APPLICATION OF CODES AND STANDARDS

OVERVIEW OF INSPECTION AND TESTING REQUIREMENTS

IIChE (NRC) LECTURE SERIES, 15 JULY 2017, NEW DELHI

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WELCOME NOTE

Tutor Introduction

Safety

Silent Mode

AGENDA

- Understand the general inspection and testing requirements related to:
  - ASME Section VIII Division 1
  - ASME Section VIII Division 2
  - EN 13445
  - PD 5500
  - EC Pressure Equipment Directive

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LLOYD'S REGISTER

- World's first ship classification Society
- Founded in 1760, headquarters in London.
- Not an insurance company and does not have any connections with Lloyd's of London
- We are a 'not for profit organisation' – we do not have any shareholders
- Business is governed by General Committee, the members of which are drawn from the industries which we serve
- Our purpose is to
  - to promote safety of life and property
  - to improve overall business performance in the industries we serve
- We achieve this by securing high technical standards of design, construction, maintenance and operation

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HIERARCHY OF CODES AND STANDARDS

- Laws and Regulations at the place of installation
  - IBR, PESO, PED, MOM, DOSH, etc.
- Construction Codes
  - ASME BPVC Section I, III, IV, VIII, X, XII
  - ASME B31.1, B31.3
  - EN-13445, PD-5500, AS1210, etc.
- Reference Code (Section II, V, IX)
- "In-service" Code (Section VI, Section VII, Section XI)
- Standards, Recommendations (ANSI, ASTM, AWS, ASNT).
- In-service inspection- National Board Inspection Code (NBIC), API-510.

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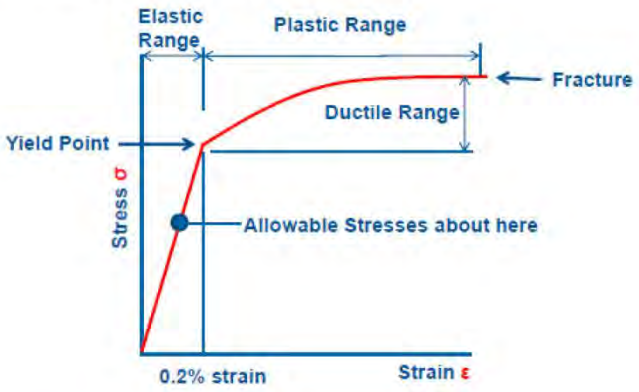
MATERIAL PROPERTIES

- STRESS STRAIN DIAGRAM



- Important Properties:
  - Yield Point
  - UTS
  - Ductility
  - Creep

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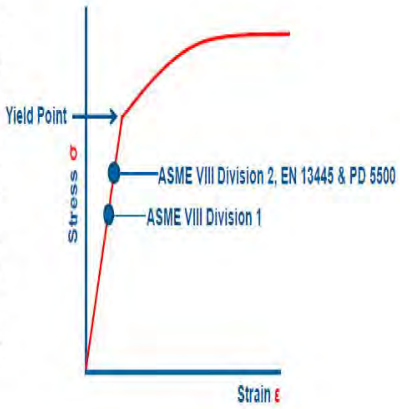
ALLOWABLE STRESSES

- ASME Section VIII Division 1 has higher safety factor – results in relatively higher thicknesses and higher material and fabrication costs.
- Other codes require lower material thicknesses – lower safety factor – usually require more stringent inspection and testing during construction. Higher costs for additional material testing, PWHT, test coupons and Non-destructive Examination.



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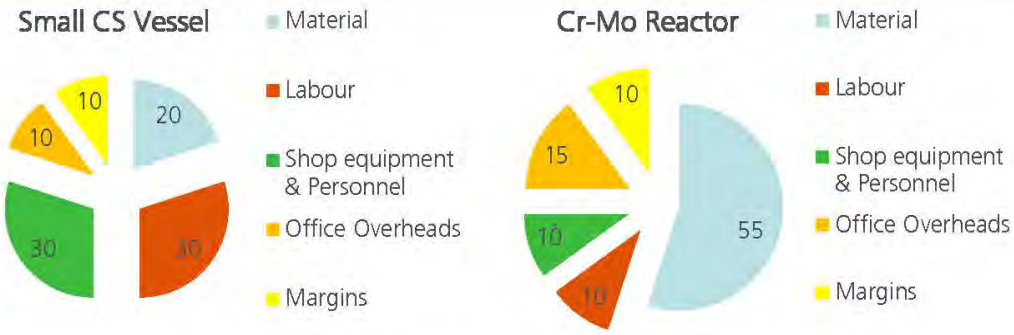
APPROXIMATE COST BREAKUP (INDICATIVE ONLY)



- Material costs proportion varies with the type of material and may constitute anywhere between 15-60% of total cost. In value terms, the shop and office costs remain more or less constant.

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MATERIALS

- ASME Code Section VIII Division 1 and 2
  - Generally ASME Materials (SA/SB) permitted.
  - Section VIII Division 1 – No significant additions to material specifications. Generally Simulation testing for low alloy steels.
  - Section VIII Division 2 – Requirements related to location of test pieces and additional NDE on materials. Simulation testing required for almost all materials.
- EN 13445 and PED – Materials to be from harmonised standards otherwise PMA or EAM route to be followed.
- PD-5500 – BS EN or BS Materials or EAM route. Other materials may be used provided meeting the requirements.

WELDING

- ASME Code Section VIII Division 1 and 2 refer to the ASME Code Section IX for welding qualifications.
  - Generally tensile and bend tests (and toughness tests, if applicable) are required for procedure qualifications.
- EN Codes refer to EN 15614 and ISO 9606 for welding qualifications.
  - Procedure qualifications require volumetric NDE (RT or UT), Surface crack detection (PT or MT), tensile, bend, hardness, toughness and macroscopic examination tests.

