

# Facility Risk Assessment Workshop

*Understanding the Tools and Techniques  
Needed to Reduce, Eliminate, or Accept  
Asset and Facility Risk*

## PRESENTERS:

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# Introductions

- Name
- Organization
- Facility Management Experience
- Expectations from Course

# Course Outline

- Understand Basic Risk Management
- Become Familiar with Risk Management Tools
- What is Failure Mode and Effect Analysis (FMEA)
- FMEA Tools and Processes
- FMEA Examples and Exercises
- Overview of a Risk Audit
- Course Summary and Questions

# Why Do You Need Risk Management?

- What Keeps You Awake at Night?
- Mike's Three (3) Priorities
  - Safety – Keeping Employees and Customers Safe
  - Ensuring He Doesn't Go to Jail
  - Making Sure He Sleeps All Night

# What is Risk Management

- Unacceptable Risk

- Risk assessment is the determination of quantitative or qualitative value of risk related to a concrete situation and a recognized hazard.
- Quantitative risk assessment requires calculations of two components of risk: the magnitude of the potential loss, and the probability the loss will occur.

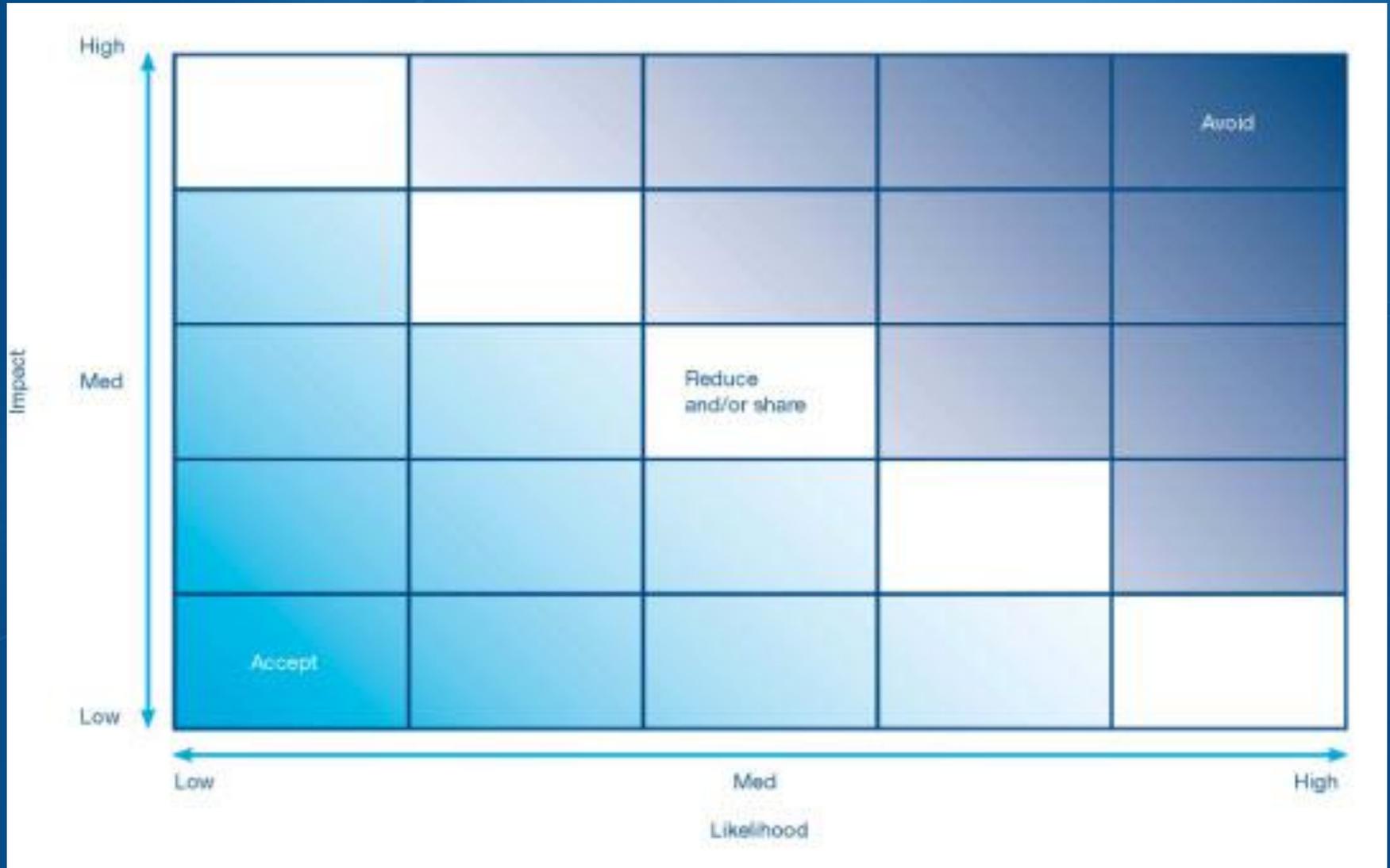
# What is Risk Management

- Acceptable Risk
  - Is a risk that is understood and tolerated usually because the cost or difficulty of implementing an effective countermeasure for the associated vulnerability exceeds the expectation of loss.

# What Does it Take to Develop a Risk Management Program?

- Management Culture of Continuous Improvement
- Leading Class Equipment and Asset Management System
- Complete and Detailed Understanding of Your Operating System and Process
- Mature Maintenance Management System and Process

# Risk Management



# Risk Types

## Opportunity

*Potential gain or positive impact to objectives*

### ● Traits

- Can be tangible or intangible
- Is often quantified in dollar terms
- Can have a positive or negative outcome

### ● Examples Include:

- Business expansion and/or property acquisition
- Change in business location
- Sub-letting

# Risk Types

## Uncertainty

*Associated with unknown and unexpected events, generally catastrophic*

### ● Traits

- Unknown or difficult to quantify
- Catastrophic or disastrous
- Can be costly
- Outside the organization's sphere of control

### ● Examples Include:

- Building damage by flash flooding, arson or sabotage
- Hurricanes, tornados or blizzards

# Risk Types

## Hazard

*Associated with a source of potential harm or a situation with the potential to cause harm*

- Traits
  - Usually known
  - Readily quantifiable, tangible
  - Impact predominantly on safety
- Examples Include:
  - Legionella outbreaks from air conditioning
