

# How Do We Prevent Losing Sight in Risk Assessments



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## Colin D Armstrong | Principal Engineer

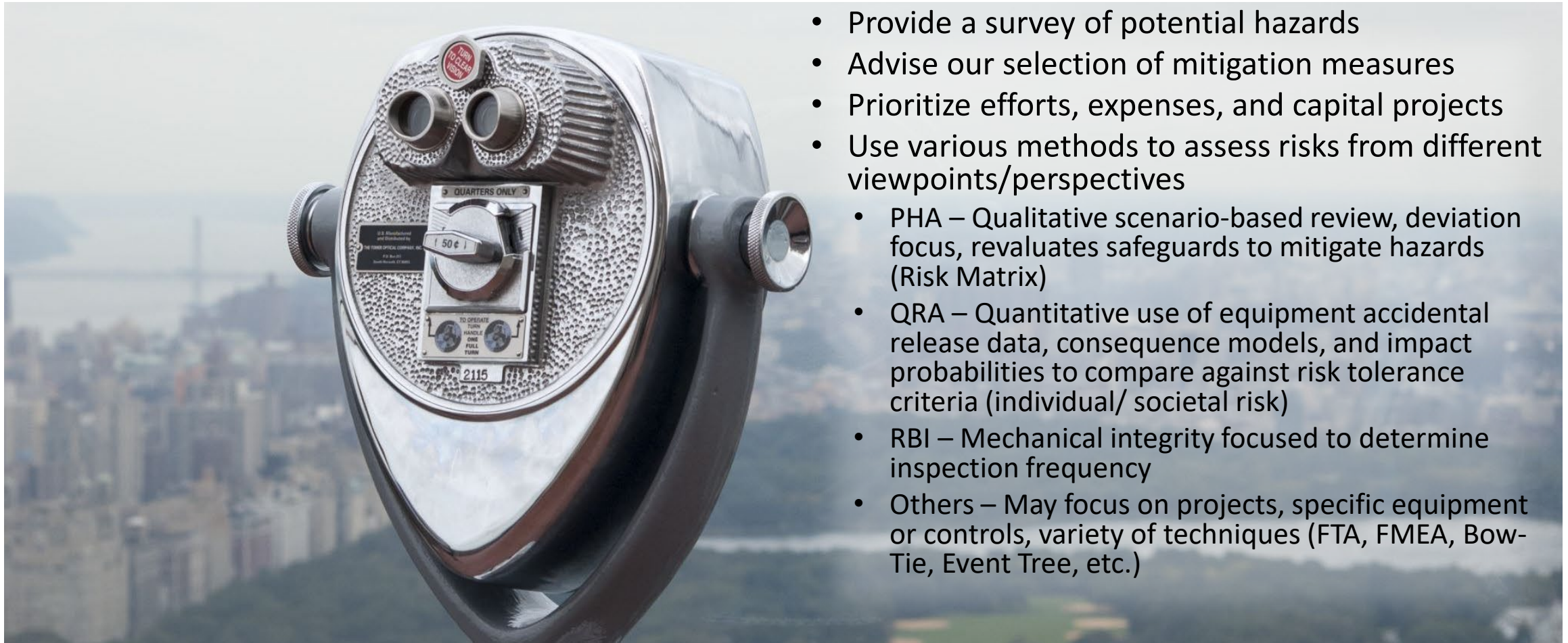
- Leads AcuTech’s QRA and FSS practice
- Completed numerous FSS and QRA projects in oil, gas, LNG, and specialty chemical industries worldwide
- Experienced in all aspects of consequence modeling, frequency assessment, scenario analysis and identification (FTA, FMEA, event tree, LOPA, etc.)
- Instructor of QRA and Consequence Modeling for operating companies and students at University of Maryland
- Investigator and expert witness in response to incidents and OSHA citations



## Brad Fuller | Manager of Risk Assessment Services

- 25+ years of engineering, consulting, and project management experience
- Accomplished in PSM, security, and risk management focusing on the energy, petroleum LNG, chemical, and transportation sectors
- Skilled in all aspects of qualitative and quantitative risk assessment
- Experienced PHA (HAZOP/LOPA) facilitator, leading projects at US and international facilities and operations
- Author of *CCPS Guidelines for Chemical Transportation Safety, Security and Risk Management*

# Assessments Are The Basis For How We Identify, Understand and Manage Risk



- Provide a survey of potential hazards
- Advise our selection of mitigation measures
- Prioritize efforts, expenses, and capital projects
- Use various methods to assess risks from different viewpoints/perspectives
  - PHA – Qualitative scenario-based review, deviation focus, reevaluates safeguards to mitigate hazards (Risk Matrix)
  - QRA – Quantitative use of equipment accidental release data, consequence models, and impact probabilities to compare against risk tolerance criteria (individual/ societal risk)
  - RBI – Mechanical integrity focused to determine inspection frequency
  - Others – May focus on projects, specific equipment or controls, variety of techniques (FTA, FMEA, Bow-Tie, Event Tree, etc.)

