

Designs supported by FEA shall comply with the following.

**DESIGN SPECIFICATION:**

A certified design specification shall be submitted for each pressure vessel or pressure containing component designed by analysis. The specification shall contain sufficient detail to provide a complete basis for design and construction. The specification shall specify, or cause to be specified the effective code edition and addenda to be used in construction and shall include but not necessarily be limited to the following;

- 1 – Vessel/component configuration and controlling dimensions.
  - a) – outline drawings.
  - b) – position ( vertical or horizontal)
  - c) – openings, connections, closures including quantity, type & size, and location (i.e. elevation & orientation)
  - d) - principal component dimensions in sufficient detail so that volume capacities can be determined.
  - d) – support method.
- 2 – Design conditions.
  - a) – design pressure
  - b) – design temperature.
  - c) – minimum design metal temperature.
  - d) – dead loads, live loads, and other loads required to perform the load case combinations required by part 5 of Section VIII division 2.
- 3 – Operating conditions.
  - a) -operating pressure
  - b) -operating temperature.
  - c) – fluid transients and flow and sufficient properties for determination of steady state and transient thermal gradients across the vessel/component sections, if applicable ( see paragraph 5.5.2 of Section VIII Division 2 part 5)
- 4 – Design fatigue life.
  - a) cyclic operating conditions and whether or not a fatigue analysis of the vessel/component is required shall be determined in accordance with paragraph 4.1.1.4 of Section VIII Division 2 part 4. When a fatigue analysis is required provide information in sufficient detail so that an analysis of the cyclic condition can be carried out in accordance with paragraph 5.5 of Section VIII Division 2 part 5.
  - b) – when the vessel is designed for cyclic conditions, the number of design cycles per year and the vessel/component design life in years shall be stated.
  - c) – when cyclic operating conditions exist and a fatigue analysis is not required based on comparable equipment experience, this shall be stated. The possible harmful effects of the design features listed in 5.5.2.2- a through f -shall be evaluated when contemplating comparable equipment experience.
- 5 – Material of construction
  - a) – specification of materials in accordance with the code of construction.
  - b) – generic material type (i.e. carbon steel or type 304 stainless steel) the specification shall identify requirements that provide an adequate basis for selecting materials to be used for the construction of the vessel/component. The manufacturer shall select the appropriate material from the code of construction considering the information provided in the design specification.
- 6 – The specification shall identify;
  - a) - type of weld joint and extent of NDE.
  - c) – required markings and location of same
  - d) – hydrostatic test pressure and temperature.

The design specification package shall be set out in a manner which addresses each of the above components in a chronological and orderly fashion. Failure to address any or all of the above will be reason for rejection.

Depending on their expertise in some or all of the above, the design specification shall be certified by one or more Professional Engineers registered in any state of the USA and /or any province or territory of Canada.

## MANUFACTURERS DESIGN REPORT:

- 1 - The manufacturer is responsible for the structural and pressure retaining integrity of the vessel/component or part thereof, as established by conformance with the requirements of the code of construction and the design specification. The manufacturer shall certify compliance with these requirements by completing a manufacturer's data report. ( ASME or CSA B51)
- 2 – Materials selection. When generic material types are specified (i.e. carbon steel or type 304 stainless steel) the manufacturer shall select the appropriate material from the code of construction, considering information provided in the design specification.
- 3 – The manufacturer shall provide a design report for the vessel/component that includes;
  - a) – final as built drawings.
  - b) – the actual ASME ( or verified equivalent) material specification used for each part
  - c) – design calculations and analysis that establish that the design as shown on the drawings complies with the requirements of the code of construction and the design specification.
- 4 – Documentation of design-by-analysis calculations in part 5 of ASME Section VIII Division 2 shall include the following;
  - a) – a detailed description of the numerical method used, including the name and version of the computer software, if applicable.
  - b) – description of the model geometry ( including element type for finite element analysis)
  - c) – loading conditions and boundary conditions used to address the load cases in the design specification.
  - d) – material models utilized for all required physical properties (i.e. modulus of elasticity, Poisson's ratio, thermal expansion coefficient, thermal conductivity, thermal diffusivity), strength parameters (i.e. allowable yield and tensile strength values), strain limits, if applicable and the design membrane stress intensity.
  - e) – description of whether material nonlinearity is utilized in the analysis including a description of the material model (i.e. stress-strain curve and cyclic stress-strain curve).
  - f) - Description of the numerical analysis procedure (i.e. static analysis, thermal analysis (temperature stress), buckling analysis, natural frequency analysis, dynamic analysis) and whether a geometrically linear or non linear option is invoked.
  - g) – graphical display of relevant results (i.e. numerical model, deformed plots, and contour plots of thermal and stress results).
  - h) – method used to validate the numerical model (i.e. mesh sensitivity review and equilibrium check for finite element analysis, e.g. check of hoop stress in a component away from structural discontinuity and a check to ensure that global equilibrium is achieved between applied loads and reaction at specific boundary conditions).
  - i) - description of results processing performed to establish numerical analysis results (i.e. stress linearization method, use of centroidal or nodal values for stress, strain, and temperature results).
  - j) –a summary of the numerical analysis results showing the acceptance criteria utilized to meet the requirements of the code of construction.
  - k) – the results of any fatigue analysis according to paragraph 5.5 as applicable.
  - l) – any assumptions used by the manufacturer to perform the vessel/component design.
  - m) – the design analysis shall be based on the allowable yield and tensile properties listed in the code of construction or, if not given in the code of construction then the values from ASME Section II D shall be used.

The manufacturer's design report package shall be set out in a manner which addresses each of the above components in a chronological and orderly fashion. Failure to address any or all of the above will be reason for rejection.

For the same reason as when a UG 101 proof test is conducted, there must of necessity be a prototype built when design by analysis is being used. The difference however is that the prototype in the latter case can be used for the purpose for which it is designed.

Depending on their expertise in some or all of the above, the design report shall be certified by one or more Professional Engineers registered in any state of the USA and /or any province or territory of Canada. The certifying Engineer(s) shall be other than those certifying the design specification.