



# 14

## EAST SADDLE ANCHOR RODS

---

*(2010) – 32 Rods*

*Fabrication Process*

## TABLE OF CONTENTS

### East Saddle Anchor Rod

#### **2010 TIMELINE**

---

SPECIAL PROVISIONS AND PLAN SHEETS.....	A
DYSON, ART AND JAPAN STEEL WORKS (JSW) AUDITS.....	B
ANCHOR RODS SAMPLING REQUIREMENTS DEFINED.....	C
HEAT TREATMENT APPROVAL.....	D
MATERIAL ARRIVED TO DYSON FROM GERDAU.....	E
FABRICATION AT DYSON.....	F
36 ANCHOR RODS GREEN TAGGED FROM DYSON TO ART.....	G
QA SAMPLING AT DYSON.....	H
TRANSLAB TEST RESULTS.....	I
MTR REVIEW AT DYSON.....	J
33 ANCHOR RODS GREEN TAGGED FROM DYSON TO JSW.....	K
RFI 2111.....	L
MACHINING AND THREADING AT JSW.....	M
PRIMER APPLICATION AT JSW.....	N
SOURCE INSPECTION AT JSW.....	O
MATERIAL BLUE TAGGED TO JOBSITE.....	P
SHOP DRAWING SUBMITTAL.....	Q
ADDITIONAL DOCUMENTS.....	R

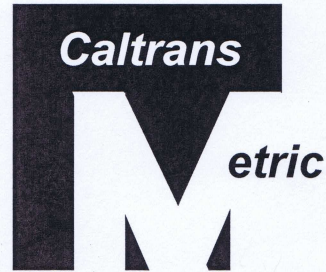
#### **ADDITIONAL DOCUMENTS**

---

ASTM A123  
ASTM A143  
ASTM A153  
ASTM A354  
ASTM A490

Location and Item		Component Description	Rod (no head) or Bolt (with head)	Threads Cut or Rolled	Supplier	Diameter (in)	Overall Length (ft)	Overall Length (mm)	Quantity Installed (not including spares)		De-Humidified Zone?	Tighten Method	Final Tension (fraction of Fu or UTS)	Date Tension or Loading Complete	Date Re-Inspected (by 4/8/13)	Date Re-Inspected (by 4/23/13)	Date Re-Inspected (by 5/5/13)	Notes
E2 Bearings and Shear Keys	1	E2 Shear Key - Connect to Concrete - Above Column, Under OBG [S1, S2]	rod	Cut	Dyson	3	17.2 10.0	5235 3035	60 36	96	No	Tension	0.7	3/5/2013	daily check	daily check	daily check	Tensioned to 0.75 Fy, with lockoff at ~ 0.7 Fu 32 of 96 rods broke after tensioning, then tension level lowered
	2	E2 Shear Key - Connect to Concrete - Above Bent Cap, Under Crossbeam [S3, S4]	rod	Cut	Dyson	3	21.9	6676	96		No	Tension	0.7	4/1/2013	daily check	daily check	daily check	Tensioned to 0.75 Fy, with lockoff at ~ 0.7 Fu
		E2 Bearing - Connect to Concrete - Under OBG [B1, B2, B3, B4]	rod	Cut	Dyson	3	22.6 22.2	6902 6777	64 32	Tension		0.7	4/9/2013	daily check	daily check	daily check	Tensioned to 0.75 Fy, with lockoff at ~ 0.7 Fu	
	3	E2 Shear Key - Connect to OBG [S1, S2]	rod	Cut	Dyson	3	4.4 1.8	1337 537	96 64	320	No	Tension	0.7	9/12/2012	4/6/2013 4/8/2013	4/17/13 to 4/23/13	5/3/2013	Tensioned to 0.75 Fy, with lockoff at ~ 0.7 Fu
		E2 Shear Key - Connect to Crossbeam [S3, S4]	rod	Cut	Dyson	3	4.3 1.7	1312 512	96 64									
		4	E2 Bearing - Connect to OBG [B1, B2, B3, B4]	rod	Cut	Dyson	2	3.6	1105									
	5	E2 Bearing Assembly Bolts (Spherical Bushing Halves)	rod	Cut	Dyson for Lubrite for Hochang	1	2.4	733	96	No	Tension	0.61	July 2009	not accessible	not accessible	not accessible	Connect 2 halves of the spherical bushing assembly housing together at Lubrite; rods are internal to bearings and <b>all rods are not accessible</b> after bearing assembly at Hochang (December 2009 & January 2010); rods tensioned to 0.7 Fy.	
	6	E2 Bearing Assembly Bolts (Retaining Rings)	Socket Head Cap Screw	Cut	Dyson for Hochang	1	0.2	55	336	No	snug + 1/4 turn	~0.4	January 2010	4/6/2013 (for 32 accessible bolts)	4/23/2013 (for 32 accessible bolts)	5/3/2013 (for 32 accessible bolts)	Bolts thread into drill and tap holes to attach retaining rings that secure the Lubrite spherical bushing assembly in the bottom housing; bolts are mechanically galvanized, not hot dip galvanized; bolts are internal to bearings and not accessible after bearing assembly at Hochang, except for a small number of bolts in limited areas -> <b>32 of 336 bolts are accessible.</b>	
Cable Anchorage	7	PWS Anchor Rods - PWS Socket to Anchorage	rod	55 Cut (20%) 219 Rolled (80%)	Dyson	3-1/2	27.9 to 31.8	8500 to 9700	274	Yes	Load Transfer	0.26	9/26/2012	4/6/2013	4/20&22/2013	5/4/2013	With DL after load transfer (current condition)	
												0.29	N/A	N/A	N/A	N/A	With DL + Added DL	
												0.32	N/A	N/A	N/A	N/A	Service Load (Group 1)	
												0.35	N/A	N/A	N/A	N/A	SEE (Seismic)	
Top of Tower	8	Tower Saddle Tie Rods	rod	Rolled	Dyson	4	6.0 to 17.5	1840 to 5325	25	Yes	Tension	0.41	7/14/2012	N/A	N/A	N/A	Load During Construction - Tensioned to 0.5 Fy	
												0.68	N/A	4/6/2013	4/19/2013	5/3/2013	Additional tension in tie rods from cable with service load	
	9	Turned Rods at Tower Saddle Segment Splices	rod	Cut	Dyson	3 @ Threads [-3-1/16 @ Shank]	1.5 1.4	463 415	100 8	108	Yes	Tension	0.45	4/6/2011	4/6/2013	4/19/2013	5/3/2013	Located at the 2 field splices connecting the 3 tower saddle segments; 100 rods tensioned prior to saddle erection; 8 rods only snug tight after tie rod tensioning due to conflict with tie rods.
	snug	~0.1	7/14/2012															
10	Tower Saddle to Grillage Anchor Bolts	Hex Bolt	Cut	Dyson	3	1.2	360	90	Head Yes, Nut No	snug	~0.1	3/25/2013	4/6/2013	4/19/2013	5/3/2013	Snug tightened before and after load transfer: <b>Initial Tension complete on 5/20/2011; final tension complete on 3/25/2013.</b>		
11	Tower Outrigger Boom (for Maintenance) at Top of Tower	Hex Bolt	Cut	Dyson	3	2.1	630	4	No	snug	~0.1	July 2012	4/6/2013	4/19/2013	5/4/2013	Act as pins for swinging out and then securing the maintenance outrigger boom at the top of 2 of 4 tower head chimneys. At each boom, one bolt is loaded and other bolt is unloaded in the current boom position. The currently unloaded bolt will be installed snug tight when the boom is swung out for use (future position).		
Bottom of Tower	12	Tower Anchor Rods - Tower at Footing (3" Dia)	rod	Cut	Vulcan Threaded Products	3	25.6	7789	388	Yes	Tension	0.48	4/17/2013	N/A	4/20/2013 4/22/2013	5/5/2013	Tensioned to 1800 kN = 404.7 kips; Tension before and after load transfer: <b>Initial Tension Late 2010 through Early 2011; Final Tension 2013</b>	
	13	Tower Anchor Rods - Tower at Footing (4" Dia)	rod	Cut	for KOS for KFM (04-0120E4)	4	25.7	7839	36	Yes	Tension	0.37	4/17/2013	N/A	4/20/2013 4/22/2013	5/5/2013	Tensioned to 2530 kN = 568.8 kips; Tension before and after load transfer: <b>Initial Tension Late 2010 through Early 2011; Final Tension 2013</b>	
East Saddles	14	East Saddle Anchor Rods	rod	Cut	Dyson for JSW	2	2.6	800	32	Yes	snug	~0.1	May 2010	4/7/2013	4/21/2013	5/3/2013	specified gap under nut/washer at one end of rod and 2 nuts snug against each other at other end of rod -> snug tight for portion of rod	
	15	East Saddle Tie Rods	Hex Bolt	Cut	Dyson	3	4.7	1420	18	Yes	snug	~0.1 0.2	4/13/2012 N/A	N/A 4/7/2013	N/A 4/21/2013	N/A 5/3/2013	Snug tightened before load transfer Additional tension in tie rods from cable with service load	
East Cable	16	B14 Cable Bands - Cable Brackets - at East End of Bridge - Strongback Anchor Rods	rod	Rolled	Dyson	3	10.3 to 11.1	3129 to 3372	24	No	Tension	0.16	2/8/2013	4/7/2013	4/21/2013	5/4/2013	pre-compress neoprene between strongback and cable band	
W2 Bent Cap	17	W2 Bikepath Anchor Rods	rod	Cut	Dyson	~1-3/16 [Metric M30]	1.5	460	43	No	Not Determined Yet		N/A	N/A	N/A	N/A	Details for bikepath connections are being redesigned and are not final. The 18 anchor rods at the bottom connections will be abandoned. The 25 anchor rods at the top connections will be used and supplemented with additional anchor rods. These rods will be tensioned on the separate YBITS-2 Contract.	

Total = 2306 New information after 5/6/2013 Update is highlighted Red



STATE OF CALIFORNIA  
DEPARTMENT OF TRANSPORTATION

---

**NOTICE TO CONTRACTORS  
AND  
SPECIAL PROVISIONS  
FOR CONSTRUCTION ON STATE HIGHWAY IN  
SAN FRANCISCO COUNTY IN SAN FRANCISCO  
FROM 0.6 KM TO 1.3 KM EAST OF THE YERBA BUENA TUNNEL EAST PORTAL**

**DISTRICT 04, ROUTE 80**

---

**For Use in Connection with Standard Specifications Dated JULY 1999, Standard Plans Dated JULY 1999, and Labor  
Surcharge and Equipment Rental Rates.**

---

**CONTRACT NO. 04-0120F4**

**04-SF-80-13.2/13.9**

**Bids Open: February 1, 2006  
Dated: August 1, 2005**

**OSD**

persons or entities hired by subcontractors who will provide other services or materials for the project, and shall have the following:

- A. A tensile testing machine capable of breaking the largest size of reinforcing bar to be tested.
- B. Operators who have received formal training for performing the testing requirements of ASTM Designation: A 970/A 970M.
- C. A record of annual calibration of testing equipment performed by an independent third party that has 1) standards that are traceable to the National Institute of Standards and Technology, and 2) a formal reporting procedure, including published test forms.

The Engineer shall be notified in writing when any lots of headed bar reinforcement are ready for testing. The notification shall include the number of lots to be tested and the location where the tests are to be conducted. After notification has been received, test samples will be randomly selected by the Engineer from each production lot of headed bar reinforcement which is ready for shipment to the jobsite. If epoxy coating is required, test samples will be taken after the headed bar reinforcement has been prepared for epoxy coating. The Engineer will be at the testing site within a maximum of one week after receiving written notification that the samples are at the testing site and ready for testing. In the event the Engineer fails to be present at the testing site within the time allowed, and if, in the opinion of the Engineer, completion of the work is delayed or interfered with by failure of the Engineer to be present at the testing site, the Contractor will be compensated for any resulting loss in the same manner as provided for in Section 8-1.09, "Right of Way Delays," of the Standard Specifications.

A minimum of 3 samples from each production lot shall be tested. One tensile test shall be conducted on each sample.

Tensile tests shall conform to the requirements specified in ASTM Designation: A 970/A 970M, Section 7, except that at rupture, there shall be visible signs of necking in the reinforcing bar 1) at a minimum distance of one bar diameter away from the head to bar connection for friction welded headed bar reinforcement, or 2) outside the affected zone for integrally forged headed bar reinforcement.

The affected zone for integrally forged headed bar reinforcement is the portion of the reinforcing bar where any properties of the bar, including the physical, metallurgical, or material characteristics, have been altered during the manufacturing process.

If one of the test specimens fails to meet the specified requirements, one retest shall be performed on one additional sample, selected by the Engineer, from the same production lot. If the additional test specimen, or if more than one of the original test specimens fail to meet these requirements, all headed bar reinforcement in the lot represented by the tests will be rejected in conformance with the provisions in Section 6-1.04, "Defective Materials," of the Standard Specifications.

A Production Test Report for all testing performed on each lot shall be prepared by the independent testing laboratory and submitted to the Engineer as specified herein. The report shall be signed by an engineer who represents the laboratory and is registered as a Civil Engineer in the State of California. The report shall include the following information for each set: contract number, bridge number, lot number, bar size, type of headed bar reinforcement, physical conditions of test sample, any notable defects, limits of affected zone, location of visible necking area, and the ultimate strength of each headed bar.

Each unit of headed bar reinforcement in a production lot to be shipped to the site shall be tagged in a manner such that production lots can be accurately identified at the jobsite. All unidentified headed bar reinforcement received at the jobsite will be rejected.

## **MEASUREMENT AND PAYMENT**

Full compensation for headed bar reinforcement shall be considered as included in the contract price paid per kilogram for bar reinforcing steel (bridge) and no separate payment will be made therefor.

Full compensation for epoxy-coated headed bar reinforcement shall be considered as included in the contract price paid per kilogram for bar reinforcing steel (epoxy-coated) (bridge) and no separate payment will be made therefor.

## **10-1.59 STEEL STRUCTURES**

Construction of steel structures shall conform to the provisions in Section 55, "Steel Structures," of the Standard Specifications and these special provisions.

Fabricators and suppliers shall be certified under the AISC Quality Certification Program, Category Cbr, Major Steel Bridges, with endorsement F, Fracture Critical members, except that certification will not be required for fabrication of the tower strut façade and tower skirt. Alternatively, ISO 9001:2000 certification standard may be substituted for the AISC Quality Certification Program.

Details of box girder and crossbeam connections shall conform to the AASHTO Standard Specifications for Highway Bridges, unless otherwise shown on the plans.

Attention is directed to "Accelerated Working Drawings Submittal," of these special provisions.

- A. Minimum tension shall be verified using the "Pre-Installation Verification Turn-of-the-Nut Method," of the "Structural Bolting Handbook," published by the Steel Structures Technology Center, Incorporated, except that the required rotation shall be as given in Table 8.2. of this section and the required tension shall be as shown in the following table:

**Pre-Installation Verification  
Required Tension, N\***

Bolt Size, mm	A325M Bolts	A490M Bolts
M16	96 000	120 000
M20	149 000	188 000
M22	185 000	232 000
M24	215 000	270 000
M27	280 000	351 000
M30	342 000	428 000
M36	499 000	625 000
*The above values are 5% higher than the required pretension values used for design, actual installation and inspection, rounded to the nearest kN.		

- B. Rotational-capacity tests in accordance with the requirements in Section 11.5.6.4.2 "Rotational-Capacity Tests," of the AASHTO LRFD Bridge Construction Specifications, except that Table 11.5.6.4.1-2 "Nut Rotation from the Snug Condition," is replaced by Table 8.2. of this section.

Test results shall confirm both the minimum bolt tension and the rotational capacity of the bolts. If either test fails, the Contractor shall modify the nut rotation in Table 8.2. of this section until the requirements of both tests are satisfied. No adjustment in compensation will be allowed for modifications to the nut rotations as necessary to satisfy test requirements. Revisions to Table 8.2. shall be approved by the Engineer prior to bolting operations.

The Engineer will randomly sample and perform quality assurance testing of high strength fasteners. Samples will be obtained at locations chosen by the Engineer. The Contractor shall provide the number of bolts specified below to the Engineer for quality assurance testing:

**Bolt Sampling Size**

Lot Size (No. of Bolts)	Sample Size (No. of Bolts)
2 to 15	3
16 to 25	4
26 to 50	5
51 to 90	7
91 to 150	8
151 to 280	9
281 to 10,000	12
10,001 to 500,000	16
500,001 and over	20

Steel fasteners, designated on the plans as A 354, Grade BC, and A 354, Grade BD, shall conform to the requirements of ASTM Designation: A 354. Steel fastener components for steel fasteners designated as A 354 shall include a bolt, nut and hardened washer. Nuts for steel fasteners designated as A 354 shall conform to Section 55-2.01, "Description," of the Standard Specifications.

Steel fasteners designated on the plans as A 354, Grade BD shall be dry blast cleaned in accordance with the provisions of Surface Preparation Specification No. 10, "Near White Blast Cleaning," of the "SSPC: The Society for Protective Coatings."

Steel fasteners designated on the plans as A 354, Grade BC, and A 354, Grade BD, shall be galvanized in accordance with the requirements in Section 75-1.05, "Galvanizing," of the Standard Specifications and shall conform to the requirements in ASTM Designation: A123 for bolts and ASTM Designation: A153 for nuts and hardware. Steel fastener assemblies designated as A354, Grade BD, shall be galvanized within 4 hours of being dry blast cleaned.

The Contractor shall submit certified test reports showing that the A 354, Grade BD fasteners conform to the provisions in ASTM Designation: A 143.

Steel fasteners, designated on the plans as A 354, Grade BC, and A 354, Grade BD, shall conform to the requirements of ASTM Designation: A 354. Steel fastener components for steel fasteners designated as A 354 shall include a bolt, nut and hardened washer. Nuts for steel fasteners designated as A 354 shall conform to Section 55-2.01, "Description," of the Standard Specifications. Nuts shall be zinc coated and be furnished with a dry lubricant conforming to Supplementary Requirement S1 and S2 in ASTM Designation: A 563.

Steel fasteners designated on the plans as A 354, Grade BD shall be tensioned not less than the value shown on the plans. Prior to installation, the Contractor shall submit to the Engineer for approval the methods and equipment to be used to tension steel fasteners designated as A354, Grade BD in accordance with Section 55-1.02, "Drawings," of the Standard Specifications. Working drawings shall include methods and equipment to be used to evaluate: 1) the presence of a lubricant, 2) the efficiency of the lubricant, and 3) the compatibility of the high strength steel bolt, nut and hardened washer.

Except where sub-punching is permitted, bolt holes shall be drilled or reamed, unless otherwise shown on the plans.

### **Punching**

The first paragraph of Section 55-3.14A(1) "Punching," of the Standard Specifications shall not apply.

Punching or sub-punching of Grade 250 structural steel where the material is thicker than 16 mm will not be permitted. Punching or sub-punching of high-strength structural steel where the material is thicker than 12 mm will not be permitted.

### **Prestressing High-Strength Bolts**

High-strength A354 bolts shall be tensioned by means of hydraulic jacks so that the force in the bolts shall not be less than the value shown on the plans.