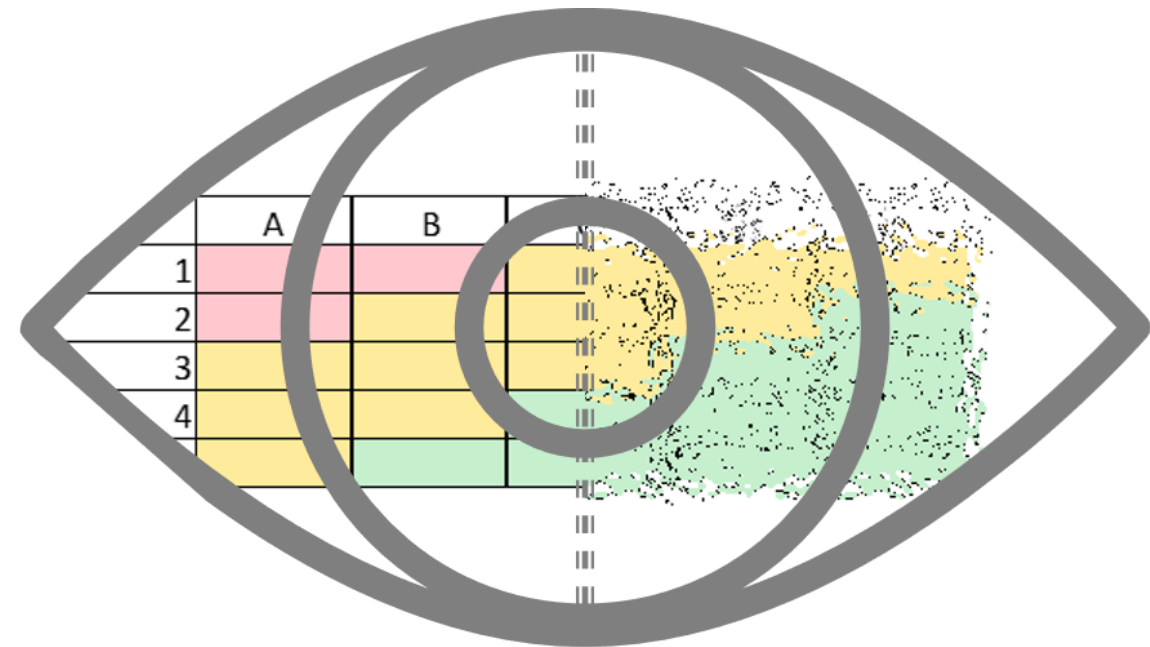
# The Problem

- Every year companies invest capital and the time of their internal resources to conduct risk assessments.
  - **Purpose** is to comply with process safety regulations, Recognized And Generally Accepted Good Engineering Practices (RAGAGEPs), company and industry guidelines, and other specialized studies.
  - **Goal** is to protect the safety and health of their personnel and communities, minimize impacts to the environment, ensure continuity of operations, and secure future sustainability.
- While there is a clear business case for investment in process safety, all too often, even when significant hazards/ risks are uncovered:
  - **There is a hesitancy to make or accept recommendations**
  - **Lack of support and follow through to drive identified recommendations to completion**
  - **Ultimately would improve safety and continually manage operational risks**



# Have You Seen These Issues?

- Issues
  - Hesitancy to highlight potential hazards/ risk, and to propose/ document recommendations to management.
  - Open Recommendations with no clear action plan.
  - Assessment reports that are shelved, filed away, and collecting dust.
- Too often, there is a disconnect between completing the studies and completing the actions required to mitigate identified risks
- Over the years AcuTech has seen that
  - Some organizations are successful in moving from study, to results, to actions, to implementation
  - Others lose sight before they can reach implementation



# Case Study

- Based on AcuTech's global consulting practice a case study with lessons learned is presented
  - Real-world examples of the obstacles and pitfalls will be assessed to determine why good studies fail.
- Includes comparison of both qualitative (e.g., Process Hazard Analysis (PHA)) and quantitative risk assessment (QRA) projects.
- Focusing on why
  - Some studies are successful – **Leading To Action**
  - Others flounder – **Never Gaining Traction**
- While all companies have good intentions when they start the risk assessment process, some can lose sight when the process moves from study completion to action and follow-up .



