SECTION 03 21 XX

CryoSTEEL® – Cryogenic Reinforcing Steel

Plain and Deformed Bars for Concrete Reinforcement

PART 1 GENERAL

* 1. SPECIFICATION SCOPE
1. This specification covers CryoSTEEL® deformed reinforcing steel bars in cut lengths used for the design of reinforced concrete components exposed to
either service or accidental cryogenic conditions where additional mechanical properties are required for compatibility with exposure to temperatures down to -274ºF [-170ºC].
2. It shall be the responsibility of the engineer of record to specify the Cryogenic Design Temperature to which CryoSTEEL® will be certified.
	1. RELATED WORK
3. Section 03 30 00 – Cast-in-Place Concrete
4. Section 03 40 00 – Pre-cast Concrete
	1. REFERENCES
5. Codes and Standards
6. American Concrete Institute (ACI)
7. Code Requirements for Design and Construction of Concrete Structures for Containment of Refrigerated Liquefied Gases (ACI 376-11)
8. Building Code Requirements for Structural Concrete (ACI 318-19)
9. American Society for Testing and Materials (ASTM)
10. Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement (ASTM A 615-20)
11. Concrete Reinforcing Steel Institute (CRSI)
12. CRSI Manual of Standard Practice, 28th Edition
13. British Standards Institute (BSI)
14. Design and Manufacture of Site Built, Vertical, Cylindrical, Flat-Bottomed, Steel Tanks for Storage of Refrigerated, Liquefied Gases with Operating Temperatures Between 0 degrees C and -165 degrees C (EN 14620-3:2006)
	1. DESIGN REQUIREMENTS
15. Design of concrete structures reinforced with CryoSTEEL® bars shall be based in accordance with the provisions of ACI 318-19 and ACI 376-11 design guides.
16. CryoSTEEL® reinforcing steel bars can be directly substituted for conventional carbon steel Grade 60 reinforcing steel bars on an equal area basis, except as noted on the plans or approved by the Engineer.
	1. SUBMITTALS
17. Comply with Specification – Submittal Procedures
18. Product Data: Submit manufacturer’s product data, including material and mechanical properties.
19. Test Reports: Submit manufacturer’s mill certifications for material and mechanical properties for each bar size used on the project.
20. Mechanical Couplers: Submit manufacturer’s product data for use with CryoSTEEL® bars.
	1. DELIVERIES, STORAGE, AND HANDLING
21. Delivery and Storage:
22. CryoSTEEL® bars shall be stored off the ground and protected from dirt, oil and other deleterious materials.
23. Handling of CryoSTEEL® bar shall be in accordance with conventional steel bars as noted in the CRSI Manual of Standard Practice.

PART 2 PRODUCTS

2.1 SUPPLIER

 A. Commercial Metals Company

CMC Steel Arizona

11444 East Germann Rd.

Mesa, AZ 85212

Phone: 888-641-8956

E-mail: cryosteel@cmc.com

* 1. MATERIAL
1. Non-prestressed deformed reinforcing steel bars shall be CryoSTEEL® conforming to the requirements of ASTM A615, Grade 60 for all ambient temperature tests, modified to also meet the additional requirements contained in this specification.
2. CryoSTEEL® reinforcing steel bars shall conform to the supplemental requirements of the following standards for cryogenic applications:
3. EN14620-3:2006, Section 6.3.2 and Annex A.3
4. ACI 376-11
5. CryoSTEEL® Technical Requirements
6. Tensile strength, min. – 90,000 psi
7. Yield strength, min. – 60,000 psi
8. Ratio actual tensile strength divided by actual yield strength – 1.15
9. Elongation in 8 in., min.
10. Bar Designation Nos. 4, 5, 6 – 12% at ambient temperature and 3% at cryogenic design temperature.
11. Bar Designation Nos. 8, 10 – 12% at ambient temperature and 3% at cryogenic design temperature.
12. Notch Sensitivity Ratio (NSR), min. – 1.00\*
13. Strain at Ultimate Stress (Un-Notched Bar), min. – 3\*

**\*** The indicated test shall be performed at Cryogenic Design Temperature +/- 9ºF [5ºC]. The result and the actual sample temperature during testing shall be reported on the Material Test Report (MTR).

1. Identification of CryoSTEEL®
2. Type of Steel – a six-pointed snowflake symbol “**❆**” shall be rolled into the bar with the mill marks. Optionally, also a letter “**S**” may be rolled into the bar, indicating that the bar was produced to meet both this specification and Specification ASTM A615.
3. Minimum Yield Strength Designation – for Grade 60 bars, the marking shall be the number “60”.
4. Certification of CryoSTEEL®
5. Upon request, a certified copy of a mill certification report shall be provided for each heat of bars delivered, showing:
6. Chemical analysis
7. Tensile properties, tested at room temperature
8. Tensile properties, tested at cryogenic design temperature, +/- 9ºF [5ºC]
9. Actual temperature of test environment during testing of cryogenic design temperature requirements. Room temperature test conditions are not required on the MTR.
10. Bend test results.