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Major Event Considerations and ALARP

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Tim Hoff – EMTech Process Safety Projects SME
For Purdue Process Safety and Assurance Center (P2SAC)
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Tim Hoff Bio

- ExxonMobil Process Safety SME for Global Projects
- B.S. in ChemE from Purdue University (2001)
- Cross-functional roles throughout career with EM:
  - Project Development, Process Design, and Execution/Start-up
  - Senior Operations Engineer for Alkylation and Light Ends Fractionation
  - Refinery Process Safety Engineer
  - Process Safety Lead for several major projects ($1B+)
  - Technical Process Safety Lead for Northeastern Operating Sites
  - Mentor/Educator/Advocate for Process Safety expectations and delivery in projects

PEMEX LPG BLEVE - 1984

- Rupture of 8” LPG line during material transfer from distant refinery
- Growing vapor cloud was not identified and massive cloud ignited at flare stack
- Series of ground fires sustained in terminal, even after Operations activated emergency shut down
- Several spheres and cylinders BLEVE’d, with impacts reaching into nearby community resulting in 500+ fatalities
- Facility had no gas detection, tight layout, limited isolation, and fire water system was disabled in initial explosion

Tacoa Boilover Disaster - 1982

- Fuel oil tank caught fire in remote thermal power plant in Venezuela
- Facility did not consider fuel oil flammable so did not have any fire suppression plans in place (no fire brigade, no training)
- External fire fighting resources (100+) and local media situated at site
- Massive boilover occurred sending fire wall over 250 meters away (tank elevated on hillside exacerbated impact)
- Fatalities estimated in excess of 150, including personnel, fire fighters, media, and civilians

Source:Wikipedia.com

Major Event Identification

- Majority of scenarios that could be labeled ‘major event’ are well known to industry, such as:
  - BLEVE
  - Liquid Overfill
  - Riser Failures
  - Boilover
  - Specific Toxics (H2S, HF, Chlorine)

- Critical to review potential scenarios for credibility of impact on vulnerable receptors (e.g. probits, onset of fatality, etc)

- Identification occurs during structured hazard identification activities, such as ISHER, HAZID

ALARP Demonstration

- Demonstration that all reasonably practicable safeguards and practices are in place and functioning as expected to reduce residual risk to a level judged as acceptable
- The subject matter expert and the risk decision-maker should confirm that all appropriate risk prevention and mitigation measures (or safeguards) have been considered
- The risk prevention and mitigation measures implemented, as well as the basis for additional potential risk reduction measures that are not implemented, should be documented.
- The decision not to implement additional potential risk reduction measures typically occurs when there is diminishing return for implementing additional safeguards (i.e., where cost is significantly disproportionate to the level of risk reduction or when the risk reduction is de minimis).

ALARP Workflow

- Step 1: Identify Reference Safeguards (RSGs)
  - Baseline set of safeguards that are generally considered sufficient to manage risk to ALARP, however they are not per se ALARP
  - RSGs are based on generally accepted good engineering practices (and/or security practices) typically used across the oil & gas and chemical industries to manage similar risks
  - Take into account regulatory requirements, risk benchmarks, as well as industry and company learnings and operating experience, and hierarchy of controls principles

- Step 2: Site/Project Evaluation of Reference Safeguards
  - Subject Matter Expert (SME) works with the site and compares the existing safeguards to the RSGs, and determines if the RSGs are present and meet design considerations

ALARP Workflow, Continued

- Step 3 – SME Review
  - If all of the RSGs are present and meet design considerations, then the SME proceeds to consider the next risk reduction opportunity, including Additional Safeguard(s), that is reasonably practicable to install
  - If an RSG is not present, or does not meet design considerations, the SME and site will consider adding the missing RSG if reasonably practicable
    - If not reasonably practicable, SME will evaluate alternate safeguards that provide similar risk reduction
    - If no alternate safeguard is reasonably practicable, proceed to next consider next risk reduction opportunity that meets reasonably practicable criteria
  - SME documents the safeguards that are present and recommended safeguards to be added (if any)

- Step 4 – Risk Manager Approval
  - The ALARP Evaluation is reviewed with the Risk Manager and if they are in agreement with the ALARP evaluation and recommended actions, then the Risk Manager approves the risk mitigation plan.
  - If the Risk Manager and the SME are not in agreement with regard to the ALARP evaluation and recommended actions, then the Risk Manager and/or the SME will consult with the business line to determine a path forward.