# Comparison PHA to QRA

## PHA



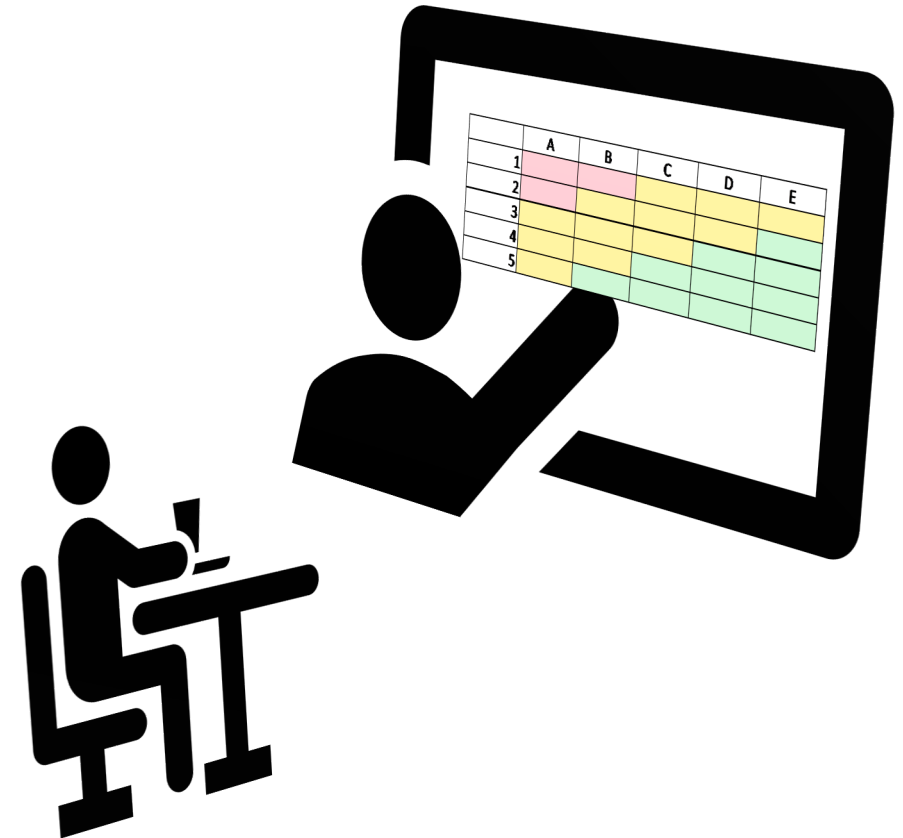
## QRA



- Evaluates risk from a process hazard/ scenario-based viewpoint
  - Causes (based on deviations from normal operation)
  - Consequence (e.g., people, environment, assets)
  - Safeguards
  - Scenario risk ranking
- Recommendations are qualitative (Risk Matrix)
- Typical Hazard and Operability (HAZOP) can be expanded to include Layer of Protection Analysis (LOPA), which is a more semi-quantitative approach
- Evaluates risk/ hazards/ impacts using quantitative methods and tools
  - Release scenarios
  - Release frequencies
  - Consequence modeling (e.g., toxic, fire, explosion)
  - Impact probabilities based on location (e.g., personnel location indoors vs. outdoors)
  - Accounting of detection/ isolation (mitigation/ safeguards)
- Results Comparison to Risk Tolerance Criteria

# Process Hazard Analysis

- Pro's
  - PHA process (What-If, HAZOP) is well understood and has been applied throughout industry
  - Team-based study includes multi-disciplines/ experts
  - Defines detailed hazard scenarios, potential consequences and safeguards, to define risk level
  - Use of Risk Matrix to determine gaps, and need for recommendations
  - Studies commonly expanded to include Layer of Protection Analysis (LOPA) and identification/ need for Independent Protection Layers (IPLs), as well as Safety Instrumented System (SIS) requirements
- Con's
  - Team-based study heavily reliant on the participation/ experience of the team
  - Subject to team's bias
  - Recommendations associated with low-risk scenarios may not be considered, documented, or rejected
  - Defined LOPA process required for successful and consistent application