  - Management and use of hazardous chemicals
  - Confined space entries

# Risk Management Framework

## Implementing Risk Management

- Assess Risk Governance and Organization Structure
- Identify Risk Management Mandate and Scope
- Link Risk Management with Strategic, Financial, and Operational Objectives
- Identify Risk Coverage and Overlap Across Risk Functions
- Leverage Technology to Align Risk Functions
- Assess Risk Function Effectiveness
- Analyze Cost of Managing Risk and Develop Flexible Responsive Cost Model
- Develop Risk Measures (Tolerance, Appetite and Reporting Metrics)

# Application

*Risk Management Formalization and  
Assessment Methods*

# Risk Management Governance Roles and Responsibilities

Team structure	Group	Roles and responsibilities
<p><b>Strategy</b></p>	<b>“C” Suite</b>	<ul style="list-style-type: none"> <li>• Ensure risk management framework</li> <li>• Endorse the vision</li> <li>• Contribute to setting approach and direction</li> </ul>
<p><b>Management</b></p>	<b>Senior management</b>	<ul style="list-style-type: none"> <li>• Align business goals and risk management objectives</li> <li>• Accountable for risk framework</li> <li>• Accountable for monitoring ongoing risk management activities</li> </ul>
<p><b>Internal audit</b></p>	<b>Internal audit</b>	<ul style="list-style-type: none"> <li>• Independent oversight of risk management framework and ongoing risk program activities</li> <li>• Oversight and acceptance of risk profiles and action plans</li> </ul>
<p><b>Facility management</b></p>	<b>Facility management</b>	<ul style="list-style-type: none"> <li>• Validate business objectives and alignment to CRE/FM business and asset infrastructure</li> <li>• Develop and maintain CRE/FM risk management plans</li> <li>• Develop, maintain and monitor risk action plans</li> </ul>
<p><b>Risk management</b></p>	<b>Risk management</b>	<ul style="list-style-type: none"> <li>• Coordinate risk management plans and activities with business lines</li> <li>• Promote and facilitate effective risk management strategy</li> <li>• Report risk management compliance to upper management and internal audit</li> </ul>
<p><b>Staff</b></p>	<b>Staff</b>	<ul style="list-style-type: none"> <li>• Identify, document and communicate any new risk potential</li> <li>• Assist in the development of a unit risk profile</li> <li>• Assess and manage any ongoing risks</li> </ul>
<p><b>Contracted resources</b></p>	<b>Contracted resources</b>	<ul style="list-style-type: none"> <li>• Understand and be aware of the risk management framework and any direct risks associated within are of responsibility</li> <li>• Develop a risk program specific to relative contract and scope of work</li> </ul>