The maximum temporary tensile stress (jacking stress) in high-strength bolts shall not exceed 75 percent of the specified minimum ultimate tensile strength of the material. Prestressing forces in high-strength bolts shall consider all losses, including creep of steel, losses due to sequence of stressing, and other losses specific to the method or system of prestressing used by the Contractor.

Hydraulic jacks used for prestressing high-strength bolts shall be calibrated in accordance with the requirements in Section 50-1.08, "Prestressing," of the Standard Specifications.

Final prestressing high strength A354 bolts at the tower anchorage shall be performed after the full dead load is transferred to the cable system.

### **ASSEMBLY**

The method of erection of the suspended structure and tower shall be determined by the Contractor to meet the seismic design load criteria and ensure control of box girder and tower deflections due to wind induced oscillations.

The Contractor shall carry out the necessary structural analyses for the erection procedure to demonstrate the adequacy of the procedure. Details of these analyses and of any supplementary damping or other measures shall be submitted to the Engineer for review and approval.

Wind pressure effects during erection shall be calculated using a gust wind appropriate to a return period of not less than 25 years and shall allow for variation of speed with height per ANSI ASCE 7-95. The 25-year wind corresponds to a 77 mph one-hour average wind speed (and a corresponding 3-second gust wind speed of 100 mph) at deck elevation of 50 meters, as well as a critical flutter wind speed threshold of 112 mph based on a 1000-year return period. The Contractor shall provide temporary connections between adjacent lift sections in order to ensure sufficient torsional stiffness of the suspended structure. The Contractor shall also provide the proper support of the suspended structure during all stages of erection. The Contractor shall similarly ensure control of tower deflections due to wind-induced oscillations at all stages of erection and shall provide holdback stays or other damping devices as necessary. All such temporary measures shall be approved by the Engineer.

Wind design loads may be reduced during lifting operations.

Seismic loading during erection shall conform to the seismic loading requirements specified in "TEMPORARY TOWERS," subsection "TEMPORARY TOWER DESIGN," subsection "Seismic Design Loads," of these special provisions.

The erection procedure shall be such that the maximum stresses in any part of the permanent structure do not cause any permanent deformation or damage. Appropriate values of loads and safety factors for erection loading conditions shall be submitted by the Contractor to the Engineer for review and approval.

The details of any fastenings which the Contractor may require in any part of the permanent works for erection, and the procedure for their removal, shall be submitted to the Engineer for approval.

### **Tower**

Tower lifts shall be in lengths as indicated on the plans. Exterior plates of the tower shafts shall be fabricated with direction of rolling aligned along the vertical direction of the tower. Within each lift, the number of transverse splices of the

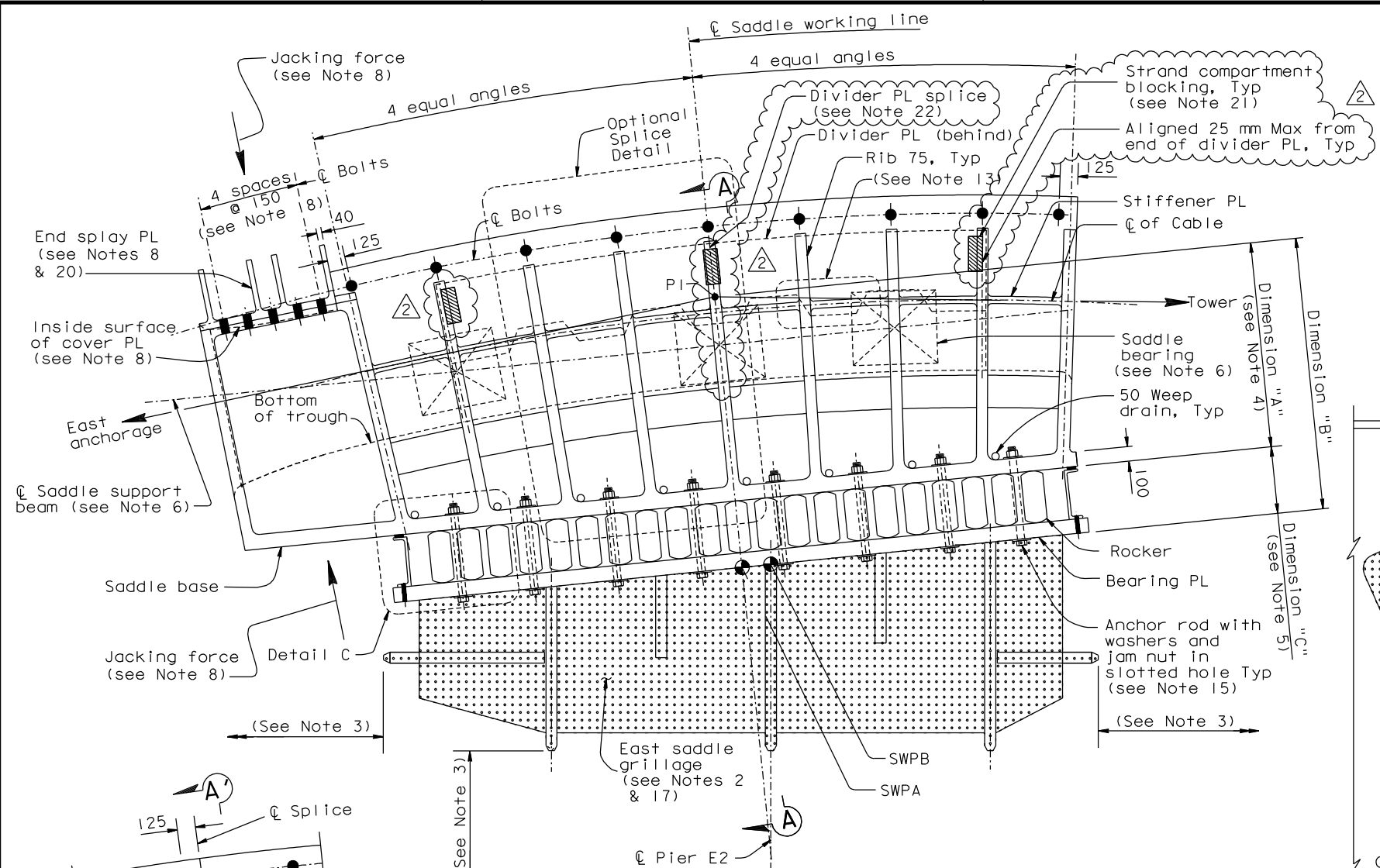
DIST.	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS
04	SF	80	13.2/13.9	786R2	1204



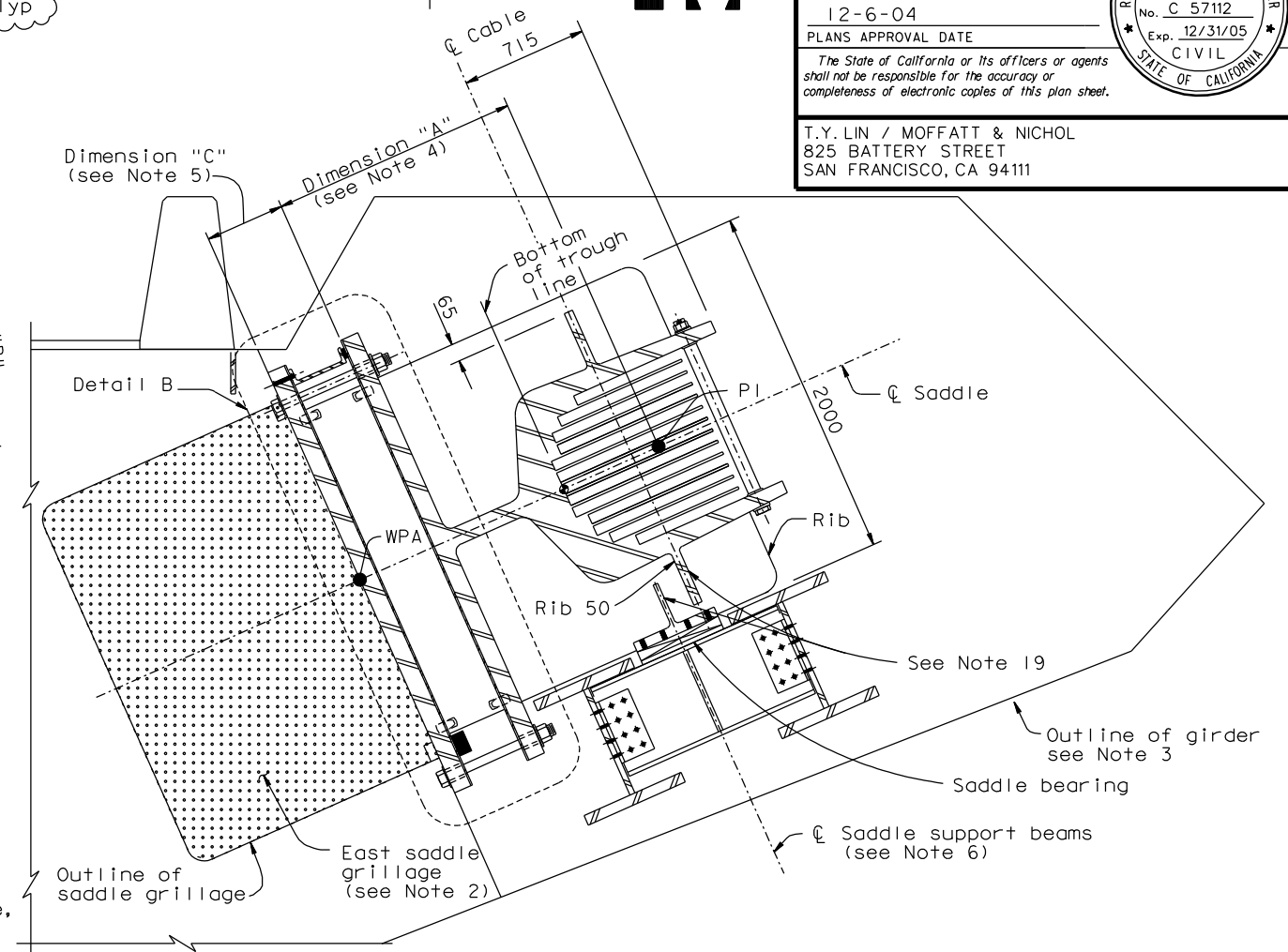
**George Baker**  
REGISTERED ENGINEER - CIVIL  
12-6-04  
PLANS APPROVAL DATE  
The State of California or its officers or agents shall not be responsible for the accuracy or completeness of electronic copies of this plan sheet.

**George S. Baker**  
No. C 57112  
Exp. 12/31/05  
CIVIL  
STATE OF CALIFORNIA

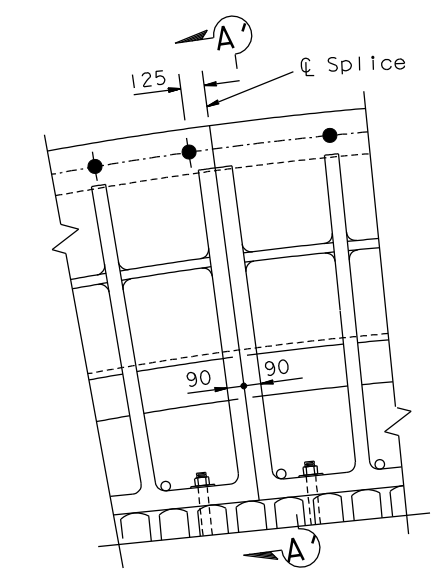
T.Y. LIN / MOFFATT & NICHOL  
825 BATTERY STREET  
SAN FRANCISCO, CA 94111



**ELEVATION OF TYPICAL EAST SADDLE  
(IN THE PLANE OF CABLE)** (See Note 6)  
1:20



**SECTION A-A**  
1:20



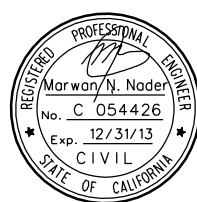
**OPTIONAL SPLICE DETAIL**  
1:20

20. At the Contractor's option, it is acceptable to incorporate permanent diaphragm plates at the end splay plate, subject to review and approval of the Engineer.
21. The Contractor shall fabricate and install new blocking. For typical blocking, see Section A-A on "East Saddle Details No.5" sheet. For typical blocking details, see "East Saddle Details No.5A" sheet.
22. The blocking shall be placed such that it straddles the divider plate splicing joint.

12. All divider plates shall be hot dip galvanized with Class A coating.
13. For detail of Divider PL joint, see "West Deviation Saddle Details No.3" sheet.
14. In the bolted splices the flatness of the faying surfaces shall be  $\pm 0.5$  mm per meter, and the gap between them shall not exceed 0.5 mm per meter. The perimeters of faying surfaces shall be caulked.
15. Slotted holes may be placed in bearing PL or saddle base PL.
16. The Contractor may propose holes and attachments for erection, subject to review and approval of the Engineer. Upon erection completion, all holes shall be filled with bolts.
17. It is acceptable to align the ends of grillage PL A with a projection of the centerline of the outmost saddle ribs, subject to review and approval of the Engineer.
18. Spacing may be adjusted to accommodate jacking, subject to review and approval of the Engineer.
19. It is acceptable to extend the saddle rib to the saddle bearing plate in lieu of the bearing plate web extension subject to review and approval of the Engineer. Where the offset between the saddle rib and the support beam centerlines exceeds 60 mm, the bearing plate shall be thickened to 60 mm.

**NOTES:**

1. For Section A'-A', Details B and C, see "East Saddle Details No.6" sheet.
2. For east saddle grillage details, see "Girder At Pier E2 No.5" sheet.
3. For girder details at the east saddle, see "Girder At Pier E2" sheets.
4. For dimension "A", see "East Saddle Details No.2" sheet.
5. For dimension "C", see "East Saddle Details No.6" sheet.
6. For saddle bearings and saddle beam support details, see "East Saddle Details No.7" sheet.
7. For the plane of the cable, see "East Saddle Details No.1" and "East Saddle Details No.2" sheets.
8. End splay plate shall be pressed into place by jacking and bolted to the saddle after completion of cable erection and before load transfer to cable. Total jacking capacity shall be at least 1.9 MN. For end splay PL details, see "East Saddle Details No.5" sheet.
9. Bearing surfaces of rockers shall be finished to ANSI 250 surface roughness. Rocker bearing surfaces shall be finished to ANSI 250 and shall be finished flat to  $\pm 0.5$  mm per meter of surface length.
10. All surfaces inside the trough shall be machined to ANSI 500 roughness. The geometric tolerance of the surfaces shall not exceed  $\pm 1.5$  mm per meter of surfaces without sudden kinks.
11. The inside of the troughs shall be metallized with a coating thickness not less than 0.4 mm.



**CONTRACT CHANGE ORDER NO. \_\_\_\_\_  
SHEET \_\_\_\_ OF \_\_\_\_**

REQUESTS FOR INFORMATION NOT ADDRESSED IN THIS CCO REMAIN IN FORCE

R. Valizadeh/V. Toan/Y.L./W.L./F.C.  
DESIGN OVERSIGHT  
Rev. Date: 5-18-98

MARK	DATE	DESCRIPTIONS	BY	CH'D	CCO#
1	05/09/12	SADDLE BLOCKING	GB	MN	240
2	09/01/11	EAST END OBG	GB	MN	87

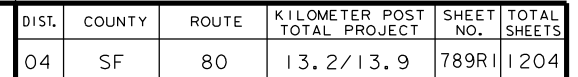
DESIGN	BY G. Baker	CHECKED J. Kuliki
DETAILS	BY R. Kanitkar	CHECKED T. McMeans
QUANTITIES	BY D. Turner	CHECKED D. Harrison


**PREPARED FOR THE  
STATE OF CALIFORNIA  
DEPARTMENT OF TRANSPORTATION**

R. Manzanarez  
PROJECT ENGINEER  
BRIDGE NO. 34-0006L/R  
KILOMETER POST 13.2/13.9

**SAN FRANCISCO OAKLAND BAY BRIDGE  
EAST SPAN SEISMIC SAFETY PROJECT  
SELF-ANCHORED SUSPENSION BRIDGE  
(SUPERSTRUCTURE & TOWER)  
EAST SADDLE DETAILS NO.3**

12. At the Contractor's option, MC13x31.8 ASTM A709 grade 36 channels may be used in lieu of MC330x47.3 ASTM A709 grade 50 channels, subject to review and approval of the Engineer.