# LOPA Overview

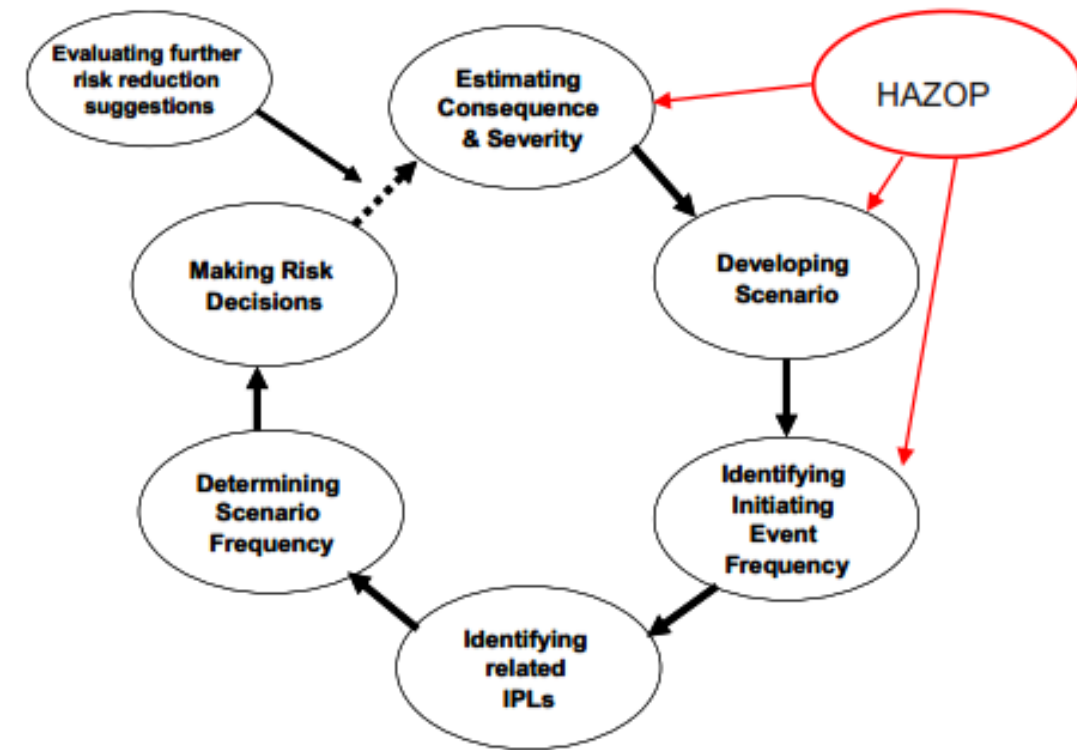
Protection layer diagram



Source:  
Factory Mutual Research

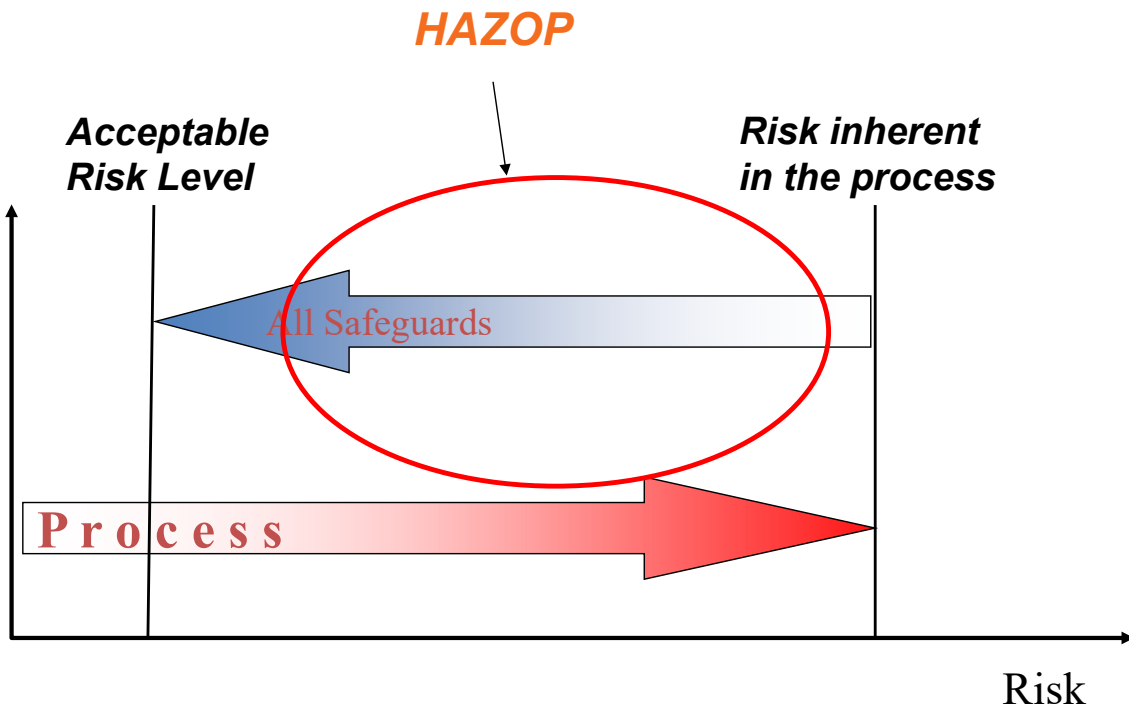
# Expanding PHA To Include LOPA

- LOPA is a simplified form of risk assessment.
- LOPA typically uses order of magnitude categories to approximate the risk of a scenario for
  - Initiating event frequency
  - Consequence severity
  - Likelihood of failure of independent protection layers (IPLs)
- Target Mitigated Event Level (TMEL) Frequency
  - Based on Scenario Consequence
- Result can be used to support SIS