# Risk Management Lifecycle

## ● Identify

- Define requirements and planning

## ● Diagnose

- Understand and evaluate current state, prioritize risks

## ● Design

- Develop detailed risk mitigation strategy

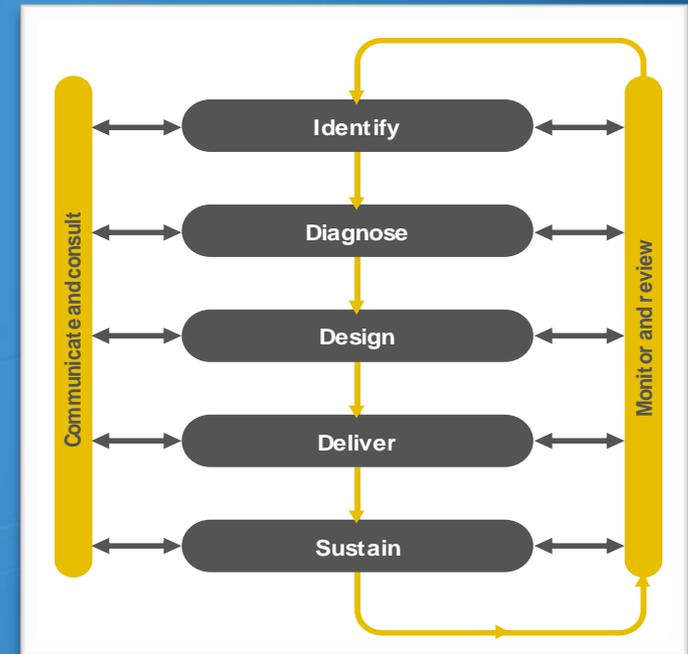
## ● Deliver

- Develop implementation plan, build and validate improvements, execute deployment plan

## ● Sustain

- Determine ongoing operational effectiveness, support continuous improvement, expand the risk program

