

# Prioritizing Project Oversight Through Risk Engineering

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Risk and Risk Management Track

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*The point of this presentation is:*

- Appraisal of quality costs time and money.
- If you have a limited budget, spend it where your risk is greatest.
- Evaluate the risk through some type of rational approach.

# An Overview Of Risk



# What are the Components of Risk?

- A definable event
- Probability that it will occur
- Impact if it does occur

# What is Risk Management?

- Risk management is a systematic process that involves:
  - Identification
  - Analysis
  - Planning
  - Management

# What Is Risk Engineering?

- My Definition...
  - Applying Risk Management principles to detailed requirements or activities, where the analysis requires:
    - Engineering education
    - Engineering training
    - Engineering experience
    - Ability to apply special knowledge or judgment of the mathematical, physical, or engineering sciences

# Why Apply Risk Engineering To Projects?

- Activities vary in risk level
- Requirements vary in risk level.
- Contractor QC skill will vary
- Engineer/Inspector QA skill will vary

# What Are Obstacles To Assigning Risk?

- Poorly written requirements.
- Poorly defined activities
- Failure modes not fully understood
- Failure probability difficult to estimate
- Adapting “academic” risk methods to real world design and construction.

# How Can We Plan For Risk?



Hope is NOT  
a plan!

# Are There Any Simple Frameworks Out There?

- "Failure Mode and Effects Analysis", or FMEA.
- The FMEA process was originally developed by the US military in 1949 to classify failures "according to their impact on mission success and personnel/equipment safety".

# Structure of FMEA

- Severity – How bad is the result in the event of a failure?
- Probability – How likely is it that a failure will occur?
- Detectability – How likely are we to catch the defect prior to failure?

# Severity



What's The Worst  
That Could  
Happen?

# Probability



I Wonder What's  
Going To Go  
Wrong Today?

# Detectability



Do You Think They  
Even Know  
They're Doing It  
Wrong?

# Actual Failure Versus Project Risk

- Project requirements are developed to provide a factor of safety between the specifications and actual failure
- Construction engineers are usually limited to determining whether or not the contractor met the specifications.

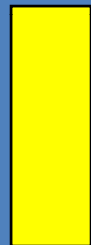
# How Do We Adapt FMEA to Project Oversight?

- **Severity** – what is the owner’s risk if work does not conform to requirements?
- **Probability** - how likely is it that the contractor’s process control will produce nonconforming work?
- **Detectability** - how likely is it that nonconforming work will get through acceptance inspection?

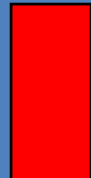
# Severity Rating Numbers



- 1 No discernable effect
- 2 Quality issues rarely noticed by stakeholders
- 3 Quality issues sometimes noticed by stakeholders



- 4 Quality issues often noticed by stakeholders
- 5 Reduction of secondary or maintenance function
- 6 Loss of secondary or maintenance function
- 7 Reduction of primary or safety function



- 8 Loss of primary or safety function
- 9 Catastrophic failure or loss of life with warning.
- 10 Catastrophic failure or loss of life without warning

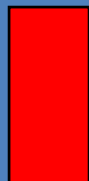
# Probability Rating Numbers



- 1 No chance that requirement will not be met
- 2 Very remote chance that requirement will not be met
- 3 Remote chance that requirement will not be met



- 4 Very low chance that requirement will not be met
- 5 Low chance that requirement will not be met
- 6 Moderate chance that requirement will not be met
- 7 Moderately high chance that requirement will not be met



- 8 High chance that requirement will not be met
- 9 Very high chance that requirement will not be met
- 10 Almost certain chance that requirement will not be met

# Detectability Rating Numbers



- 1 Almost certain detection of requirement violation
- 2 Very high chance of detection of requirement violation
- 3 High chance of detection of requirement violation



- 4 Moderately high chance of detection of requirement violation
- 5 Moderate chance of detection of requirement violation
- 6 Low chance of detection of requirement violation
- 7 Very low chance of detection of requirement violation



- 8 Remote chance of detection of requirement violation
- 9 Very remote chance of detection of requirement violation
- 10 No chance of detection of requirement violation

# Applicability to Traditional Civil Project Framework

- Severity – based on negative outcomes. Is a late schedule worse than the wrong rebar?
- Probability – based on contractor quality control ability to prevent defects.
- Detectability – based on the ability of inspectors to find defects.