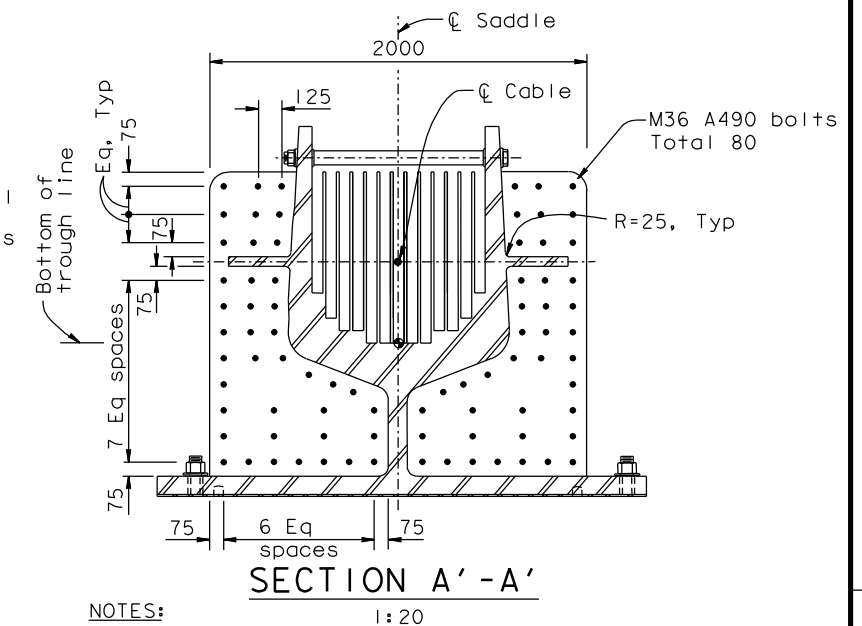
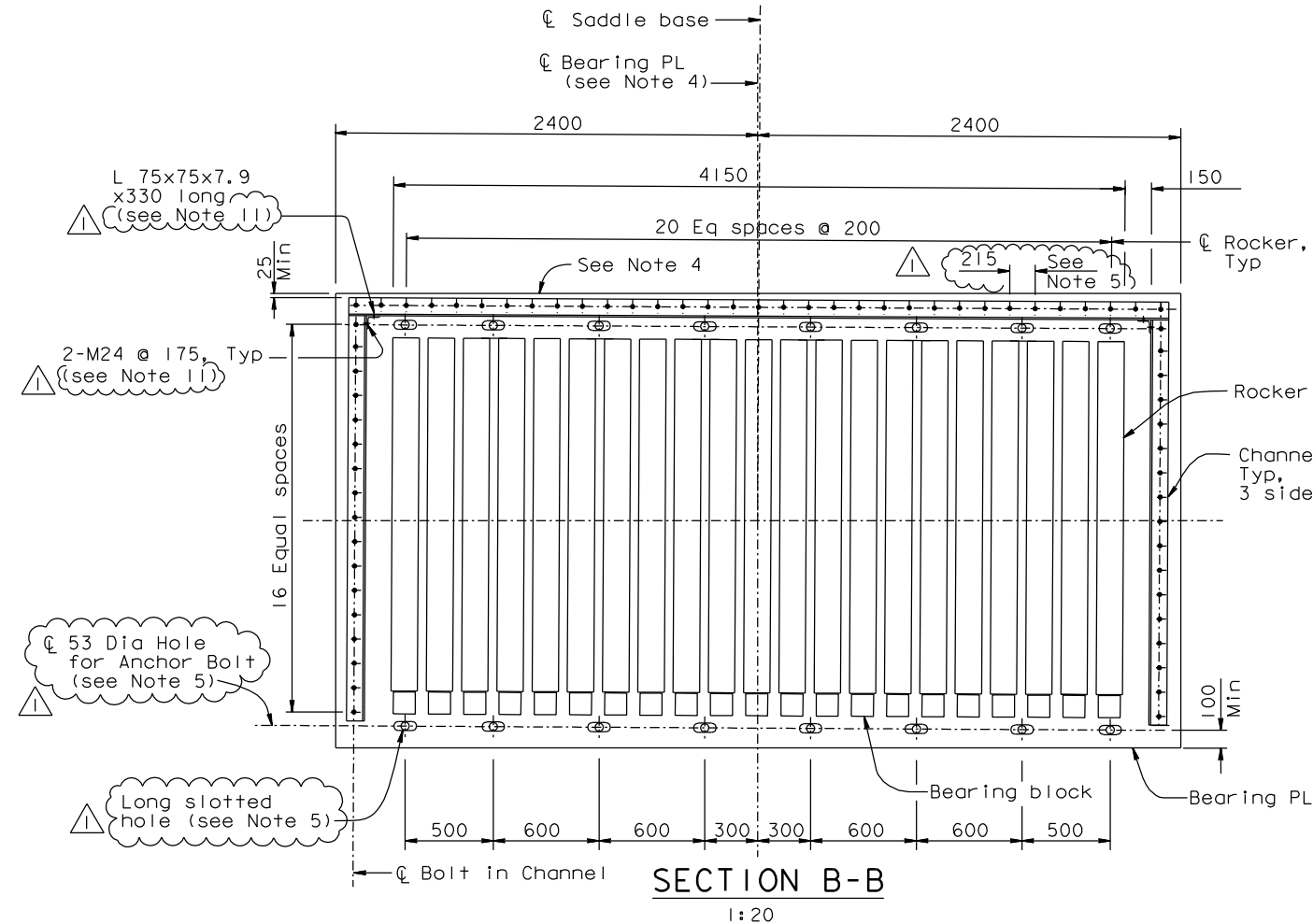



 The seal is circular with "REGISTERED PROFESSIONAL ENGINEER" around the top and "STATE OF CALIFORNIA" around the bottom. In the center, it says "George S. Baker", "No. C 57112", "Exp. 12/31/05", and "CIVIL".

*George Baker*  
 REGISTERED ENGINEER - CIVIL  
 12-6-04  
 PLANS APPROVAL DATE  
 The State of California or its officers or agents  
 shall not be responsible for the accuracy or  
 completeness of electronic copies of this plan sheet.

T.Y. LIN / MOFFATT & NICHOL  
825 BATTERY STREET  
SAN FRANCISCO, CA 94111

Caltrans now has a web site! To get to the web site, go to: <http://www.dot.ca.gov>



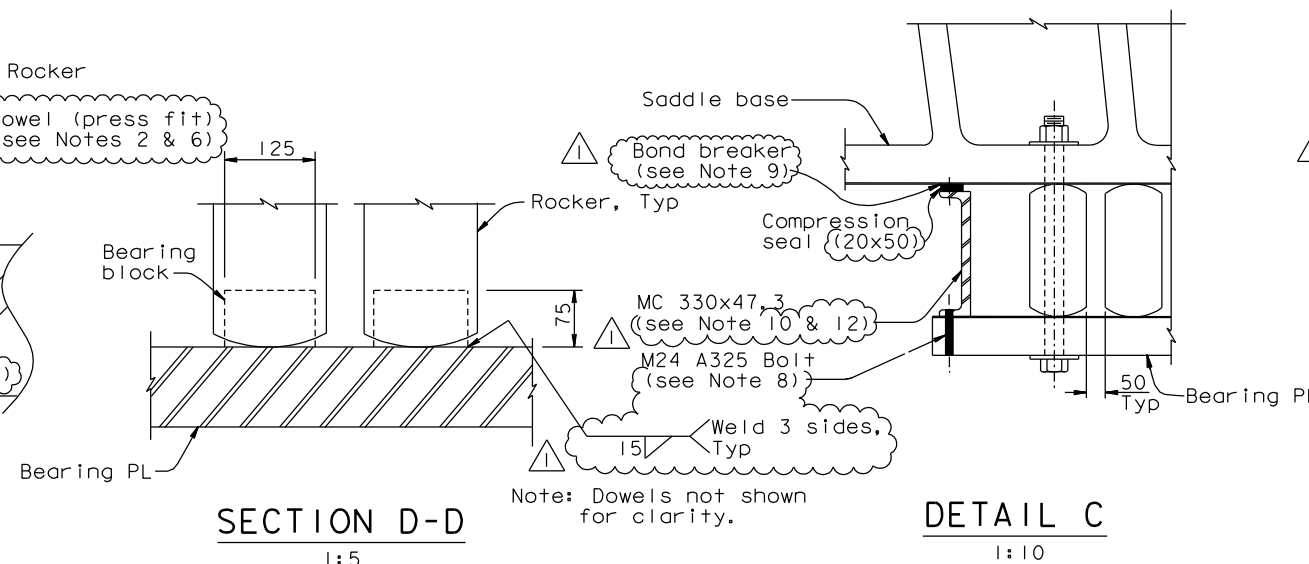
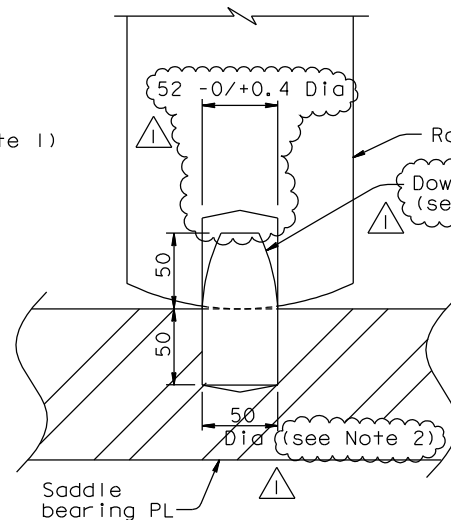
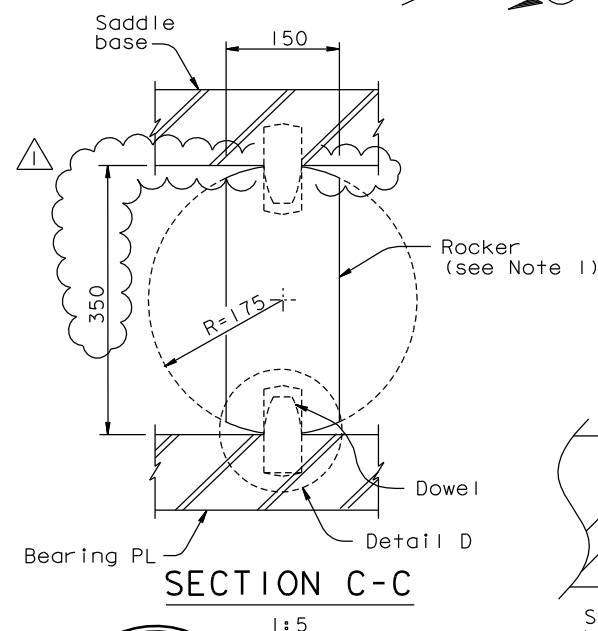
**NOTES:** 1:20

1. Rockers shall be ASTM A668 Class J.
2. Dowels shall be ASTM A276 Type 410 condition T. Dowels of 50 Dia shall be press fit into holes of diameter 0.15 mm smaller than the dowel.

⚠ 3. Each anchor rod shall hand wrench tightened.

⚠ 4.  The saddle and rockers shall be oriented according to the saddle layout. See "East Saddle Details No.1" and "East Saddle Details No.2" sheets.

5. Slotted holes shall be detailed to accommodate all saddle movements during erection, and after completion of the bridge shall accommodate a range of saddle movement of at least 50 mm in each direction. Slotted holes may be placed in the Bearing PL or the saddle base PL.
6. The shape of the dowel shall be a cycloid consistent with the radius of the rocker.
7. For slotted holes in the saddle base plate option the following shall apply: the anchor rods shall be threaded in both ends; two nuts and one washer shall be installed in the bearing plate to clamp the rod in the standard hole; a nominal gap (0.8 mm), a washer and a jam-nut (or other anti-loosening device) shall be provided at the slotted holes in the saddle base plate.
8. The MC 330 may be welded, subject to approval of the Engineer.
9. PTFE tape (0.5mm thick), shall be applied to the neoprene compression seal.
10. It is acceptable to shift the MC 330 on the tower side 50 mm towards the east anchorage, subject to review and approval by the Engineer.



CONTRACT CHANGE ORDER NO. \_\_\_\_\_  
SHEET \_\_\_\_\_ OF \_\_\_\_\_

REQUESTS FOR INFORMATION NOT ADDRESSED IN THIS CCO REMAIN IN FORCE

R. Valizadeh/V. Toan/Y. L. /W. L. /F. C.									
DESIGN OVERSIGHT									
R. Valizadeh / V. Toan / Y. L. / W. L. / F. C.									
SIGN OFF DATE: 09/01/11									
REVISIONS									

Rev. Date: 5-18-98

DESIGN	BY G. Baker	CHECKED J. Kuliki
DETAILS	BY R. Kanitkar	CHECKED T. McMeans
QUANTITIES	BY D. Turner	CHECKED D. Harrison

**PREPARED FOR THE  
STATE OF CALIFORNIA  
DEPARTMENT OF TRANSPORTATION**

R. Manzanarez  
PROJECT ENGINEER

CU 04
EA 0120F

BRIDGE NO.

34-00061 /R

KILOMETER POST

KILOMETER POST
13 2413 6

13.27/13.9

DISREGARD PRI

SAN FRANCISCO OAKLAND BAY BRIDGE  
EAST SPAN SEISMIC SAFETY PROJECT  
SELF-ANCHORED SUSPENSION BRIDGE  
(SUPERSTRUCTURE & TOWER)  
EAST SADDLE DETAILS NO. 6

DISREGARD PRINTS BEARING EARLIER REVISION DATES →	REVISION DATES (PRELIMINARY STAGE ONLY)							SHEET	OF
	05/15/99	08/02/99	05/27/01	04/08/02	07/01/02	12/18/02		372R1	

```

USERNAME => Alishansky  DATE PLOTTED => 30 AUG 2011  TIME PLOTTED => 13:35:35

```

**DEPARTMENT OF TRANSPORTATION - District 4 Toll Bridge Program**

333 Burma Rd.  
Oakland, CA 94607  
(510) 622-5660, (510) 286-0550 fax



*Flex your power  
Be energy efficient!*

August 24, 2007

Contract No. 04-0120F4  
04-SF-80-13.2 / 13.9  
Self-Anchored Suspension Bridge  
Letter No. 05.03.01-000487

Michael Flowers  
Project Executive  
American Bridge/Fluor Enterprises, a JV  
375 Burma Road  
Oakland, CA 94607

Dear Michael Flowers,

**Department Audit of Dyson Corporation**

The Department has reviewed ABF letter 257, dated August 14, 2007, and the "Corrective Action Request" from the Dyson Corporation, dated August 09, 2007. Based upon the information provided and in accordance with Special Provisions section 8-4, "Audits," the Dyson Corporation receives a "Pass" for the Department audit. This "Pass" applies only to the Dyson Corporation. Suppliers and subcontractors to the Dyson Corporation are subject to separate MFSQA reviews and audits. The following table summarizes the current status of associated audits:

Company	Letter No.	Date of Notice	MFSQA	AUDIT
AAA Galvanizing	321	06-18-2007	Approved	
Art Galvanizing	336	06-22-2007	Approved	
	403	07-25-2007		Contingent Pass
Central Testing Lab	320	06-18-2007	Approved	
	413	07-26-2007		Fail
Custom Industrial Processing	325	06-18-2007	Not Approved	
Industrial Coatings Inc	444	08-06-2007	Approved	
Mechanical Galv-Plating Corp	361	07-05-2007	Approved	
	432	08-02-2007		Pass
North American Galvanizing	337	06-22-2007	Approved	
	421	07-31-2007		Fail
Stork Herron Testing Lab	297	06-06-2007	Approved	
	417	07-30-2007		Contingent Pass
TC Industries	367	07-09-2007	Approved	
Tensile Testing Metallurgical Lab	296	06-06-2007	Approved	
	409	07-26-2007		Pass
Universal Galvanizing	338	06-25-2007	Approved	

The Contractor is reminded that work may not proceed at the facilities receiving a "Contingent Pass," until the outstanding issues detailed in the Department's letters have been addressed.

If you have any further questions, please contact Gary Lai at the Working Drawing Campus.

Sincerely,



GARY PURSELL  
Resident Engineer

cc: Rick Morrow  
Mazen Wahbeh

file: 05.03.01, 55.0097

**DEPARTMENT OF TRANSPORTATION - District 4 Toll Bridge Program**

333 Burma Rd.

Oakland, CA 94607

(510) 622-5660, (510) 286-0550 fax

*Flex your power  
Be energy efficient!*

October 18, 2007

Contract No. 04-0120F4

04-SF-80-13.2 / 13.9

Self-Anchored Suspension Bridge

Letter No. 05.03.01-000706

Michael Flowers  
Project Executive  
American Bridge/Fluor Enterprises, a JV  
375 Burma Road  
Oakland, CA 94607

Dear Michael Flowers,

**Department Audit - Art Galvanizing Works**

The Department is in receipt of ABF-CAL-LTR-000271, dated August 29, 2007, responding to the Department's review of Submittal ABF-SUB-000160R00, MFSQA for Art Galvanizing Works. Based upon the information provided, Art Galvanizing Works is receiving a Pass. The following issues must be satisfactorily addressed in writing prior to the start of fabrication:

1. The previous response to MFSQA response R6 indicated positively that there is a separation between Quality Control and Production. Currently, the same individual is managing both Production and Quality Control. Please confirm whether or not a third party will be used for Quality Control.
2. Regarding the Observations:
  - a. **Observation 1:** This matter is closed as it does not relate directly to production.
  - b. **Observation 2:** This matter is closed. The Department notes and accepts the Contractor's explanation.
  - c. **Observation 3:** This item was meant to convey that Art Galvanizing Works did not have facilities to handle blasting independently. Maximum capacity is 3 feet in length, while rods for this Contract are up to 15 feet long. The Department notes and accepts the Contractor's explanation. This matter will be closed pending submission of procedures detailing the blasting and inspection of the material.
  - d. **Observation 4-8:** These issues can be resolved by addressing the previous comment regarding the separation between Quality Control and Production.

American Bridge/Fluor Enterprises, a JV  
October 18, 2007  
Page 2 of 2

The Department requests that notification be provided prior to the start of any work at this facility for this Contract.

If you have further questions, please contact Dr. Venkatesh Iyer at 858.967.6363.

Sincerely,



GARY PURSELL  
Resident Engineer

cc: Rick Morrow, Brian Boal, Mazen Wahbeh, Vankatesh Iyer  
file: 05.03.01, 55.0160

**DEPARTMENT OF TRANSPORTATION -Toll Bridge Program**

333 Burma Rd.  
Oakland, CA 94607  
(510) 622-5660, (510) 286-0550 fax



*Flex your power  
Be energy efficient!*

November 12, 2009

Contract No. 04-0120F4  
04-SF-80-13.2 / 13.9  
Self-Anchored Suspension Bridge  
Letter No. 05.03.01-005829

Michael Flowers  
Project Executive  
American Bridge/Fluor, A JV  
375 Burma Road  
Oakland, CA 94607

Dear Michael Flowers,

**Department Audit - Fujibiken Kogyo KK/Japan Steel Works, Ltd.**

In accordance with Section 8-4.01, "Audits," of the Contract Special Provisions, the Department completed an audit of Fujibiken Kogyo KK/Japan Steel Works, Ltd. on October 13, 2009. The facility has demonstrated the capability to perform painting and metallizing of bridge saddles and accordingly has passed the Department Audit.

As discussed and agreed upon at the Audit's exit meeting, the Contractor confirmed that proper paint storage in accordance with the manufacturer's recommendations would be provided.

If you have any questions please contact Nina Choy at (510) 385-5910.

Sincerely,

**<<< ORIGINAL SIGNED >>>**

GARY PURSELL  
Resident Engineer

cc: Rick Morrow  
Brian Boal  
Gary Lai  
Nina Choy  
file: 05.03.01, 55.1274

**DEPARTMENT OF TRANSPORTATION - District 4 Toll Bridge Program**

333 Burma Rd.

Oakland, CA 94607

(510) 622-5660, (510) 286-0550 fax

*Flex your power  
Be energy efficient!*

July 14, 2008

Contract No. 04-0120F4

04-SF-80-13.2 / 13.9

Self-Anchored Suspension Bridge

Letter No. 05.03.01-002360

Michael Flowers  
Project Executive  
American Bridge/Fluor, A JV  
375 Burma Road  
Oakland, CA 94607

Dear Michael Flowers,

**Quality Assurance Testing of Externally Threaded Fasteners**

This letter is issued in response to renewed discussions at the Working Drawing Campus (WDC) and ABF-RFI-001233R04, concerning the Quality Assurance (QA) testing regimen of externally threaded fasteners, nuts and washers (fastener assemblies) for the SAS Project.

Initial discussions concerning the QA sampling requirements took place at the WDC in June 2007 and predominately concentrated on the QA sampling quantity for specialized and large diameter fastener assemblies used on the Cable System and the E2 Bearing and Shear Keys. A spreadsheet quantifying the sample size was provided at that time in draft format for discussion purposes only.

In addition, the Contractor was reminded at these meetings that QA testing of fastener assemblies will be performed pursuant to Standard Specification Section 6-1.01, "Source of Supply and Quality of Materials," and that the sample quantity, per heat, will be in accordance with Contract Special Provision Section 10-1.59, "Steel Structures," subsection "Bolted Connections," as shown below:

Lot Size (No. of Bolts)	Sample Size (No. of Bolts)
2 to 15	3
16 to 25	4
26 to 50	5
51 to 90	7
91 to 150	8
151 to 280	9
281 to 10,000	12
10,001 to 500,000	16
500,001 and over	20

July 14, 2008

Page 2 of 2

The spreadsheet attached to this letter titled "*QA Sampling – Cable System/E2 Bearings & Shear Keys*," modifies the sample size provided above for some of the Cable System and E2 Bearing and Shear Key fastener assemblies. Please provide test samples in accordance with the attachment.