## ● Monitor, Communicate and Consult



# Tools

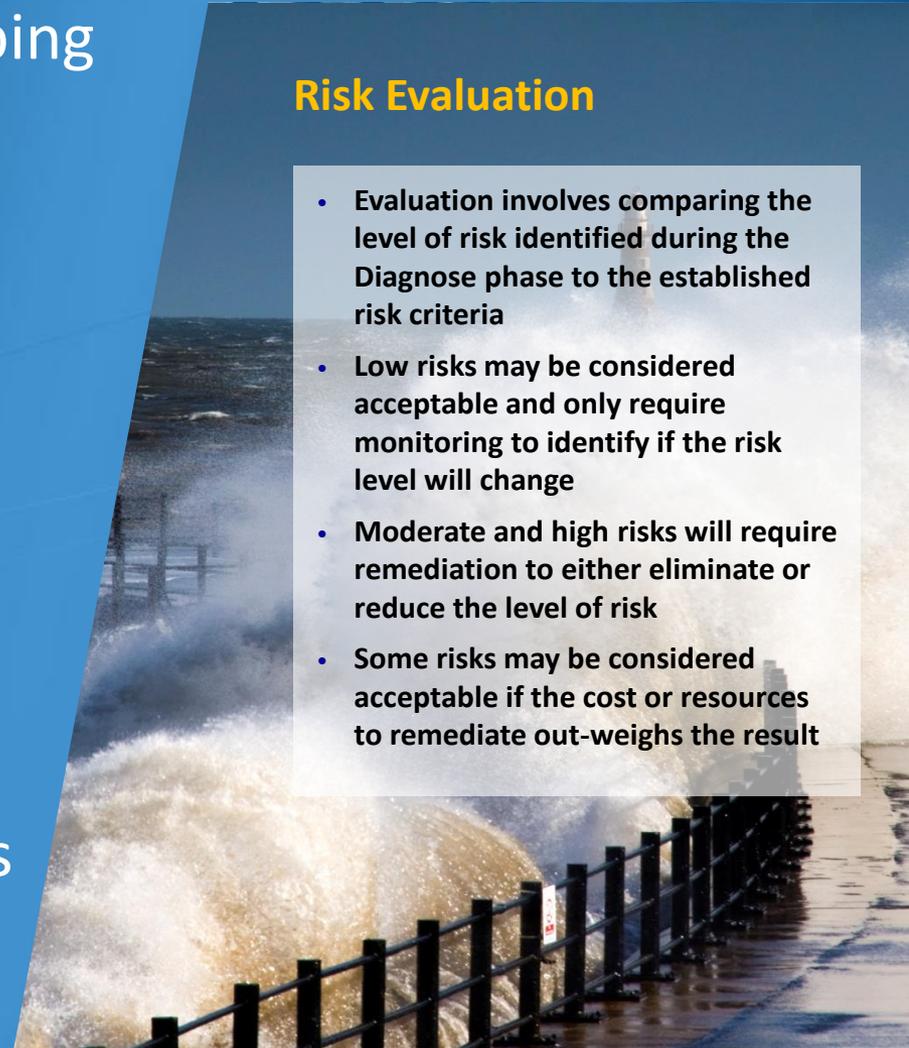
*A Tool for Each Purpose and FMEA  
Explained*