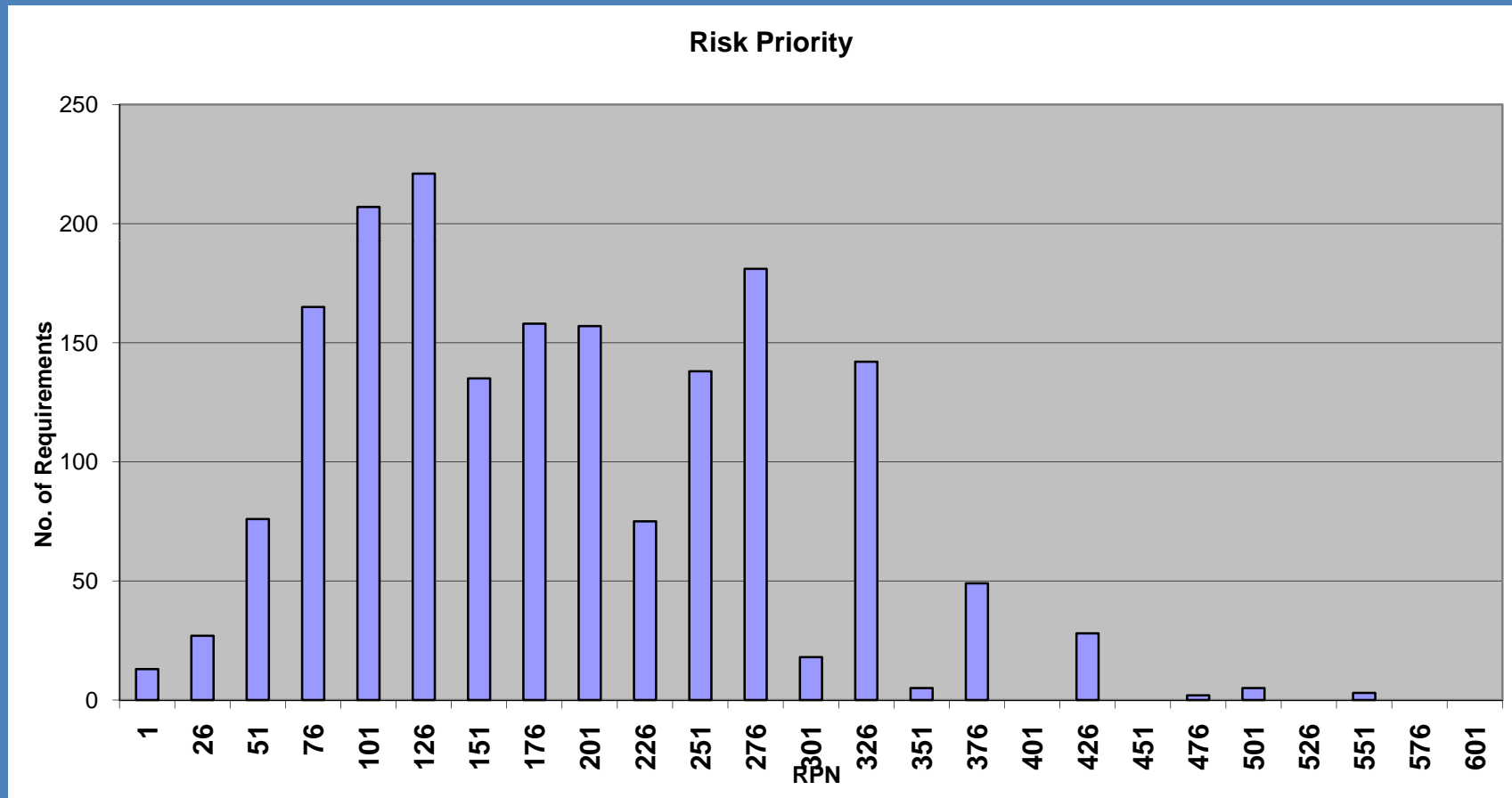
# Risk Priority Number

- Multiply severity, probability, and detectability to produce *Risk Priority Number* ( $S \times P \times D = \text{RPN}$ )
- Possible range of numbers from 1 to 1,000
- Typical range of numbers from 10 to 500
- Average numbers from 100 to 200

