**Coast Guard, DHS Pt. 154, App. B**

**TABLE 4—SUMMARY OF MINIMUM REQUIREMENTS—Continued**

<table>
<thead>
<tr>
<th>Cargo name</th>
<th>Ship type</th>
<th>Independent tank type C required</th>
<th>Control of cargo tank vapor space</th>
<th>Vapor detection</th>
<th>Gauging</th>
<th>Electrical hazard class and group</th>
<th>Special requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulfur dioxide</td>
<td>IG</td>
<td>Yes</td>
<td>Dry</td>
<td>T</td>
<td>C</td>
<td>154.660 (b) (3), 154.1345 (c), (d), 154.1400 (c), 154.1405, 154.1410, 154.1702 (a), (b), 154.1405, 154.1410, 154.1702 (a) (b) (d) (f), 154.1710, 154.1740, 154.1745, 154.1750, 154.1818, 154.1830 (f), 154.1870.</td>
<td></td>
</tr>
</tbody>
</table>

1 Refrigerant gases include non-toxic, non-flammable gases such as: dichlorodifluoromethane, dichloromonofluoromethane, dichlorotetrafluoroethane, monochlorodifluoromethane, monochlorotetrafluoroethane, and monochlorotrifluoromethane.

2 As used in this column: "I" stands for flammable vapor detection; "T" stands for toxic vapor detection; "O" stands for oxygen detection; and see §§ 154.1345 thru 154.1660.

3 As used in this column: "C" stands for closed gauging; "R" stands for restricted gauging; and see § 154.1300.

4 The designations used in this column are from the National Electrical Code.


**APPENDIX A TO PART 154—EQUIVALENT STRESS**

I. Equivalent stress ($\sigma_c$) is calculated by the following formula or another formula specially approved by the Commandant (CG–522) as equivalent to the following:

$$\sigma_c = \sqrt{\sigma_x^2 + \sigma_y^2 - \sigma_x \sigma_y + 3 \tau_{xy}^2}$$

where:

- $\sigma_x$=total normal stress in "x" direction.
- $\sigma_y$=total normal stress in "y" direction.
- $\tau_{xy}$=total shear stress in "xy" plane.

II. When the static and dynamic stresses are calculated separately, the total stresses in paragraph I are calculated from the following formulae or another formulae specially approved by the Commandant (CG–522) as equivalent to the following:

$$\sigma_x = \sigma_x\text{(static)} \pm \sqrt{\sum (\sigma_x\text{(dynamic)})^2}$$

$$\sigma_y = \sigma_y\text{(static)} \pm \sqrt{\sum (\sigma_y\text{(dynamic)})^2}$$

$$\tau_{xy} = \tau_{xy}\text{(static)} \pm \sqrt{\sum (\tau_{xy}\text{(dynamic)})^2}$$

III. Each dynamic and static stress is determined from its acceleration component and its hull strain component from hull deflection and torsion.


**APPENDIX B TO PART 154—STRESS ANALYSES DEFINITIONS**

The following are the standard definitions of stresses for the analysis of an independent tank type B:

**Normal stress** means the component of stress normal to the plane of reference.

**Membrane stress** means the component of normal stress that is uniformly distributed and equal to the average value of the stress across the thickness of the section under consideration.

**Bending stress** means the variable stress across the thickness of the section under consideration, after the subtraction of the membrane stress.

**Shear stress** means the component of the stress acting in the plane of reference.
Primary stress means the stress produced by the imposed loading that is necessary to balance the external forces and moments. (The basic characteristic of a primary stress is that it is not self-limiting. Primary stresses that considerably exceed the yield strength result in failure or at least in gross deformations.)

Primary general membrane stress means the primary membrane stress that is so distributed in the structure that no redistribution of load occurs as a result of yielding.

Primary local membrane stress means the resulting stress from both a membrane stress, caused by pressure or other mechanical loading, and a primary or a discontinuity effect that produces excessive distortion in the transfer of loads to other portions of the structure. (The resulting stress is a primary local membrane stress although it has some characteristics of a secondary stress.) A stress region is local if:

\[ S_1 \leq 0.5\sqrt{Rt}; \text{ and} \]

\[ S_2 \leq 2.5\sqrt{Rt} \]

where:

- \( S_1 \) = distance in the meridional direction over which the equivalent stress exceeds 1.1 \( f \).
- \( S_2 \) = distance in the meridional direction to another region where the limits for primary general membrane stress are exceeded.
- \( R \) = mean radius of the vessel.
- \( t \) = wall thickness of the vessel at the location where the primary general membrane stress limit is exceeded.
- \( f \) = allowable primary general membrane stress.

Secondary stress means a normal stress or shear stress caused by constraints of adjacent parts or by self-constraint of a structure. The basic characteristic of a secondary stress is that it is self-limiting. Local yielding and minor distortions can satisfy the conditions that cause the stress to occur.

**PART 155 (RESERVED)**