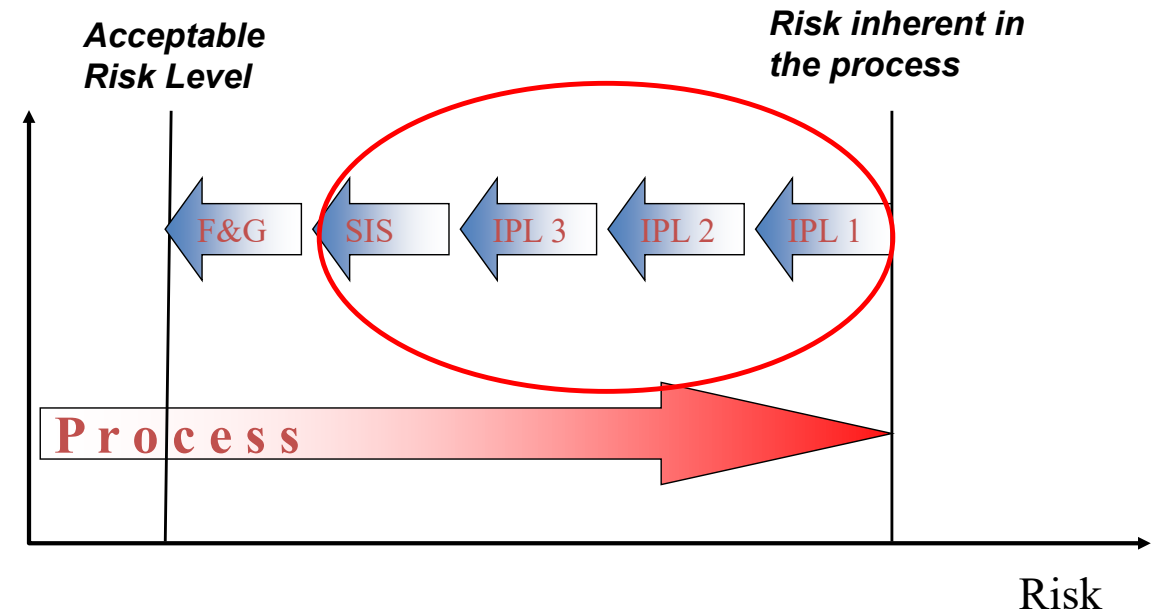


# Comparison HAZOP to LOPA

HAZOP is Concerned with Overall Risk

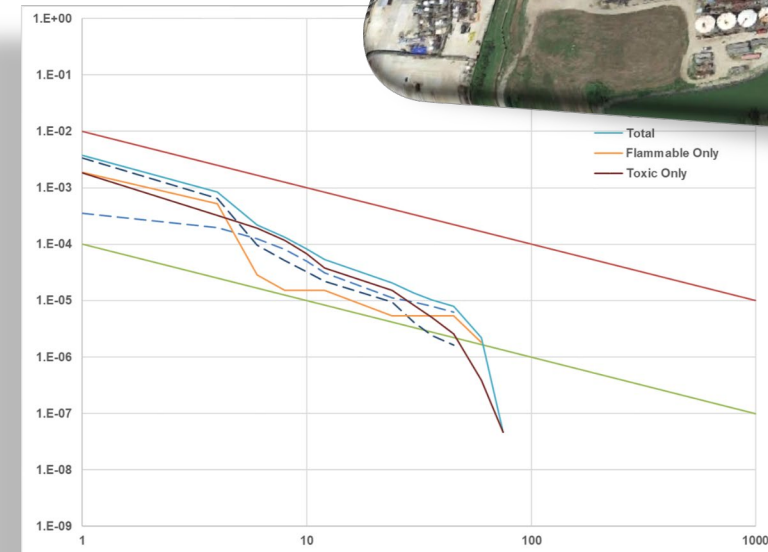
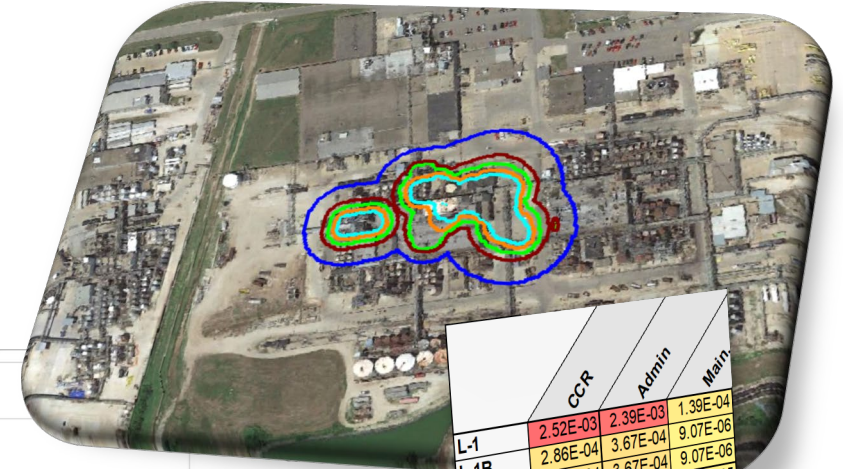