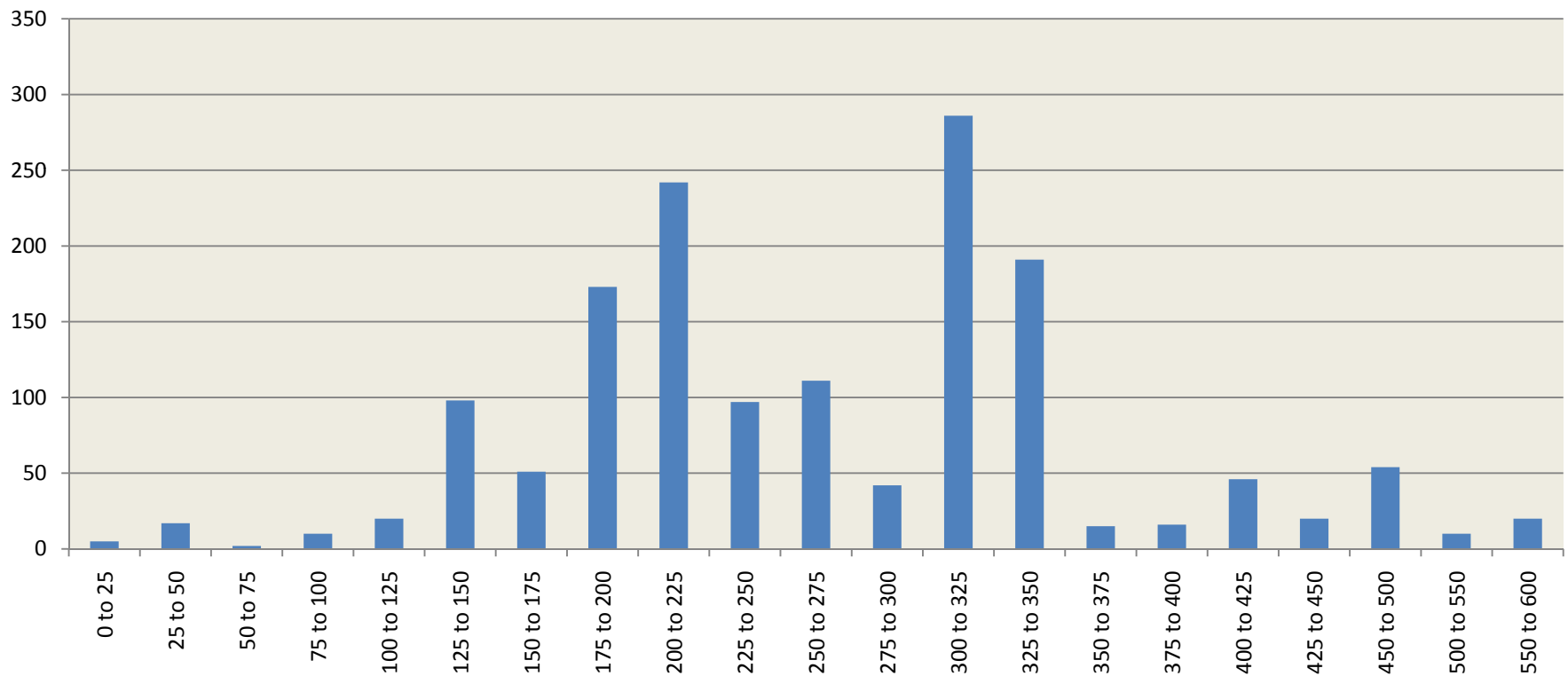
# Sample Requirement Ratings From An Actual Project

CONTRACT REQUIREMENT	S	P	D	RPN
Epoxy coated reinforcement steel bars and WWF shall conform to Standard Specification for Construction and Materials	8	3	3	72
Epoxy coated reinforcement is provided at the appropriate locations.	9	6	7	378
Minimum clear cover requirements are met.	7	6	4	168
Welding of reinforcement steel is prohibited.	8	6	7	336
Substructure units shall be designed so that the largest size of reinforcement steel bar utilized will be No. 11 bars or smaller.	7	5	4	140

# Requirement RPNs From An Actual Project



# Activity RPNs From An Actual Project



# Where Did This Idea Come From?

- Started in Texas in 2005 based on discussions within the ASQ Design and Construction Division.
- Prototyped on Maryland ICC in 2007.
- Deployed on Missouri I-64 and KCICON in 2008.

# Can We Apply This To Design Review Comments?

- Utah Department of Transportation
- Pioneer Crossing Design-Build

# Deficiency Risk Components

The First Step Is To Ask The Right Questions.....

- **Severity** – how significantly is the project affected by the requirement deficiency?
- **Detectability** - how likely is it that the design firm's internal design QC processes should have resolved the issue related to the deficiency at this submittal stage?

# Deficiency Severity Rating Numbers



**1 LOW** – Minimal detrimental effect to the project



**2 MEDIUM** – Moderate detrimental effect to the project



**3 HIGH** – Significant detrimental effect to the project

# Deficiency Detectability Rating Numbers



**1 LOW** – Minimal expectation that design QC should have already resolved the issue



**2 MEDIUM** – Moderate expectation that design QC should have already resolved the issue

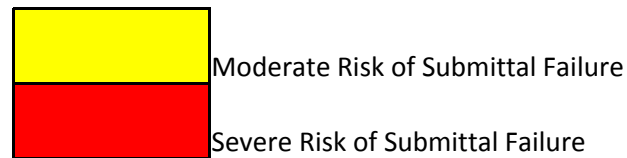


**3 HIGH** – Significant expectation that design QC should have already resolved the issue

# Deficiency Risk Number

- Multiply severity and detectability to produce *Deficiency Risk Number* ( $S \times D = DRN$ )
- Highest DRN – significant and easily preventable through QC review
- Lowest RPN – insignificant and difficult to prevent even with QC review

# Effect of Risk Number on Submittals



Severity

		1	2	3
Detectability	1	1	2	3
	2	2	4	6
	3	3	6	9

# Questions?

For Further Information Contact...

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