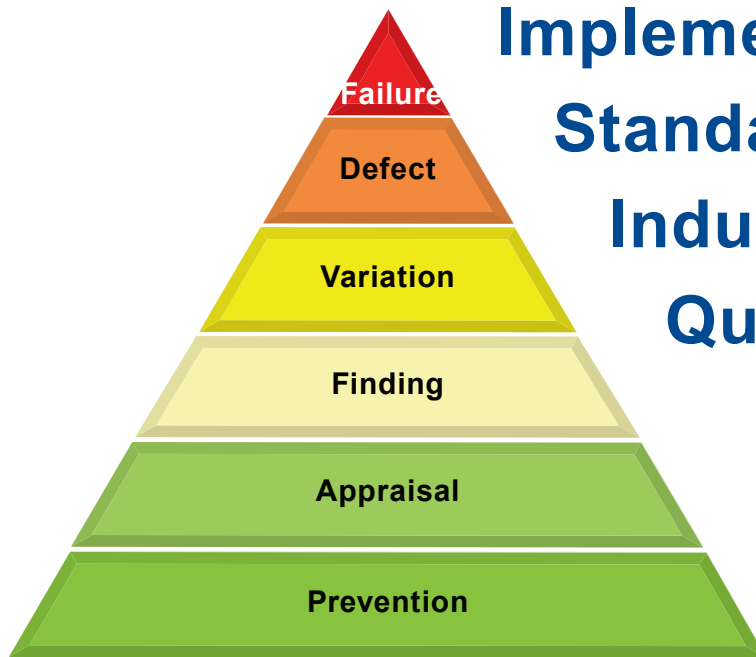




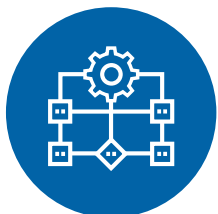
Implementing Standard Industry-wide Quality Metrics



Common Language



Common Metric



Common Work Process

CII Member Companies

Owner Organizations

Abbott
Adventist Health
Ameren Corporation
American Transmission Company LLC
Anadarko Petroleum Corporation
Andeavor
Anheuser-Busch InBev
Aramco Services Company
ArcelorMittal
Architect of the Capitol
Ascend Performance Materials
AstraZeneca
BP America, Inc.
Cargill, Inc.
Chevron
ConocoPhillips
Consolidated Edison Company of New York
Consumers Energy Company
Covestro LLC
DTE Energy
Eastman Chemical Company
Eli Lilly and Company
EnLink Midstream
ExxonMobil Corporation
General Electric Company
General Motors Company
GlaxoSmithKline
Global Infrastructure Partners
Honeywell International Inc.
Huntsman Corporation
Irving Oil Limited
Johnson & Johnson
Kaiser Permanente
Koch Industries, Inc.
LyondellBasell
Marathon Petroleum Corporation
National Aeronautics & Space Administration
NOVA Chemicals Corporation
Nutrien
Occidental Petroleum Corporation
ONEOK, Inc.
Ontario Power Generation
Petroleo Brasileiro S/A - Petrobras
Petronas
Phillips 66
Pioneer Natural Resources
Public Service Electric & Gas Company
Reliance Industries Limited (RIL)
SABIC - Saudi Basic Industries Corporation
Shell Global Solutions US Inc.
Smithsonian Institution
Southern Company
Tennessee Valley Authority
The Dow Chemical Company
The Procter & Gamble Company
TransCanada Corporation
U.S. Army Corps of Engineers
U.S. Department of Commerce/NIST/EL
U.S. Department of Defense/Tricare Management Activity
U.S. Department of Energy
U.S. Department of State
U.S. Department of Veterans Affairs
U.S. General Services Administration

Breakthrough Organizations

Blue Cats
Concord Project Technologies Inc.
Construct-X, LLC
Design + Construction Strategies
Group ASI
iConstruct
Index AR Solutions
Insight-AWP Inc.
O3 Solutions
OnTrack Engineering LTD

