

## § 54.30-1

apply to welded pressure vessels and non-pressure vessel type tanks of quenched and tempered steels other than 9-percent nickel.

(b) [Reserved]

[CGFR 68-82, 33 FR 18828, Dec. 18, 1968, as amended by USCG-2003-16630, 73 FR 65171, Oct. 31, 2008]

## Subpart 54.30—Mechanical Stress Relief

### § 54.30-1 Scope.

(a) Certain pressure vessels may be mechanically stress relieved in accordance with the requirements in this subpart.

(b) [Reserved]

### § 54.30-3 Introduction.

(a) Large conventional pressure vessels used to transport liquefied petroleum and natural gases, at “low temperatures” may often be difficult to thermally stress relieve. Where no other problem, such as corrosion exists, mechanical stress relief will be permitted for Class II-L pressure vessels.

(b) Mechanical stress relief serves to cause small flaws, particularly in the weld zone, to yield plastically at the flaw tip resulting in a local relief of stress and a blunting of the crack tip. To achieve the maximum benefit from mechanical stress relief, it is necessary that the stresses so imposed be more severe than those expected in normal service life. At the same time, it is necessary that the stresses which are imposed are not so high as to result in appreciable deformation or general yielding.

(c) The weld joint efficiencies as listed in Table UW-12 of section VIII of the ASME Boiler and Pressure Vessel Code (incorporated by reference; see 46 CFR 54.01-1) shall apply except that a minimum of spot radiography will be required. UW-12(c) of section VIII of the ASME Boiler and Pressure Vessel Code that permits omitting all radiography does not apply. Spot examination shall follow UW-52 of section VIII of the ASME Boiler and Pressure Vessel Code and, in addition, these vessels will be required to have radiographic examination of intersecting circumferential

## 46 CFR Ch. I (10-1-10 Edition)

and longitudinal joints for a distance of at least 20 times the plate thickness from the junction. See 46 CFR 54.25-8 on spot radiography.

(d) Severe cold forming will not be permitted unless thermal stress relief is used. For example, parts of the vessels which are individually cold formed, such as heads, must be thermally stress relieved, where the extreme fiber strain measured at the surface exceeds 5 percent as determined by:

$$\text{Percent strain} = (65t/R_f)[1 - (R_f/R_o)]$$

where:

t=Plate thickness.

R<sub>f</sub>=Final radius.

R<sub>o</sub>=Original radius (equals infinity for flat plate).

[CGFR 68-82, 33 FR 18828, Dec. 18, 1968, as amended by USCG-2000-7790, 65 FR 58460, Sept. 29, 2000; USCG-2003-16630, 73 FR 65171, Oct. 31, 2008]

### § 54.30-5 Limitations and requirements.

(a) Class II-L pressure vessels which require stress relief (see Table 54.01-5(b)) may be mechanically stress relieved provided:

(1) The steels from which they are fabricated do not specifically require thermal stress relief in UCS-56 of section VIII of the ASME Boiler and Pressure Vessel Code (incorporated by reference; see 46 CFR 54.01-1) and have a ratio of yield to ultimate tensile strength not greater than 0.8. For example: A-537 steels could be mechanically stress relieved.

(2) Pressure difference across the shell is not greater than 100 pounds per square inch, thickness of shell is not greater than 1 inch, and the design temperature is not greater than 115 °F.

(3) It will carry liquids of specific gravity no greater than 1.05.

(4) Design details are sufficient to eliminate stress concentrators: Mechanical stress relief is not acceptable in designs involving the following types of welded connections shown in UW-16.1 of section VIII of the ASME Boiler and Pressure Vessel Code:

(i) Types l, m, n, and p because of nonintegral reinforcement. Type o will be acceptable provided the plate, nozzle, and reinforcement assembly are

furnace stress relieved and the reinforcement is at least 6 inches or 10t, whichever is larger, from the plate head.

(ii) Types d, e, and f because expansion and contraction stresses are concentrated at the junction points.

(5) That no slip-on flanges in sizes greater than 2 inches are used.

(6) The categories A and B joints are type one as described in Table UW-12 of section VIII of the ASME Boiler and Pressure Vessel Code and all categories C and D joints are full penetration welds. See UW-3 of the ASME Code for definition of categories.

(b) When a pressure vessel is to be mechanically stress relieved in accordance with § 54.30-10(a)(1), its maximum allowable working pressure will be 40 percent of the value which would otherwise be determined. However, an increase of this 40 percent factor may be permitted if the stress relief is carried out at a pressure higher than that required by § 54.30-10(a)(1) and an experimental strain analysis is carried out during stress relief. This evaluation should provide information as to the strains at the saddles, welded seams and nozzles as well as the body of the vessel. The hydrostatic pressure applied during stress relief should be such that, except in the case of welds, the stresses in the vessel shall closely approach but not exceed 90 percent of the yield stress of the material at the test temperature. The proposed experimental program should be submitted to the Commandant for approval prior to its use. Photo-elastic coating, strain gaging, or a brittle coating technique is suggested for the experimental analysis.

[CGFR 68-82, 33 FR 18828, Dec. 18, 1968, as amended by USCG-2003-16630, 73 FR 65171, Oct. 31, 2008]

#### **§ 54.30-10 Method of performing mechanical stress relief.**

(a) The mechanical stress relief shall be carried out in accordance with the following stipulations using water as the pressurizing medium:

(1) At a hydrostatic pressure (measured at the tank top) of 1½ times the design pressure. (See UA-60(e) of section VIII of the ASME Boiler and Pressure Vessel Code.)

(2) At a temperature of 70 °F. or the service temperature plus 50 °F., whichever is higher. Where the ambient temperature is below 70 °F., and use of water at that temperature is not practical, the minimum temperature for mechanical stress relief may be below 70 °F. but shall not be less than 50 °F. above service temperature.

(3) The stress relief shall be at the required temperature and pressure and held for a period not less than 2 hours per inch of metal thickness, but in no case less than 2 hours.

(b) It is considered preferable that mechanical stress relief be accomplished with the tanks in place on their saddles or supporting structure in the barge or ship in which they will be utilized. In any case, it is considered mandatory that the tank be supported only by its regular saddles or supporting structure, without any auxiliary or temporary supports.

[CGFR 68-82, 33 FR 18828, Dec. 18, 1968, as amended by USCG-2003-16630, 73 FR 65171, Oct. 31, 2008]

#### **§ 54.30-15 Requirement for analysis and computation.**

(a) A stress analysis shall be performed to determine if the tank may be exposed to excessive loadings during the mechanical stress relief process. This analysis should include consideration of the local stresses in way of saddles or other supporting structure and additional bending stresses due to the weight of the pressurizing liquid particularly in areas of high stress concentration. While it is necessary that the general stress level during the process be in excess of the normal working level, the calculated maximum stress during test shall not exceed 90 percent of the yield strength of the material at test temperature. The supporting structure shall be analyzed to verify its adequacy.

(b) In all cases where the tanks are mechanically stress relieved in place in the ship or barge and the tanks are designed to carry cargoes with a specific gravity less than 1.05, the ship or barge shall be shown to have adequate stability and buoyancy, as well as strength to carry the excess weight of the tank during the stress relief procedure.