NON-DESTRUCTIVE EXAMINATION REQUIREMENTS

- ASME Section VIII Division 2 and EN 13445 sorts equipment based on "Test Groups" which define the required NDE and other limitations.
- The testing groups or sub-groups are based on manufacturing difficulties associated with different groups of steel, maximum thickness, welding process, service temperature range and joint coefficient (EN 13445) or weld joint efficiency.
  - EN code permits weld joint coefficient of 1.0, 0.85, and 0.70 for with the related NDE requirements.
  - ASME Section VIII Division 2 permits weld joint efficiencies of 1.0 and 0.85 with the related NDE requirements.
  - Material and thickness limitations for use of E<1.0.

NON-DESTRUCTIVE EXAMINATION REQUIREMENTS

- ASME Section VIII Division 1 is more straight forward
  - Joint efficiencies of 1.0, 0.85 or 0.7 (For Type-1 welds).
  - Designs with lesser joint efficiencies require less examination, but result in thicker vessels.
  - Above certain thicknesses (for example 32mm for carbon steels), full RT (or UT) mandatory.
  - For certain services (e.g. Lethal, unfired steam boilers, etc.), special requirements apply for weld joint design and NDE.
- PD 5500 categorizes vessels in Category 1 (100% NDE), Category 2 (Spot NDE) and Category 3 (Visual only).

PRESSURE TEST REQUIREMENTS

- Hydrostatic pressure test is the standard.
- Pneumatic testing is potentially a much more dangerous operation than hydrostatic testing.
  - Permitted only if it is not practicable to be filled with liquid.
  - Vessels to be used in processes where even small traces of liquid cannot be tolerated.
- Combined hydrostatic/pneumatic test. In some cases it may be desirable to test a vessel partly filled with liquid. This is as dangerous as the pneumatic test.

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PRESSURE TEST REQUIREMENTS

- EN 13445 (Testing Group 1, 2, 3) and PED (2014/68/EU)
  - The test pressure shall be determined by the greater of:

$$P_t = 1{,}25 \cdot P_d \frac{f_a}{f_{T_d}}$$

or

$$P_t = 1{,}43 \cdot P_s$$

P_t is the test pressure measured at the highest point of the chamber of the vessel in the test position;

P_d and T_d are the coincident design pressure and design temperature values for the maximum pressure load case;

P_s is the maximum allowable pressure of the vessel;

f_a is the nominal design stress for normal operating load cases of the material of the part under consideration at the test temperature;

f_{T_d} is the nominal design stress for normal operating load cases of the material of the part under consideration at temperature T_d;

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PRESSURE TEST REQUIREMENTS

- ASME Section VIII Division 1
  - Hydrostatic Test pressure at least 1.3 x MAWP x lowest stress ratio (LSR) for the materials of which the vessel is constructed.
  - Pneumatic test pressure at least 1.1 x MAWP x lowest stress ratio (LSR) for the materials of which the vessel is constructed.
- ASME Section VIII Division 2
  - Hydrostatic test pressure greater of $P_T = 1.43 \cdot MAWP$ or, $P_T = 1.25 \cdot MAWP \cdot \left[\frac{S_T}{S}\right]$
  - Pneumatic test pressure at least $P_T = 1.15 \cdot MAWP \cdot \left[\frac{S_T}{S}\right]$

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PRESSURE TEST REQUIREMENTS

- PD-5500
  - The test pressure shall be: $p_t = 1.25\left(p\frac{f_a}{f_t} \times \frac{t}{t-c}\right)$

p	is the design pressure;
f_a	is the nominal design strength value (i.e. category 1 or 2) for the material, or its nearest equivalent, at test temperature from the design strength tables of this specification;
f_t	is the nominal time-independent design strength value (i.e. category 1 or 2) for the material, or its nearest equivalent, at the design temperature, or at the highest temperature at which time-independent design strengths are given in the design strength tables of this specification if this is lower than the design temperature;
t	is the nominal thickness of the section under consideration;
c	is the corrosion allowance.

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EC PRESSURE EQUIPMENT DIRECTIVE (2014/68/EU)

- Materials:
  - Material for pressurized parts shall be sufficiently ductile and tough.
    - Elongation after rupture ≥ 14 % and bending rupture energy measured on an ISO V test-piece ≥ 27 J, at ≤ 20 °C but not higher than the lowest scheduled operating temperature.
  - Documentation prepared by the material manufacturer affirming compliance with a specification shall be obtained for all materials.
  - For the main pressure-bearing parts of equipment in categories II, III and IV, this shall take the form of a certificate of specific product control.

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EC PRESSURE EQUIPMENT DIRECTIVE (2014/68/EU)

- Permanent joining (Welding, Brazing, etc.):
  - For pressure equipment in categories II, III and IV, procedures and personnel shall be approved by a competent third party which, at the manufacturer's discretion, may be:
    - A notified body, or a third-party organisation recognised by a Member State as provided for in Article 20.
- NDE - For pressure equipment in categories III and IV, NDE personnel shall be approved by a third-party organisation recognised by a Member State pursuant to Article 20.
- Requirements for involvement of notified body based on the conformity assessment module selected.
  - The extent of involvement (at design and construction stages) is defined as per conformity assessment module selected.

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TR 032/2013

- Technical Regulations of Custom Union
- Establishes common principles and rules for safety of pressure equipment at high pressure.
- Joint efforts by Republic of Belarus, the Republic of Kazakhstan and the Russian Federation.
- Classification of equipment is somewhat similar to PED:
- Classed into vessels, boilers and pipelines.
- Categorization based on pressure and volumes for fluid groups 1 and 2 and liquid or gaseous condition.

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THANK YOU...

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