



## Long Island Rail Road

Date: February 23, 2012

To: Prospective Proposers

Subject: New York Metropolitan Transportation Authority (MTA) Long Island Rail Road and Metro-North Railroad M-9/M-9A Rolling Stock Procurement - Responses to Carbuilder Questions

Enclosure: (1) Technical Questions  
(2) Commercial Questions  
(3) Referenced DRAFT Specification paragraphs  
(4) APTA SS-C&S-004-98, Revised 10/24/2007

Provided herein as Enclosures (1) and (2) are questions which were recently received from a prospective carbuilder. Referenced DRAFT specification paragraphs are provided as Enclosure (3) and Enclosure (4) provides the APTA standard for Austenitic Stainless Steel for Railroad Passenger Equipment. Please be advised that In accordance with the Request for Information (RFI) process, responses to these questions are being provided to all prospective carbuilders who have expressed an interest in participating in the M-9/M-9A Project. Once the formal Request for Proposal (RFP) process commences (currently scheduled for March 2012), all questions and responses will be provided via a formal Addendum.

Should you have any questions, or require additional information, please contact the undersigned at telephone (718) 725-2641, or via email at [makelly@lirr.org](mailto:makelly@lirr.org).

Best Regards,

Maura A. Kelly  
M-9/M-9A Procurement Officer  
MTA Long Island Rail Road  
Procurement & Logistics Department

### TECHNICAL QUESTIONS

1. What is the indication of stainless steel that is allowed to use for construction of new vehicles?

The structural elements of the carbody are addressed in M-9 TS 402 A.5.a.1 and shall be austenitic stainless steel, except the end underframe which shall be HSLA. The austenitic stainless steel needs to conform to APTA SS-C&S-004-98.

2. Is there a requirement for stainless steel for bogie frames as well?

The truck requirements are addressed in M-9 TS 405 A.2. Truck frames and bolsters shall be of cast and/or welded steel construction.

3. What is the length of one car?

85 feet

4. What is the number of cars in one train?

Train consist length is addressed in M-9 TS 101. Train consist length under normal operating conditions shall be a minimum of four cars (outside of yard and shop moves), and shall include as many as 14 cars. However, the cars shall be designed to be operated in consists up to 28 cars in length, but at reduced speed and performance

5. What is the track gauge?

Nominal track gauge 4' 8-1/2"

6. What is the wheel diameter (new and completely worn)?

The wheel requirements are addressed in M-9 TS 405 A.8. Wheels shall have a nominal diameter of 36 inches, and initial rim thickness shall be at least three inches so as to allow for two full inches of wheel wear (a four-inch decrease in wheel diameter) before the condemning limit is reached.

7. What are the requirements of safety systems? (preferred systems or systems that are resulting from legal regulations)

The Safety requirements are addressed in M-9 TS 205. The car shall conform to all applicable laws, rules, regulations, standards and recommended practices including, but not limited to, New York State, FRA, APTA, AAR, NFPA, ADA, USDOT, U.S. Department of Health and Human Services, U. S. Department of Homeland Security, and OSHA.

8. What are the requirements for commissioning?

The commissioning rate will be 12 to 18 cars a month. The Commissioning testing is addressed in M-9 TS 604 Operational Service Testing which includes body testing, Pneumatic system testing, performance measurements, Communication system testing, ATC/ACES and operational testing.

9. What are the requirements for passenger information systems?

The passenger information systems requirements are addressed in M-9 TS 421 A.9. The Passenger Information System/Automatic Station Identification (PIS/ASI) system shall the present station, next station, destination, car position in a train, and any other messages that the Railroads wish to make. The station announcements shall be triggered by the car's Global Positioning System (GPS) and by distance dead reckoning when the GPS data is unavailable (e.g., in tunnels). The information shall be given in the form of PA announcements and visual displays, both on the interior and the exterior of the car.

10. What is the required compatibility with current types of vehicles? \*

The cab make-up, propulsion, doors and friction brake systems trainline functionality shall be interoperable with the Railroads' M-7 Cars to the extent required for train rescue and non-revenue train moves.

11. Is there available list of technical norms and standards?

The car shall conform to all applicable laws, rules, regulations, standards and recommended practices including, but not limited to, New York State, FRA, APTA, AAR, NFPA, ADA, USDOT, U.S. Department of Health and Human Services, U. S. Department of Homeland Security, and OSHA.

12. Any other important information.

**COMMERCIAL QUESTIONS**

1. “Buy America Act” – what the requirements for European suppliers?

We plan to issue two RFPs simultaneously – an RFP for a base order of 76 Cars with options for up to 600 additional Cars (the M-9), and an RFP for 160 Cars (the M-9A). The M-9 will be governed by NYS terms and conditions, and the M-9A by FTA required terms and conditions. Carbuilders may bid on either or both; the Cars will be required to be interoperable.

The rolling stock provisions of Buy America (see 49 CFR 661.11) will apply to M-9A. Generally, these regulations require 60% of the cost of all components to be produced in the US. Final assembly must be in the US and all iron, steel and manufactured parts must be produced in the US. Buy America will not apply to M-9. With respect to M-9, the Railroads will seek to maximize the NYS content of the Cars, in accordance with NYS law.