Service Providers

AECOM
APTIM
Atlas RFID Solutions
Autodesk, Inc.
AVEVA Solutions Ltd.
AZCO INC.
Baker Concrete Construction Inc.
Barton Malow Company
Bechtel Group, Inc.
Bentley Systems Inc.
Black & Veatch
Burns & McDonnell
CB&I
CCC Group
CDI Corporation
Consolidated Contractors Company
Construtora Norberto Odebrecht S.A.
Continuum Advisory Group
CRB
CSA Central, Inc.
Dassault Systèmes SE
Day & Zimmermann
Deloitte
DMS Corporation
Eichleay, Inc.
Emerson
Ensto, Inc.
ePM
Fluor Corporation
FMI Corporation
Hargrove Engineers + Constructors
Haskell
Hatch
Hexagon Process Power & Marine
Hilti Corporation
Hitachi Construction Machinery Co., Ltd.
I.M.P.A.C.T.
IHI E&C International Corporation
Jacobs
JMJ Associates LLC
KBR
Kiewit Corporation
Linde North America
M&H Enterprises (Energy Services)
Matrix Service Company
McCarthy Building Companies, Inc.
McKinsey & Company, Inc.
Midwest Steel, Inc.
NPCC
Pathfinder, LLC
PCL Constructors, Inc.
Pillsbury Winthrop Shaw Pittman LLP
PTAG, Inc.
Quality Execution, Inc.
Richard Industrial Group
S & B Engineers and Constructors, Ltd.
Samsung Engineering America
Saulsbury Industries
SBM Offshore
Siemens Energy, Inc.
Sinopec Engineering (Group) Co., Ltd. - SEG
Skanska USA
SNC-Lavalin Constructors Inc.
TechnipFMC plc.
The Beck Group
The Boldt Company
thyssenkrupp Industrial Solutions (USA), Inc.
Turner Industries Group LLC
Valency Inc.
Victaulic
Wanzek Construction, Inc.
Wilhelm Construction, Inc.
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Implementing Standard Industry-wide Quality Metrics

Research Team 313, Creating Standards for Industry-wide Quality Metrics
Construction Industry Institute

Implementation Resource 313-2

April 2018

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Executive Summary

CII chartered Research Team 313 (RT-313), Creating Standards for Industry-wide Quality Metrics, to develop a common set of quality metrics for the capital facilities delivery industry. Upon achieving industry-wide acceptance, these metrics would provide aggregated data to enable CII member organizations (owners and contractors) to benchmark quality performance within their projects and across organizations.

RT-313 viewed project quality as a series of planned activities, unplanned outcomes of planned activities (unplanned outcomes), and unplanned events. The team structured these potential project outcomes into a Quality Pyramid, where each level was commensurate with the severity of the consequences of a quality issue. The team then used the Quality Pyramid's severity levels of unplanned events to develop a metric called the Quality Performance Rate (QPR).

The QPR indicates the effectiveness of a quality management system being implemented on a project or within an organization. It enables comparative assessments of project quality performance throughout the front end planning and execution of new or modified facilities. The metric uses currently available data and is scalable, simple to capture, and sustainable.

This document outlines a step-by-step approach to implement the Quality Pyramid, use its quality performance data to calculate a QPR, and incorporate these tools into an organization's existing quality management practices. An organization can use the QPR to quantify the quality achieved on one project, and to compare the quality performance of several projects. The QPR can also be "rolled up" to quantify the quality performance of a portfolio, division, or company.

Used consistently over time, a standard quality metric like the QPR has the potential to measure the effectiveness of new methods or ideas, drive improvement by lowering the cost of capital projects, enhance schedule performance, improve project processes and operational performance, and deliver more predictable project results. When the QPR achieves wide acceptance in the industry, including owners, service providers, contractors, manufacturers, and suppliers, it will have the potential to create industry-wide benchmarks; increasing its usefulness by improving how organizations evaluate and measure the effectiveness of their business and quality management systems.



1

Introduction

CII tasked RT-313 with the objective of identifying and defining a set of quality metrics that the capital facilities delivery industry could use effectively throughout a project life cycle to assess, analyze, measure, and benchmark project performance. By drawing on the available literature and the internal practices at its members' organizations, RT-313 defined project quality activities as planned quality activities, unplanned outcomes of planned quality activities (unplanned outcomes), or unplanned quality events:

- **Planned quality activities** include preventive and appraisal actions, such as training, audits, and inspections.
- **Unplanned outcomes of planned activities** are designated as *findings*.
- **Unplanned events** include *variations*, *defects*, and *failures*.

