E²G | The Equity Engineering Group, Inc.

WHO WE ARE

E²G | The Equity Engineering Group, Inc. is internationally recognized in the refining and petrochemical industries as a leader in aging infrastructure service and support. Our engineers pioneered the advancement of Fitness-for-Service (FFS) technologies and were the lead investigators of the international standard API 579-1/ASME FFS-1 (API 579). The document has rapidly become the FFS standard of choice for other industries including pulp & paper, fossil utility, food processing, and non-commercial nuclear.

API 579/ASME FFS – FOR THE WEB

The new web-based delivery of API 579 offers a complete set of WebTools for conducting an FFS assessment. Each Part (3 through 14) of API 579 is included as a separate WebTool. The WebTools incorporate the most recent updates to API 579 and offer numerous features including an intuitive user interface, a clear organization of results, modern graphics, automatically generated reports for easy sharing, the ability to save and load assessments, easy access to help, and much more.

WHY THE WEB?

» Runs in any compatible web browser so no special software installation is required

» Deployment on tablets and phones as well as traditional desktop browsers

» All calculations are done on powerful servers running in the cloud (does not use any local CPU resources)

» Instant access to updates and improvements

CAPABILITIES COMMON TO ALL WEBTOOLS

» At all steps, users are able to send feedback directly from within each WebTool. Users can use this function to ask questions, provide general comments, and recommend enhancements.

» Each WebTool includes a catalogue of pre-populated examples to demonstrate typical use cases and highlight specific capabilities.

» Data validation and logic checks are built into the inputs so that users are alerted to out-of-bounds conditions that could lead to misleading results or errors.

» Information buttons containing text, figures, and tables are provided for inputs that warrant a more detailed explanation.

» Each WebTool is compatible with both metric (SI) and imperial (US Customary) unit systems.

» Each WebTool has access to E²G’s extensive database of temperature-dependent material properties (including ASME Section II-Part D, ASME B31, etc.). The material specification can be entered using either a search bar with autocomplete or a more detailed material editor.

» Tabular inputs can be entered directly or copy-and-pasted from Excel.

» Each WebTool is organized so that primary results are presented first. Along with the primary results, written conclusions, notes, limitations of the assessment, and recommendations in the event of a failed assessment are provided. Detailed results are included in separate pages that are easily accessible.

» Each assessment can be saved to a file on the user’s local hard drive and files from previous assessments can be loaded to automatically populate all input fields.

» With each assessment, a printable or downloadable PDF report is generated that contains all inputs necessary to reproduce the calculation, and all primary and intermediate results.

PART 3 - BRITTLE FRACTURE ASSESSMENT

LEVELS 1, 2, AND 3

» Level 1 outputs a single value for the minimum allowable temperature (MAT) at the maximum operating pressure.

» Level 2 includes Methods A and B.

» Level 3 involves a more detailed evaluation using a fracture mechanics methodology based on Part 9, including a systematic evaluation of all of the factors that control the susceptibility of the component to brittle fracture: stress, flaw size, and material toughness.

» Levels 2 and 3 output an allowable internal pressure vs. temperature (MAT) envelope.

» A user-defined operating curve can be entered for comparison to the MAT envelope.
PARTS 4 AND 5
GENERAL AND LOCAL THINNING ASSESSMENTS

LEVELS 1 AND 2

- Includes both general thinning (Part 4) and local thinning (Part 5).
- Thickness measurements can be entered as random point thickness readings (PTRs), a critical thickness profile (CTP), or a grid of thickness readings.
- No limits are placed on the number of thickness readings.
- Acceptability is based on both MAWP and thickness criteria.
- Remaining life (time until the applicable acceptance criteria is not satisfied) is calculated based on a specified corrosion rate.
- Output includes a graphical representation of thickness readings via a critical thickness profile and/or a contour plot of the thickness measurements.

PART 6
PITTING ASSESSMENTS

LEVELS 1 AND 2

- Level 1 includes a comparison with standard pitting charts. Alternatively, a case-specific customized pitting chart can be generated on the fly and included in the report.
- Level 2 assesses both widespread pitting and localized pitting based on detailed pit-couple interactions.
- No limits are placed on the number of pit-couple interactions that can be entered.
- Acceptability is based on both MAWP and thickness criteria.

PART 7
HYDROGEN DAMAGE ASSESSMENT

LEVELS 1 AND 2

- Includes both hydrogen-induced cracking (HIC) and hydrogen blisters.
- Level 1 HIC and blister assessments provide screening criteria to evaluate the damage, considering the damage from the perspective of local metal loss.
- Level 2 HIC assessments use the methodologies of Parts 5 and 9 to evaluate the damaged zone as a region of local metal loss and as a crack.
- Level 2 blister assessments use the methodology of Part 5 to evaluate the blister as an equivalent region of local metal loss.
PART 8
SHELL DISTORTION ASSESSMENT

LEVELS 1 AND 2

- Includes weld misalignment, out-of-roundness, and combined weld misalignment with out-of-roundness.
- Weld misalignment assessments can be performed for centerline offset and/or angular misalignment at both the longitudinal and circumferential weld seams.
- Out-of-roundness assessments can be performed for both global and general (arbitrary-shape) out-of-roundness.
- Level 1 assessments are based on the fabrication tolerances of the original construction code.
- Level 2 assessments include a fatigue assessment by either the ASME structural stress method or the ASME smooth bar method.
- Acceptability is based on both MAWP and thickness criteria.