2. Planned time of announcement of nearest procurement?

The Request for proposal is scheduled to be released in March 2012

3. Time of delivery of first train (counting from contract signature)?

From date of contract award, for the base order M-9 Cars, generally 36 months for the delivery of the first pilot cars and 48 months for the delivery of the first production cars. M9A delivery will follow the base order M-9 Cars, to be followed by the delivery of M-9 option Cars.

4. What is the required warranty period for new vehicles?

Generally 2 years from Conditional Acceptance of the Cars or 3 years from full Acceptance, whichever occurs first. Longer warranty periods will apply to certain systems.

5. Who is responsible for maintenance of new vehicles?

LIRR and MNR maintain their own cars

6. What are the criteria of choosing the best offer by the customer?

The Evaluation Criteria has not yet been finalized

**Referenced DRAFT Specification Paragraphs**

1. TS 402.A.5.a.1

*The structural elements of carbody shall be constructed from austenitic stainless steel meeting the requirements of Section 302 A.2., except the end underframe which shall be made from HSLA steel meeting the requirements of Section 302 A.3. and suitably finished per Section 308 A.3. The collision and corner posts and anti-telescoping (AT) plate may also be made from HSLA steel meeting the requirements of Section 302 A.3., if completely covered by the cab end cap and interior linings.*

2. TS 405.A.2

*Truck frames and bolsters shall be of cast and/or welded steel construction. All structural components of the truck assembly shall be steel and shall have a Charpy V-Notch (Type A) impact strength of at least 20 ft-lbs at -40 degrees F (-40 degrees C) when tested in accordance with ASTM E 23.*

3. TS 101 (A.1.d)

*Cars shall be configured for normal operation as two-car units (married pairs). Each married pair shall consist of two cars of different types, designated A Cars and B Cars. The cars shall have a full-width cab at the F End. The B Car within the married pair shall be provided with an ADA-compliant toilet room. Train consist length under normal operating conditions shall be a minimum of four cars (outside of yard and shop moves), and shall include as many as 14 cars. However, the cars shall be designed to be operated in consists up to 28 cars in length, but at reduced speed and performance. Options for other car types are also included as part of this Contract as described in the addenda. The married pair cars shall be base order cars, all other car types (single and/or multi-level cars) shall be option cars.*

4. TS 405.A.8

*Wheels shall have a nominal diameter of 36 inches, and shall conform to APTA Standard SS-M-015-06, Wheel Profile 220, based upon the AAR 1-B for 1:20 taper, multiple wear wheels. Initial rim thickness shall be at least three inches so as to allow for two full inches of wheel wear (a four-inch decrease in wheel diameter) before the condemning limit is reached. The minimum safe wheel diameter shall be determined and submitted to the Railroads for approval. Straight plate wheels are permitted if it is shown that the thermal stresses in that wheel do not exceed those in an equivalent curved plate wheel under the same operating conditions.*

5. TS 205 (A.1)

*The car shall conform to all applicable laws, rules, regulations, standards and recommended practices including, but not limited to, New York State, FRA, APTA, AAR, NFPA, ADA, USDOT, U.S. Department of Health and Human Services, U. S. Department of Homeland Security, and OSHA. Deviations from, and substitutions of, specified standards, or portions thereof, shall be made only as approved in writing by the Railroads. The Contractor shall submit a detailed description of the proposed alternate standard, the rationale for the alternate, a detailed line-by-line comparison of the alternate standard with the specified standard, and a statement whether the proposed code or standard is equal to or more restrictive than the specified standard and 3 copies of proposed alternate standard.*

**SECTION 604**  
**OPERATIONAL SERVICE TESTING**

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**SECTION 604**  
**OPERATIONAL SERVICE TESTING**

**A. DESCRIPTION**

***1. General***

Operational Service Testing shall be conducted on the Railroads' property on all married pairs.

- a. Upon arrival on the Railroads' property, each car will be inspected by the Railroads and any part, device or apparatus which requires adjustment, repair, or replacement, will be called to the attention of the Contractor, who shall make such adjustment, repair, or replacement before Operational Service Testing is begun.
- b. If any previously-tested components or systems were altered or removed for shipping, or were damaged in transit, the Contractor shall retest such components or systems upon repair or reinstallation prior to beginning Operational Service Testing.
- c. The Contractor shall test each car upon delivery to the commissioning site. This testing shall begin with a ground insulation check of all apparatus and controls. Disassembly of the car shall not be required in order to perform this test.
- d. A complete, orderly, and comprehensive functional static test of each and every Component, System and Subsystem on the car including, but not limited to, the horn, windshield wiper, windshield heater, toilet system, air compressor duty cycle, inter-pair trainlines, door operation, cab controls, and no-motion controls shall be made to verify its proper operation before commencement of Operational Service Testing. Portable Interface Units (PIUs) shall be used for these tests to the extent possible. Network traffic shall be monitored to verify that the network availability falls within specified conditions. Devices bypassed by the use of these PIUs, if any, shall also be verified.
- e. The Contractor shall be responsible for performing the FRA Periodic Inspections and tests as required by 49 CFR 229.23, 229.25, and 236.588, and maintaining form FRA F 6180-49A until time of Conditional Acceptance or Acceptance of the car, whichever comes first. The Contractor shall perform the last set of inspections and tests within five days of car Conditional Acceptance or Acceptance by the Railroads. The most recent calibration of ATC relays and other devices shall not precede Conditional Acceptance or Acceptance of the car by more than six months.