Please contact Brian Boal at (510) 622-5191 should you have any questions.

Sincerely,



GARY PURSELL  
Resident Engineer

Attachment

cc: Rick Morrow  
Brian Boal  
Mark Woods  
Gary Lai  
Venkatesh Iyer  
Ryan Smith  
file: 05.03.01

## QA Sampling - Cable System/E2 Bearings & Shear Keys

Description	Size	Material & Grade	Coating	Dwg Quantity Required	Spare Fasteners	Finished Item (Notes 10, 11, 12)	Material Only (Notes 10 & 13)	Comments
Cable Band Bolts	51mm dia x 610	A354 BC	HD Galv	1260		20	0	30 Bolts are required in addition to those listed in the table per Section 10-1.60 Cable System, for tensile testing & load extension curves
Cable Band Bolts	51mm dia x 710	A354 BC	HD Galv	48	T.B.D. by ABF	1	0	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
Cable Band Anchor Rods	75mm dia x ###	A354 BD	HD Galv	24	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
Tower Saddle Tie Rods	4" dia x ###	A354 BD	HD Galv	24	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
East Saddle Tie Rods	3" dia x ***	A354 BD	HD Galv	18	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
East Saddle Anchor Rods	50mm dia x ***	A354 BD	HD Galv	32	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
West Saddle Tie Rods	1.75" dia x ***	A354 BC	HD Galv	42	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
West Deviation Saddle Anchor Rods	50mm dia x ***	A354 BC	HD Galv	168	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
Jacking Saddle Tie Rods	1.5" dia x ***	A354 BC	HD Galv	8	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
Suspender Socket Anchor Rods - Type I	90mm dia x ***	A354 BC	HD Galv	352	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
Suspender Socket Anchor Rods - Type II	100mm dia x ***	A354 BC	HD Galv	48	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
Tower Suspender Anchor Rod	90mm dia x ***	A354 BC	HD Galv	16	T.B.D. by ABF	Included with Type I Suspender		
E2 Shear Key	76mm dia x ***	A354 BD	HD Galv	192	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
E2 Shear Key	76mm dia x ***	A354 BD	HD Galv	336	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
E2 Bearing	76mm dia x ***	A354 BD	HD Galv	96	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
E2 Bearing	50mm dia x ***	A354 BD	HD Galv	224	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.
Main Cable Anchor Rods	90mm dia x ###	A354 BD	HD Galv	274	T.B.D. by ABF	1	2	In all cases, three (3) samples per heat are required. At the Contractor's option, 3 full size finished items may be furnished.

### Notes/Legend:

1) Quantities for testing are per Lot. (Lot implies same diameter, length, heat, as well as heat treatment batch)

2) The number of samples indicated will be for Caltrans Lab testing.

3) Quantities listed do not take into account re-testing criteria due to failure

4) This list is NOT all inclusive. Items not listed are to follow the sampling size table in Section 10-1.59 "Steel Structures" of the Contract Special Provisions

5) ### = Fastener length varies; length to be determined by ABF's Means & Methods; \*\*\* = Fastener length to be determined by ABF's Means & Methods

6) A354 does not have metric equivalent. All Fastener diameters will be in Imperial. Those shown in Imperial were requested in RFI #278R0 & #281R1. Contract Plans - General Note allows for size substitution as clarified in RFI #65R0

7) ASTM A354 requires that the number of tests conform to ASTM F1470 and performed in accordance with ASTM F606

8) Number of tests/requirements for ASTM F1470 not shown

9) Quantities assume that no ROCAP testing required

10) Quantities provided are ONLY applicable if manufacturer passes Department Audit

11) Finished items shall be fabricated full-size; the Engineer will select one at random, and the fabricator may send to Trans Lab either this sample OR a 1200 mm length cut from a threaded end of the sample.

12) Each Finished item sample shall include the same number of washers, nuts, or similar components that will accompany an item's field installation.

13) "Material Only" denotes a sample 300 mm in length (minimum) which need not be threaded; it shall be from the same rod stock/heat treatment lots as the finished product.

# REQUEST FOR INFORMATION (RFI)

RFI No.: ABF-RFI-001233R04 Submitted By: Gatsos, Levi Pages: 1  
RFI Date: 23-June-2008 Contact Name: Kick, Robert Pages Attached: 0  
Phone No. (510) 808-4571

**Subject:** E2 Bearing and Shear Key Anchor Rod Spherical Washers

**References:**

**Sub/Sup:** DYS **Sub RFI #:**

**Response Required by:** 24-June-2008 **Response affects critical path activity?** Yes

**Description:**

Per WDC discussions, ABF understands the following;

1. The Proof Test Rod Assemblies are not required to be a part of a permanent heat treatment lot and that the heat treatment and galvanizing can be performed at any facility as long as it is in conformance with the contract requirements. Please confirm.
2. Caltrans would like additional QA samples to be provided for each heat treatment lot of E-2 Bearing and Shear Key Rods. Please provide details and quantity of additional samples per rod heat treatment lot.

**Contractor Disposition:**

This RFI is being submitted for:

The Cost and Time Impact from this RFI is: Cost and/or time impacts in the performance of our Work will result.

**Response:**

**Agreed Ext. Due Date:**

**Pages:** 1  
**Pages Attached:** 0

- 1) Contractor's proposal is acceptable.
- 2) For QA testing, the Contractor shall provide the following for each heat treated lot:  
3 – Nuts, washers, and plates  
1 – Test rod sample threaded 300mm on each end. Min.length of 1200mm  
2 – Material rod sample with minimum length of 300mm

The Department will issue a forthcoming letter clarifying QA sampling quantities for the job.

**Administrative Action:**

This response resolves the RFI.

**Date:** 25-June-2008

**Respondent:** Matin, Ron

**Phone No.:** 510-808-4611

# REQUEST FOR INFORMATION (RFI)

RFI No.: ABF-RFI-001631R00 Submitted By: Hester, Daniel Pages: 8  
 RFI Date: 05-February-2009 Contact Name: Sheffield, Pat Pages Attached: 7  
 Phone No. \_\_\_\_\_

<b>Subject:</b> Heat Treatment of A354 Grade BD Material	
<b>References:</b>	
<b>Sub/Sup:</b> DYS	<b>Sub RFI #:</b>
<b>Response Required by:</b> 12-February-2009 <b>Response affects critical path activity?</b>	

## Description:

ABFJV's supplier (The Dyson Corporation) is in the process of procuring ASTM A354 Grade BD material for use on the project. The mill that Dyson is proposing to use for the material (Gerdau-Ameristeel) is also capable of performing the requisite heat treatment and their own facility (Gerdau-Macsteel). The proposed heat treating facility operates a continuous quench & temper line using induction heating technology. Dyson proposes to procure "fully upgraded" materials from Gerdau-Ameristeel in the quenched & tempered condition in accordance with the contract requirements (ASTM A354 Gr. BD). Consequently, Dyson has the following questions:

1. It is understood that an audit would not be required of the mill/heat treatment facility. Please verify Dyson's understanding.
2. Unlike other facilities, Gerdau-Macsteel heat treating operation is "truly continuous". What would be considered as the heat treat "lot size" for mechanical testing purposes?

Please see the attached for information on the heat treatment facility.

## Contractor Disposition:

This RFI is being submitted for:

The Cost and Time Impact from this RFI is: Not selected

## Response:

**Agreed Ext. Due Date:**

**Pages:** 1  
**Pages Attached:** 0

1. Correct, an audit is not required for this mill/heat treatment facility.
2. With the information provided by Gerdau-Macsteel, the heat treatment run would be considered one lot, unless the following occurred during heat treatment:
  - A. An interruption in heat treatment operations,
  - B. The end of a shift or a personnel change,
  - C. A change in the material mill heat.

## Administrative Action:

This response resolves the RFI.

<b>Date:</b> 12-February-2009	<b>Respondent:</b> Brignano, Bob	<b>Phone No.:</b> 510-286-0503
-------------------------------	----------------------------------	--------------------------------



Quench and Temper production lines #1 and #2.

## QUENCH AND TEMPER AT IT'S FINEST

The Heat Treating Division of MACSTEEL had its beginnings nearly twenty-five years ago as a "greenfield" operation in Huntington, Indiana. The location was selected for its proximity to major customer bases and it allowed ample room for future expansion. MACSTEEL engineering carefully analyzed available manufacturing processes then "re-engineered" additional capabilities. The resulting unique quench and temper line was able to achieve the following results:

- 1 Straightness deviations of less than 0.030 inch per 3 ft. of tubing material and 0.125" per 5 ft. of bar material.**
- 2 Rockwell C hardness uniformity of less than 4 points.**
- 3 One-half commercial heat treat tolerances as cited by the (ASTM) American Society Testing and Materials in its A519 specification.**

Today, MACSTEEL's Heat Treating Division has three full quench and temper lines coupled with a host of value-added services. Operators are highly skilled and undergo continual technical training that exceeds typical industry practice. With nearly a quarter century of experience MACSTEEL has taken heat treating from an art to a science.

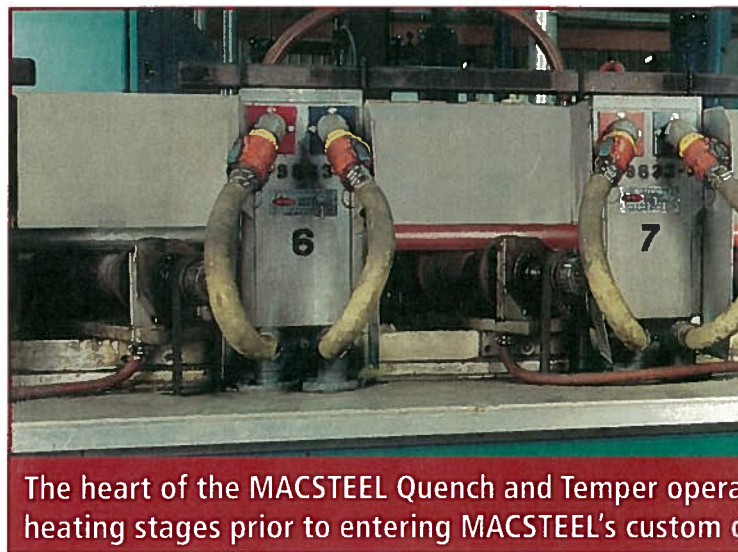
Quench and Temper production line #3.



## WHY MACSTEEL HEAT TREATING?

The Heat Treating Division of MACSTEEL is a complete state-of-the-art facility specializing in technically advanced induction heating for long length bars and tubes.

Value-added support equipment for customized cutting, straightening, tensile testing and metallographic analysis are part of what this unique facility has to offer. Another distinctive attribute of this facility is that it can accommodate long bar from 12 to 35 ft. and tube product from 12 to 60 ft. in length. Customers receive the added benefit of single-source responsibility with an array of technical expertise and support that goes through the complete ranks of MACSTEEL in all their world class production facilities. MACSTEEL is recognized for its state-of-the-art metallurgical services and highly experienced product development support.



The heart of the MACSTEEL Quench and Temper operation: heating stages prior to entering MACSTEEL's custom quench tanks.

## THE REAL ADVANTAGE OF FROM INDUCTION HEATING

### ■ ONE PIECE AT A TIME

Each bar or tube is individually heat treated, ONE BAR AT A TIME. This is better than "batch" heat treating.

### ■ UNIFORM HEATING

Each rotating bar or tube is uniformly heated to a precise temperature through computer controlled induction coils.

### ■ INDIVIDUAL BAR & TUBE QUENCHING

Every bar or tube is individually quenched through a proprietary quench process that achieves optimum transformation kinetics.

### ■ SUPERIOR STRAIGHTNESS

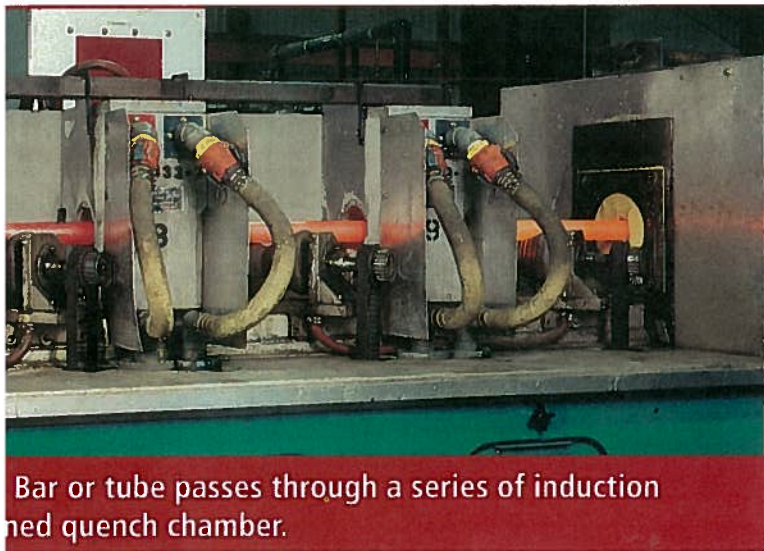
Rotation of individual bars or tubes through the spray quench leads to superior straightness.

## THE STEEL HEAT TREATING PROCESS

Individually, every bar or tube is processed through precision controlled induction heating coils to the optimum hardening temperature. The next step is a proprietary quench that achieves the highest quench factor for the most complete transformation. Induction tempering then provides a uniform structure to meet your strength and hardness requirements.

Full length heat treating of bar and tubing enables MACSTEEL customers to machine distortion-free parts, eliminate production processes and save money.

This is really the essence of what makes MACSTEEL's Heat Treating Division unique and special in today's market place.



Bar or tube passes through a series of induction heated quench chamber.

## QUENCH AND TEMPER (Q&T) MACSTEEL

### ■ STRENGTH AND TOUGHNESS

Each bar and tube transforms to a martensitic structure that is tempered in line to the desired strength and toughness.

### ■ UNIFORM HARDNESS

Every bar and tube has uniform hardness end-to-end, piece-to-piece and order-to-order.

### ■ STRESS FREE & DECARB FREE

Each bar and tube is STRESS FREE, decarb free and ready for your critical part applications.

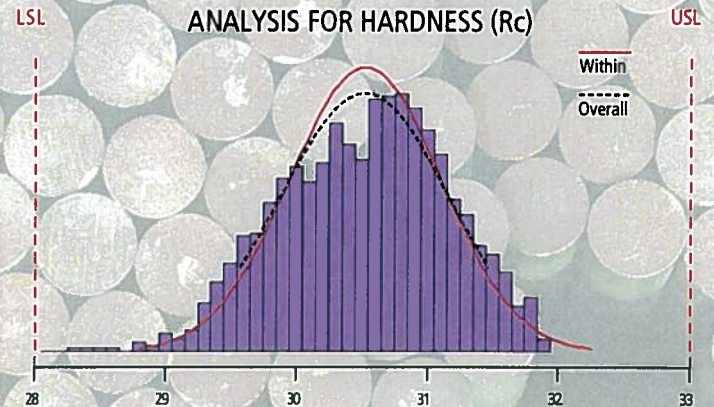
### ■ VALUE-ADDED SERVICES

Orders can be CUSTOM CUT (saw or plasma) for specific product applications along with a host of other available services.

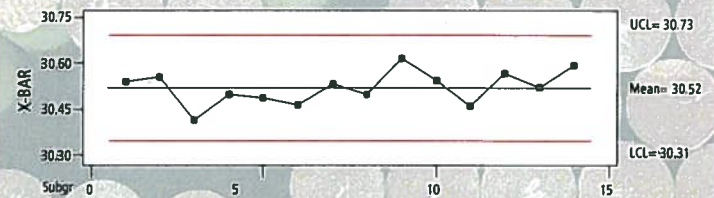
## MACSTEEL Heat Treating Division PROCESS CAPABILITY

(Grade 4145, 1.062" diameter)

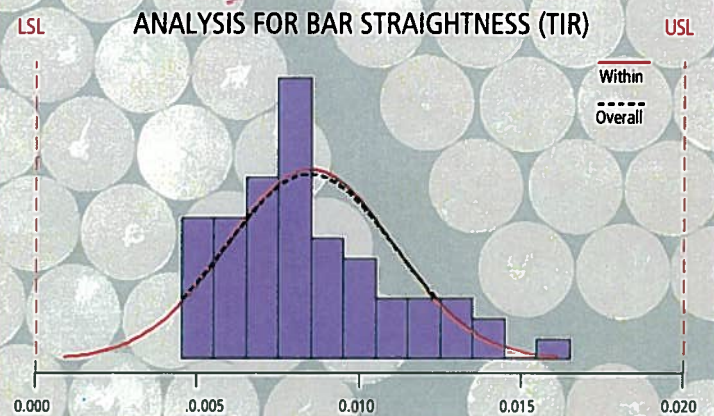
### ANALYSIS FOR HARDNESS (Rc)



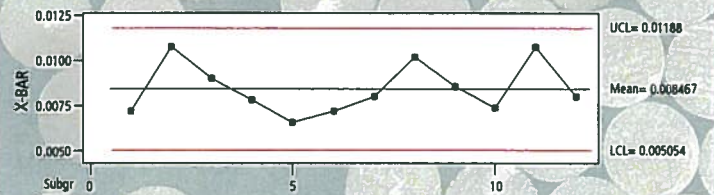
Process Data		Potential (Within) Capability	
USL	33.0000	Cp	2.88
Target	*	CPU	2.86
LSL	28.0000	CPL	2.91
Mean	30.5201	Cpk	2.86
Sample N	1357		
StDev (Within)	0.578314		
StDev (Overall)	0.635911		

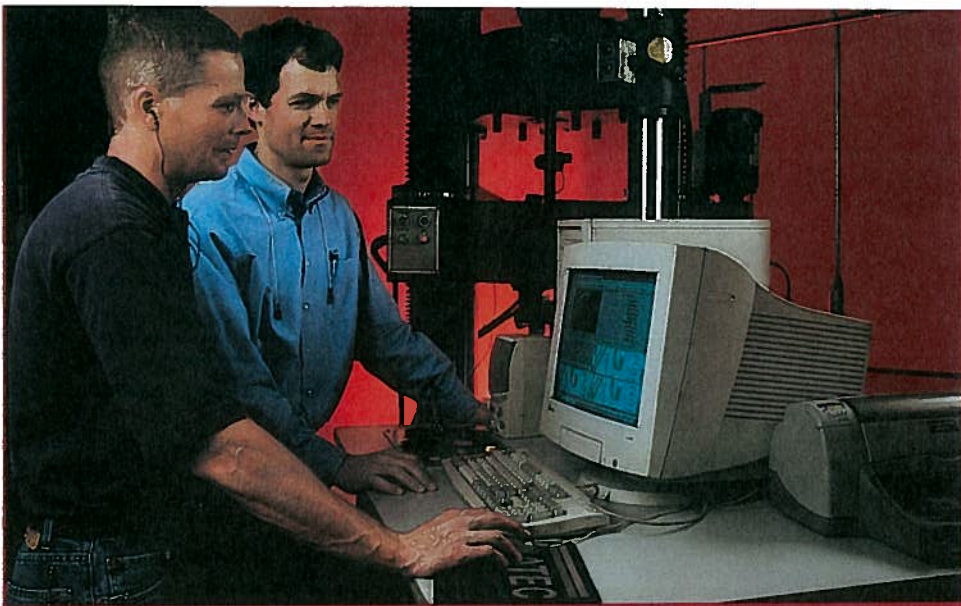


### ANALYSIS FOR BAR STRAIGHTNESS (TIR)



Process Data		Potential (Within) Capability	
USL	0.0200000	Cp	2.62
Target	*	CPU	3.02
LSL	0.0000000	CPL	2.22
Mean	0.0084667	Cpk	2.22
Sample N	60		
StDev (Within)	0.0025437		
StDev (Overall)	0.0026113		





Production Bay #3 Tensile Testing Facility.



