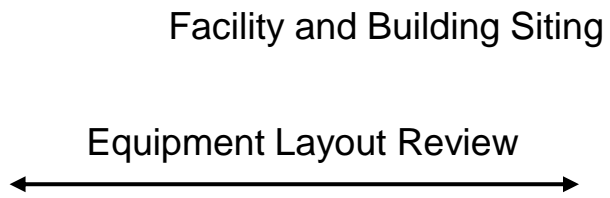
EPC DESIGN TIMELINE



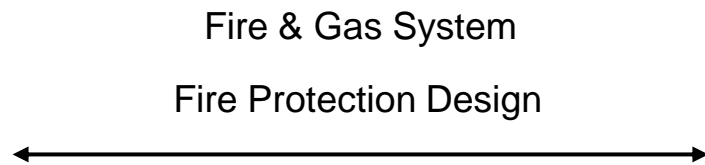
PREVENTION



LOSS OF CONTAINMENT EFFECTS

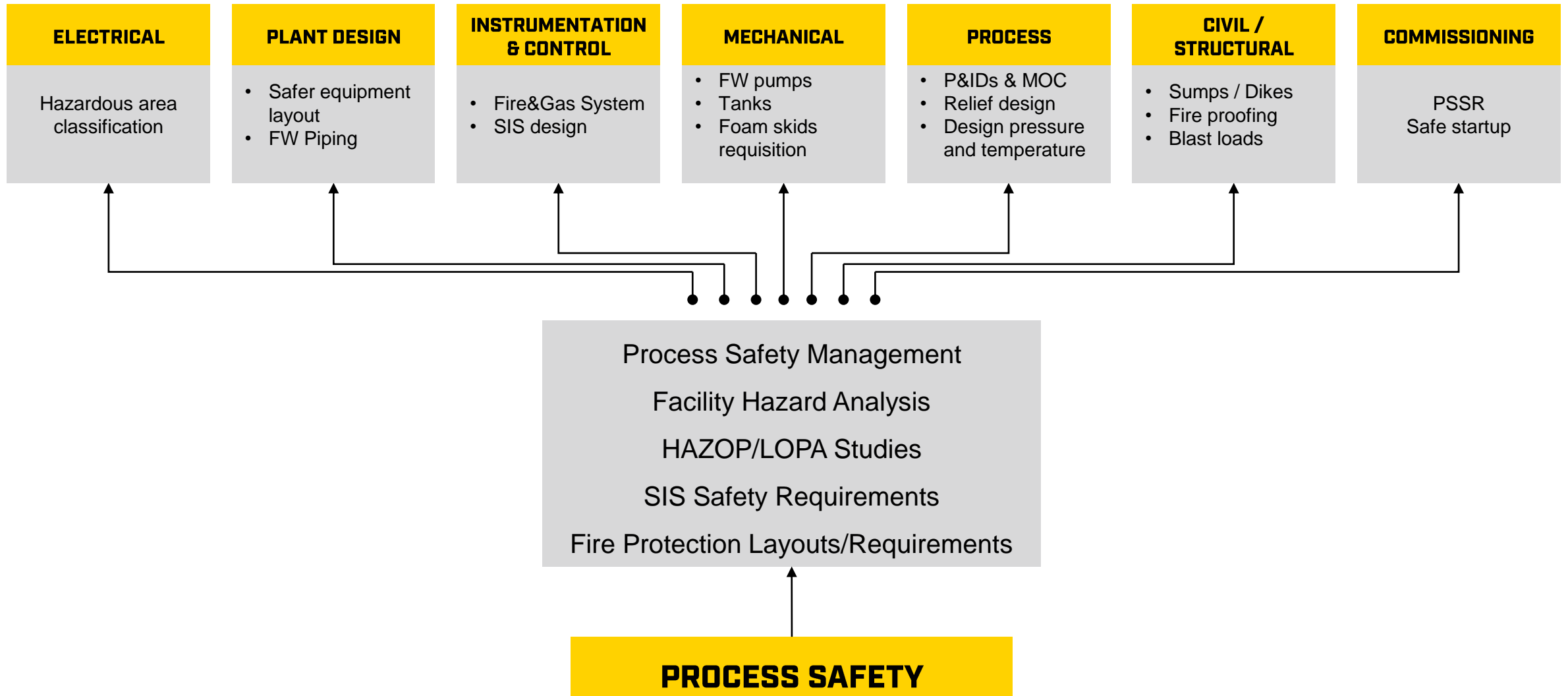


DETECTION & MITIGATION



EPC – Engineering, Procurement & Construction

PROCESS SAFETY AND OTHER DISCIPLINES



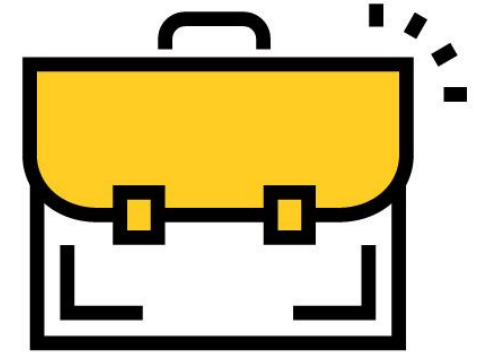
VALUE OF PROCESS SAFETY



**BUILD SAFER PLANTS
COST EFFECTIVELY**



**RISK REDUCTION
AND CONTROL**



**CORPORATE
LIABILITY**

“

There's an old saying that if you think safety is expensive, try an accident. Accidents cost a lot of money. And, not only in damage to plant and in claims for injury, but also in the loss of the company's reputation.

”

THANK YOU

Sanjay Ganjam, Chief Engineer Chemical Process Safety

Kiewit OGC Engineering

Email: Sanjay.Ganjam@Kiewit.com