***2. Miscellaneous Body Tests and Adjustments***

- a. Truck clearances, lengths and locations of electrical jumpers, and all other end connections shall be verified.
- b. Coupler height shall be checked and adjusted to the proper height and level.

- c. Air springs shall be leveled within the specified design tolerances, and floor and cab signal receiver antennae heights verified.
- d. Buffers shall be verified for proper level and alignment.
- e. Third rail shoe equipment shall be adjusted and verified.

### ***3. Pneumatic System Leakage Testing***

The pneumatic system leakage test described in Section 603 A.7.c. shall be performed upon arrival at the Railroads. If the married pair fails to meet this test, the leak(s) shall be corrected and the married pair retested until the requirements are met.

### ***4. Performance Measurement***

- a. Prior to the Operational Test of Section 604 A.7. each married pair shall undergo the following tests which shall demonstrate that each married pair's tractive power, dynamic braking, and friction braking systems are compliant with the requirements of Sections 201 A.5., 6., 8., and 9. Testing shall be conducted at the AW0 weight condition only.
- b. Data shall be recorded on the test instrumentation specified in Section 601 A.5.f. The data recorded for each type of test may differ because of recorder channel limitations, but shall be appropriate for the testing being performed. Channels shall be allocated such that parameters which are independent between trucks or axles, such as traction motor torques, brake cylinder pressures, and speeds, are recorded separately. The data channels to be recorded per Section 601 A.5.f.4) may be reduced upon approval by the Railroads. Each test shall be performed three times in each direction to cancel the directional differences due to the environment.
- c. Any adjustments required to obtain values corresponding to the specified performance shall be made by the Contractor and retested prior to Operational Testing.
- d. All charts obtained from the recordings shall become the property of the Railroads after the data has been analyzed by the Contractor and verified by the Railroads. The charts shall be included in the Car History Documents (see Section 105 A.22.).
- e. The tests shall include an acceleration test sufficient to demonstrate that the propulsion systems of the married pair have been adjusted to produce performance compatible with that of the Pilot Cars. Testing shall replicate the conditions tested in Section 602 A.7. using the same data points to demonstrate performance that is the same as the Pilot Cars.
- f. The tests shall include the following braking tests, which shall replicate the car performance conditions tested in Section 602 A.7. using the same data points to demonstrate performance that is the same as the Pilot Cars.

- 1) Full service blended brake stops from an initial speed of 80 mph.
- 2) Full service "friction only" brake stops from an initial speed of 80 mph.
- 3) Emergency brake stops from an initial speed of 80 mph.

## **5. *Communications System***

### **a. PA System and Intercom**

Proper transmission and reception of PA and Intercom messages, initiated from each Master Door Controller and each cab, shall be verified as the married pair is operated over the Railroads. Proper transmission of radio to PA messages and text-to-speech conversion messages shall also be verified.

### **b. Train Radio**

Proper operation of the Train Radio shall be demonstrated by completing the following transmissions:

- 1) Car to Railroad Control Center
- 2) Railroad Control Center to Car
- 3) Car to Car

### **c. Data Radio Function**

Proper transmission and/or reception of files via the data radios shall be demonstrated. This shall include but is not limited to Passenger Information/Automatic Station Identification System files, Monitoring and Diagnostic System files, train heart beat files to both the WMDS and GIS servers, and the Multimedia/ Passenger WiFi system information.

### **d. Passenger Information/Automatic Station Identification System Announcement**

Proper operation of Passenger Information/Automatic Station Identification System announcements shall be verified. This shall include PA announcements, and interior message display and exterior destination sign operation.

### **e. Passenger Emergency Intercommunication**

Proper initiation, transmission and reception of messages between the Passenger Emergency Intercoms (PEIs) and the Operator and train crew shall be verified.

### **f. Crew Buzzer**

Proper operation of the crew buzzers shall be demonstrated to verify that the buzzers function properly and sound at all locations.

## **6. ATC/ACSES Equipment Testing**

- a. ATC/ACSES equipment shall be tested by means of on-board test apparatus and portable test equipment to verify proper functioning of the ATC/ACSES equipment before allowing equipment to operate on the Railroads.
- b. The ATC equipment shall also be tested by the Contractor by performing FRA daily and periodic ATC tests as required by 49 CFR 236.586, .587, and .588.
- c. ATC equipment shall also be tested during the Operational Test to verify proper operation of the overspeed function and proper functioning with the signal system.