Rockwell Hardness Testing.

## QUALITY, CONSISTENCY, DEPENDABILITY

MACSTEEL takes great pride in the quality of its products and in the consistency in which they are delivered. Quality control measures are routine throughout our entire quench and temper process assuring you a reliable product with no need for additionally stress relieving. Also, when MACSTEEL is specified for the raw material as well, you can count on a **stress free and decarb free** product. In any production process a "consistent" quality material is what puts dollars on the bottom line. And that's exactly what you get from the MACSTEEL Heat Treating Division.

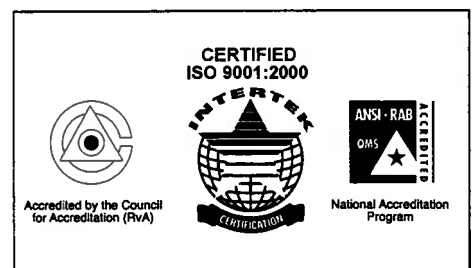
## ASK FOR THE MACSTEEL EXPERTS

Let us help you discover new ways to save on your application with a heat treated product. Our people are ready and eager to help you right from the initial design all the way through the production process. Heat treating before machining is a perfect way for you to machine distortion-free parts and eliminate several production steps, thereby saving bottom-line dollars. Test our capabilities. We're ready to work with you from concept to reality. From long-run OEM contract orders to Steel Service Center conversion work, MACSTEEL Heat Treating Division is ready, willing and more than able.



Brinell Hardness Testing.

Bar exiting MACSTEEL's proprietary quenching chamber.



# SPECIFICATIONS/CAPABILITIES

## GRADES TREATED

- All heat treatable grades of carbon, alloy, and stainless steels.

## HEAT TREATMENTS

- Quench & Temper
- Thru-hardening
- Surface hardening
- Normalizing
- Stress Relief Annealing

## BAR PRODUCTS

- Hot Finished or Cold Finished
- Size range—0.875" to 4.125"
- Hex Shape (Inquire)

## TUBULAR PRODUCTS

- Welded or DOM
- Hot Finished Seamless
- Cold Drawn Seamless
- Size range—0.75" to 6.25" O.D.

## LENGTH CAPACITY

- BAR—12 ft. to 35 ft.
- TUBE—12 ft. to 60 ft.
- Max. weight per piece—2000 lb.

## STRAIGHTNESS TOLERANCES

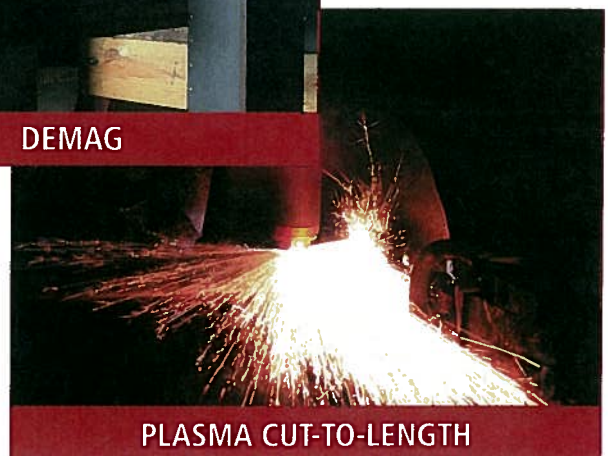
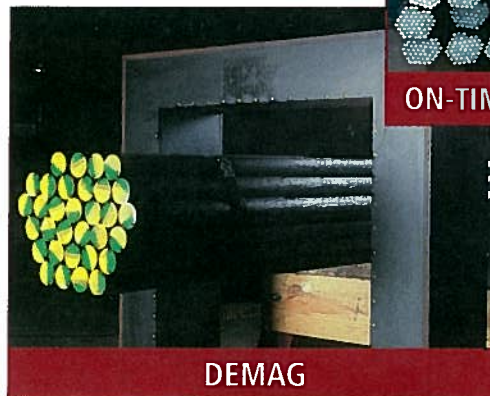
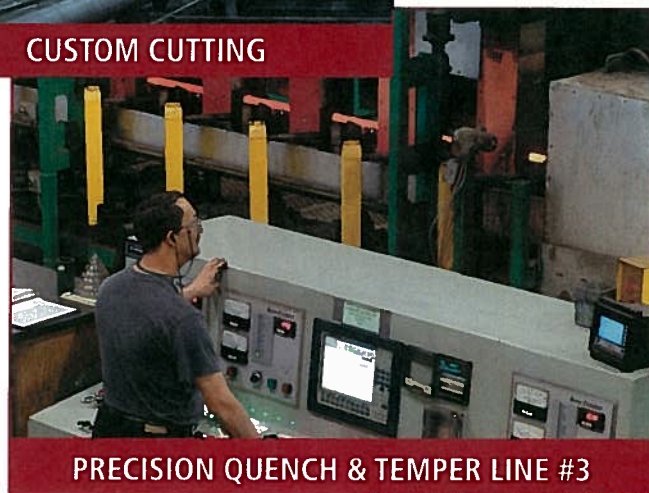
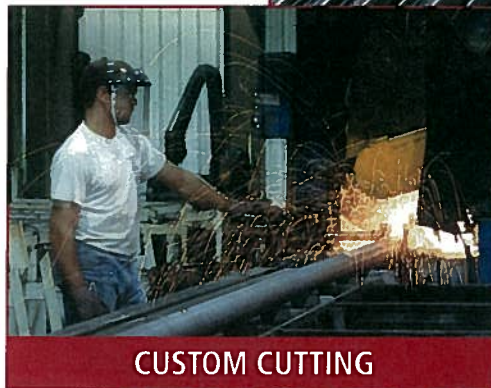
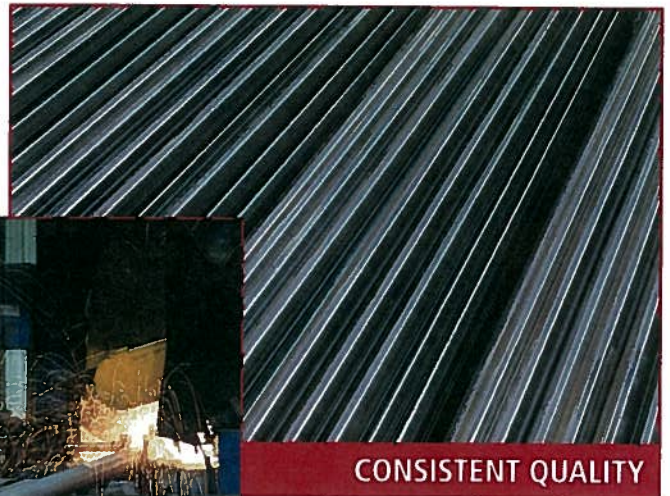
- BAR—0.125" per 5 ft.
- TUBE—0.030" per 3 ft.

## CUTTING

- Close tolerance custom cutting...saw and plasma
- Cut to length for product applications

## OTHER VALUE-ADDED SERVICES

- |                              |   |
|------------------------------|---|
| ■ Demagnetization            | ■ Stenciling/color coding                 |
| ■ Chamfering                 | ■ Experimental or trial orders encouraged |
| ■ Metallurgical support      | ■ Short lead times                        |
| ■ Complete traceability      | ■ On-time, all-the-time delivery          |
| ■ Complete test reports      | ■ Overseas packaging available            |
| ■ Small quantities available |   |
| ■ Hex bundling               |   |



## TYPICAL APPLICATIONS



- Automotive drivetrains & suspensions
- Automotive safety appliances
- Axle tubing
- Bolting stock
- Motor shafting
- Off-road equipment
- OCTG high pressure casing & tubing
- Oil country accessories



- Construction equipment
- Crane booms
- Farm equipment machinery
- Gun barrels
- King pins
- Machinery
- Perforator guns
- Screw machine parts
- Stabilizer bars
- Torsion bars
- Truck & Trailers



**GERDAU MACSTEEL**  
**HEAT TREAT**

25 Commercial Road • Huntington, IN 46750 • 260-356-9520 • Fax 260-356-9522  
[www.gerdaumacsteel.com](http://www.gerdaumacsteel.com)

Registered trademark of MACSTEEL.  
NSI 0903-5M Printed in U.S.A.



25 Commercial Road  
Huntington, IN 46750  
(219) 356-9520  
Direct (219) 355-2202  
Fax (219) 356-9522  
Dmelchi@Gerdaumacsteel.com

February 5, 2009

Dyson Corp.  
Attn: Mr. Pat Sheffield  
53 Freedom Road  
Painesville, OH 44077

Subject: Single bar processing vs. batch processing

Dear Mr. Sheffield:

Thank you for allowing me to give a brief overview of our Induction quench and temper heat treating lines. We will receive your material/order for processing at our facility in Huntington Indiana. Your material will be assigned a unique mill order number for our internal tracking. The material will then be run when it is received "complete".

Material is placed on the inlet table and the line is adjusted appropriately for the material size. A three piece sample run will be made and the material qualified for hardness and mechanical properties. After qualifications process is completed we will run the order in its entirety. The material will be run in a bale for bale fashion to maintain traceability. The bars will be processed one-after-another for the entire order. No separate batches will be made or will be distinguishable. In-process checks will be made at the front, middle and back of the material run to validate material specifications. A material sample will be procured for submission to an outside laboratory for any Charpy Impact testing requirements. Material will exit the line and drop into an exit bunk. The material bales will be taken to the finishing operation for further work.

The induction heat treat line consists of 9-18 induction coils for austenitizing. The induction equipment is a minimum of a 1 MWatt unit operating at a nominal 3 KHz. The material is conveyed individually through the coils on skewed rolls for uniform heating and adequate support. The material is butted together on the roll conveyor to provide for uninterrupted heating. The temperature of the material is measured using an infrared pyrometer and recorded for traceability to the order.

The material moves into a robust water quench for superior transformation into martensite. The high pressure spray system is applied to each individual bar in a uniform matter. Each bar sees the same quenching as the material is conveyed through the quench. The uniform quenching is what produces outstanding straightness control.

The Tempering of the bar is then carried out on the bar with the use of induction coils. The individual bars are conveyed through 7-14 induction coils from an 850kWatt inverter operating at a nominal 1 KHz. The material continues to be conveyed on skewed rolls with precision speed control. The tempering temperature is monitored with pyrometers.

Quench and tempered material is rolled off the line onto a cooling table where the material can cool in air. A chain drive will index material across the table. The material will finally exit into a bunk.

The finishing operation will trim two inches of material from each end of the bar. The direct bar ends are harder due to some heat loss during tempering. The cut bars will be chamfered and placed on an inspection table. Each individual bar will be checked for straightness, size. Steel stamping identification of the heat number and any color coding necessary will be applied. Material is tallied and packed for shipment.

If you have any questions or comments, please feel free to contact me on this matter.

Sincerely,

Doug Melchi  
Metallurgist

# KREHER STEEL COMPANY, LLC.

## THE DYSON CORPORATION

LOT ROLLED ROUNDS 4140  
1.0000 X 24' 3"  
PART NO.

PO/Rel 69142

I hereby certify that this data is correct as  
contained in the records of this company.  
I hereby certify that no mercury came in contact

### Certificate of Mill Test Results

SO 1 -189220-001

10Nov09

with or no weld repair was done to this product  
while in our possession.

Pg 1/2



# GERDAU MACSTEEL

CODE NHE 9

5591 MORRILL ROAD  
JACKSON, MICHIGAN 49201

### CERTIFIED MATERIAL TEST REPORT

CUSTOMER ORDER NUMBER	CUSTOMER PART NUMBER	HEAT NUMBER	WORK ORDER NUMBER	DATE
20266	5324	M34065	232213 101	10/23/09

#### REPORT TO

ERIN  
KREHER STEEL

1550 N. 25TH AVE

MELROSE PARK , IL 60160

#### SHIP TO

KREHER STEEL

1550 N. 25TH AVE.

MELROSE PARK , IL 60160

### ORDERED

GRADE	SIZE	LENGTH
4140	2" RND	24' 3"

#### CUSTOMER SPECIFICATIONS

ASTM A29/A29M-05; A322-07; E381-01

### CHEMICAL ANALYSIS

C	Mn	P	S	Si	Ni	Cr	Mo	Cu	Sn	Al
0.41	0.86	0.015	0.020	0.26	0.14	0.93	0.17	0.21	0.010	0.032
V	Nb									
0.006	0.002									

GRAIN SIZE

SPECIFICATION ASTM E112

FINE GRAIN 5-8

HARDENABILITY

SPECIFICATION ASTM A255/A304

#### THEORETICAL

J1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	20	22	24	26	28	30	32	34
57	57	57	57	57	57	56	54	53	51		49		47		45	44	43		41		39		37	

MACROCLEANLINESS

SPECIFICATION ASTM E381

#### PLATE I

#### PLATE II

	S	R	C
FRONT	1	1	1
MIDDLE	1	1	1

PAGE 1

We certify that these data are correct and in compliance with specified requirements.	
Gerda MacSteel Monroe 3000 East Front Street Monroe, MI 48111	Chris Easter

CONTINUED ON PAGE 2

B212-018-10

NHE 2

# KREHER STEEL COMPANY, LLC.

THE DYSON CORPORATION

PO/Rel 69142

10T ROLLED ROUNDS 4140

2.0000 X 24" 3"

'ART NO.

I hereby certify that this data is correct as  
contained in the records of this company.  
I hereby certify that no mercury came in contact

## Certificate of Mill Test Results

SO 1 -189220-001

10Nov09

with or no weld repair was done to this product  
while in our possession.  
Atto:

Pg 2/2



# GERDAU MACSTEEL

CODE NHE 9

5591 MORRILL ROAD  
JACKSON, MICHIGAN 49201

### CERTIFIED MATERIAL TEST REPORT

CUSTOMER ORDER NUMBER	CUSTOMER PART NUMBER	HEAT NUMBER	WORK ORDER NUMBER	DATE
20266	5324	M34065	232213 101	10/23/09

#### REPORT TO

ERIN  
KREHER STEEL

1550 N. 25TH AVE

MELROSE PARK , IL 60160

#### SHIP TO

KREHER STEEL

1550 N. 25TH AVE.

MELROSE PARK , IL 60160

### ORDERED

GRADE	SIZE	LENGTH
4140	2" RND	24' 3"

#### CUSTOMER SPECIFICATIONS

ASTM A29/A29M-05; A322-07; E381-01

BACK 1 1 1  
AVERAGE 1 1 1

NONE

#### REDUCTION RATIO

RATIO= 11.5 TO 1.0

\*\* MATERIAL 100% MELTED AND MANUFACTURED IN THE U.S.A. BY THE ELECTRIC  
ARC FURNACE AND CONTINUOUS CASTING METHOD. THE PRODUCT HAS NOT  
BEEN REPAIRED BY WELDING AND THIS MATERIAL HAS NOT BEEN EXPOSED  
TO MERCURY OR TO ANY OTHER METAL ALLOY THAT IS LIQUID AT AMBIENT  
TEMPERATURES DURING PROCESSING OR WHILE IN OUR POSSESSION. \*\*

PAGE 2 OF 2

We certify that these data are correct and in compliance with specified requirements.	
Gerda MacSteel Monroe 3000 East Front Street Monroe, MI 48166	Chris Easter

6212-01970

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave.St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 76.15**SOURCE INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-001617**Date Inspected:** 06-Jan-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1700**Contractor:** Dyson Corp. & Subs**Location:** Painesville, Ohio**Quality Control Contact:** Bob Bobnar**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:** N / A**Bridge No:** 34-0006**Component:** See below**Bid Item:** See below**Lot No:** See below**Summary of Items Observed:**

The Caltrans Quality Assurance (QA) Inspector Scott Croff was present at Dyson Corp in Painesville, Ohio, to observe the fabrication of components that will be used in the San Francisco / Oakland Bay Bridge (SFOBB) project.

The QA Inspector was requested to release suspender socket components [bid item 68 (s-f)] to WireCo. The QA Inspector verified that check samples have been tested by TransLab and found satisfactory for use. The QA Inspector reviewed the contractor's Certificates of Compliance (C.O.Cs) and shipping documentation. The QA Inspector also made random observations of the materials as it was presented / palletized for shipping. The QA Inspector noted that the material and documentation appeared to be in general compliance with the contract requirements. The QA Inspector issued green tags and TL-6011 reports with lot numbers B212-001-10, B212-002-10 and B212-003-10 for the material releases. See the accompanying TL-6011 reports for specific information.

During this shift, the QA Inspector also noted that Dyson personnel are machining / fabricating components for: bid item 45 (s), bid item 59 (s-f), bid item 61 (s-f) and bid item 68 (s-f). The QA Inspector made general observations of the milling, machining and threading of the various components (rods, bolts, nuts, washers). The QA Inspector noted that all observed work appeared to be performed to commonly accepted industry standards and procedures.

The QA Inspector was informed that tomorrow, Jan. 7th, 2010, a Stork-Herron technician will be present to conduct Magnetic Particle Testing (MT) on fabricated components for bid item 61. There were no other notable

---

## SOURCE INSPECTION REPORT

( Continued Page 2 of 2 )

---

observations made during this shift.

### Summary of Conversations:

See above.

### Comments

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy, (510) 385-5910, who represents the Office of Structural Materials for your project.

---

<b>Inspected By:</b>	Croff, Scott	Quality Assurance Inspector
<b>Reviewed By:</b>	Levell, Bill	QA Reviewer

---

**DEPARTMENT OF TRANSPORTATION**

DIVISION OF ENGINEERING SERVICES

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave.St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 76.15**SOURCE INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-001624**Date Inspected:** 11-Jan-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1700**Contractor:** Dyson Corp. & Subs**Location:** Painesville, Ohio**Quality Control Contact:** Bob Bobnar**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:****Bridge No:** 34-0006**Component:** See below**Bid Item:** See below**Lot No:** See below**Summary of Items Observed:**

The Caltrans Quality Assurance (QA) Inspector Scott Croff was present at Dyson Corp in Painesville, Ohio, to observe the fabrication of components that will be used in the San Francisco / Oakland Bay Bridge (SFOBB) project.

The QA Inspector met with Dyson Quality Control Manager (QCM) Bob Bobnar and Art Galvanizing Manager Adrienne Klein, at Art Galvanizing in Cleveland, Ohio. The QA Inspector witnessed galvanizing in progress on type 1 suspender socket anchor rods bid item 68 (s-f). The QA Inspector also components that have been galvanized. The QA Inspector witnessed Dyson QCM measure the mil thickness of the zinc coating on the galvanized components. The QA Inspector was requested to green tag release the galvanized parts back to Dyson Corp. The QA Inspector made random observations of the components and documentation and noted that they appear to be in general compliance with the contract requirements. The QA Inspector issued green tags and TL-6011 reports with lot numbers B212-005-10 and B212-006-10 for the material releases. See the accompanying TL-6011 reports for specific information.

