



API RBI SOFTWARE

Originally developed as an API-sponsored joint-industry project to implement the recommended procedures and quantitative calculations for Risk-Based Inspection (RBI) as defined in API RP 581, API RBI is now developed and maintained by the experts at E²G. API RBI remains the only true quantitative tool available that is fully compliant with API RP 581, including the most recent updates.

API RBI KEY DIFFERENTIATORS

DAMAGE FACTOR CALCULATIONS

- » All API RP 581 damage mechanisms are supported
- » User-defined extensions such as direct damage factor entry to support additional cracking damage mechanisms are supported

LEVEL 1 AND LEVEL 2 CONSEQUENCE MODELS

- » Standard representative fluids for simple modeling
- » State-of-the-art proprietary fluid modeler available to calculate multi-component fluid streams and two-phase fluid mixture properties over a significant range of operating conditions

QUANTITATIVE OUTPUT

- » Risk reduction can be compared to reliability program expenses
- » Risk values expressed in safety area or financial terms
- » Qualitative risk interpretation using such tools as configurable risk matrices, including the new iso-risk format
- » Numerous risk, POF, and COF reports are available

HEAT EXCHANGER TUBE BUNDLE SUPPORT

- » Cost/benefit analysis incorporating Bayesian updating
- » Extensive failure database provided to supplement customer historical data superposition approach to multiple damage factors
- » Advanced options, including secondary damage mechanism consideration and minimum thickness targets, refined through extensive real world application

PRESSURE RELIEF DEVICE SUPPORT

- » Manage multiple protected components
- » All overpressure scenarios considered, including user-specified cases

INVENTORY GROUPS

- » Manage components at the unit level to accurately define fluid inventory and additional release mass
- » Accurately characterize risk; this is not considered by many solutions

ADVANCED INSPECTION PLANNING

- » Standard risk and damage factor plans based on superposition approach to multiple damage factors
- » Advanced options, including secondary damage mechanism consideration and minimum thickness targets, refined through extensive real world application
- » Inspection plan reports available for each piece of equipment

ATMOSPHERIC STORAGE TANK SUPPORT

- » Standard tank consequence financial model provided
- » Additional Level 2 consequence model available, leveraging fluid modeler for safety area results
- » Tanks designed to API 650 as well as low-pressure API 620 tanks supported

SMART TECHNOLOGY.

API RBI DATA + RESULTS

API RBI RESULTS

The API RBI application delivers a calculated inspection plan for each component based on risk, defined in API RP 581 as the product of probability of failure and consequence of failure.

- » When the calculated risk for a component exceeds a user-specified risk target before the specified plan date, an inspection will be recommended with the category or inspection level required and a target date for inspection.
- » Each plan includes inspection recommendations for thinning, cracking, external damage, and HTHA.
- » A detailed risk results summary is provided for risk and damage factors at the RBI date, the target date of inspection, the specified plan date without inspection and the specified plan date with inspection.
- » Detailed damage factor and consequence results are easily accessible for insight into the risk drivers for each component.

API RBI REPORTS

PlantManager™ provides a custom reporting plugin allowing for analysis and visualization using such third-party software as Excel, Crystal Reports, SQL Server Reporting Services, and others. Using this feature, specified users may archive time-stamped snapshots of the complete API RBI database, allowing powerful analysis of data, such as total risk over time, and comparing time-based and risk-based approaches to inspection.

API RBI includes more than 30 standard RBI summary sheets categories such as the following:

- » Inspection planning – Available summary collates all equipment and components, design and operating conditions, recommended inspection levels and dates
- » Fixed equipment
- » Consequence of failure
- » Probability of failure
- » Risk matrix reports – Available for both area and financial targets in the traditional 5x5 or iso-risk format
- » Pressure relief devices
- » Heat exchanger tube bundles
- » Tank summaries

API RBI SOFTWARE DETAILS

The API RBI application provides equipment and component-level extensions to PlantManager™ for the additional data considered in the RBI process. A series of input categories in a convenient tab layout organizes all required and supplemental data in an instantly accessible structure:

The screenshot displays the software interface with several tabs: Inspection Plan, Inspection Recommendation, RBI Data Risk Details, Inspection Plan Details, Analysis Messages, and Graphs. The 'Inspection Plan' tab is active, showing a table for 'Recommended Inspection Plan' with columns for Thinning, Cracking, and External, and rows for C, ---, and ---. To the right, 'Inspection Plan Targets' are listed: Damage Factor, Area Risk (Rt/yr), Maximum Inspection Interval (yrs), and Minimum Thickness (in). Below this, 'Calculated Risk Results' are shown in a table with columns for RBI Date, Target Date, and Plan Date. The table lists various damage mechanisms like Thinning/Lining, Cracking, External Damage, HTHA, Brittle Fracture, Mechanical Fatigue, and Creep, with their respective Risk (Rt/year) and Damage Factor values for three different dates. At the bottom, there are 'Options' for Area Risk, Financial Risk, Damage Factor, and Probability of Failure.