LOPA Evaluates IPLs



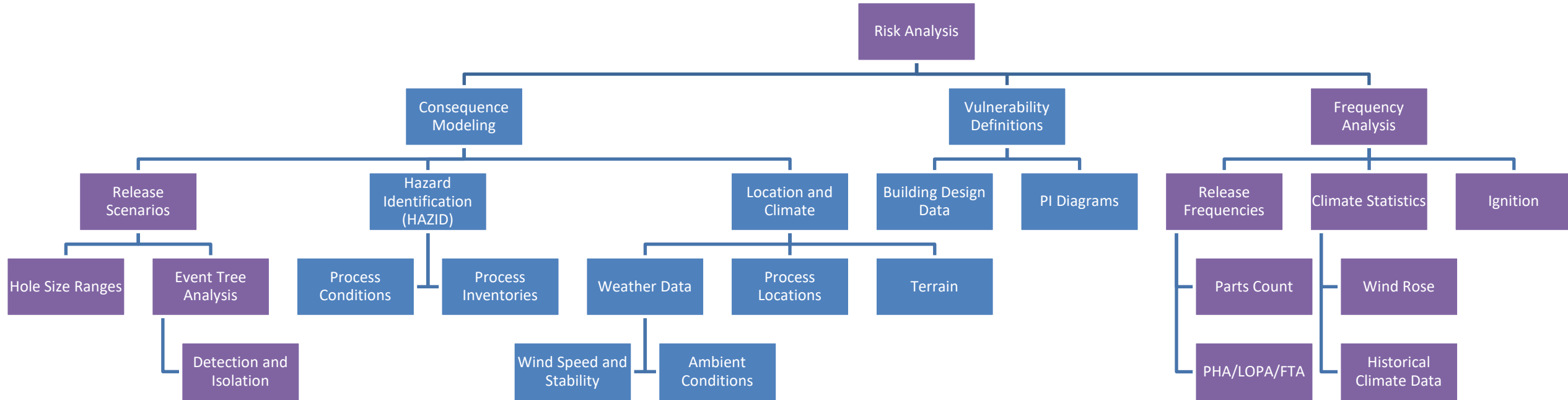
# Quantitative Risk Assessment

- Pro's
  - More accurate consequence results (e.g., modeling of toxic, fire and explosions)
  - Results based on consequence and/or risk level
  - Risk Results (individual, societal, location specific, building specific, worker/ public specific)
  - Results compared to Risk Criteria
- Con's
  - Time consuming
  - Cost
  - Methods and results not as commonly understood
  - Lack of company risk criteria
  - Results are aggregate and not linked to a single scenario
  - Difficult to translate results to actionable plan