## **7. Operational Test**

Once all other on-site testing has been successfully completed, each married pair, except the Pilot Cars, shall undergo a 1,000-mile Operational Test, in simulated revenue service, without failure of a major system or operating components that would cause a train to be removed from revenue service or prevent it from entering into revenue service if the car were to be the lead car in a consist. Failure of a major system or operating component shall require correction, modification (if necessary) and a repeat of the complete Operational Test.

- a. The consist shall be controlled from each cab for a minimum of 200 miles for the Operational Test.
- b. Each trip shall operate into Penn Station.
- c. All car systems shall be fully operational during the Operational Test.
- d. The Operational Test shall include stops at every station.
- e. Trainlined functions shall be monitored in each car. Married pairs undergoing test shall be coupled to other married pairs undergoing test to verify proper trainline function.
- f. Proper functioning of door controls and associated safety features (door light, traction interlock, bypass switch, obstruction detection, pushback, etc.) shall be demonstrated by operating every door control feature a minimum of ten consecutive cycles with no failures and by normal operations during simulated revenue service without failures.
- g. The Event Recorder and Monitoring and Diagnostic Systems shall be downloaded after each day's test, producing a printed report. A copy of the report shall be included in the Car History Documents for that particular car. The logs shall be electronically archived in addition to the electronic copy for the Car History Documents. The Monitoring and Diagnostic System logs shall be reviewed at the conclusion of each day's test for failures. All failures shall be evaluated and corrected before the next day's test runs unless otherwise approved by the Railroads. Failures may be cause for the Railroads to restart the Operational Test in

accordance with Section 604 A.7. False faults, i.e., those faults that inaccurately indicate system failures, may also be cause for the Railroads to restart the Operational Test. The Monitoring and Diagnostic System logs shall be cleared each day and at the successful completion of the test.

- h. The HVAC System shall be checked for proper function during the Operational Test. Both the heating and cooling system functions shall be checked.
- i. All lighting shall be checked at the start and completion of each day's test to confirm that it is operating properly. All controls shall be operated, including lamp test switches.
- j. Interior and exterior noise shall be measured and compared with the Pilot Car test data to demonstrate that noise levels are consistent.
- k. An abbreviated vibration test shall be conducted. The data collected shall be compared with the Pilot Car test data to demonstrate that vibration levels are consistent.

## ***8. EMI Footprint Testing***

- a. The EMI footprint (electrical noise output characteristics) based on the worst-case scenario of conductive/inductive and CSI emissions determined from the actual EMI qualification testing shall be recorded for every lot of 100 Production Cars or a portion thereof. Tests shall be performed on a consist of cars at the same location as was done during the EMI qualification testing on the Railroads. Results shall be compared to those from Qualification Testing to verify conformance to the acceptable limits as tested in Section 602 A.9. Any unacceptable variation in the footprint shall require modification of cars and testing until a stable footprint can be consistently produced.

## **B. SUBMITTALS**

- 1. A complete description of the instrumentation package to be used to perform dynamic testing as required by Section 604 A.4., for ATC testing as required by Section 604 A.6., and for Operational Testing as required by Section 604 A.7.
- 2. Test procedures as required by Section 601.

## **C. DELIVERABLES**

- 1. Acceptance test reports, upon successful completion of the test. This information shall be included in the Car History Documents.
- 2. Copies of Event Recorder and Diagnostic System printouts, upon completion of the

Operational Test. This information shall be included in the Car History Documents.

3. Acceptance testing electronic test data in a format determined by the Railroads on optical media (CD-ROM or DVD disks).

#### **D. TESTS AND INSPECTIONS**

As required by this section.

**END OF SECTION**

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7. TS 421.A.9.(a.1))

*A Passenger Information System/Automatic Station Identification (PIS/ASI) system shall be provided to inform passengers of the present station, next station, destination, car position in a train, and any other messages that the Railroads wish to make. The station announcements shall be triggered by the car's Global Positioning System (GPS) and by distance dead reckoning when the GPS data is unavailable (e.g., in tunnels). The information shall be given in the form of PA announcements and visual displays, both on the interior and the exterior of the car, as defined in this section.*



### 3. APTA SS-C&S-004-98 Rev. 1 Standard for Austenitic Stainless Steel for Railroad Passenger Equipment

Revision 1 Approved October 24, 2007  
Reaffirmed June 14, 2006  
Originally Approved March 26, 1998  
**APTA PRESS Task Force**

Authorized March 17, 1999  
**APTA Commuter Rail Executive Committee**

**Abstract:** This standard covers the minimum properties of austenitic stainless steels used in fabrication of passenger railroad equipment. Principal grades of austenitic stainless steels for railroad passenger equipment structural applications are the low carbon types 201L, 201LN and 301L, 301LN. Other austenitic stainless steels may be applied where justified by design considerations. This standard also includes requirements and precautions for forming, welding, and handling of the low carbon, austenitic stainless steel.

**Keywords:** austenitic stainless steel, structural materials, welding

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## **Introduction**

This standard describes the minimum-acceptable properties of austenitic stainless steel sheet, plate, strip, bar, tubing, forgings, and castings to be used for structural parts in passenger railroad equipment. The described properties include chemical composition and mechanical properties.

