

**TECHNICAL NOTE** On Cold-Formed Steel Construction

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# **AISI S100 Section A2.2 Other Steels**

**Summary**: AISI S100, Section A2.1, Applicable Steels, provides a list of pre-qualified steels that can be used without restriction. The Specification also permits steels that are not listed in Section A2.1 to be used without restriction. This Tech note provides specific examples to demonstrate how to implement Section A2.2, Other Steels.

**Disclaimer**: Designs cited herein are not intended to preclude the use of other materials, assemblies, structures or designs when these other designs and materials demonstrate equivalent performance for the intended use; CFSEI documents are not intended to exclude the use and implementation of any other design or construction technique.

### INTRODUCTION

Section A2.2, Other Steels, of the North American Specification for the Design of Cold-Formed Steel Structural Members (AISI S100-07) permits the use of steels that are not listed in Section A2.1, Applicable Steels.

ASTM International (ASTM) is the basic source of steel designations for use with AISI S100. Section A2.1, contains the complete list of ASTM Standards for steels that are accepted by AISI S100.

The intent of Section A2.2 is to expedite use of steel specifications that are suitable for use as a cold-formed steel structural member but have not gone through the complete code approval process. The approval process for a new steel specification can take years from the initiation of the process as an ASTM standard, to approval by the AISI Committee on Specifications and finally adoption by national and state building codes.

It is important to note that the "Other Steels" must meet the same rigorous requirements as the pre-approved steels that are listed in Section A2.1 and discussed herein. This is to ensure there is no reduction in safety or performance of the fabricated products. Of primary concerns are the yield stress, the tensile strength and the minimum ductility.

An example of the time it takes to develop and implement a new steel specification is that ASTM A1063/A 1063M-09 was initiated within ASTM in 2007 and approved as an ASTM standard in 2009. A1063/A1063M-09 was approved for inclusion in AISI S100 Section A2.1, Applicable Steels, by the AISI Committee on Specifications in February of 2012. The 2012 edition of the Specification was approved at the July 2012 meeting of the AISI Committee on Specifications. Following the July meeting, the new specification was subjected to a 45 day public review. Following the public review and resolution of comments, the *North American Specification for the Design of Cold-Formed Steel Structural Members* (AISI S100-12) has been published. AISI S100-12 was approved by the International Code Council for adoption by reference in the 2015 edition of the ICC *International Building Code*. State adoption of the ICC *International Building Code* typically follows a year later. So from start to finish, the entire process will take almost nine years, assuming there are no delays in the process.

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In the following we will look at three common ways to comply with AISI S100 Section A2.2, Other Steels. In the following examples it is assumed the performance of the cold-formed steel member can be calculated per AISI S100. AISI S100 requires that steel be ordered from a published specification. The definition of a published specification is that (1) it be generally available in the public domain or is available to the public upon request, (2) is established before the steel is ordered, and (3) as a minimum, specify minimum mechanical properties, chemical composition limits, and, if coated sheet, coating properties.

### Option 1—Publish a Stand Alone Specification

In Option 1, we will specifically look at ASTM A1063 / A1063M-09 SS Grade 40 and 50 as we discuss the five requirements of Section A2.2, Other Steels, below.

- The steel shall conform to the chemical and mechanical requirements of one of the listed specifications or other published specification.—ASTM A 1063 / A1063M is a published specification. In addition ASTM A1063 / A1063M has comparable chemistry to ASTM A1039 / A1039M, which is an approved specification.
- The chemical and mechanical properties shall be determined by the producer, the supplier, or the purchaser, in accordance with the following specifications. For coated sheets, ASTM A924 / A924M; for hot-rolled or cold-rolled sheet and strip, ASTM A568 / 568M; for plate and bar, ASTM A6 / A6M; for hollow structural sections, such tests shall be made in accordance with the requirements of A500 (for carbon Steel) or A847 (for HSLA steel).— ASTM A1063 / A1063M references ASTM A924 / A924M.
- The coating properties of coated sheet shall be determined by the producer, the suppliers, or the purchaser, in accordance with ASTM A924 / A924M. - ASTM A1063 / A1063M references ASTM A924 / A924M.
- 4. The steel shall meet the requirements of Section A2.3. See below A2.3, Ductility.
- If the steel is to be welded, its suitability for the intended welding process shall be established by the producer, the supplier, or the purchaser in accordance with AWS D1.1 or D1.3 as applicable. -ASTM A1063/A1063M has comparable chemistry in comparison to ASTM A1039 / A1039M, which is listed in section A2.1, Approved Steels.

If the identification and documentation of the production of the steel have not been established, then in addition to requirements (1) through (5), the manufacturer of the cold-formed product shall establish that the yield stress and tensile strength of the master coil are at least 10 percent greater than specified in the referenced published specification. The identification and documentation of the production of ASTM A1063 / A1063M has been established.