Together, these activities and events allow the classification of quality incidents into increasing levels of severity and enable organizations to translate their own specific quality data to a common platform. This approach is analogous to the well-known and widely accepted Safety Pyramid, which allows organizations to translate their specific safety data to a common platform. The development of the Quality Performance Rate (QPR) represents a significant advance in the industry's quality management systems.



2

Quality Pyramid

RT-313 defined a series of quality events and categorized them in order of increasing severity: preventative actions, appraisals, findings, variations, defects, and failures. The team then assembled these elements into the Quality Pyramid (see Figure 1). Analogous to the widely accepted Safety Pyramid, this quality model allows an organization to map its own types of quality data to a common platform shared across the industry.

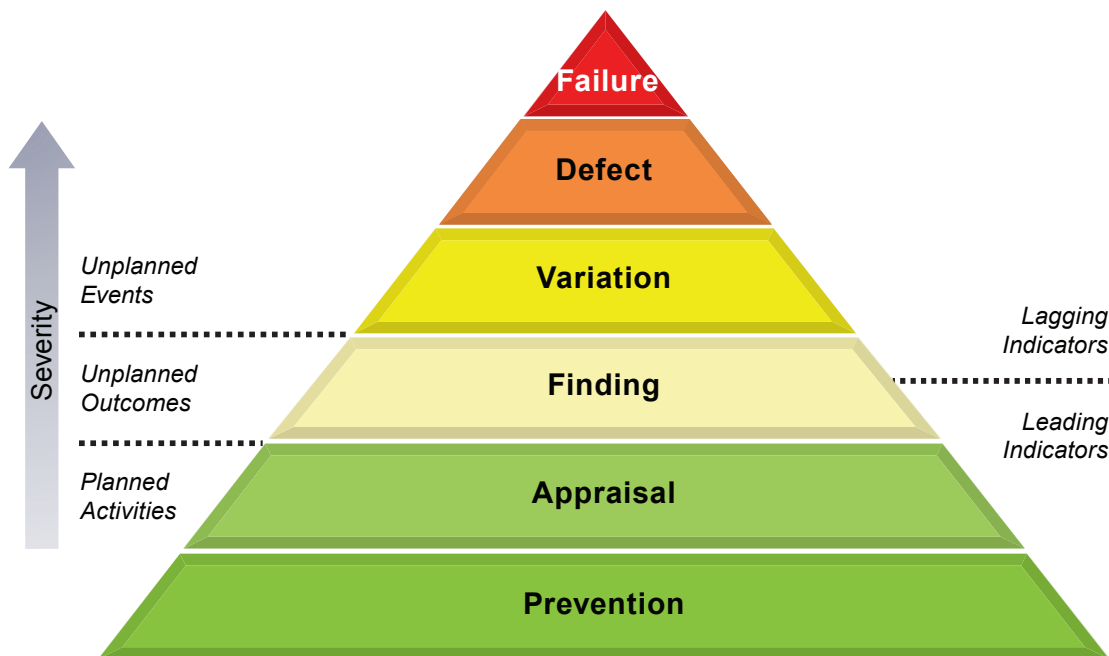


Figure 1. Quality Pyramid

Definitions and Examples

The six categories of the Quality Pyramid can be bisected into two sections: **Leading Indicators** and **Lagging Indicators** (shown on the right side of Figure 1). At the same time, the pyramid can also be separated into three broad classifications (indicated by the divisions along the left side of Figure 1). Starting from the base and ascending through categories of increasing severity, the bottom two levels of **Planned Activities** (Prevention and Appraisal) are clearly leading indicators. A middle layer of **Unplanned Outcomes** (Finding) could be a leading or lagging indicator. (A note on Findings follows the discussion of lagging indicators below.) The top three levels contain **Unplanned Events** (Variation, Defect, and Failure), all clearly lagging indicators.

Note: The standardized approach to developing and implementing metrics is based on developing definitions for each planned activity, unplanned outcome, and unplanned event, and then providing guidance to interpret what is included in each element. Since measurement is the key to standardizing the output and developing consistent benchmarks, a clear understanding of the categories of the Quality Pyramid is paramount.