# Risk assessment and analysis tools

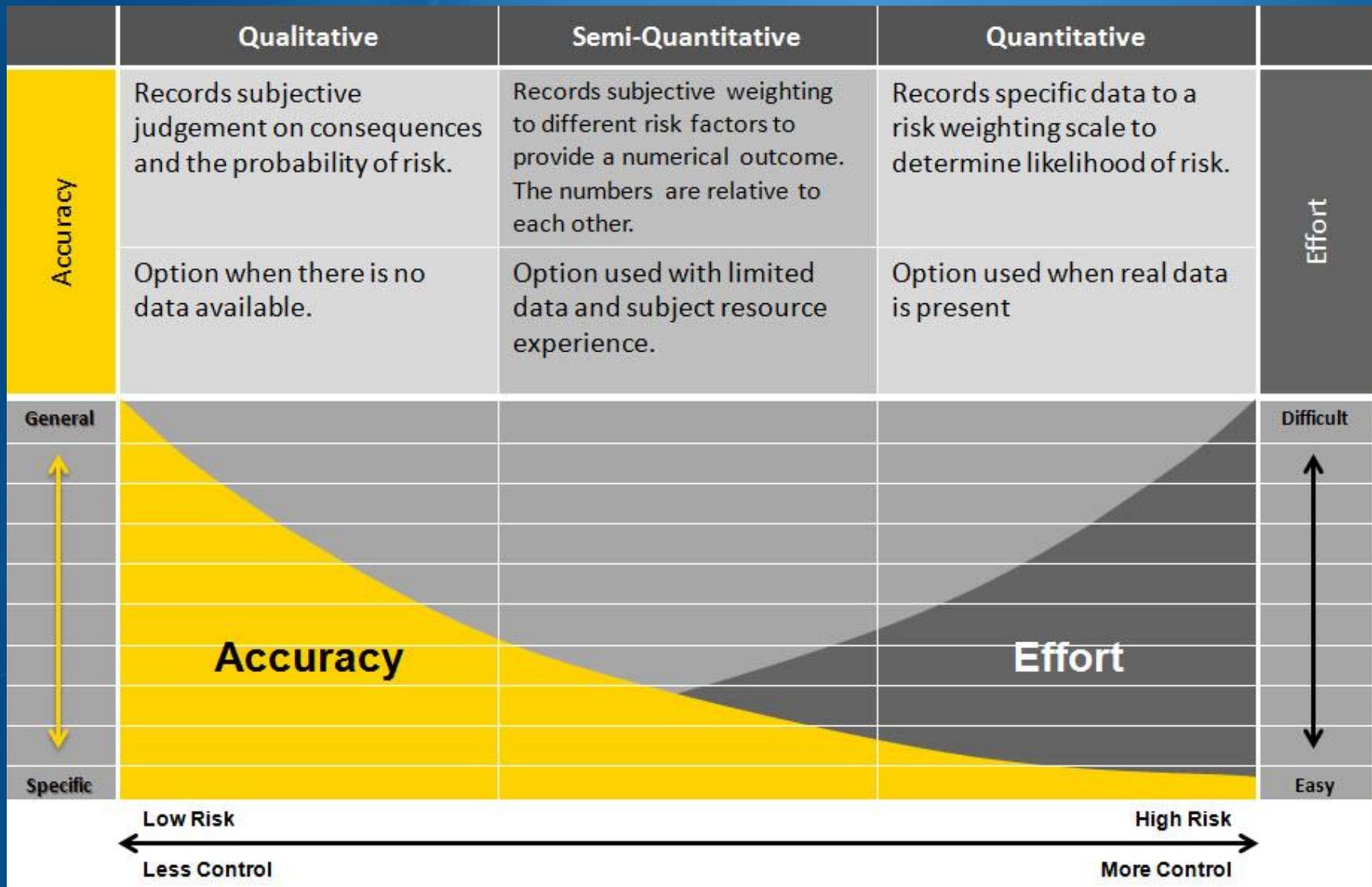
- War Gaming
- Flow Charts and Process Mapping
- Task Analysis
- Scenario Analysis
- Procedural Change Analysis
- Past Record Review
- Physical Inspections
- SWOT Analysis
- Operational Test Evaluation
- Change Analysis
- Hazard and Operability Studies
- Failure Mode Effects Analysis
- Fault Trees
- Surveys and Questionnaires

## Risk Evaluation

- Evaluation involves comparing the level of risk identified during the Diagnose phase to the established risk criteria
- Low risks may be considered acceptable and only require monitoring to identify if the risk level will change
- Moderate and high risks will require remediation to either eliminate or reduce the level of risk
- Some risks may be considered acceptable if the cost or resources to remediate out-weighs the result



# Risk Analysis Methods



# FMEA – What Is It?

- Failure Mode and Effect Analysis
  - FMEA is a systematic method of identifying and preventing product and process problems before they occur
  - Potential problem analysis
  - Anticipate problems before they occur
  - Crystal ball method of maintenance
  - What if this happens????

