2.6 WELDABILITY OF HIGH STRENGTH STEELS

When high strength steel is used in welded applications, welding procedures must be suitable for the steel chemistry and intended service. Unspecified chemical elements, when present, are subject to the limits stated in Table 2.6-1. The sum Cu, Ni, Cr, and Mo must not exceed 0.50% on heat analysis. When one or more of these elements is specified, the sum does not apply; only the individual limits on the remaining unspecified elements will apply as described in J2340.

Table 2.6-1 Chemical limits on unspecified elements

Element	Type A,B, &R %	Type S %	Type X & Y %	Type D & M %
Phosphorus	0.100	0.100	0.060	0.020
Sulfur	0.015	0.020	0.015	0.015
Copper	0.200	0.200	0.200	0.200
Nickel	0.200	0.200	0.200	0.200
Chromium	0.150	0.150	0.150	0.150
Molybdenum	0.060	0.060	0.060	0.060

Note: Maximum phosphorus must be less than 0.050 % on Grades 180A & 180B

In welding high strength steels it is important to consider several factors usually not considered in welding lower strength steels: for example, welding process, welding parameters and material combinations. Integration of these types of considerations can result in a successful system of welding for HSS. Various welding methods (arc welding, resistance welding, laser welding and high frequency welding) all have unique advantages in welding specific sheet steel combinations. Considerations for production rate, heat input, weld metal dilution, weld location access, etc., may make one system more weldable than another system. For instance, a HSS that is problematic for spot welding may not exhibit the same difficulty in arc or high frequency welding. In fact, a low heat input resistance seam welding method has been successfully employed for commercial production of bumper beams with a 1300M grade. In general, caution should be exercised in spot welding an HSS to itself because of possible weld metal interfacial fracture tendencies, but even a problematic HSS can be spot welded to a low carbon mild steel.

The resistance spot weldability requirements for low strength steels evaluate the operational robustness of the candidate steel. This often embodies measurements of current range and electrode wear (for galvanized coatings). The resistance spot weldabilility requirements for HSS may be similar to those of low strength steels. End use requirements will determine required spot weld performance. These requirements may limit the current range and/or electrode life based on individual application weld quality specifications. For instance, fast quenching of the weld may damage the weld metal integrity causing interfacial fracture, or excessive weld heat input may cause metallurgical changes that soften the heat affected zone. Both of these conditions could result in a loss of joint strength. Incorporation of appropriate weld and temper cycles or modification of weld chemistry through selective dilution of the joint can lead to acceptable weld strength and thus ensure the retention of advantages to using HSS for weight reduction in automotive components.

The resistance spot weld behavior for uncoated and coated sheet steels having a minimum yield strength up to 420 MPa, as defined by this Recommended Practice, shall be determined by the

test procedure defined in Weld Quality Test Method Manual, published by the Resistance Welding Task Force, Auto/Steel Partnership ; and the American Welding Society, Recommended Practices for Test Methods for Evaluating the Resistance Spot Welding Behavior of Automotive Sheet Steel Materials, (AWS/ANSI/SAE Standard D8.9-97). Acceptance criteria must be agreed upon between customer and supplier. Note these standard test methods are intended for strength levels up to 420 MPa (60 ksi), and modifications may be required for higher strength levels. Due to unique properties of HSS, selection of the weld process parameters should be determined in consultation with the steel supplier.

BIBLIOGRAPHY FOR SECTION 2.6

Refer to Section 2.14 for a comprehensive bibliography for Section 2.1 to 2.13.