This standard covers the common austenitic grades of stainless steel suitable for passenger railroad equipment structure. Several grades of austenitic stainless steels are referenced in this standard; however, this standard is not intended to specify the acceptable applications of the various grades in a structure. The latter would normally be prescribed by the procurement contract for new or refurbished equipment. Furthermore, the majority of existing stainless steel railroad vehicles which would have been subject to this standard, have been manufactured of AISI Type 201 or 301 austenitic grades, or low carbon variations thereof. Therefore, application of the various grades of austenitic stainless steel covered by this standard must be prescribed by the contract documents.

The standard also contains requirements for testing, forming, handling and welding, and material test reports and certifications.

The standard is intended to formalize the properties of austenitic stainless steels used for passenger railroad equipment for use by railroad vehicle builders, component fabricators and suppliers, railroad vehicle refurbishers, and passenger and commuter railroad operating authorities.

This standard makes extensive use of existing standards for stainless steels that are published by the American Society for Testing and Materials (ASTM).

## Participants

The American Public Transportation Association greatly appreciates the contributions of the following individual(s), who provided the primary effort in the drafting of *the APTA- SS-C&S 004-98 Standard for Austenitic Stainless Steel For Railroad Passenger Equipment*.

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At the time that this standard completed, the PRESS Construction & Structural Committee included the following members:

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# APTA SS-C&S-004-98 Rev. 1

## Standard for Austenitic Stainless Steel for Railroad Passenger Equipment

### 1. Overview

Some materials covered in this standard, because of their alloy content and specialized properties, may require special care in their fabrication and welding. Specific welding procedures are of fundamental importance, and it is presupposed that all parameters will be in accordance with approved methods capable of producing the desired properties in the finished fabrication.

The values stated are in English units. Metric units are provided for reference only. Metric units may be used by agreement between the railroad operating authority and the vehicle builder along with the steel mill.

In case of a conflict between this standard and a referenced specification, the more stringent requirement shall prevail.

#### 1.1 Scope

This standard covers chromium-manganese-nickel, and chromium-nickel stainless steel sheet, plate, strip, bar, tubing, forgings and castings for welded fabrication of structural parts in passenger rail vehicles.

#### 1.2 Purpose

This standard was developed to help ensure the quality of steel used in the fabrication of passenger rail equipment

### 2. References

This Standard shall be used in conjunction with the publications listed below. When the following publications are superseded by an approved revision, the revision shall apply.

American Iron and Steel Institute (AISI)

Steel Products Manual, Stainless and Heat Resisting Steels

American Society for Testing and Materials Standards (ASTM)

A 240/240M, Standard Specification for Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels.

- A 262, Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels.
- A 276, Standard Specification for Stainless Steel Bars and Shapes.
- A 370, Test Methods and Definitions for Mechanical Testing of Steel Products.
- A 380, Standard Practice for Cleaning and Descaling of Stainless Steel Parts, Equipment, and Systems.
- A 480/A 480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip
- A 484/A 484M, Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings.
- A 511, Standard Specification for Seamless Stainless Steel Mechanical Tubing.
- A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- A 743/A 743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
- A 967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
- American Welding Society Standards (AWS)
- A 4.2, Standard Procedures for Calibrating Magnetic Instruments, (Measure Delta Ferrite Content).
- B 2.1, Standard for Welding Procedure and Performance Qualification.
- C 1.1, Recommended Practices for Resistance Welding.
- D 1.1, Structural Welding Code - Steel.
- D 1.3, Structural Welding Code - Sheet Steel.
- D 1.6 Structural Welding Code – Stainless Steel.
- D 15.1, Railroad Welding Specification - Car and Locomotives.
- D-17.2/ D 17.2M: 2007 Specification for Resistance Welding for Aerospace Applications
- Military Specifications (NAVSEA Specifications)
- NAVSEA S9074 AQ GIB -010/ 248, Requirements for Welding and Brazing Procedure and Performance Qualification.

American Society of Mechanical Engineers Code (ASME Code), Section IX, Welding and Brazing Qualification.

**British Standards (BS)** , BS 7608, 1993 Code of Practice for Fatigue Design and Assessment of Steel Structures.

### **3. Chemical Composition**

Chemical composition of austenitic stainless steel sheet, strip and plate shall conform to the requirements in ASTM Specification A 240. Chemical compositions of the most frequently used austenitic stainless steels for rail vehicle structural applications are given in Table 1.

Where welded fabrication is required, only austenitic stainless steels with a carbon content below 0.030%, or with proven weldability that resists atmospheric corrosion (no sensitization in the weld heat-affected-zone) shall be used.

Chemical composition of austenitic stainless steel bar shall conform to the requirements of ASTM A 276.

Chemical composition of austenitic stainless steel forgings shall conform to the requirements of ASTM A 484/A 484M.

Chemical composition of stainless steel tubing shall conform to the requirements of ASTM A 511 for austenitic grades.