ALARP Documentation

1. Business Line (check one)	☐ Refining ☐ Chemicals ☐ Midstream ☐ Upstream					
2. Facility / Operating Unit						
3. Equipment # / Equipment Name						
4. Primary Potential Hazard(s)						
5. Higher Consequence Classification (check one)	☐HC1 ☐ HC2					
6. Risk Assessment or Risk Screening Reference						
7. Reference Safeguard (SG) Analysis	**Reference SG**		**Alternate SG**		**Accepted As-Is[1]**	**Explain risk decision making / rationale:** 1. Why the existing SG is ALARP without meeting design considerations; or, 2. Description of the proposed alternate SG, or 3. Why the Reference / Alternate SG are deemed not practicable (i.e., accepted as-is)[2]
	Exists	**Planned**	**Exists**	**Planned**		
	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	
	☐	☐	☐	☐	☐	
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	☐	☐	☐	☐	☐	
8. Additional Safeguards Considered	**Comments** *Why utilized / not utilized*					
9. Describe special considerations/conditional modifier that warrant additional safeguards.						
10. Risk reduction measures to be implemented (if any)	**Risk Reduction Measure**				**Cost Estimate[2]** (Capex/Opex $M USD)	**Target Completion Date**
11. Final ALARP Risk Matrix Position (e.g. HC-1/F) (Use the ALARP Reference Case and Align with ALARP SME to assign HCRM position)						
Risk Approver				**Date**		
SME Review				**Date**		

- Document all reference safeguards whether applied or not
- Document alternate safeguards if reference safeguards cannot be applied
- For all safeguards, document decision on why it was applied or not considered reasonably practicable
- Document additional safeguards considered to bring scenario to ALARP

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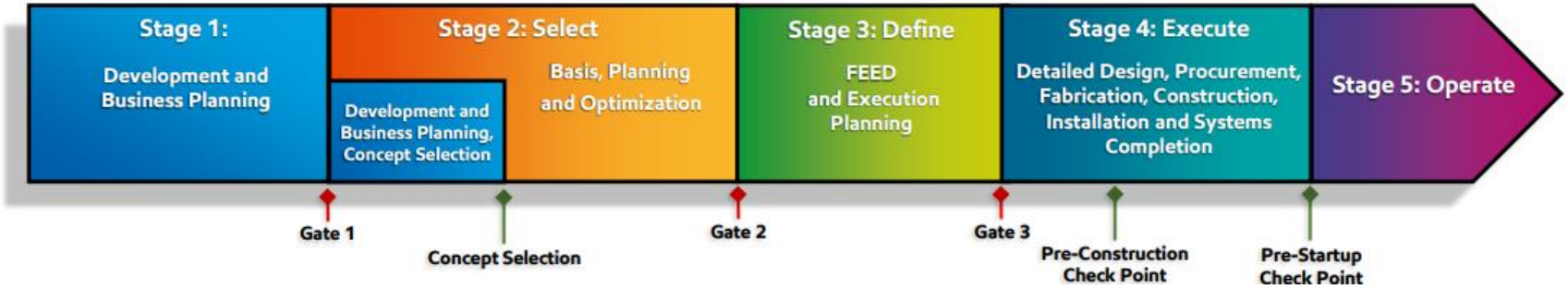
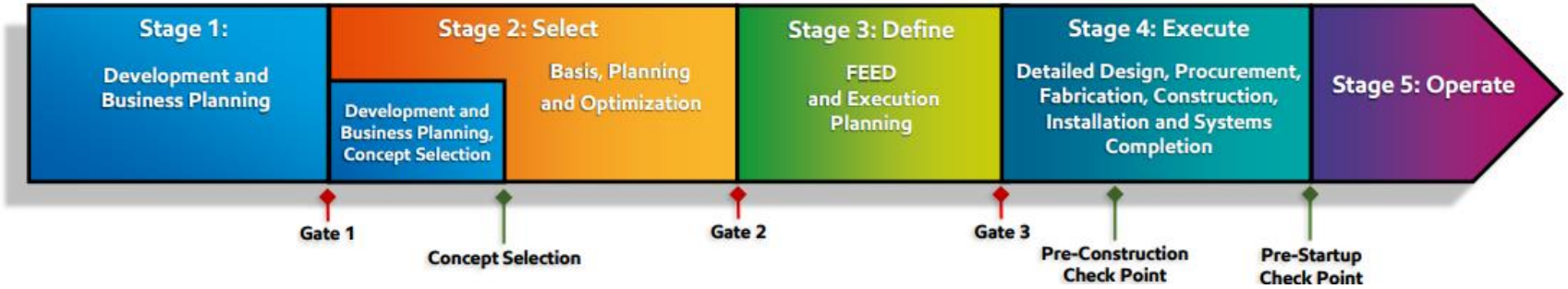
Stage 1 & 2