PART 9
CRACK-LIKE FLAW ASSESSMENTS

LEVELS 1 AND 2

- Level 1 determines the limiting flaw length using the Level 2 methodology with the Level 1 restrictions, per API 579/ASME FFS-1.
- Level 1 can be performed for both semi-elliptical surface-breaking and through-wall cracks.
- Level 2 evaluates the critical points on the crack front with respect to the failure assessment diagram (FAD).
- Level 2 can be performed for semi-elliptical, through-wall, and embedded cracks parallel or normal to longitudinal or circumferential welds.
- The weld residual stress is evaluated based on input welding parameters and the residual stress solutions in Part 9 – Annex 9D.
- Material toughness is evaluated using either the Master Curve or the ASME Section XI model.
- The sensitivity of the flaw size is evaluated with the FAD and the maximum crack length is output as a function of the crack depth (i.e., a critical flaw screening curve).
The Level 1 assessment option for Rupture Life can be used to determine a conservative estimate of a creep-governed allowable stress based on the Part 10 Level 1 Creep Damage Screening curves for a specified target component life (25, 250, 2,500, 25,000, or 250,000 hours) and operating temperature. This analysis also enables users to specify an operating pressure and outer and inner corrosion rates to predict whether the component operating stress will exceed the calculated allowable stress during the component’s lifespan.

The Level 1 assessment for creep damage enables users to specify multiple historical operating conditions (duration, pressure, temperature, corrosion rate) and determine whether a component satisfies the Level 1 Creep Damage acceptance criterion.

The Level 2 assessment includes an appraisal of the accumulated creep damage based on specified historical operating conditions (operating pressure, temperature, and corrosion rate). Also included is an estimate of the remaining life of the component based on projected future conditions. Users are able to choose between calculating the creep damage based on either the MPC Omega or the Larson Miller Parameter procedures from Part 10 of API 579.

Level 2 estimates the fire damaged tensile stress and allowable stress of vessels subjected to flame impingement and the radiant heat of a fire.

Fire damaged properties are estimated based on either Brinell or Vickers hardness test values.

The MAWP, MDMT, and retirement thickness of the vessel are calculated with the estimated fire damaged material properties.
PART 12
DENT/GOUGE ASSESSMENT

LEVELS 1 AND 2

» Includes dents, gouges, and dent-gouge combinations.

» Level 1 dent assessments are based on limiting the maximum dent depth in the component to a percentage of the component’s outside diameter.

» Level 2 dent assessments include a fatigue assessment to evaluate the effects of cyclic pressure loading.

» Level 1 and 2 gouge assessments use the methodology of Part 5 to evaluate the gouge as an equivalent region of local metal loss.

» Level 1 combined dent-gouge assessments use a screening curve to determine the acceptability for continued operation based on the ratio of the dent depth to cylinder outside diameter and the ratio of the gouge depth-to-wall thickness.

» Level 2 combined dent-gouge assessments use a remaining strength factor approach to determine an acceptable MAWP based on the dent and gouge depths. In addition, a fatigue assessment to evaluate the effects of cyclic pressure loading is provided.

PART 13
LAMINATION ASSESSMENT

LEVELS 1 AND 2

» Levels 1 and 2 assess laminations that are parallel to the surface of the plate or that have a through-thickness component (i.e., the lamination is not parallel to the surface of the plate).

» The acceptability of the lamination is determined based on the lamination’s size, its orientation relative to the surface, and the spacing of the lamination to weld joints, structural discontinuities, and other laminations.
Level 1 includes initial screening criteria that may be used to determine if a more thorough fatigue analysis is required. The fatigue screening procedures are based on the methods available in Part 5 of ASME Section VIII-2 with customization for in-service components.

Level 2 includes methods for both smooth bar and welded joint specimens.

Level 2 smooth bar procedures are based on the local primary + secondary + peak equivalent stress range computed for each cycle in the user-specified loading history. An alternating stress is then calculated for proper indexing into the ASME Section VIII-2 smooth bar fatigue curves. Damage is accumulated according to the Palmgren-Miner model.

The Level 2 welded joint procedure uses the mesh-insensitive equivalent structural stress method that takes advantage of the explicit Master S-N fatigue curve that collapses a large collection of weld-fatigue data onto a single curve.

Level 3 is a multiaxial critical-plane, strain-life approach that incorporates the effects of non-proportional loading and load sequence effects to identify the plane of maximum damage.

No limit is placed on the size of the loading history used in the assessment.

Primary output includes the cumulative fatigue damage and number of permissible repetitions of the user-specified loading history until failure. Additional results include cycle data, loading history plots, and the applicable fatigue curve used in the assessment.