Chemical composition of stainless steel castings shall conform to the requirements of ASTM A 743 for austenitic grades.

### **4. Mechanical Properties**

Mechanical properties of austenitic stainless steel sheet, strip and plate in annealed condition shall conform to the requirements of ASTM A 240. Table 2 lists mechanical properties of the most frequently used stainless steels in passenger rail vehicle structural applications.

Mechanical properties of austenitic stainless steel sheet in the cold rolled (temper rolled) condition shall conform to the requirements of ASTM A 666. Table 3 lists mechanical properties for tension tests of specimens taken in the transverse direction. Because cold worked stainless steel is highly anisotropic, properties taken in the longitudinal direction, or determined by compression testing can be significantly different and must be addressed by special agreement between the producer and purchaser. Also, adjustments of specific properties to meet formability requirements may be made by special agreement between the producer and purchaser.

Mechanical properties of austenitic stainless steel bar shall conform to the requirements of ASTM A 276.

Mechanical properties of austenitic stainless steel forgings shall conform to the requirements of ASTM A 484.

Mechanical properties of austenitic stainless steel mechanical tubing shall conform to the requirements of ASTM A 511.

Mechanical properties of stainless steel castings shall conform to the requirements of ASTM A 743 for austenitic grades.

## **5. Manufacture**

### **5.1 Dimensional Tolerances**

The dimensional tolerances of stainless steel sheet, strip and plate shall be in accordance with ASTM A 480/A 480M, or as otherwise agreed to by the railroad operating authority and the vehicle builder along with the steel mill. It is recommended that rolled materials be held to the minimum-acceptable thickness within the allowable tolerance to the extent possible where it is desirable to minimize structure weight.

### **5.2 Surface Finish**

Surface finish shall be in accordance with ASTM A-480/A 480M or as otherwise agreed to by the railroad operating authority and the vehicle builder along with the steel mill. Sheets and coils shall be produced in continuous passes, with surface finish within limits agreed to by the railroad operating authority and vehicle builder along with the steel mill.

### **5.3 Material Test Reports and Certifications**

Material test reports and certifications shall be in accordance with ASTM A 480/A 480M. An intergranular corrosion test in accordance with ASTM A 262 shall be required for each heat of austenitic stainless steel. Following provisions of A 262, material may be accepted to Practice A of A 262. Material shall be rejected only by application of Practice E of A 262.

### **5.4 Handling**

Austenitic stainless steel sheet and coil shall be packaged for shipment to protect the finished surface. Coils shall have paper or protective separator placed on the finished surface as the coil is wound. Recommended practices for handling and protection of stainless steel are discussed in Annex A.

### **5.5 Forming**

Bending, forming and metal working shall be performed on tooling that has been cleaned and is free of iron particles and slivers. Formed parts shall have smooth radii, free of cracks, creases, or stretcher-strains, as demonstrated by visual inspection.

### **5.6 Welding**

5.6.1. All fusion welding shall be performed by welders qualified to AWS B 2.1, D 1.1, D 1.3, D 1.6, or ASME Section IX requirements and in accordance with approved welding procedure



specifications that conform to AWS D 1.1, D 1.3, D 1.6, and D 15.1 requirements, or equivalent standards approved by the purchaser.

5.6.2 Fusion welding of austenitic stainless steels shall use 308 L or equivalent filler metal. Fusion welds in austenitic stainless steels shall have a ferrite number in the range of WRC 4 to 10, according to AWS A 4.2.

5.6.3 Fusion welding of stainless steels to carbon or LAHT (HSLA) steels shall use 309 L, or equivalent filler metal. The heat-affected-zone hardness shall not exceed 400 Vickers.

5.6.4 Resistance welding shall be in accordance with requirements of D-17.2/ D 17.2M, Class B for structural welds and Class C for non-structural welds. It is recommended that a more restrictive limit on indentation on visible structures than permitted by the standard be considered for improved appearance, as agreed to by the vehicle builder and railroad operating authority.

5.6.5 Fatigue design stresses in welded austenitic stainless steel structures shall be developed in accordance with the provisions of AWS D 1.1 Design Section for dynamically loaded structures, British Standard BS 7608, and the vehicle builder's design standards, or as otherwise agreed by the railroad operating authority and the vehicle builder.

5.6.6 Fusion welding of cold worked stainless steels tends to soften or anneal the weld heat-affected-zone (HAZ). The degree of loss of strength must be determined by testing.

## **5.7 Pre- and Post Weld Heat Treatment**

Pre- and post-weld heat treatments are not typically applied to the austenitic stainless steels covered by this standard, and shall not be required, except as necessary for a particular approved application or approved welding procedure qualification.

## **5.8 Post Fabrication Cleaning**

All surface contamination such as free iron, oil and crayon marks, as well as welding discoloration and weld spatter shall be removed before delivery of the fabricated stainless steel structure. The cleaning processes shall be in accordance with ASTM A 380 and A 967. Practice A, B or C of ASTM A 967, or other such similar procedure as agreed to by vehicle builder and railroad operating authority, should be used to demonstrate that the stainless steel is free of iron contamination.

