

Risk-based Machinery Management

API RECOMMENDED PRACTICE 691
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Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

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Introduction

The origins for the development of this recommended practice came from the recognition among responsible companies that more effective machinery risk management requirements are needed in view of:

- major accidents occurring within the industry;
- new manufacturing centers having difficulty in consistently achieving acceptable levels of quality;
- new applications and services that involve unproven design envelopes;
- larger fleets of aging machinery operating in process and pipeline facilities;
- limited experienced resources operating and maintaining machinery.

These and other drivers have influenced the content of the pages that follow, including understanding of the following.

- 1) Machinery risk is context dependent. It may be quite different among companies operating identical machinery within the same process service. Therefore, to be truly effective, the API Subcommittee on Mechanical Equipment (SOME) determined that prescriptive design requirements, as seen in machinery base standards, such as API 610, could not be imposed upon the industry by API 691. Since every company has unique engineering specifications, process requirements, worker competencies, work processes, risk tolerances, etc., API 691 allows internal risk criteria and methodologies to be utilized by individual operating companies for the purpose of identifying and managing high-risk machinery applications within the context of their own operating regimes.
- 2) Machinery risk is systemic. As such, the recommended practice sets minimum requirements for operating companies, selected designated responsible parties (DRPs), and vendors. Depending on the companies within this system, risk levels may either rise or fall for any given machinery asset. Each company is encouraged to map the API 691 processes outlined herein to their internal work process to the extent possible. The vendor is required to maintain on file design failure mode and effects analysis (DFMEA) as specified by the operating company. They are also responsible to track the technology readiness levels (TRL < 7) of components and subcomponents whose failure may lead to a loss of containment and/or a loss of functionality that could lead to a potential process safety event and to define integrity operating window (IOW) as required. Any other risk management requirement placed upon the vendor is considered outside the scope of this recommended practice. The DRP is required to perform all tasks and activities required by the operating company to enable safe and environmentally compliant machinery.
- 3) Machinery risk is dynamic. It changes over time and, therefore, API 691 is organized by machinery life cycle phase, including feasibility and concept selection; front end engineering design; detailed design; installation and commissioning, and operations and maintenance. There are periodic risk assessments that are required in each of these phases. The recommended practice requires the operating company to put in place a management system to track and mitigate risks where required over time, develop machinery standard operating procedures, define safe operating limits (SOLs), and provide adequate training for operating and maintenance personnel working on high-risk machinery, hereafter referred to as “API 691 Machinery.”

While not required, the user of this recommended practice is encouraged to utilize the Informative annexes where internal requirements are either lacking or found to be insufficient. The operating company and/or their DRP will find that issuing both the base API machinery datasheet (e.g. the API 618 datasheet) concurrently with the API 691 data sheet (Annex H) at the proposal stage is a useful way to define and communicate all API 691 requirements to ensure these are properly addressed and in the most timely manner.

A bullet (•) at the beginning of a section or subsection indicates that either a decision is required or further information is to be provided by the operating company. When such decisions and actions are taken, they may be specified in company documents (e.g. requisitions, change orders, datasheets, and drawings).

Risk-based Machinery Management

1 Scope

1.1 General

1.1.1 This recommended practice defines the minimum requirements for the management of health, safety, and environmental (HSE) risks across the machinery life cycle. It shall be applied to the subset of operating company and/or vendor defined high-risk machinery.

1.1.2 Unless otherwise specified, the following criteria shall be used for initial risk screening to identify potential high-risk machinery for which this recommended practice will be applied:

- a) hazardous gas or liquid services as defined by jurisdiction, appropriate regulatory body, and/or operating company standards or specifications,
- b) services operating at temperatures >350 °F (177 °C) and having design or specified off design operating pressures >80 % maximum allowable working pressure (MAWP),
- c) services operating at temperatures >400 °F (204 °C),
- d) components and subcomponents having technology readiness levels (TRLs) < 7 whose failure may lead to a loss of containment and/or a loss of functionality that could lead to a potential process safety event (see Table 1),
- e) liquid services operating at pressures in excess of 600 psig (41.4 bar),
- f) liquid services having specific gravities less than 0.5.

It is acknowledged that most operating companies and vendors may have existing risk management processes. This recommended practice is not written to replace or invalidate company practices but is meant to supplement them to provide safe working and living environments for facilities and surrounding communities. Operating companies (i.e. Sections 5, 6, 7, and 8 for design, installation, and operating purposes) or vendors [i.e. in Section 4 for research and development (R&D) and product development purposes] can use their own initial risk screening criteria where these have been found to be effective or the criteria recommended above.

NOTE 1 Typically only between 10 % and 20 % of machinery falling within any given initial risk screening will be considered API 691 Machinery. This can include a subset of “critical,” “unspared,” “special purpose,” “prototype,” and/or worst actor machinery. Risks can include loss of containment of hazardous fluids, loss of functionality, high energy releases, etc.

NOTE 2 Applicable international (e.g. GHS ^[1]) or national (e.g. OSHA 1910.119, API 570 ^[2], Class 1, etc.) hazardous service classifications are typically defined within operating company specifications.

NOTE 3 Operating companies and vendors can choose to apply this recommended practice to machinery not covered by existing API standards (e.g. hyper compressors).

1.1.3 The following machinery protection and safety standards shall be applied to new API 691 Machinery where applicable:

- a) API 670;
- b) IEC 61508-1, IEC 61508-2, and IEC 61508-3;
- c) IEC 61511 (Parts 1, 2, and 3) or ANSI/ISA-84.00-2004 (Mod IEC 61511);
- d) IEC 62061 or ISO 13849-1 and ISO 13849-2.