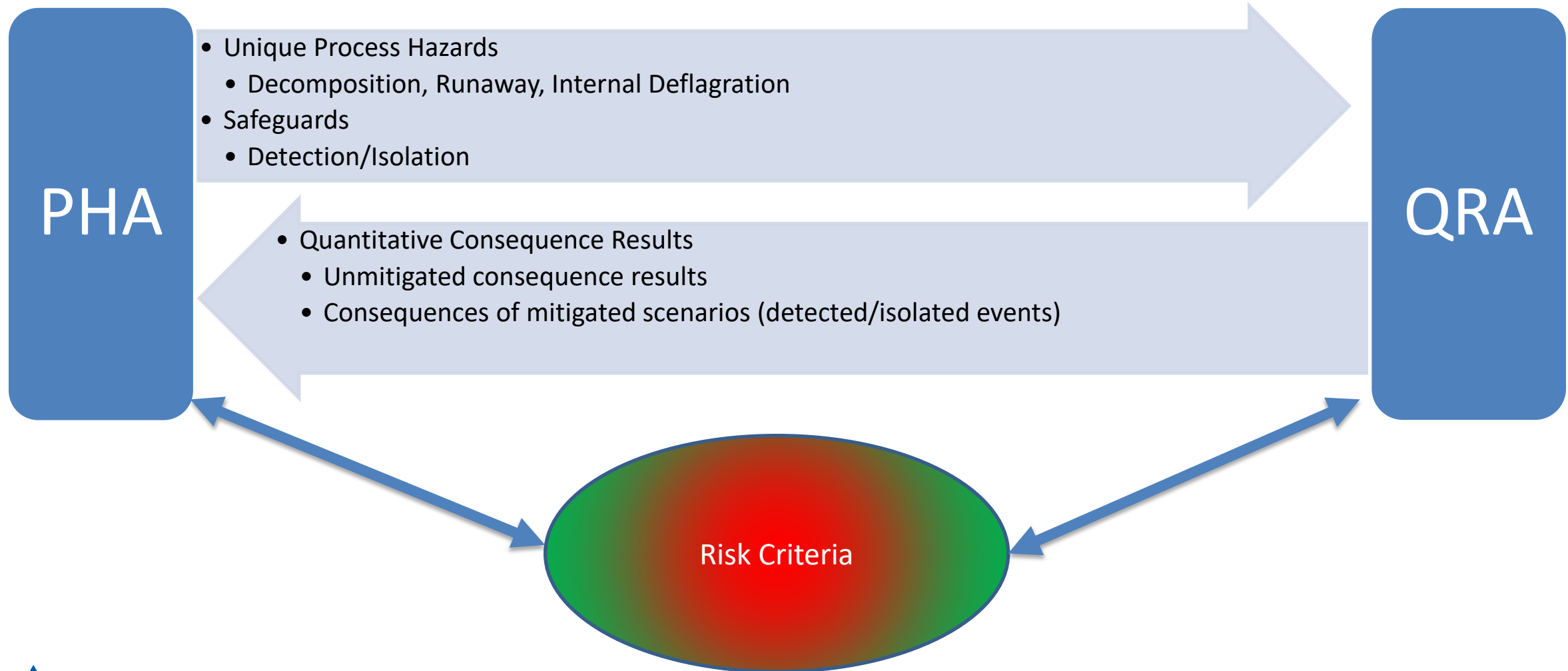


	CCR	Admin	Main
L-1	2.52E-03	2.39E-03	1.39E-04
L-1B	2.86E-04	3.67E-04	9.07E-06
L-1A	2.86E-04	3.67E-04	9.07E-05
L-7	3.70E-04	1.83E-04	3.14E-05
L-6	3.00E-04	1.98E-04	1.76E-07
L-3	2.41E-04	1.11E-04	4.79E-09
L-4	3.01E-04	2.11E-05	2.24E-06
V-6	1.26E-04	1.15E-04	0.00E+00
L-2	1.38E-04	7.36E-05	0.00E+00
L-5	7.87E-05	5.63E-06	0.00E+00
V-1B	1.22E-06	2.25E-05	0.00E+00
V-1A	1.24E-06	2.14E-05	4.78E-07
V-10	1.00E-05	3.71E-06	4.02E-07
V-9	8.33E-06	4.39E-06	6.57E-08
V-3	6.81E-06	6.27E-06	1.41E-08
V-7	2.43E-06	3.32E-07	6.86E-08
V-8	1.84E-06	4.58E-07	0.00E+00
V-2B	4.62E-08	1.90E-06	0.00E+00
V-5	1.16E-06	5.28E-07	8.42E-09
V-2A	1.93E-08	3.88E-07	0.00E+00
<b>TOTAL</b>	<b>4.68E-03</b>	<b>3.89E-03</b>	<b>2.41E-04</b>

# QRA Complexity As Compared To PHA



# Information Flow Between Studies



# Need for Established Risk Criteria

- PHAs assess risk for each scenario that is considered in the study
- The team estimates the severity of each scenario
- The team estimates or calculates the frequency of each scenario
- Risk assessments are for individual scenarios
- LOPA additionally requires initiating event frequencies, IPL probabilities, and TMELs

	A	B	C	D	E
1					
2					
3					
4					
5					

- QRAs assess risk from all scenarios in the study
- The study models the consequence severity of each scenario (including potential impacts probabilities)
- The study calculates the frequency of each scenario
- The risk is aggregated/summed to determine the cumulative risk at specific locations, the overall site, or the surrounding community



# Why Can Good Studies Fail?

- Process safety culture
- Lack of risk assessment guidelines
- Engagement/ buy-in to the risk assessment process
- Skepticism in the results/ lack of transparency
- Non-practical recommendations
- Non-regulatory recommendations
- Results are not clearly communicated
- Risk assessment goals not defined, next steps are not clear
- Large of recommendations to be resolved
- Cost to implement recommendations
- Imperfect management systems



# Stakeholder Engagement - Issues

- Stakeholders may not be
  - knowledgeable in the study scope, methods, or objectives
  - aware of requirements
- When stakeholders are not engaged in the risk assessment process
  - Results may be dismissed, “They made a mistake”, “ ‘They used the wrong information”
  - The scope and limitations of the study are not understood
  - The inputs or assumptions are questioned
    - “This wouldn’t happen here”
    - “This isn’t how we operate”

# Stakeholder Engagement - Solutions

- Stakeholders should be involved in risk assessments from the beginning of the study
  - Stakeholders are not necessarily the engineers associated with the scope of the study, but the decision-makers
  - Stakeholders could change based on the results
- Involve stakeholders at the start and thoroughly present the risk assessment plan, including potential outcomes
  - Don't be shy, especially if the study could require major actions.
- Present the results to stakeholders following completion
  - Don't just toss a report over the fence
- Involve stakeholders in the recommendation process if possible
  - For QRAs or Facility Siting Studies, provide results, and hold a meeting to review them and develop the recommendations together

# Traits of Successful Companies

- Process safety culture
  - Leadership of an organization has the primary responsibility for identifying the need for, fostering, and sustaining the process safety culture.
  - Top-down commitment to day-to-day safety, support of the risk assessment process, communication of hazard/risks, and visible continuous improvement.
  - Everyone in the organization has a role in process safety culture.
- Risk assessment guidelines
  - Key for successful and consistent assessments.
  - Defined risk assessment processes for PHA, LOPA, QRA, etc.
  - Defined required participants (e.g., operations, engineering, instrumentation & controls, maintenance, EHS, etc.).
  - Defined Risk Criteria (Risk Matrix and Quantitative Risk Criteria).
  - Ensures engagement/ buy-in to the risk assessment process.
  - Reduces skepticism in the results/ lack of transparency .