Annex A (informative)

**Recommended Practice for the Handling of Austenitic Stainless Steel**

- A1. Stainless steel should be stored off the ground by cribbing with wood, stacked to promote draining and to prevent damage and contamination.
- A2. When processing stainless steel, care should be taken to ensure that all working surfaces of the forming equipment, layout tables, and handling equipment are clean so that contamination of the stainless steel surface is avoided.
- A3. Plasma arc and laser cutting or gouging should be the only acceptable methods for thermal cutting. All arc-cut edges shall be ground to bright metal prior to welding.
- A4. All tools, such as wedges, lifting clamps, and wire brushes used in contact with stainless steel should be stainless steel or other non-contaminating metal or material. Abrasives used on stainless steel, such as grinding wheels, flapper wheels, and flexible abrasive disks, should not have been used previously on carbon steel.
- A5. In shipping fabricated components, care should be taken that ordinary steel chains, tie-downs, and banding do not come in contact with the stainless steel.

**Table 1: Chemical Composition Requirements, wt. % (1)**

**Austenitic Stainless Steels**

| UNS Designation | Common Name | Carbon | Manganese | Phosphorus | Sulfur | Silicon | Chromium  | Nickel   | Nitrogen  | Other Elements |
|-----------------|-------------|--------|-----------|------------|--------|---------|-----------|----------|-----------|----------------|
| S20103          | 201L        | 0.030  | 5.5-7.5   | 0.045      | 0.030  | 0.75    | 16.0-18.0 | 3.5-5.5  | 0.25      | ***            |
| S20153          | 201LN       | 0.030  | 6.4-7.5   | 0.045      | 0.015  | 0.75    | 16.0-17.5 | 4.0-5.0  | 0.10-0.25 | Cu 1.00        |
| S30103          | 301L        | 0.030  | 2.00      | 0.045      | 0.030  | 1.00    | 16.0-18.0 | 6.0-8.0  | 0.20      | ***            |
| S30153          | 301LN       | 0.030  | 2.00      | 0.045      | 0.030  | 1.00    | 16.0-18.0 | 6.0-8.0  | 0.07-0.20 | ***            |
| S30403          | 304L        | 0.030  | 2.00      | 0.045      | 0.030  | 0.75    | 18.0-20.0 | 8.0-12.0 | 0.10      | ***            |
| S30453          | 304LN       | 0.030  | 2.00      | 0.045      | 0.030  | 0.75    | 18.0-20.0 | 8.0-12.0 | 0.10-0.16 | ***            |

(1) Maximum, unless range or minimum is indicated.

**Table 2: Mechanical Test Requirements**  
**Solution Annealed, Wrought Stainless Steels**

| UNS Designation | Common Name | Tensile Strength, min. |     | Yield Strength, min. |     | Elongation, in 2 inches min% | Hardness, Max. |            |
|-----------------|-------------|------------------------|-----|----------------------|-----|------------------------------|----------------|------------|
|                 |             | Ksi                    | MPa | Ksi                  | MPa |                              | Brinell        | Rockwell B |
| S20103          | 201L        | 95                     | 655 | 38                   | 260 | 40.0                         | 217            | 95         |
| S20153          | 201LN       | 95                     | 655 | 45                   | 310 | 45.0                         | 241            | 100        |
| S30103          | 301L        | 80                     | 550 | 32                   | 220 | 45.0                         | 241            | 100        |
| S30153          | 301LN       | 80                     | 550 | 35                   | 240 | 45.0                         | 241            | 100        |
| S30403          | 304L        | 70                     | 485 | 25                   | 170 | 40.0                         | 201            | 92         |
| S30453          | 304LN       | 75                     | 515 | 30                   | 205 | 40.0                         | 217            | 95         |

**Note:** Direction of testing shall be transverse to rolling direction unless otherwise agreed to by purchaser and supplier.