- Stage 1 & 2 focuses on identification of the major hazard scenarios and establishing credibility of consequences to vulnerable receptors (public and onsite)
  - Discovery via structured reviews, such as Inherent Safety Reviews, HAZID

- Consequence reduction by application of safeguards is not considered to render scenarios non-credible

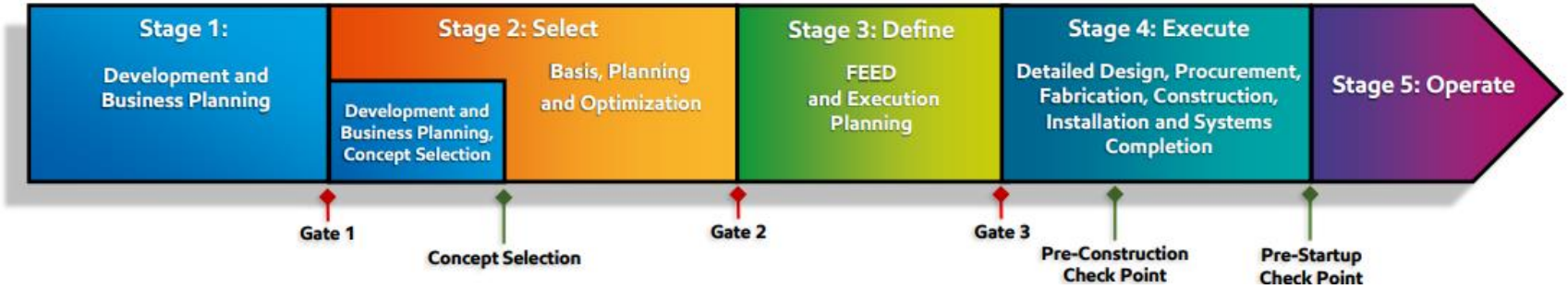
Stage 3



- Complete ALARP Demonstration, providing confirmation of required preventative and mitigative safeguards
  - Receiving organization (business line representative) must be in attendance and actively participating in demonstration
  - Health verification criteria to be established

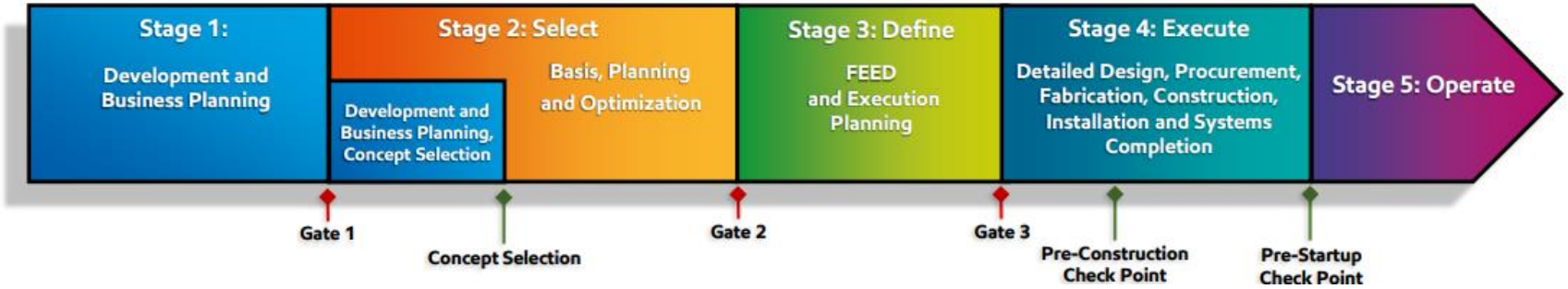
- Designed safeguard incorporated into FEED

Stage 4



- Verification that designed safeguards can meet required availability and health verification criteria
- Finalize procedural safeguards with receiving organization
- Prepare documentation for handover to receiving organization

Stage 5



- Complete loop checks of SIFs and verify installation meets required SIL
- Field verify that EIVs are installed as validated in Stage 4
  - Test motors if installed

Conclusion

- ‘Major Events’ risk can be mitigated if identified early and following a structured ALARP approach
- ALARP safeguards should leverage generally accepted good engineering practices (and/or security practices) typically used across the oil & gas and chemical industries to manage similar risks
- Even after application of reference safeguards, further evaluation should be completed to determine if additional safeguards meet ALARP criteria (reasonably practicable) and should be incorporated

First Name	Tim
Last Name	Hoff
Title	Process Safety Engineer
Email	timothy.p.hoff@exxonmobil.com
Work Phone	346-225-3765
Mobile Phone	
Address	25915 South Frontage Road, Channahon, IL, 60440
URL