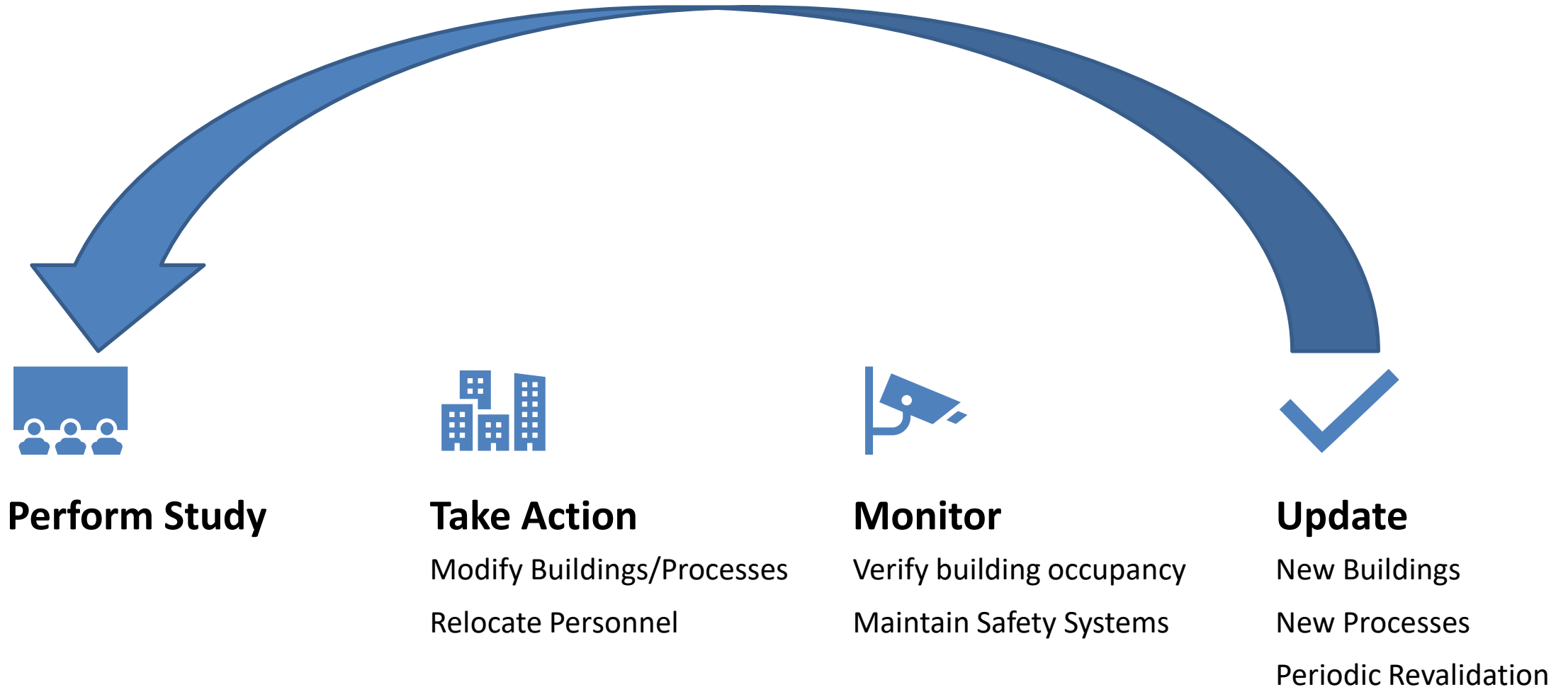
# Traits of Successful Companies

- Identifying and developing recommendations
  - Recommendations need to follow company risk assessment guidelines
    - When are recommendations required (e.g., high hazard, high risk, LOPA gap, exceed risk criteria)?
    - When are recommendations at the discretion of the team?
    - When are recommendations not required (e.g., low hazard, low risk, operability issue only)?
    - What type of recommendations will management not accept (e.g., focus on safety and environment, or other non-regulatory impacts to assets, reputation, operability to be identified)?
    - Recommendations should identify issues and engineered solutions should be a follow-on activity to avoid non-practical recommendations.
- Risk results review
  - To ensure results and recommendations are clearly communicated.
  - Team should review recommendations for clarity before completion of the study.
  - Recommendations with management should be with the full risk assessment team.

# Traits of Successful Companies

- Risk assessment goals need to be defined
  - What if a high risk is identified (immediately notify management, is a temporary mitigation measure required, etc.)?
  - Defined recommendation owner(s).
  - If recommendation requires SIS can that be implemented or a long-term solution?
  - If recommendation requires relocation/ retrofit of an occupied building is more analysis required or the risk drivers, can be existing building be modified, what is the suitable new location, how will the risk to building occupants be communicated and managed until the final changes are implemented?
- Resolution of recommendations
  - Processes are needed to ensure success.
  - Prioritization system based (e.g., risk level, ease of implementation, regulatory requirement, etc.).
  - Defined recommendation review, approval, and implementation timeline.
  - Reoccurring management review meeting to review status of open risk recommendations, including cost, other risk-management solutions, or risk acceptance.

# Risk Assessment Life Cycle



# Questions?



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