**Table 3: Mechanical Test Requirements, Cold Rolled Austenitic Stainless Steel**

| UNS Designation         | Common Name | Tensile Strength, min. |      | Yield Strength, min. |     | Elongation in 2 in., min. % |                  |           |
|-------------------------|-------------|------------------------|------|----------------------|-----|-----------------------------|------------------|-----------|
|                         |             | Ksi.                   | MPa  | Ksi                  | MPa | <0.015 in                   | 0.015 - 0.030 in | >0.030 in |
| <b><u>1/16 Hard</u></b> |             |                        |      |                      |     |                             |                  |           |
| S20103                  | 201L        | 100                    | 690  | 50                   | 345 | 40                          | 40               | 40        |
| S20153                  | 201LN       | 100                    | 690  | 50                   | 345 | 40                          | 40               | 40        |
| S30103                  | 301L        | 100                    | 690  | 50                   | 345 | 40                          | 40               | 40        |
| S30153                  | 301LN       | 100                    | 690  | 50                   | 345 | 40                          | 40               | 40        |
| S30403                  | 304L        | 80                     | 550  | 45                   | 310 | 40                          | 40               | 40        |
| S30453                  | 304LN       | 90                     | 620  | 45                   | 310 | 40                          | 40               | 40        |
| <b><u>1/8 Hard</u></b>  |             |                        |      |                      |     |                             |                  |           |
| S20103                  | 201L        | 105                    | 725  | 55                   | 380 | 35                          | 35               | 35        |
| S20153                  | 201LN       | 110                    | 760  | 60                   | 415 | 35                          | 35               | 35        |
| S30103                  | 301L        | 110                    | 760  | 60                   | 415 | 35                          | 35               | 35        |
| S30153                  | 301LN       | 110                    | 760  | 60                   | 415 | 35                          | 35               | 35        |
| S30403                  | 304L        | 100                    | 690  | 55                   | 380 | 30                          | 30               | 30        |
| S30453                  | 304LN       | 100                    | 690  | 55                   | 380 | 33                          | 33               | 33        |
| <b><u>1/4 Hard</u></b>  |             |                        |      |                      |     |                             |                  |           |
| S20103                  | 201L        | 120                    | 825  | 75                   | 515 | 25                          | 25               | 25        |
| S20153                  | 201LN       | 120                    | 825  | 75                   | 515 | 25                          | 25               | 25        |
| S30103                  | 301L        | 120                    | 825  | 75                   | 515 | 25                          | 25               | 25        |
| S30153                  | 301LN       | 120                    | 825  | 75                   | 515 | 25                          | 25               | 25        |
| S30403                  | 304L        | 125                    | 860  | 75                   | 515 | 8                           | 8                | 10        |
| S30453                  | 304LN       | 125                    | 860  | 75                   | 515 | 10                          | 10               | 12        |
| <b><u>1/2 Hard</u></b>  |             |                        |      |                      |     |                             |                  |           |
| S20103                  | 201L        | 135                    | 930  | 100                  | 690 | 22                          | 22               | 22        |
| S20153                  | 201LN       | 135                    | 930  | 100                  | 690 | 22                          | 22               | 22        |
| S30103                  | 301L        | 135                    | 930  | 100                  | 690 | 20                          | 20               | 20        |
| S30153                  | 301LN       | 135                    | 930  | 100                  | 690 | 20                          | 20               | 20        |
| S30403                  | 304L        | 150                    | 1035 | 110                  | 760 | 5                           | 6                | 6         |
| S30453                  | 304LN       | 150                    | 1035 | 110                  | 760 | 6                           | 7                | 7         |

Note: Direction of testing shall be transverse to rolling direction unless otherwise agreed to by purchaser and supplier.

Table 3: (Continued)  
**Free Bend Requirements**

| UNS Designation                           | Common Name | Thickness, $t \leq 0.050$ in. |                  | Thickness, $t > 0.050$ to $< 0.1874$ in. |                     |
|---|-------------|-------------------------------|------------------|--|---------------------|
|   |             | Included Bend Angle, E        | Min. Bend Radius | Included Bend Angle, E                   | Minimum Bend Radius |
| <b><u>Annealed, 1/16 and 1/8 Hard</u></b> |             |                               |                  |  |                     |
| S20103                                    | 201L        | 180                           | 1t               | 180                                      | 1t                  |
| S20153                                    | 201LN       | 180                           | 1t               | 180                                      | 1t                  |
| S30103                                    | 301L        | 180                           | 1t               | 180                                      | 1t                  |
| S30153                                    | 301LN       | 180                           | 1t               | 180                                      | 1t                  |
| S30403                                    | 304L        | 180                           | 1t               | 180                                      | 2t                  |
| S30453                                    | 304LN       | 180                           | 1t               | 180                                      | 2t                  |
| <b><u>1/4 Hard</u></b>                    |             |                               |                  |  |                     |
| S20103                                    | 201L        | 180                           | 1.5t             | 135                                      | 1.5t                |
| S20153                                    | 201LN       | 180                           | 1.5t             | 135                                      | 1.5t                |
| S30103                                    | 301L        | 180                           | 1.5t             | 90                                       | 1.5t                |
| S30153                                    | 301LN       | 180                           | 1.5t             | 90                                       | 1.5t                |
| S30403                                    | 304L        | 180                           | 2t               | 90                                       | 3t                  |
| S30453                                    | 304LN       | 180                           | 2t               | 90                                       | 3t                  |
| <b><u>2 Hard</u></b>                      |             |                               |                  |  |                     |
| S20103                                    | 201L        | 180                           | 2t               | 135                                      | 2t                  |
| S20153                                    | 201LN       | 180                           | 2t               | 135                                      | 2t                  |
| S30103                                    | 301L        | 180                           | 2t               | 90                                       | 2t                  |
| S30153                                    | 301LN       | 180                           | 2t               | 90                                       | 2t                  |
| S30403                                    | 304L        | 180                           | 3t               | 90                                       | 2t                  |
| S30453                                    | 304LN       | 180                           | 3t               | 90                                       | 3t                  |

Note: Direction of testing shall be transverse to rolling direction unless otherwise agreed to by purchaser and supplier.