# API CRE 10/12/99

# Proposal to Rewrite Section VIII, Division 2

*Presented to the API CRE*
*October 12, 1999 - New Orleans, LA*
*by*
*Bob Sims*

## Overall Concept

- Provide a "world class" Code that can be used for the simplest to the most complex pressure vessels.
  - ✓ Ensure consistency with the European PED and the ISO TC-11 Standard that is currently under development.
- Remove ***perceived*** barriers to the current Div. 2
  - ✓ Permit spot radiography
  - ✓ Provide simple "closed form" design approaches for a broader range of vessels to eliminate the need for FEA in many cases.
- Provide for 3 "classes" of vessels. All classes will have a margin of 1.5 on yield strength and the following margins on room temperature:tensile strength:
  - ✓ Class 1 - 1.875
  - ✓ Class 2 - 2.4
  - ✓ Class 3 - 3.0

Div 2 2

## Overall Concept (continued)

- Vessel classes represent trade offs between design margin and the following construction variables:
  - ✓ Design methodology
  - ✓ Material toughness
  - ✓ Extent of examination.and testing
- The rules will be primarily deterministic as in current codes, but provisions will be made for the application of risk based approaches.
- Pressure/volume classifications and consequence of failure will be considered.

Div 2 3

## Overall Concept (continued)

- Develop as a "standalone" Code that could eventually replace Div. 1, but do not plan for or set a timetable for the phase out of Div. 1.
  - ✓ The initial issue of the revised Div. 2 will contain a limited number of acceptable details and design approaches covering the most common applications.
  - ✓ Additional details and design approaches will be added over time as appropriate design margins can be developed for each
  - ✓ The ISO TC-11 International Pressure Equipment Standard will create competition, so the market will decide whether Div. 1, Div. 2, CEN or another Code will have the broadest acceptance.

Div 2 4

## Proposal

- Form a Project Team using the redesign process to undertake a "clean sheet" rewrite of the ASME Boiler and Pressure Vessel Code, Section VIII, Division 2
- Hire a contractor (possibly through PVRC) to provide initial drafts, and to handle rewrites as needed to respond to comments from the consensus committee.
- Fund the contractor through a combination of ASME development funds and contributions from industry.
  - ✓ A contribution of $9k per year for two years is requested.
  - ✓ Contributors will be able to participate on the Steering Committee and will receive copies of background information, computer applications and other materials.
  - ✓ Contributors will be acknowledged in the revised Code.

Div 2 5

## General Proposals

- Consider all failure modes now covered in Div. 1, Div. 2, and the PVRC Design Margins Report.
  - ✓ Require a User's Design Specification for Class 1 and 2.
  - ✓ Provide some form of fatigue consideration for all classes.
- Provide a form of weld joint efficiency factor by allowing less examination for welds with low stress.
  - ✓ Allow less examination for multiple vessels
- Include "legacy" approaches for design and fabrication, such as area replacement for nozzles.
- Also include more sophisticated approaches, such as FEA, with lower design margins as appropriate.

Div 2 6

## General Proposals (continued)

- Include elevated temperature design (Phase 2 or 3).
- Include currently accepted methodology, and provide for future enhancements as they are developed.
- Put most mandatory requirements, including alternative requirements, into the body of the Code rather than into Appendices.
- Eliminate tables of allowable stresses for Div. 2 in Section II, Part D. Publish only material properties (e.g. yield and tensile strength; fatigue and creep properties) as a function of temperature. Designer to derive allowable stress based on rules in the Code.

Div 2 7

## General Proposals (continued)

- Put all "administrative" requirements into an Appendix.
  - ✓ Ensuring an appropriate level of quality in the User's Design Specification, the design calculations, the Manufacturer's Design Report and fabrication and examination of a pressure vessel is difficult, and this area requires additional study.
  - ✓ Many approaches to quality assurance exist worldwide. For example, some countries conduct a detailed, third party design review.
  - ✓ It is unlikely that one approach will be adopted worldwide in the near future. Therefore, an Appendix with general requirements should be provided. Specific requirements for the US, Canada and other countries that adopt the ASME Code by law or regulation should be in another Appendix that would be mandatory for vessels shipped to those areas. An Appendix should also be provided to meet the European PED.

Div 2 8

## Fatigue and Fracture Analyses

- In the design approach for each component, guidance on determining a conservative estimate of the peak stress should be provided such that a fatigue and/or creep analysis can be performed without FEA.
- As an alternative, a fracture mechanics approach should be provided, similar to that in Section VIII, Division 3.
- Fatigue curves and dA/dN values should be provided in Section II, Part D.

Div 2 9

## Guidance on FEA to be Included

- General guidance on the use of FEA should be included in the initial issue, but detailed guidance should be developed in a Phase 2 or 3 effort:
  - ✓ For each component type (e.g. nozzle, cone to cylinder junction, head, etc.), specific guidance on the application of both linear-elastic and elastic-plastic FEA should be provided.
  - ✓ In the case of linear-elastic FEA, specific guidance on mesh density, stress linearization and categorization, and other important parameters should be provided.
  - ✓ For elastic-plastic FEA, guidance on meshing and results interpretation should also be provided.

Div 2 10

## Consider Risk-Based Approaches

- Basic risk management principles should be used in establishing design and construction requirements and in setting design margins.
- Probabilistic approaches should be included as part of a phase 2 or Phase 3 effort:
  - ✓ Design margins could be established as a function of an acceptable probability of failure.
  - ✓ Determination of an acceptable probability of failure could be done based on the consequences of failure.
  - ✓ Consideration should be given to the classification of service conditions (pressure, volume, etc.).
  - ✓ Average material properties could be published, with mean and standard deviation for use in a probabilistic analysis.

Div 2 11

## Overview of Requirements for Class 1 Vessels

- Detailed User's Design Spec required (e.g. like Div. 3)
- Fatigue analysis will be required
  - ✓ Will not require FEA for common geometries - SIF's for weld details will be provided
- Upper shelf toughness required for full design stress.
  - ✓ May need special consideration for welds and HAZ.
  - ✓ Lower toughness permitted at lower stress levels.
  - ✓ May need minimum elongation and/or RA to ensure ductility
- 100% volumetric and surface examination required.
  - ✓ Exceptions provided for inaccessible areas with low stress
- Misalignment and peaking limited.
- Guaranteed properties permitted, with some reduction.

Div 2 12

## Overview of Requirements for Class 2 Vessels

- Simple User's Design Spec required (e.g. like Div. 2)
- Simplified fatigue analysis will be required
  - ✓ Will not require FEA for common geometries - SIF's for weld details will be provided
- Toughness requirements similar to current CEN Code.
- 100% volumetric and surface examination of welds with stresses >50% of allowable is required.
  - ✓ Could provide table of required NDE for several stress levels
- Misalignment and peaking limited.
- Guaranteed properties permitted, with some reduction.

Div 2 13

## Overview of Requirements for Class 3 Vessels

- Maximum number of operational cycles specified on name plate in lieu of fatigue analysis
- Toughness requirements similar to current Div. 2.
- 100% volumetric and surface examination of welds with stress >60% of allowable is required.
- Misalignment and peaking limited.
- Guaranteed properties permitted, with 3% reduction.

Div 2 14