Leading Indicators *(Not included in the QPR)*

Prevention

Definition: Activities for preventing nonconformance in products or services through the use of established procedures, instructions, and other applicable documents.

Guidance: Procedures, processes, and tools continuously employed to lower the risk of quality nonconformities. (Think of this activity as part of “the cost of quality.”)

Examples of prevention include the following:

- Quality procedures are in place and may include the following examples:
 - Deliverable verification
 - Corrective action or preventive action (CAPA) process
 - Equipment quality assurance and inspection procedures
 - Management quality review process.
- A project execution plan has been developed and includes, at a minimum, the plans of the discipline (i.e., engineering, procurement, construction, commissioning, or startup) and a project quality plan.
- A quality infrastructure has been erected in the organization on the project, office, and overall organizational levels.
- Quality roles and responsibilities are documented.
- A corporate quality metrics procedure has been set up.
- Contract partners with quality programs meet all expectations and requirements.
- Quality training activities are in place and are executed.
- Contract partners have implemented quality programs.
- Scope and criteria management systems are implemented.
- Stakeholder alignment is achieved.

Appraisal

Definition: Planned and documented activities performed to determine adequacy, effectiveness, and compliance with established procedures, resources, instructions, and/or drawings and other applicable documents.

Guidance: An appraisal is conducted to assure that a process and/or work product is in compliance by identifying the key measurements and tolerances related to that process and/or product. Examples of appraisal activities include audits, surveillance, testing, assessments, and verifications.

Transitional Category: Could Be Leading or Lagging Indicators (Not included in the QPR)

Finding

Definition: An outcome of an appraisal that documents the inadequacy of either the compliance with or the implementation of established procedures, resources, instructions, and other applicable documents. A finding is required to document corrective and/or preventative actions, and to follow up to assure that the stated corrective actions have been implemented. With a finding, a process exists, but there is a deficiency in how it is executed.

Guidance: Examples of quality-related findings within the project delivery process include the following:

- A procedure that did not accomplish the intended function.
- A deficiency in the execution of required processes, such as design deliverables, inspections, audits, tests, checklists, protocols, and documentation
- The execution of activities or processes by unqualified personnel or organizations.
- Known management system weaknesses were not investigated and rectified.
- Required corrective or preventative actions were not implemented.

Note: Because a finding is considered to be a potential (unplanned) outcome of a planned activity (i.e., appraisals: audits, and inspections), it can be either a lagging indicator (relative to project impact) or a leading indicator (relative to variations, defects, and failures). **Findings are not included in the QPR with the other lagging indicators.**

Lagging Indicators *(Included in the QPR)*

Variation

Definition: A nonconforming item (e.g., system, structure, component, or service) that has been determined through investigation, examination, or evaluation of objective evidence to be acceptable as-is, and may change the requirement.

Guidance: Acceptable variations may take the form of documented and communicated design deviations or specification variances in which the results of acceptance do not compromise the intended form, function, or purpose of the item. This kind of nonconformance to a specification or design can be “accepted as-is,” because it will not lead to a defect or a failure.

Examples of variations include the following:

- A tolerance violation was identified during the inspection of fabricated products. An engineering evaluation determined that the out-of-tolerance condition of the fabrication was acceptable. The resolution of the nonconformance resulted in a “use as-is” disposition for the identified condition.
- During the installation of a piping spool that mates with a heat exchanger nozzle, it was determined that the nozzle flange was in the 150 lb. class. The engineering specification and equipment supplier documents indicated that the flange should have been in the 300 lb. class, but an engineering evaluation determined that the 150 lb.-class flange was acceptable for the system pressure and temperature conditions. The resolution of the nonconformance resulted in a “use as-is” disposition for the identified condition.
- During the final walkdown of a steam system prior to the final pressure test, it was discovered that the relief valve discharge line was not supported as indicated on the engineer’s drawings. An engineering evaluation determined that the as-installed support system was acceptable for the system conditions. The resolution of the nonconformance resulted in a “use as-is” disposition for the identified condition.

Note: It is critical that as-built data and drawings accurately reflect the as-built status (with the approved variation), rather than the original design.