The QA Inspector and Dyson QCM returned to Dyson where the QA Inspector noted that Dyson personnel are machining / fabricating components for: bid item 45 (s), bid item 59 (s-f), bid item 61 (s-f) and bid item 68 (s-f). The QA Inspector made general observations of the milling, machining and threading of the various components (rods, bolts, nuts, washers). The QA Inspector noted that all observed work appeared to be performed to commonly accepted industry standards and procedures. There were no other notable observations during this shift.

---

## SOURCE INSPECTION REPORT

( Continued Page 2 of 2 )

---



### Summary of Conversations:

The QA Inspector had conversations with the QA Inspector Craig Hager. The QA Inspector Craig Hager was given a general status update for materials / machining / galvanizing being performed at Dyson and sub-contractor's facilities. The QA Inspector also spoke with the Structural Materials Representative (SMR) Kit Guest. The SMR was informed of the equipment / testing set-up at Dyson for hardness testing of materials. The QA Inspector also relayed this information to the SMR Nina Choy. There were no other notable conversations during this shift.

### Comments

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy, (510) 385-5910, who represents the Office of Structural Materials for your project.

---

**Inspected By:** Croff, Scott

Quality Assurance Inspector

---

**Reviewed By:** Levell, Bill

QA Reviewer

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave.St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 76.15**SOURCE INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-001625**Date Inspected:** 12-Jan-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1700**Contractor:** Dyson Corp. & Subs**Location:** Painesville, Ohio**Quality Control Contact:** Bob Bobnar**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:****Bridge No:** 34-0006**Component:** See below**Bid Item:** See below**Lot No:** N / A**Summary of Items Observed:**

The Caltrans Quality Assurance (QA) Inspector Scott Croff was present at Dyson Corp in Painesville, Ohio, to observe the fabrication of components that will be used in the San Francisco / Oakland Bay Bridge (SFOBB) project.

The QA Inspector met with Dyson Quality Control Manager (QCM) Bob Bobnar. The QA Inspector and Dyson QCM noted that Dyson personnel are machining / fabricating components for: bid item 45 (s), bid item 59 (s-f), bid item 61 (s-f) and bid item 68 (s-f). The QA Inspector made general observations of the milling, machining and threading of the various components (rods, bolts, nuts, washers). The QA Inspector noted that all observed work appeared to be performed to commonly accepted industry standards and procedures.

The QA Inspector reviewed contract documents and reports. There were no other notable observations or conversations during this shift.

**Summary of Conversations:**

See above.

**Comments**

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy, (510) 385-5910, who represents the Office of Structural Materials for your project.

---

## SOURCE INSPECTION REPORT

( Continued Page 2 of 2 )

---

---

<b>Inspected By:</b>	Croff, Scott	Quality Assurance Inspector
<b>Reviewed By:</b>	Levell, Bill	QA Reviewer

---

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave.St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 76.15**SOURCE INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-001626**Date Inspected:** 13-Jan-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1700**Contractor:** Dyson Corp. & Subs**Location:** Painesville, Ohio**Quality Control Contact:** Bob Bobnar**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:****Bridge No:** 34-0006**Component:** See below**Bid Item:** See below**Lot No:** See below**Summary of Items Observed:**

The Caltrans Quality Assurance (QA) Inspector Scott Croff was present at Dyson Corp in Painesville, Ohio, to observe the fabrication of components that will be used in the San Francisco / Oakland Bay Bridge (SFOBB) project.

The QA Inspector met with Dyson Quality Control Manager (QCM) Bob Bobnar and was requested to release suspender socket components [bid item 68 (s-f)] to Art Galvanizing. The QA Inspector reviewed the Certificate of Compliance (C.O.C) and shipping documentation and noted that additional machining will be performed after hot dip galvanizing of the components. The QA Inspector also made random observations of the materials as it was presented. The QA Inspector noted that the material and documentation appeared to be in general compliance with the contract requirements. The QA Inspector issued a green tag with lot number B212-007-10. The QA Inspector was informed that the material will be shipped to Art Galvanizing in Cleveland, Ohio, for hot dip galvanizing. See the accompanying TL-6011 report for specific information. See the attached photo.

The QA Inspector met with the Dyson QCM and Art Galvanizing Manager Adrienne Klein, at Art Galvanizing in Cleveland, Ohio. The QA Inspector was presented with galvanized components that will be returned to Dyson Corp for additional work. The QA Inspector witnessed the Dyson QCM measure the mil thickness of the zinc coating on the galvanized components. The QA Inspector was requested to green tag release the galvanized parts back to Dyson Corp. The QA Inspector made random observations of the components and documentation and noted that they appear to be in general compliance with the contract requirements. The QA Inspector issued a green tag and TL-6011 report with lot number B212-008. See the accompanying TL-6011 report for specific information.

---

## SOURCE INSPECTION REPORT

( Continued Page 2 of 2 )

---

The QA Inspector and the Dyson QCM returned to Dyson, where the QA Inspector was requested to release 4" x 775mm type 1 suspender socket components [bid item 68 (s-f)] to WireCo. The QA Inspector verified that check samples have been tested by TransLab and found satisfactory for use. The QA Inspector reviewed the contractor's Certificates of Compliance (C.O.Cs) and shipping documentation. The QA Inspector also made random observations of the materials as it was presented / palletized for shipping. The QA Inspector noted that the material and documentation appeared to be in general compliance with the contract requirements. The QA Inspector issued a green tag and TL-6011 report with lot number B212-009-10 for the material release. See the accompanying TL-6011 report for specific information.

The QA Inspector also noted that Dyson personnel are machining / fabricating components for: bid item 45 (s), bid item 59 (s-f), bid item 61 (s-f) and bid item 68 (s-f). See the attached photo. There were no other notable observations made during this shift.



### Summary of Conversations:

See above.

### Comments

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy, (510) 385-5910, who represents the Office of Structural Materials for your project.

---

<b>Inspected By:</b>	Croff, Scott	Quality Assurance Inspector
<b>Reviewed By:</b>	Levell, Bill	QA Reviewer

---

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave. St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 76.15**SOURCE INSPECTION REPORT****Resident Engineer:** Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-001628**Date Inspected:** 14-Jan-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1700**Contractor:** Dyson Corp. & Subs**Location:** Painesville, Ohio**Quality Control Contact:** Bob Bobnar**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:****Bridge No:** 34-0006**Component:** See below**Bid Item:** See below**Lot No:** B212-010-10**Summary of Items Observed:**

The Caltrans Quality Assurance (QA) Inspector Scott Croff was present at Dyson Corp in Painesville, Ohio, to observe the fabrication of components that will be used in the San Francisco / Oakland Bay Bridge (SFOBB) project.

The QA Inspector met with Dyson Quality Control Manager (QCM) Bob Bobnar and was requested to release east saddle anchor rod components [bid item 59 (s-f)] to Art Galvanizing. The QA Inspector reviewed the Certificate of Compliance (C.O.C) and shipping documentation and noted that additional machining will be performed after hot dip galvanizing of the components. The QA Inspector also made random observations of the materials as it was presented. The QA Inspector noted that the material and documentation appeared to be in general compliance with the contract requirements. The QA Inspector issued a green tag with lot number B212-010-10. The QA Inspector was informed that the material will be shipped to Art Galvanizing in Cleveland, Ohio, for hot dip galvanizing. See the accompanying TL-6011 report for specific information.

The QA Inspector also noted that Dyson personnel are machining / fabricating components for: bid item 45 (s), bid item 59 (s-f), bid item 61 (s-f) and bid item 68 (s-f). There were no other notable observations made during this shift.

**Summary of Conversations:**

See above.

**Comments**

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or

---

## SOURCE INSPECTION REPORT

( Continued Page 2 of 2 )

---

remedial efforts please contact Nina Choy, (510) 385-5910, who represents the Office of Structural Materials for your project.

---

<b>Inspected By:</b>	Croff, Scott	Quality Assurance Inspector
<b>Reviewed By:</b>	Levell, Bill	QA Reviewer

---

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch

690 Walnut Ave.St. 150

Vallejo, CA 94592-1133

(707) 649-5453

(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 76.8**COMPONENT MATERIAL INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** CMI-000160**Date Inspected:** 14-Jan-2010**Contractor:** Dyson Corp. & Subs**Location:** Painesville, Ohio**Bridge No.:** 34-0006**OSM Arrival Time:** 900**OSM Departure Time:** 1700**Component:#** Bridge saddle bolt components

The following material has been inspected in accordance with Section 6 of the Standard Specifications at the above location. At this point in the fabrication process it appears to comply with contract plans and specifications.

To be shipped to the following vendor or locations: Art Galvanizing, Cleveland, Ohio

Lot #	Bid Item #	Quantity		Material Description
B212-010-10 59		115	ea	2.0" - 4UNC-2B A563 heavy hex nuts - heat/lot - DCNJ2
B212-010-10 59		36	ea	2.0" - 4UNC-2A x 800mm long A354 BD East saddle anchor rods - heat/lot - NHE9

**Identification:** Green tags were attached to the Certificates of Compliance / Shipping packages.**Summary of Items Observed:**

The QA Inspector reviewed the contractor's Certificate of Compliance (C.O.C) and shipping documentation. The QA Inspector also made random observations of the materials as it was presented. The QA Inspector noted that the material and documentation appeared to be in general compliance with the contract requirements. The QA Inspector issued a green tag with lot number B212-010-10. The QA Inspector was informed that the material will be shipped to Art Galvanizing in Cleveland, Ohio, for hot dip galvanizing and that additional work / machining will be performed on the components when they are returned to Dyson Corp.

**Summary of Conversations:**

See above.

**Comments**

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy, (510) 385-5910, who represents the Office of Structural Materials for your project.

**Inspected By:** Croff, Scott

Quality Assurance Inspector

**Reviewed By:** Levell, Bill

QA Reviewer

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave.St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 76.15**SOURCE INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-001632**Date Inspected:** 19-Jan-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1700**Contractor:** Dyson Corp. & Subs**Location:** Painesville, Ohio**Quality Control Contact:** Bob Bobnar**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:****Bridge No:** 34-0006**Component:** See below**Bid Item:** See below**Lot No:** See below**Summary of Items Observed:**

The Caltrans Quality Assurance (QA) Inspector Scott Croff was present at Dyson Corp in Painesville, Ohio, to observe the fabrication of components that will be used in the San Francisco / Oakland Bay Bridge (SFOBB) project.

The QA Inspector was requested to select bid item # 59 (s-f) check samples that will be sent to TransLab. The QA Inspector reviewed the contractor's Certificates of Compliance (C.O.C.s) and shipping documentation. The QA Inspector also made random observations of the materials as it was presented. The QA Inspector reviewed the contract requirements and State Letter 05.03.01-002360 and selected the material / parts to be sampled. The QA Inspector noted that the material and documentation appeared to be in general compliance with the contract requirements. The QA Inspector issued TL-101 # C642636 with lot # B212-018-10 and a TL-102 sample form for the 2" east saddle anchor rod components. See the accompanying TL-101 and TL-102 for specific information. The samples were put onto a pallet for shipment to TransLab. See the attached photo.

The QA Inspector noted that Dyson personnel are machining / fabricating components for: bid item 45 (s), bid item 61 (s-f) and bid item 68 (s-f). The QA Inspector made general observations of the milling, machining and threading of the various components (rods, bolts, nuts, washers). The QA Inspector noted that all observed work appeared to be performed to commonly accepted industry standards and procedures. See the attached photo.

The QA Inspector was informed that the check samples will be next day air shipped to TransLab. The QA Inspector relayed this information and the TL-102 sample form to the QA Inspector Bill Levell. The QA Inspector also relayed the shipping status to the Structural Materials Representatives (SMRs) Nina Choy and Kit Guest.

---

## SOURCE INSPECTION REPORT

( Continued Page 2 of 2 )

---

There were no other notable observations or conversations.



### Summary of Conversations:

See above.

### Comments

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy, (510) 385-5910, who represents the Office of Structural Materials for your project.

---

**Inspected By:** Croff, Scott

Quality Assurance Inspector

---

**Reviewed By:** Levell, Bill

QA Reviewer

State of California  
Department of Transportation

**Structural Materials Testing Laboratory**  
**5900 Folsom Boulevard, Sacramento, CA 95819**



**TEST REPORT**



CERTIFICATE NO. 2364.01

Remarks

ref: ASTM A354, A563, F436, A153, TM03. Bolt Lot #NHE9, Heat #M34065; Nut Lot #DCNJ2, Jam Nut Lot #DCNJ3, Washer Lot #NAQ2

Sample No: SM-10-0063

Date Sampled: 01/19/10

Date Rec'd: 01/20/10

Date Reported: 01/29/10

Lot No: B21201810

TL-101 / SIC No: C642636

Contract/Permit No: 04-0120F4

Material: 2"x 800mm A354 Grade BD HDG Anchor Bolts w/ Nuts & Washers

Manufacturer: Dyson

Sampler: Scott Croff

2-1-10

Results: SAMPLES SUBMITTED ARE SATISFACTORY FOR USE

SOURCE	DISTRICT	E.A.	SUB JOB	SPECIAL DESIGNATION	OBJECT
59318	04	0120F3			1270

STATE OF CALIFORNIA, DEPARTMENT OF TRANSPORTATION  
SAMPLE IDENTIFICATION CARD  
TL-0101 (REV. 10/97)

1/20/10 SM-10-0063  
CARD NUMBER C642636

<input type="checkbox"/> PRELIMINARY TESTS <input type="checkbox"/> PROCESS TESTS <input checked="" type="checkbox"/> ACCEPTANCE TESTS <input type="checkbox"/> INDEPENDENT ASSURANCE TESTS	SAMPLE SENT TO: <input type="checkbox"/> HDQTRS. LAB <input type="checkbox"/> BRANCH LAB <input type="checkbox"/> DIST. LAB SHIPMENT NO. AUTHORIZATION NO.	FIELD NO. DIST. LAB NO. LOT NO. B212-018-10 P.O. OR REQ. NO.
--	---	---

SAMPLE OF East Saddle Anchor Rods / Nuts / Washers  
FOR USE IN SAs Bridge Saddle Bid # 59

SAMPLE FROM 3 rods from Heat-Treat Lot, 8 Full Nuts  
5 Jam nuts and 5 washers

DEPTH

LOCATION OF SOURCE Fabricator, Perrinville, Ohio

THIS SAMPLE IS SHIPPED IN 1 pallet	AND IS ONE OF A GROUP OF	SAMPLES REPRESENTING (TENS, BARS, BILLS, ETC.)
OWNER OR MANUFACTURER Dyson Corp	TEST RESULTS DESIRED	DATE NEEDED
TOTAL QUANTITY AVAILABLE 36	<input type="checkbox"/> NORMAL <input checked="" type="checkbox"/> PRIORITY	
REMARKS ASTM A354 grade BD HDG 2"-4.5 UNC-2A 800 mm 100% Rods 2"-4.5 UNC-2B A563 DH Full 8 Jam and F436 washers Rods sampled per State letter 05-03-01-002360. Nuts/Washers per Special previous		

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLED 1.19.10

BY S. CRUFF TITLE QA Inspector

DIST. CO. RTE. PM 04 SF/ALA 80 13.2/13.9

LIMITS

CONT. NO. 04-0120F4

FED. NO.

RES. ENGR. OR Supt. Gary Pursell

ADDRESS

CONTRACTOR Dyson/ABF

ENCLOSE WITH SAMPLE

Lab Manager

Quality Manager

Print

10 vvvv

Caltrans Test Number:		0		Field Inspectors Fastener Assembly Sampling Sheet									
Date Sampled:	1/19/2010	Contractor:		Dyson Corp		Bid Item No.:		59					
Contract:	04-0120F4	Location Sampled:		Painesville, Ohio		Contact:		Bob Bobnar					
CT Lot No.	B212-018-10	Sampled By:		Scott Croff		Sampler's Title:		QA Inspector					
R. E.'s Name:	Gary Pursell	Inspectors Office:		Vallejo, CA		Phone #:		858-200-6007		Fax #:		707-552-7758	
R. E.'s Address:	333 Burma Road					Co.:		SF		Rt.:		80	
City St. Zip:	Oakland, CA 94607					Date Released:				Ship To:			
						Identification:				File Loc.:		76.32 .09	
Sample No.		1	2	3	4	5	6	7	8	9	10		
Assembly or Rocap No.	NHE9												
Quantity Available	36												
Number of Samples	3												
Bolt Manufacture	Dyson												
Heat Number	M34065												
Mfg. Lot Number	NHE9												
Grade/Description	A354 BD												
Size	2"x800mm												
Finish	A153 HDG												
Verify Test Reports	yes												
Pass/Fail	Pass												
Nut Manufacture	Dyson												
Heat Number	M653560												
Mfg. Lot Number	DCNJ2 / 3												
Grade	A563 DH												
Finish	A153 HDG												
Verify Test Reports	yes												
Pass/Fail	Pass												
Washer Manufacture	Prestige												
Heat Number	0179412												
Mfg. Lot Number	NAQ2												
Grade	F436-1												
Finish	A153 HDG												
Verify Test Reports	yes												
Pass/Fail	Pass												
Notes:	East Saddle Anchor Rod assemblies - no rocap testing performed												
	Nuts / Washers sampled per special provisions table, rods sampled per S.L. 05.03.01-002360												
	TL-101 # C642636 also sent with samples.												
Note to TL-29:	listed rods and supporting documents. The samples were randomly drawn from the available quantities an												



**.505 SAMPLES**



Department of Transportation  
Structural Materials Testing Laboratory  
UTM: BALDWIN 60 Kip

SM Number = 10-0063

Sample	Heat Number	Diameter (in)	Area (in <sup>2</sup> )	Stress at Offset (psi)	Tensile Strength (psi)	Elongation in 4 x d (%)	Tested By
065A	M34065	0.494	0.1917	132218	153770	14.1	FSaylor
065B	M34065	0.502	0.1979	142024 OK	160440 OK	15.7 OK	FSaylor

S. M. NO. 10-0063	DATE RECEIVED 1/28/10
T 101 NO. C642636	CONT. , W.O., OR P.Q. NO. 04-0120474
LOT NO. B21201810	F.A.P. NO.