# 3 Key Factors to FMEAs

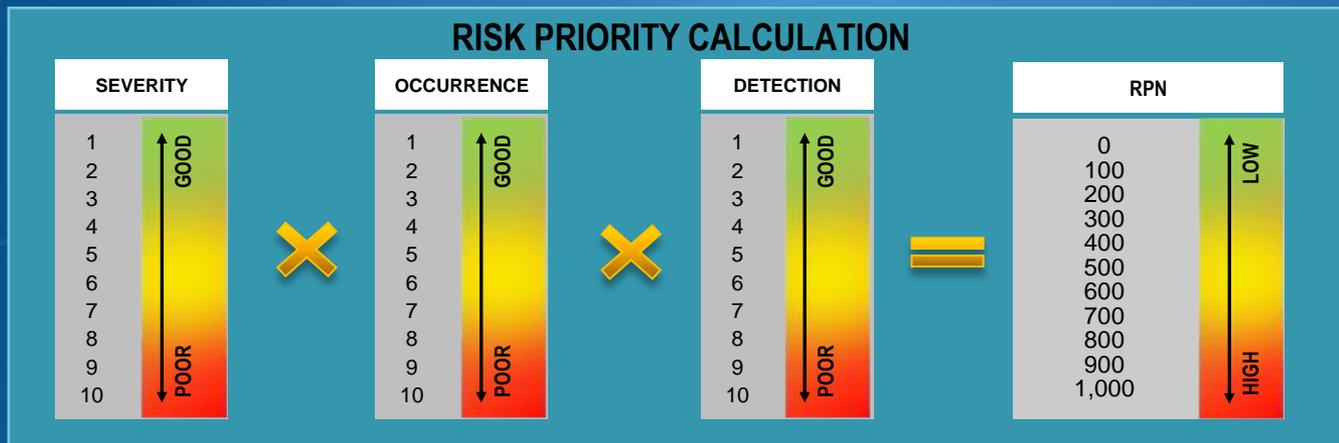
## Risk Rating Scales

*Requires the analysis team to use past experience and engineering judgment to rate each potential risk according to three rating scales*

- Severity
  - The consequence of the failure should it occur
- Occurrence
  - The probability of frequency of the failure occurring
- Detection
  - The probability of the failure being detected before the impact of the effect is realized

# Risk Priority Number (RPN)

- The Risk Priority Number (RPN) Calculation Takes the 3 Key Factors and Multiplies them Together for a Maximum Score of 1,000



# Risk Priority Number

- RPN Number Will Range From 1 to 1,000
- Highest Numbers Should be Attended to First
- Any RPN's with Severity Numbers of 9 or 10 Should be Addressed Regardless of the RPN
- Once Remediation has Taken Place the RPN Should be Recalculated
- Once it is Within the Acceptable Range it Should Only be Reviewed if Process, Conditions, Outside Factors Change

# Severity Guidelines

Score	Severity Guidelines		
	AIAG	Six Sigma	
10	Hazardous without warning	Injure a customer or employee	
9	Hazardous with warning	Be illegal	
8	Very High	Render product or service unfit for use	
7	High	Cause extreme customer dissatisfaction	
6	Moderate	Result in partial malfunction	
5	Low	Cause a loss of performance which is likely to result in a complaint	
4	Very Low	Cause minor performance loss	
3	Minor	Cause a minor nuisance but can be overcome with no performance loss	
2	Very Minor	Be unnoticed and have only minor effect on performance	
1	None	Be unnoticed and not affect the performance	

# Occurrence Guidelines

Score	Occurrence Guidelines			
	AIAG	Six Sigma		
10	Very High: Persistent Failures, Ppk < 0.55	More than once per day	> 30%	
9	Very High: Persistent Failures, Ppk >= 0.55	Once every 3-4 days	< 30%	
8	High: Frequent Failures, Ppk >= 0.78	Once every week	< 5%	
7	High: Frequent Failures, Ppk >= 0.86	Once per month	< 1%	
6	Moderate: Occasional Failures, Ppk >= 0.94	Once every 3 months	< 0.03%	
5	Moderate: Occasional Failures, Ppk >= 1.00	Once every 6 months	< 1 per 10,000	
4	Moderate: Occasional Failures, Ppk >= 1.10	Once per year	< 6 per 100,000	
3	Low: Relatively Few Failures, Ppk >=1.20	Once every 1-3 years	< 6 per million	
2	Low: Relatively Few Failures, Ppk >=1.30	Once every 3-6 years	< 3 per 10 million	
1	Remote: Failure is Unlikely, Ppk >=1.67	Once every 6-9 years	< 2 per billion	

# Detection Guidelines

Score	Detection Guidelines			
	AIAG		Six Sigma	
10	Almost Impossible: Absolute certainty of non-detection		Defect caused by failure is not detectable	
9	Very Remote: Controls will probably not detect		Occasional units are checked for defects	
8	Remote: Controls have poor chance of detection		Units are systematically sampled and inspected	
7	Very Low: Controls have poor chance of detection		All units are manually inspected	
6	Low: Controls may detect		Manual inspection with mistake-proofing modifications	
5	Moderate: Controls may detect		Process is monitored (SPC) and manually inspected	
4	Moderately High: Controls have a good chance to detect		SPC is used with an immediate reaction to out of control conditions	
3	High: Controls have a good chance to detect		SPC as above, 100% inspection surrounding out of control conditions	
2	Very High: Controls almost certain to detect		All units are automatically inspected	
1	Very High: Controls certain to detect		Defect is obvious and can be kept from affecting the customer	