RBI Date	1/1/2015	Target Date	3/1/2019	Plan Date	12/31/2022
Thinning/Lining	Risk (Rt/year) 0.13549, Damage Factor 0.98734	Risk (Rt/year) 0.30821, Damage Factor 2.24602	Risk (Rt/year) 0.0, Damage Factor 0.0	Risk (Rt/year) 0.0, Damage Factor 0.0	Risk (Rt/year) 2.47, Damage Factor 2.47
Cracking	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.0, 0.0
External Damage	0.16594, 1.20925	0.21172, 1.54289	0.0, 0.0	0.0, 0.0	0.38, 0.38
HTHA	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.0, 0.0
Brittle Fracture	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.0, 0.0
Mechanical Fatigue	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.0, 0.0
Creep	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.0, 0.0	0.0, 0.0
Total	0.16594, 1.20925	0.30821, 2.24602	0.0, 0.0	0.0, 0.0	2.47, 2.47

GENERAL

Design, geometry, material of construction, and inventory group.

COMPONENT SETTINGS

Level 1 or Level 2 Consequence model, RBI date, RBI target, Plan date, and other component settings used to calculate risk.

OPERATING CONDITIONS

Operating pressure, temperature, and process fluid.

INSPECTION HISTORY

Inspection activity can be entered directly, synchronized with E²G's SnapIMS module or imported from external sources.

VOLUME AND MASS

Detailed fluid state data calculated by E²G's proprietary fluid modeler, with user-optional overrides. Volume and mass is computed for entire inventory groups and considered for release in the event of containment loss.

DAMAGE MECHANISMS

Each damage mechanism defined in API RP 581 is available based on the selected material of construction and is easily activated via a simple control interface. Only the input data for the activated damage mechanisms are displayed at any given time and are supplemented by relevant information from other input areas as well as previously calculated output to assist in evaluating the appropriate settings.

RBI CASE STUDY

▼ OPTIMIZE INSPECTION STRATEGIES TO FOCUS ON HIGH-RISK ASSETS

Planning for a turnaround is a major endeavor. All accessible vessels are typically candidates for an intrusive inspection. The Turnaround Planner prioritizes inspection activities, allowing the inspectors to focus their attention on high-risk assets during the TA.

PROBLEM

The initial plan was to inspect equipment in the Catalytic Reforming Unit based on the API 510 time-based interval. In addition, many assets were scheduled to be stripped of insulation for a CUI inspection. The inspection activities were numerous. The facility desired to optimize the inspection activities before the scheduled shutdown.

API RBI 581 ASSESSMENTS

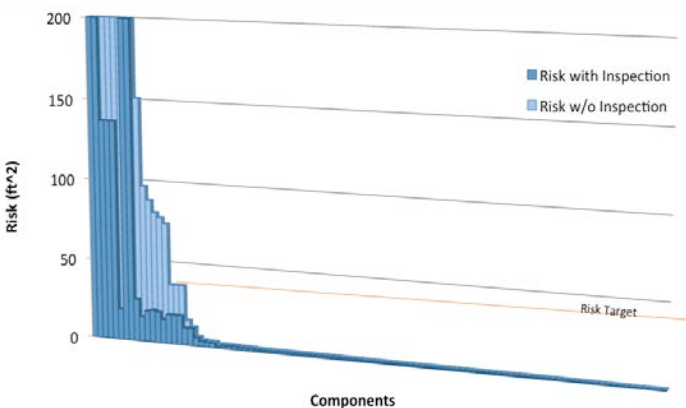
A rigorous API 581 assessment was performed. The assessment analyzed many aspects of the piece of equipment including, but not limited to, operation temperature and pressure, process fluid, material of construction, thickness surveys, and damage mechanisms.

RECOMMENDATIONS

Based on components requiring additional mitigation action besides inspection.

- » Perform the recommended inspection activities noted in the inspection plan.
- » Actions such as the removal of insulation, the increasing of the corrosion allowance, or changes to the metallurgy are suggested to reduce the unmitigated risk to an acceptable level.

CURRENT RISK VS. INSPECTION-MITIGATION RISK



Total 100 components in the Catalytic Reforming unit. Each column represents one component. Components are arranged from highest (left) to the lowest (right) in the chart. When the risk level reaches the risk target, an inspection activity is required. There are 21 components that exceed the risk target in the plan period. Seven components require other risk mitigation to manage the risk besides inspection activity.

BENEFITS TO THE CLIENT

FLEXIBILITY

The inspections can be satisfied with either an intrusive or non-intrusive inspection method allowing more flexibility in scheduling the inspection activities. This also alleviates the issue of having all inspections completed during the shutdown.

COST SAVINGS

The RBI assessment in this unit provided significant cost savings to the facility. The facility can restructure inspection resources to focus on high-risk assets in other units. While inspection cost savings are not the primary goal of an RBI assessment, in many instances, it is a byproduct of optimizing the inspection activities.

CONTINUOUS IMPROVEMENT

Utilization of RBI provides a vehicle for continuously improving the inspection of facilities and systematically reducing the risk associated with pressure boundary failures.

SMART TECHNOLOGY. ANSWERS FOR TODAY. INSIGHTS FOR TOMORROW.

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