TEST NAME	DISTRICT	COUNTY	ROUTE	POST MILES
CONTRACTOR	SAMPLED BY		DATE SAMPLED	SUPPLY SOURCE
AGENCY	MANUFACTURER		MATERIAL TESTED FOR	

[illegible]

REMARKS

A354 GR BD

DATE TESTED

1850

TESTED BY

FILED S

APPROVED BY \_\_\_\_\_

TEST SPECIMEN PREPARATION  
AND RECORD

APPROVED FOR USE BY SMTL  
QUALITY MANAGER: *B. B. B.*

SM No.  
10-0063

Contract No.  
04-0120F4

Requesting Lab Technician  
F Saylor

Date Needed  
normal

TL-0101 No.  
C642636

E.A./Spec. Desg./Object  
04-0120F3

Date Received  
1/20/10

Date Tested/Provided  
1/27/10

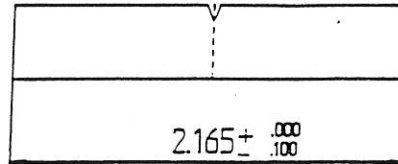
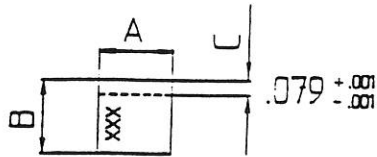
<input checked="" type="checkbox"/> Machine Shop Work Requested <input checked="" type="checkbox"/> standard round tension test specimen, circle one: 0.500" 0.350" 0.250" <input type="checkbox"/> standard rectangular tension test specimen, circle one: 18" long, 8" gage length 8" long, 2" gage length <input type="checkbox"/> Charpy, circle one: 10mm x 10mm 10mm x 7.5mm <input checked="" type="checkbox"/> hardness measurement sample (fasteners) <input type="checkbox"/> weld nugget <input type="checkbox"/> chemistry slug <input type="checkbox"/> other: _____ hardness • <input checked="" type="checkbox"/> see instructions →	<p>Please Machine .505 Heat #M34065 Mark 065A &amp; B Please Machine Nut For Hardness Test</p>	<input type="checkbox"/> Chemistry Lab type of material: _____ Work Requested <input type="checkbox"/> neoprene verification <input type="checkbox"/> oil swell <input type="checkbox"/> zinc coating weight <input type="checkbox"/> steel chemistry analysis <input type="checkbox"/> other: _____ ← <input type="checkbox"/> see instructions <input type="checkbox"/> Other (explain)
--	--	--

Comments or further instructions	<p>The received service is acceptable</p> <p><i>Fred B. B.</i> Receiving Lab Technician</p> <p><i>1/28/10</i> Date</p>
----------------------------------	--

# TRANSLAB

S.M. INSPECTION REPORT FOR HEAT # 065

COMPLETED BY MD  
DATE: 1-28-10



## CHARPY IMPACT SPECIMENS

- ☐ FULL SIZE 10MM X 10MM  
☐ REDUCED

MATERIAL SURFACE



NOTCH ORIENTATION

OK

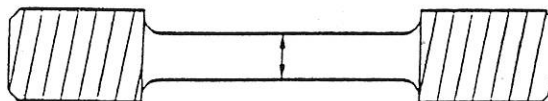
1	
2	
3	

A B C 2.165 .010 R  $\pm .001$

1					
2					
3					

NOTE: IMPACT SPECIMENS ARE TO BE GROUND TO  $.394 \pm .008$  ON SURFACE GRINDER  
ASTM E23 CALLS FOR 45 deg. V NOTCH WITH A  $.010 \pm .001$  RADIUS

A DIA.



- ☒  $.500 \pm .010$   
☐  $.350 \pm .007$   
☐ OTHER

A DIA. IS

A	.496
B	.502

NOTES / SPECIAL INSTRUCTIONS

# CERTIFIED MATERIAL TEST REPORT

 DYSON CORP.

53 Freedom Road  
Painesville, OH 44077

440-946-3500  
440-352-2700 fax

 DOMESTIC NUT

DYSON ORDER#	CUSTOMER ORDER#	ITEM NUMBER	QUANTITY SHIPPED	DATE SHIPPED
S 106529	660110-SA-017 C/O 019	41 of 111	1 set	1/19/10

**CUSTOMER**

American Bridge / Fluor JV  
375 Burma Road  
Oakland, CA 94607

USA

**DRAWING**

**PRODUCT DESCRIPTION**

2.00"-4.50UNC-2A x 800mm (31.50") lg. double end stud (Assembly incl. 3 full nuts, 1 jam nut & 3 washers) w/300mm (11.81") and 160mm (6.30") of useable thread per Dwg. JSW-ES-012. HDG per Caltrans Standard Specification 75-1.05 and ASTM-A123 w/near white metal blast prior to galvanize. REF: East Saddle Anchor Rod

**SPECIFICATIONS**

ASTM-A354 Grade BD with special provisions  
10-1.59, 10-1.60, 10-1.61 std specifications 75-1.05

STARTING MATERIAL	DIA	GRADE	QTY	LOT CODE	HEAT NO.	ORIGINAL MILL
Round Bar	2.000	4140	1	NHE9	M34065	Gerdau Macsteel

The product listed above was manufactured, tested, sampled, and inspected in accordance with the specification, purchase order, and any supplementary requirements and was found to meet those requirements unless otherwise noted.  
Hardness Results: 341 HBW

check samples  
B212-018-10

Attachments:

Mill Test Report  
Mechanical Test Report  
Galvanizing Certification

  
Deborah A. Smith

Q.A. Admin. Assistant

1/19/10

# CERTIFIED MATERIAL TEST REPORT

 DYSON CORP.

DTN DOMESTIC NUT

53 Freedom Road  
Painesville, OH 44077

440-946-3500  
440-352-2700 fax

DYSON  
ORDER#

CUSTOMER  
ORDER#

ITEM  
NUMBER

QUANTITY  
SHIPPED

DATE  
SHIPPED

S 106535

660110-SA-017 C/O 019

45 of 111

2 pcs

1/19/10

CUSTOMER

American Bridge / Fluor JV  
375 Burma Road  
Oakland, CA 94607

USA

DRAWING

None

PRODUCT DESCRIPTION

Caltrans sample material: 2.00"-4.50UNC-2A x 800mm (31.50") lg. double end stud (Assembly incl. 3 full nuts, 1 jam nut & 3 washers) w/300mm (11.81") and 160mm (6.30") of useable thread per Dwg. JSW-ES-012. HDG per Caltrans Standard Specification 75-1.05 & ASTM-A123 w/near white metal blast prior to galvanize.

SPECIFICATIONS

ASTM-A354 Grade BD with special provisions  
10-1.59, 10-1.60, 10-1.61 std specifications 75-1.05

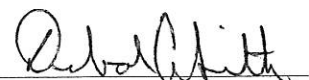
STARTING MATERIAL	DIA	GRADE	QTY	LOT CODE	HEAT NO.	ORIGINAL MILL
Round Bar	2.000	4140	2	NHE9	M34065	Gerdau Macsteel

The product listed above was manufactured, tested, sampled, and inspected in accordance with the specification, purchase order, and any supplementary requirements and was found to meet those requirements unless otherwise noted.  
Hardness Results: 341 HBW

check samples  
B212-018-10

Attachments:

Mill Test Report  
Mechanical Test Report  
Galvanizing Certification



Deborah A. Smith

Q.A. Admin. Assistant

1/19/10

# KREHER STEEL COMPANY, LLC.

## THE DYSON CORPORATION

LOT ROLLED ROUNDS 4140  
1.0000 X 24' 3"  
PART NO.

PO/Rel 69142

I hereby certify that this data is correct as  
contained in the records of this company.  
I hereby certify that no mercury came in contact

### Certificate of Mill Test Results

SO 1 -189220-001

10Nov09

with or no weld repair was done to this product  
while in our possession.

Pg 1/2



# GERDAU MACSTEEL

CODE NHE 9

5591 MORRILL ROAD  
JACKSON, MICHIGAN 49201

### CERTIFIED MATERIAL TEST REPORT

CUSTOMER ORDER NUMBER	CUSTOMER PART NUMBER	HEAT NUMBER	WORK ORDER NUMBER	DATE
20266	5324	M34065	232213 101	10/23/09

#### REPORT TO

ERIN  
KREHER STEEL

1550 N. 25TH AVE

MELROSE PARK , IL 60160

#### SHIP TO

KREHER STEEL

1550 N. 25TH AVE.

MELROSE PARK , IL 60160

### ORDERED

GRADE	SIZE	LENGTH
4140	2" RND	24' 3"

#### CUSTOMER SPECIFICATIONS

ASTM A29/A29M-05; A322-07; E381-01

### CHEMICAL ANALYSIS

C	Mn	P	S	Si	Ni	Cr	Mo	Cu	Sn	Al
0.41	0.86	0.015	0.020	0.26	0.14	0.93	0.17	0.21	0.010	0.032
V	Nb									
0.006	0.002									

GRAIN SIZE

SPECIFICATION ASTM E112

FINE GRAIN 5-8

HARDENABILITY

SPECIFICATION ASTM A255/A304

#### THEORETICAL

J1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	18	20	22	24	26	28	30	32	34
57	57	57	57	57	57	56	54	53	51		49		47		45	44	43		41		39		37	

MACROCLEANLINESS

SPECIFICATION ASTM E381

#### PLATE I

#### PLATE II

	S	R	C
FRONT	1	1	1
MIDDLE	1	1	1

PAGE 1

We certify that these data are correct and in compliance with specified requirements.	
Gerda MacSteel Monroe 3000 East Front Street Monroe, MI 48111	Chris Easter

CONTINUED ON PAGE 2

B212-018-10

NHE 2

# KREHER STEEL COMPANY, LLC.

THE DYSON CORPORATION

PO/Rel 69142

10T ROLLED ROUNDS 4140

2.0000 X 24" 3"

'ART NO.

I hereby certify that this data is correct as  
contained in the records of this company.  
I hereby certify that no mercury came in contact

## Certificate of Mill Test Results

SO 1 -189220-001

10Nov09

with or no weld repair was done to this product  
while in our possession.  
Atto:

Pg 2/2



# GERDAU MACSTEEL

CODE NHE 9

5591 MORRILL ROAD  
JACKSON, MICHIGAN 49201

### CERTIFIED MATERIAL TEST REPORT

CUSTOMER ORDER NUMBER	CUSTOMER PART NUMBER	HEAT NUMBER	WORK ORDER NUMBER	DATE
20266	5324	M34065	232213 101	10/23/09

#### REPORT TO

ERIN  
KREHER STEEL

1550 N. 25TH AVE

MELROSE PARK , IL 60160

#### SHIP TO

KREHER STEEL

1550 N. 25TH AVE.

MELROSE PARK , IL 60160

### ORDERED

GRADE	SIZE	LENGTH
4140	2" RND	24' 3"

#### CUSTOMER SPECIFICATIONS

ASTM A29/A29M-05; A322-07; E381-01

BACK 1 1 1  
AVERAGE 1 1 1

NONE

#### REDUCTION RATIO

RATIO= 11.5 TO 1.0

\*\* MATERIAL 100% MELTED AND MANUFACTURED IN THE U.S.A. BY THE ELECTRIC  
ARC FURNACE AND CONTINUOUS CASTING METHOD. THE PRODUCT HAS NOT  
BEEN REPAIRED BY WELDING AND THIS MATERIAL HAS NOT BEEN EXPOSED  
TO MERCURY OR TO ANY OTHER METAL ALLOY THAT IS LIQUID AT AMBIENT  
TEMPERATURES DURING PROCESSING OR WHILE IN OUR POSSESSION. \*\*

PAGE 2 OF 2

We certify that these data are correct and in compliance with specified requirements.	
Gerda MacSteel Monroe 3000 East Front Street Monroe, MI 48166	Chris Easter

6212-01970



A DIVISION OF J.T. ADAMS CO., INC.

4520 WILLOW PARKWAY  
CLEVELAND, OHIO 44125  
PHONE (216) 641-3290  
FAX (216) 641-1223  
www.tensile.com

---

**CERTIFIED TEST REPORT**

---

Dyson Corporation  
53 Freedom Road  
Painesville OH 44077

Job No.: B0-008-293  
Date: 1-13-10  
Cust. PO#: 70075

Description: 1 sample 2" Dia.  
SO# 106525 Cust PO# 660110-SA-017 Code# NHE 9

Material: AISI 4140 Heat# M34065

Spec: ASTM A354-07a Gr. BD

---

**TEST RESULTS**

---

	<u>Tensile, ksi</u>	<u>Yield, .2% ksi</u>	<u>Elong., % in 4D</u>	<u>Red. of Area, %</u>
Requirements (Min.):	150	130	14	40
	155	136	16	55

Test Method: ASTM A370-09a

The above **conforms** to specifications listed.

This material tested in accordance with the Tensile Testing's Quality System Manual dated 2/15/07 Rev. D as audited and approved by Dyson. The reported results represent the actual attributes of the material tested and indicate full compliance with all applicable specification and contract requirements. We certify that the foregoing is a true copy of the data resulting from tests performed in the laboratory.

Authorized Signature

Timothy J. Adams, President

B212-018-10

		<b>THE ART GALVANIZING WKS., INC.</b>					
		3935 VALLEY ROAD--CLEVELAND, OHIO 44109-3092 PHONE:216-749-0020					
		<b>PACKING SLIP / CERTIFICATIONS</b>					
TO:	DYSON CORP-DOMESTIC NUT DIV			PO#	70143		
	PAINESVILLE, OH						
DATE:	1/15/2010						
<b>NOTE:</b> THE FOLLOWING MATERIAL HAS BEEN GALVANIZED TO ASTM -A 153 CL CLASS C AND F2329. A COPY OF THE ABOVE PURCHASE ORDER IS AN INTEGRAL PART OF THIS CERTIFICATION AND MUST REMAIN ATTACHED.							
2"HHFN				2-4.5UNC231.5 DBLE END STUD		A354-BD	
CODE	NA	CODE#		CODE#			
LOT#	510 L106526	LOT#	510 L106525	LOT#			
GALV WEIGHT		335#	GALV WEIGHT		934#	GALV WEIGHT	
MILS	OZ/SQ FT		MILS	OZ/SQ FT		MILS	OZ/SQ FT
0.0044	2.59		0.0028	1.65		0	0.00
0.0036	2.12		0.0038	2.24		0	0.00
0.0038	2.24		0.0032	1.88		0	0.00
0.0028	1.65		0.0036	2.12		0	0.00
0.004	2.35		0.004	2.35		0	0.00
AVG	2.19		AVG	2.05		AVG	0.00
CODE#		CODE#		CODE#			
LOT#		LOT#		LOT#			
GALV WEIGHT		GALV WEIGHT		GALV WEIGHT			
MILS	OZ/SQ FT	MILS	OZ/SQ FT	MILS	OZ/SQ FT		
0	0.00	0	0.00	0	0.00		
0	0.00	0	0.00	0	0.00		
0	0.00	0	0.00	0	0.00		
0	0.00	0	0.00	0	0.00		
0	0.00	0	0.00	0	0.00		
AVG	0.00	AVG	0.00	AVG	0.00		
CODE#		CODE#		CODE#			
LOT#		LOT#		LOT#			
GALV WEIGHT		GALV WEIGHT		GALV WEIGHT			
MILS	OZ/SQ FT	MILS	OZ/SQ FT	MILS	OZ/SQ FT		
0	0.00	0	0.00	0	0.00		
0	0.00	0	0.00	0	0.00		
0	0.00	0	0.00	0	0.00		
0	0.00	0	0.00	0	0.00		
0	0.00	0	0.00	0	0.00		
AVG	0.00	AVG	0.00	AVG	0.00		

B212-018-10: *For malm*

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch

690 Walnut Ave.St. 150

Vallejo, CA 94592-1133

(707) 649-5453

(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 76.15**SOURCE INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-001727**Date Inspected:** 02-Feb-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 800**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1630**Contractor:** Dyson Corp. & Subs**Location:** Painesville, Ohio**Quality Control Contact:** Bob Bobnar**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:** Fastener Assemblies**Bridge No:** 34-0006**Component:** Cable System, E2 Bearing, Shear Keys**Bid Item:** 45,59,58,61**Lot No:** n/a**Summary of Items Observed:**

The Caltrans Quality Assurance (QA) Inspector Sherri Brannon was present at Dyson Corporation in Painesville, Ohio, to observe the fabrication of components that will be used in the San Francisco / Oakland Bay Bridge (SFOBB) project.

QA Inspector Brannon met with Quality Control Manager (QCM) Mr. Bob Bobnar with Dyson Corporation. Mr. Bobnar gave QA Inspector Brannon a tour of the Dyson facility. Mr. Bobnar explained their Quality Control (QC) program as the fastener assemblies moves throughout the different process and introduced QA to some of the production, shipping, and laboratory personnel at various points throughout the tour. After the tour of the Dyson facility QA Inspector Brannon reviewed applicable documents.

QA Inspector Brannon and Mr. Bobnar discussed the status of the check samples that QA Inspector Mr. Scott Croff had sampled under Caltrans lot numbers B212-011-10, B212-012-10 and B212-018-10. Mr. Bobnar, stated that results from Structural Materials Testing Laboratory are still pending as of January 28, 2010. QA Inspector Brannon stated to Mr. Bobnar that I would check the status of the above check samples. Later in the day QA Inspector Brannon informed Mr. Bobnar that check samples for the 2" x 800mm A354 Grade BD HDG Anchor Bolts w/ Nuts & Washers results are satisfactory for use. The QA Inspector relayed this information to the Structural Materials Representatives (SMRs) Nina Choy and Kit Guest. Reference documents: Caltrans QA Lot No: B212-018-10; Sample Identification Card TL-101 No: C642636; and Structural Materials Testing Laboratory Sample No: SM-10-0063.

The QA Inspector Brannon randomly observed Dyson personnel machining / fabricating components for fasteners

---

## SOURCE INSPECTION REPORT

( Continued Page 2 of 2 )

---

assemblies for the following: bid item 45 - Furnish and Install Spherical Bushing Bearing (Pier E2), bid item 59 - Furnish Structural Steel (Bridge) (Saddle), bid item 61 - Furnish and Install Shear Key (Pier E2), and bid item 68 Furnish Suspender System. QA Inspector Brannon made general observations of the milling, machining and threading of the various components (rods, bolts, nuts, washers). The QA Inspector Brannon noted that all observed work appeared to be performed to commonly accepted industry standards and procedures.

### Summary of Conversations:

As stated within this report.

### Comments

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy, (510) 385-5910, who represents the Office of Structural Materials for your project.

---

<b>Inspected By:</b>	Brannon, Sherri	Quality Assurance Inspector
<b>Reviewed By:</b>	Levell, Bill	QA Reviewer

---

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave. St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 76.15**SOURCE INSPECTION REPORT****Resident Engineer:** Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-001730**Date Inspected:** 03-Feb-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 800**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1630**Contractor:** Dyson Corp. & Subs**Location:** Painesville, Ohio**Quality Control Contact:** Bob Bobnar**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:** Fastener Assemblies**Bridge No:** 34-0006**Component:** Cable System, E2 Bearing, Shear Keys**Bid Item:** 45,59,61,68**Lot No:** B208-012-10, B208-013-10**Summary of Items Observed:**

The Caltrans Quality Assurance (QA) Inspector Sherri Brannon was present at Dyson Corporation in Painesville, Ohio, to observe the fabrication of components that will be used in the San Francisco / Oakland Bay Bridge (SFOBB) project.