# Building the FMEA Team

- Team Leader
- Process or Equipment Expert
- 4-6 Members

# Building the FMEA Team

## ● Team Leader

Responsible for:

- Communication
- Organization
- Documentation
- Resource provider
- Ensure team stays focused and on subject
- Does not need to be process or equipment expert
- Does need to fully understand the FMEA process
- Leader is more of facilitator than decision maker

# Building the FMEA Team

- Process or Equipment Expert
  - Engineer
  - Architect
  - Equipment designer
  - Primary operator

**Note:** Be aware process experts can slow the process down. Leader needs to keep process on track.

# Building the FMEA Team

- Team Members

- 4-6 members
- Members have different levels of knowledge and familiarity with process or equipment
- Members should change from time to time if manpower is available
- Fresh eyes are always helpful especially after repeat failures
- Team members can take turns as team leader

# Team Training

- Basic FMEA Process Training
- Problem Solving Techniques
- Brainstorming Processes
- Simple and Common FMEA Exercises

**Note:** Lower amounts of training are required if the team leader is experienced in the FMEA process

# Team Boundaries

- Consider Important Boundaries
  - Keeps team on task
- Periodic Reviews by Management Will Add Some Controls
- Will the Team be Responsible for Implementing the Recommendations?
- Is There a Financial Component?
  - What is team's budget?
- Are There Deadlines?
- How Does the Team Communicate the Final Results?

# 10 Keys to Successful FMEA

## 1. Review the Process or Equipment

- Review drawings and process flow diagrams
- Tour the location or equipment
- Have process or operations expert present

## 2. Brainstorm Possible Failure Modes

- Begin the brainstorming process
- Each member of team should be responsible for numerous ideas
- Remember it's brainstorming, listen to all thoughts even the unusual

# 10 Keys to Successful FMEA

3. List Potential Effects of Each Failure Mode
  - List all effects of each potential failure mode
  - Some may have several potential effects
4. Assign Severity Ranking for Each Effect
  - How severe is the effect if it happens?
  - What are the consequences of the failure?
  - The ranking is 1-10

# 10 Keys to Successful FMEA

## 5. Assign an Occurrence Ranking for Each Failure

- Use actual data if available
- Obtained from CMMS history or event logs from operators
- The ranking is 1-10

## 6. Assign a Detection Ranking for Each Failure Mode and/or Effect

- How likely will you be able to detect the failure?
- If difficult or impossible to detect then it warrants a high score
- Detection rankings are 1-10

# 10 Keys to Successful FMEA

## 7. Calculate the Risk Priority Number for Each Failure Mode

- $RPN = \text{Severity} \times \text{Occurrence} \times \text{Detection}$

## 8. Prioritize the Failure Modes for Action

- The highest RPN possible is 1,000
- Pareto 80/20 rule will tell you that you only need to work on the highest 20%
- With experience you will develop a range where anything above that number gets attention
- Could be in the 400-500 range or higher depending on the all RPN scores

# 10 Keys to Successful FMEA

## 9. Take Action to Eliminate or Reduce the High-Risk Failure Modes

- Take action to eliminate the failure
- If not possible, take actions to reduce the RPN to an acceptable level
- Always strive to reduce the RPN even further

## 10. Calculate the Resulting RPN as the Failure Modes are Reduced or Eliminated

- Recalculate the RPN
- Resulting RPN's should be significantly lower than the original calculation

# Process / Risk

FMEA No			Prepared by					
Rev No / Date			Approved by					
Process			Risk					
Process Step	Potential Failure Mode	Potential Failure Effect	Severity (1 - 10)	Potential Causes	Occurrence (1 - 10)	Current Process Control	Detection (1 - 10)	RPN
Briefly outline function, step or item being analyzed	Describe what has gone wrong	What is the impact on the key output variables or internal requirements?	How severe is the effect to the customer?	What causes the key input to go wrong?	How frequently is this likely to occur?	What are the existing controls that either prevent the failure from occurring or detect it should it occur?	How easy is it to detect?	Risk priority number
Tire function: support weight of car, traction, comfort	Flat tire	Stops car journey, driver and passengers stranded	10	Puncture	2	Tire checks before journey. While driving, steering pulls to one side, excess noise	3	60

