(because of base metal thicknesses). The above limitations shall be in strict accordance with the steel producer's recommendations. The use of stringer beads to avoid overheating is strongly recommended. Oxygen gouging of quenched and tempered steels is not permitted.

4.4 Stress Relief Heat Treatment

4.4.1 Where required by the contract drawings or specifications, welded assemblies shall be stress-relieved by heat treating.[9] Finish machining shall preferably be done after stress relieving.

4.4.2 The stress relief treatment shall conform to the following requirements:

(1) The temperature of the furnace shall not exceed 600°F (315°C) at the time the welded assembly is placed in it.

(2) Above 600°F, the rate of heating shall not be more than 400°F (200°C) per hour divided by the maximum metal thickness of the thicker part, in inches, but in no case more than 400°F per hour.[10] During the heating period, variations in temperature throughout the portion of the part being heated shall be no greater than 250°F (140°C) within any 15 ft (4.6 m) interval of length.

(3) After a maximum temperature of 1100°F (590°C) is reached on quenched and tempered steels, or a mean temperature range between 1100 and 1200°F (650°C) is reached on other steels, the temperature of the assembly shall be held within the specified limits for a time not less than specified in Table 4.4, based on weld thickness. When the specified stress relief is for dimensional stability, the holding time shall be not less than specified in Table 4.4, based on the thickness of the thicker part. During the holding period there shall be no difference greater than 150°F (84°C) between the highest and lowest temperature throughout the portion of the assembly being heated.

(4) Above 600°F, cooling shall be done in a closed furnace or cooling chamber at a rate no greater than 500°F (260°C) per hour divided by the maximum metal thickness of the thicker part in inches, but in no case more than 500°F per hour. From 600°F, the assembly may be cooled in still air.

4.4.3 Alternatively, when it is impractical to postweld heat treat to the temperature limitations stated in 4.4.2, welded assemblies may be stress-relieved at lower temperatures for longer periods of time, as given in Table 4.5.

9. Stress relieving of weldments of A514, A517, A709 Grades 100 and 100W, and A710 steels is not generally recommended. Stress relieving may be necessary for those applications where weldments must retain dimensional stability during machining or where stress corrosion may be involved, neither condition being unique to weldments involving A514, A517, A709 Grades 100 and 100W, and A710 steels. However, the results of notch toughness tests have shown that postweld heat treatment may actually impair weld metal and heat-affected zone toughness, and intergranular cracking may sometimes occur in the grain-coarsened region of the weld heat-affected zone.

10. The rates of heating and cooling need not be less than 100°F (55°C) per hour. However, in all cases, consideration of closed chambers and complex structures may indicate reduced rates of heating and cooling to avoid structural damage due to excessive thermal gradients.

Part B
Shielded Metal Arc Welding

4.5 Electrodes for Shielded Metal Arc Welding

4.5.1 Electrodes for shielded metal arc welding shall conform to the requirements of the latest edition of ANSI/AWS A5.1, *Specification for Mild Steel Covered Arc Welding Electrodes*, or to the requirements of ANSI/AWS A5.5, *Specification for Low Alloy Steel Covered Arc Welding Electrodes.*

4.5.2 Low Hydrogen Electrode Storage Conditions. All electrodes having low hydrogen coverings conforming to ANSI/AWS A5.1 shall be purchased in hermetically sealed containers or shall be dried for at least two hours between 450°F (230°C) and 500°F (260°C) before they are used. Electrodes having a low hydrogen covering conforming to ANSI/AWS A5.5 shall be purchased in

Table 4.4
Minimum Holding Time (see 4.4.2)

1/4 in. (6.4 mm) or Less	Over 1/4 in. (6.4 mm) Through 2 in. (50.8 mm)	Over 2 in. (50.8 mm)
15 min	1 hr/in.	2 hrs plus 15 min for each additional in. over 2 in. (50.8 mm)

Table 4.5
Alternate Stress-relief Heat Treatment (see 4.4.3)

Decrease in Temperature below Minimum Specified Temperature, Δ °F	Δ °C	Minimum Holding Time at Decreased Temperature, Hours per Inch (25.4 mm) of Thickness
50	28	2
100	56	3
150	84	5
200	112	10