### A2.3 Ductility

Steels not listed in Section A2.1 and used for structural members and connections in accordance with Section A2.2 shall comply with ductility requirements in either Section A2.3.1 or A2.3.2: A2.3.1 The Ratio of tensile strength to yield stress shall not be less than 1.08, and the total elongation shall not be less than 10 percent for a two-inch (50 mm) gage length or 7 percent for an eight-inch (200 mm) gage length standard specimen tested in accordance with ASTM A370.-The tensile strength to yield stress ratio is 1.3 for Grade 50 and 1.37 for Grade 40. The minimum elongation is 11% for Grade 50 and 15% for Grade 40 for a two-inch (50 mm) gage length. Therefore use of ASTM A1063 / A1063M SS Grades 40 and 50 complies with the requirements of AISI S100. In this case we used an ASTM specification, but it is not required that the specification be published by an ANSI accredited organization. It is acceptable for a producer or other organization to publish the specification as long as all of the required information is included.

## Option 2—Modify the Ductility of an Existing Published Specification

In Option 2 we will use ASTM A1063 / A1063M SS Grade 60. The mechanical properties are as follow, minimum yield strength = 60 ksi, minimum tensile strength = 70 ksi, and the minimum elongation in 2 in. (50 mm) gage length = 8%. The tensile strength to yield strength ratio is 1.17, therefore the five requirements listed in Section A2.2, Other Steels, are met with the exception of the minimum elongation. The specified minimum elongation for SS Grade 60 is only 8%, which is less than the 10% required.

Since there is no assumed excess ductility within AISI S100, a minimum of 10% is acceptable, even if the determination is made after production of the steel. Therefore it is acceptable to order ASTM A1063 / A 1063M SS Grade 60 with an additional (supplementary) requirement that it have minimum elongation of 10%.

# 🕼 A 1063/A 1063M – 09

TABLE 5 Mechanical Property Requirements for Steel Sheet designations SS and HSLAS <sup>A</sup>							
Designation	Yield Strength ksi [MPa] min	Tensile Strength ksi [MPa] min	Elongation in 2 in. [50 mm] min, %				
Grade 60 [410]	60 [410]	70 [480]	8				

### Option 3—Modify the Yield Strength of a Published Specification to Create a New Specification

In Option 3 we will look at ASTM A653 / A653M SS Grade 55 modified to a Grade 57. There is a Grade 55 and a Grade 80, but there is no Grade 57 listed in ASTM A653 / A653M. For the purposes of our example the producer has used the ASTM A653 standard to determine the required chemistry and processing to produce a 57 ksi minimum yield strength and has made the product known through a published specification. Because the requested grade is not listed in ASTM A653 / A653M, the published specification is not considered an ASTM standard.

Within the *published specification* the producer has defined the product as A653 SS Grade 57 MODIFIED with the specified minimum elongation as 11%. The chemical composition, mechanical and all other requirements comply with ASTM A653 / A653M SS Grade 55 except as modified in the previous sentence.

The tensile strength to yield ratio is 1.23, which is greater than 1.08 and the minimum elongation is great than 10%.

In this case the mill certificate identifies the steel as "A653 SS Grade 57 MODIFIED" and a separate published specification defines "A653 SS Grade 57 MODI-FIED" by referencing ASTM A653 and modifying the yield stress to 57 ksi, the tensile strength to 70 ksi and setting a minimum elongation of 11%. Since the target mechanical properties were determined prior to production and a production methodology consistent with ASTM A653 / A653M was used, there is no need for the yield and tensile properties of the master coil to be 10% greater than the specified yield stress and tensile strength. Therefore it is acceptable to order A653 SS Grade 57 MODIFIED as defined above.

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#### TABLE 4 Continued

Inch-Pound Units						
Designation	Grade	Yield Strength, min, ksi	Tensile Strength, min, ksi <sup>4</sup>	Elongation in 2 in., min, % <sup>A</sup>	Bake Hardening Index, min, ksi Upper Yield/Lower Yield <sup>A</sup>	
	40	40	55	16		
	50 Class 1	50	65	12		
	50 Class 2	50		12		
	50 Class 3	50	70	12		
	50 Class 4	50	60	12		
	55	55	70	11		
	80 Class 1 <sup>B</sup>	80 <sup>C</sup>	82			
	ou Class 2 <sup>5,5</sup>	800	82			

#### References

- 1. ASTM A653 / A653M Standard Specification for Steel Sheet, Zinc Coated (Galvanized) of Zinc Iron alloy Coated (Galvannealed) by the Hot Dip Process, ASTM International, West Conshohocken, PA.
- 2. ASTM A1063 / A1063M Standard Specification for Steel Sheet, Twin-Roll Cast, Zinc-Coated (Galvanized) by the Hot Dip Process, ASTM International, West Conshohocken, PA.
- ASTM A1039 / A1039M Standard Specification for Steel, Sheet, Hot Rolled, Carbon, Commercial, Structural, and High-Strength Low-Alloy, Produced by Twin-Roll Casting Process, ASTM International, West Conshohocken, PA.
- 4. North American Specification for the Design of Cold-Formed Steel Structural Members (AISI S100) American Iron and Steel Institute, Washington, DC

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