# Remediation

					Prepared by	
					Approved by	
Remediation						
Recommended Actions	Actions Taken	Remediated Severity (1 - 10)	Remediated Occurrence (1 - 10)	Remediated Detection (1 - 10)	Remediated RPN	
What are the actions for reducing the occurrence of the cause or improving the detection?	What were the actions implemented? Now recalculate the RPN to see if the action has reduced the risk.					
Carry spare tire and appropriate tools to change tire	Spare tire and appropriate tools permanently carried in trunk	4	2	3	24	

# FMEA Case Studies

SKIMMINGS

HEADWORKS

HEADWORKS

01/20/2015



# Pump Performance Requirements

1. Must pump 500 GPM on consistent basis
2. Must pump 24/7
3. Pump flow monitored in control room, but not an alarm function
4. Operator rounds conducted every 2-4 hours. Unless other problems are being handled
5. Pump leakage detected by observation only
6. Might take operator 24 hours to discover pump performance is sub-standard. Due to rise in sludge blanket in clarifiers
7. 2 pumps normally operate at one time
8. Pump speed and flow managed by VFD's

# Pump Performance FMEA Outcome

- What was the Top Failure Mode?
- What do You Think the RPN (Risk Priority Number) Was?
- What do You Think Were the Most Critical Components of the System?
- What Part of the System Needed the Most Attention to Ensure Consistent Operation and Pumping?

# Pump Performance FMEA Outcome

Answer:

The Fractional horsepower motor on  
the VFD cabinet cooling Fan!!

and

Pump shaft packing problems



# ID (Induced Draft) Fan Performance Requirements. Fluidized Bed Sludge Incinerator

1. Provide significant air flow to maintain negative pressure through collectors and scrubbers
2. Fan must perform to maintain incinerator function
3. Fan shuts down and system goes into emergency shut-down
4. After 48 hours of downtime, trucking of sludge to landfill commences and cost escalates dramatically

# ID (Induced Draft) Fan Performance Requirements. Fluidized Bed Sludge Incinerator

1. 500 horse power motor
2. 60 inch fan impeller
3. 24 inch SS duct work
4. Numerous flanged connections
5. 4 inch shaft
6. Lubricated pillar block bearings
7. Predictive maintenance using:
  - a) Thermography
  - b) Vibration analysis

# ID Fan Performance FMEA Outcome

- What was the Top Failure Mode?
- What do You Think the RPN (Risk Priority Number) Was?
- What do You Think Were the Most Critical Components of the System?
- What Part of the System Needed the Most Attention to Ensure Consistent Operation and Pumping?



LUBE MOTOR BEARING  
POLYREX EM  
(OR EQUAL)

LUBE SHAFT BEARING  
MOBILITH SHC-100  
(OR EQUAL)

# ID Fan FMEA Outcome

Answer:

The batteries powering the  
automatic bearing lubricators

and

Fasteners on flanges and motor base  
housing

# Questions?

Visit us at Booth #2037

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- Established CE Maintenance Solutions, LLC in 2004 to provide training, coaching and consulting services to facility and manufacturing organizations
- 30+ years of hands-on experience in production maintenance and facility engineering fields
- My Mechanical Engineering education as well as my extensive experience gives me an unusual insight into how organizations work
- My fundamental understanding and knowledge of the components and the culture needed helps me to properly structure, organize and maintain a World Class maintenance organization

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- Senior manager in EY's Construction and Real Estate Advisory Services practice
- 20+ years of experience in strategic and operational management of facilities and real estate spanning the full spectrum of the real estate life cycle
- A Lean Six Sigma Greenbelt and PMP, helps organizations transform their real estate business by streamlining operations, reducing risk and eliminating waste
- Building a better working world through operational transformation, alignment of mission and operational effectiveness enabled through enterprise technologies