QA Inspector Brannon checked the status of pending tests results and informed Mr. Bobnar that check samples for the 4" HDG Type II Suspender Socket Anchor Rods and 4" HDG Suspender Socket Anchor Nuts & Jam Nuts results are satisfactory for use. QA Inspector Brannon relayed this information to the Structural Materials Representatives (SMRs) Nina Choy and Kit Guest. Reference documents: Caltrans QA Lot No: B212-011-10 & B212-012-10; Sample Identification Card TL-101 No: C642634 & C642645; and Structural Materials Testing Laboratory Sample No: SM-10-0081 & SM-10-0082 respectively.

Mr. Bob Bobnar informed QA Inspector Brannon that the 2.00"-4.50 UNC 2A x 800mm (31.5") lg. double end stud (Assembly incl. 3 full nuts, 1 jam nut & 3 washers) for bid item 59, are ready for QA Inspection and green tag release for shipping. QA Inspector Brannon reviewed applicable documents and verified quantities. After review of the documents and material to be shipped QA Inspector Brannon assigned Caltrans lot number B208-012-10. See Caltrans Component Material Inspection Report, TL-6011 dated February 03, 2010 for specific information.

Mr. Bob Bobnar informed QA Inspector Brannon that the 4" HDG Type II Suspender Socket Anchor Rods with Anchor Nuts & Jam Nuts for bid item 68, are ready for QA Inspection and green tag release for shipping. QA Inspector Brannon reviewed applicable documents and verified quantities. After review of the documents and

---

## SOURCE INSPECTION REPORT

( Continued Page 2 of 2 )

---

material to be shipped QA Inspector Brannon assigned Caltrans lot number B208-013-10. See Caltrans Component Material Inspection Report, TL-6011 dated February 03, 2010 for specific information.

The QA Inspector Brannon randomly observed Dyson personnel machining / fabricating components for fasteners assemblies for the following: bid item 45 - Furnish and Install Spherical Bushing Bearing (Pier E2), bid item 59 -Furnish Structural Steel (Bridge) (Saddle), bid item 61 - Furnish and Install Shear Key (Pier E2), and bid item 68 Furnish Suspender System. QA Inspector Brannon made general observations of the milling, machining and threading of the various components (rods, bolts, nuts, washers). The QA Inspector Brannon noted that all observed work appeared to be performed to commonly accepted industry standards and procedures.

The following digital photograph below illustrates observation of the activities being performed.



### Summary of Conversations:

As stated within this report.

### Comments

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy, (510) 385-5910, who represents the Office of Structural Materials for your project.

---

<b>Inspected By:</b>	Brannon, Sherri
----------------------	-----------------

Quality Assurance Inspector
-----------------------------

---

<b>Reviewed By:</b>	Levell, Bill
---------------------	--------------

QA Reviewer
-------------

---

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch

690 Walnut Ave.St. 150

Vallejo, CA 94592-1133

(707) 649-5453

(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 76.8**COMPONENT MATERIAL INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** CMI-000171**Date Inspected:** 03-Feb-2010**Contractor:** Dyson Corp. & Subs**Location:** Painesville, Ohio**Bridge No.:** 34-0006**OSM Arrival Time:** 800**OSM Departure Time:** 1630**Component:#** East Saddle Anchor Rod Assembly

The following material has been inspected in accordance with Section 6 of the Standard Specifications at the above location. At this point in the fabrication process it appears to comply with contract plans and specifications.

To be shipped to the following vendor or locations: Japan Steel Works, Mouroran Japan

<b>Lot #</b>	<b>Bid Item #</b>	<b>Quantity</b>		<b>Material Description</b>
B208-012-10	59	33	ea	2.00"-4.50 UNC 2A x 800mm (31.50")lg. double end stud. Lot Code: NHE9, Heat No:M34065
B208-012-10	59	99	ea	2.00"-4.50 UNC 2B (+0.500" O/S) heavy hex nut, HDG with wax and dye. Lot Code DCNJ2, Heat No:M653560
B208-012-10	59	33	ea	2.00"-4.50 UNC 2B (+0.050" O/S) heavy jam hex nut, HDG with wax and dye . Lot Code: DCNJ3, Heat No: M653560
B208-012-10	59	99	ea	2.00" diameter hardened flat washer, HDG. Lot Code: NAQ2, Heat No: 0179412

**Identification:** Green tag attached to Certificate of Compliance / Shipping package.

**Summary of Items Observed:**

QA Inspector Brannon reviewed the contractor's Certificate of Compliance (C.O.C) and shipping documentation. QA Inspector Brannon also made random observations of the materials as it was presented. QA Inspector Brannon noted that the material and documentation appeared to be in general compliance with the contract requirements. QA Inspector Brannon also noted that check samples of the anchor rods, heavy hex nuts, heavy jam nuts and hardened flat washers, have been found satisfactory for use. QA Inspector Brannon issued a green tag with Caltrans QA lot number B208-012-10 for tacking purposes. QA Inspector was informed by Mr. Bob Bobnar that the material will be shipped to Japan Steel Works for additional fabrication.

**Summary of Conversations:**

As stated within this report.

**Comments**

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy, (510) 385-5910, who represents the Office of Structural Materials for your project.

---

## COMPONENT MATERIAL INSPECTION REPORT

( Continued Page 2 of 2 )

---

---

**Inspected By:** Brannon, Sherri

Quality Assurance Inspector

---

**Reviewed By:** Levell, Bill

QA Reviewer

# REQUEST FOR INFORMATION (RFI)

RFI No.: ABF-RFI-002111R00 Submitted By: Gatsos, Levi Pages: 2  
 RFI Date: 06-April-2010 Contact Name: Smith, Kevin Pages Attached: 1  
 Phone No. (412) 631-1000

<b>Subject: East Saddle Anchor Rod Modifications</b>	
<b>References:</b>	
<b>Sub/Sup: JSW</b>	<b>Sub RFI #:</b>
<b>Response Required by: 08-April-2010</b>	
<b>Response affects critical path activity?</b>	

## Description:

PLEASE EXPEDITE REVIEW

With regards to the East Saddle Anchor Rod modification details, drawing 789C, provided in State Letter No. 05.03.01-007261; ABFJV believes that this detail does not adequately take into account allowable tolerances for the East Saddle Assembly.

Due to the allowable tolerances of the East Saddle Base Plate and the East Saddle Bearing Plate (+/-5.5 for each), the East Saddle Anchor Rod grip length may vary by as much as 11mm.

ABFJV has the following questions and concerns (please see attachment for details):

1. The 110mm top of rod thread dimension in conjunction with Note 1 on drawing 789C does not provide enough clearance to ensure fit-up of the bottom nuts to East Saddle Bearing Plate. ABFJV recommends that the Department increase this dimension by 30mm to 140mm. Please review and approve.
2. Please confirm that the taper shown in Detail A is required only on the bottom transition. The top transition is cut into the threads and will not be tapered.
3. The location of the machined portion of threads at the top of rod in assembled condition is unclear. Please provide the location of the machined portion of the threads with respect to the bottom plate. Please consider fabrication tolerances and be advised that the anchor rods cannot be adjusted after saddle assembly.
4. A standard F436 washer has a nominal thickness of 4.8mm. This thickness is not adequate to compensate for the East Saddle Anchor Rod grip length tolerance of 11mm. Please provide washer details, (thickness, material grade, hardness requirements, coating, quantity ect.) that take into account the tolerances of the East Saddle Assembly and the tolerance requested in No. 3 above.
5. Please clarify the intent of Note 1.

Please be advised that Japan Steel Works requires that details and pricing for this change be finalized by April 9, 2010 otherwise additional impacts and delays may occur.

Please review and respond.

## Contractor Disposition:

This RFI is being submitted for

The Cost and Time Impact from this RFI is: Not selected

# REQUEST FOR INFORMATION (RFI)

**Response:****Agreed Ext. Due Date:****Pages:** 3**Pages Attached:** 1

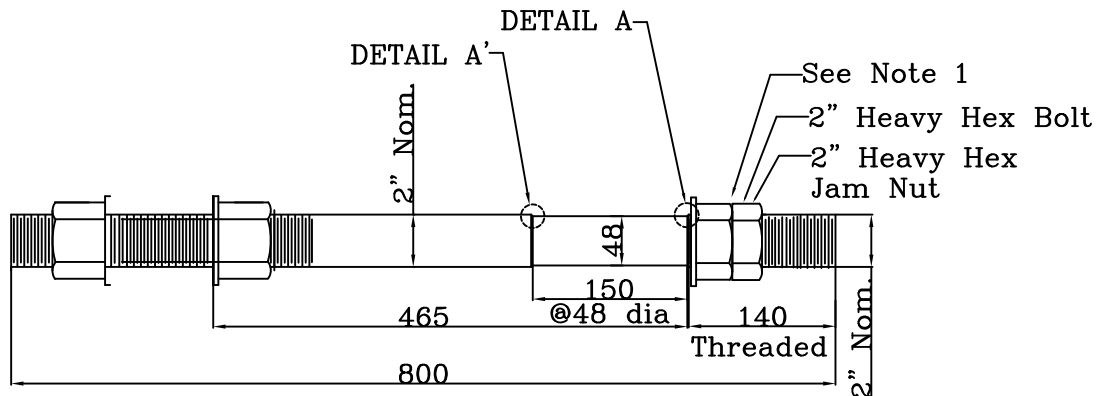
Further to WDC discussions, the details below along with attached sketch RFI 2111 R0—SK01 clarifies the questions regarding machining and assembly of the East Saddle Anchor Rods. Please note that the Anchor Rod details take into account East Saddle as-built dimensions:

1. The proposal to start the machined portion an additional 30mm from the end of the rod is acceptable.
2. A taper (chamfer) is required at both ends of the machined portion.
3. The location of the machined portion and its relative position from the top of the bearing plate (bottom plate) is defined on sketch RFI 2111 R0—SK01.
4. Provide additional ASTM F436 washers as needed so that position of the nut is located within 3mm from the taper of the machined portion. A plate washer fabricated from ASTM A709M Gr. 345 may be used at the Contractor's option. Provide details for review if the Contractor wishes to pursue this option.
5. Note #1 has been revised to clarify the requirement.

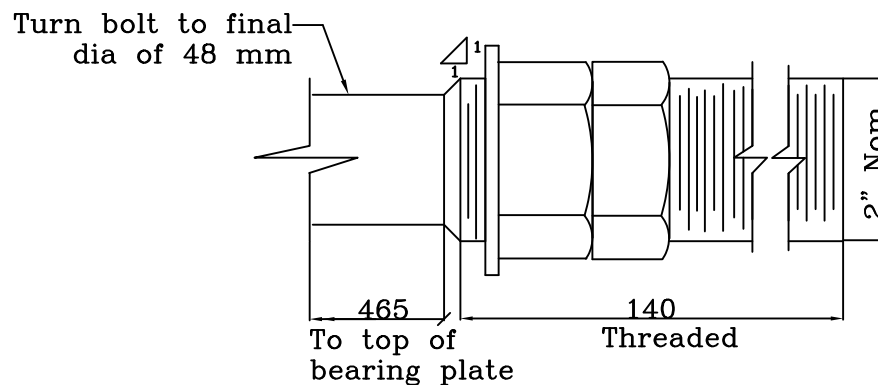
**Administrative Action:**

This response resolves the RFI.

<b>Date:</b> 15-April-2010	<b>Respondent:</b> Collins, Warren	<b>Phone No.:</b> 510-622-5661
----------------------------	------------------------------------	--------------------------------



ASTM A 354 Gr BD ANCHOR BOLT



DETAIL A  
(Detail A' SIMILAR)

Note

1. The Contractor shall provide additional washers to ensure that the nut is located within 3mm of the start of thread.
2. The Contractor shall apply organic zinc rich primer after machining.

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave. St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 70.15**SOURCE INSPECTION REPORT****Resident Engineer:** Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-002063**Date Inspected:** 20-Apr-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 700**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1730**Contractor:** Japan Steel Works**Location:** Muroran, Japan**Quality Control Contact:** Hideaki Kon**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:** Trial Fit of Divider Plates inside Trough of East Saddles and Machining of Anchor Rods for East Saddles**Bridge No:** 34-0006**Component:** Tower, Jacking, and Deviation Saddles**Bid Item:** 59**Lot No:****Summary of Items Observed:**

On this date, Caltrans OSM Quality Assurance (QA) Inspector Mr. Art Peterson was present during the times noted above for observations relative to the work being performed in Fabrication Shop #4 and the Machine Shop at Japan Steel Works.

**Trial Fit of Divider Plates in-process on Saddle: East Saddle E2-W1 (Fabrication Shop #4)**

The QA Inspector observed that the trial assembly installation of the lower tier divider plates inside of the trough's divider plate grooves were in-process on east saddle E2-W1. The JSW personnel are preliminary setting the individual divider plates inside of the troughs' grooves prior to positioning the divider plates into their final position in regards to the final depth inside the groove and its final position along the grooves' length. The east saddle E2-W1 will have 2 divider plate segments inside of the trough and JSW will try ensure that the divider plate segments are fit flush against each other after being placed in their final position. Once the divider plates are in their final position, JSW will verify and record the divider plates' depth inside of the troughs' grooves, JSW will ensure that the divider plates are fit plumb and true at the segmented joints and at the saddles' splice and record any misalignment of the divider plates greater than the specified tolerance of 0.5 mm and also any gaps at the divider plate segments where they are not flush fit. If the alignment of the divider plates are outside this specified tolerance and there are gaps at the divider plate segment splice, then JSW will submit a request for information (RFI) to allow the gaps at the divider plate segment splice to be left as is. Afterwards, the JSW QC Inspection personnel will verify the dimensions of the as-built spacing between the divider plates at the saddle compartments to verify that the strand compartments are not too narrow for the parallel wire strand (PWS) installation. On this date, the QA Inspector observed that the trial fit assembly of the lower tier divider plates on east saddle E2-W1 were in-process at the end of the QA Inspectors' shift.

---

## SOURCE INSPECTION REPORT

( Continued Page 2 of 3 )

---

### Trial Fit of Divider Plates in-process on Saddle: East Saddle E2-E1 (Fabrication Shop #4)

The QA Inspector observed that the trial assembly installation of the lower tier divider plates inside of the trough's divider plate grooves were in-process on east saddle E2-E1. The JSW personnel are preliminary setting the individual divider plates inside of the troughs' grooves prior to positioning the divider plates into their final position in regards to the final depth inside the groove and its final position along the grooves' length. The east saddle E2-E1 will have 2 divider plate segments inside of the trough and JSW will try ensure that the divider plate segments are fit flush against each other after being placed in their final position. Once the divider plates are in their final position, JSW will verify and record the divider plates' depth inside of the troughs' grooves, JSW will ensure that the divider plates are fit plumb and true at the segmented joints and at the saddles' splice and record any misalignment of the divider plates greater than the specified tolerance of 0.5 mm and also any gaps at the divider plate segments where they are not flush fit. If the alignment of the divider plates are outside this specified tolerance and there are gaps at the divider plate segment splice, then JSW will submit a request for information (RFI) to allow the gaps at the divider plate segment splice to be left as is. Afterwards, the JSW QC Inspection personnel will verify the dimensions of the as-built spacing between the divider plates at the saddle compartments to verify that the strand compartments are not too narrow for the parallel wire strand (PWS) installation. On this date, the QA Inspector observed that the trial fit assembly of the lower tier divider plates on east saddle E2-E1 were in-process at the end of the QA Inspectors' shift.

### Machining of Anchor Rods in Process: East Saddle E2-E1 and East Saddle E2-W1

The QA Inspector visited Nitto-Kikai Company in Muroran, Japan to randomly observe the machining or turning down of a section along the length of the (50) mm diameter anchor rods required for east saddle E2-E1 and east saddle E2-W1. A total of (33) anchor rods will be required to be machined in accordance with reference sheet 789C of 1204 that was an attachment of the response to ABF-RFI-002111R00 dated April 15, 2010. The (33) anchor rods each have a length of (800) mm with threads on both ends and will be turned down to a finished diameter of (48) mm and for a length of (150) mm starting from (140) mm from one end of the anchor rod- (measured from the east saddle base plate toward bearing plate). The QA Inspector observed that a (1 to 1) taper was to be machined into the anchor rods on each end of the turned down (150) mm machined section of the anchor rods. The QA Inspector also observed that on one end of the turned down machined section of the anchor rods is where a threaded portion will be turned down with a (1 to 1) taper provided on the end of the machined threads included in the (150) mm length. The threaded portion will still be visible after the machining operation due to the finished diameter being (48) mm of the (50) mm diameter anchor rods. The QA Inspector verified the length of the machined section and the finished diameter of the machined section on a total of (3) out of the (9) anchor rods machined on this date using a tape measure and a calibrated micrometer. The QA Inspector observed that the length of the machined section and the finished diameter on the (3) anchor rods inspected appeared to be in compliance with reference sheet 789C of 1204 and the response to ABF-RFI-002111R00. The machining operation was still in-process on this date at the end of the QA Inspectors' shift. The QA Inspector was informed by Office of Structural Materials (OSM) Materials Engineering Testing Services (METS) Structural Materials Representative (SMR) Mr. Kittric Guest (Pier 7) during April 19, 2010 tele-conference that a Manufacturing Fabrication Self Qualification Audit (MFSQA) audit would not be required on the machining facility performing the work on the (33) anchor rods of Japan Steel Works (JSW) sub-vendor Nitto-Kikai Company in Muroran, Japan.

Unless otherwise noted in this report, all observations reported on this date appeared to be in general compliance

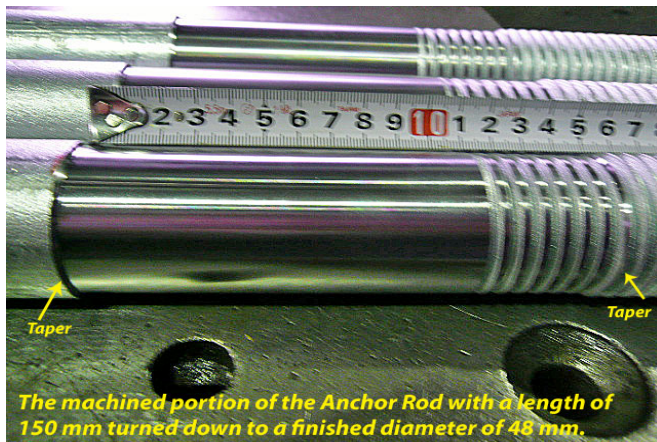
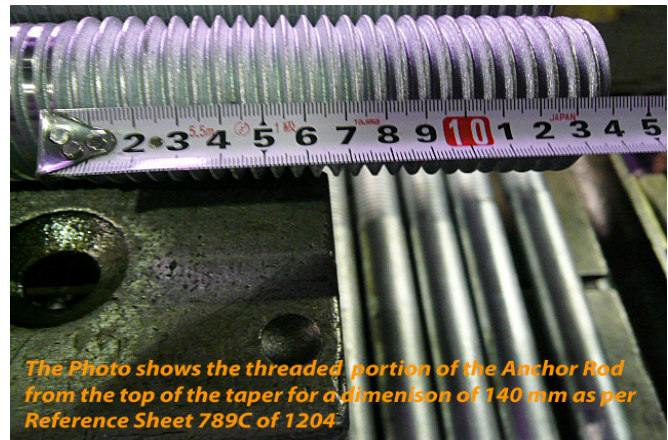
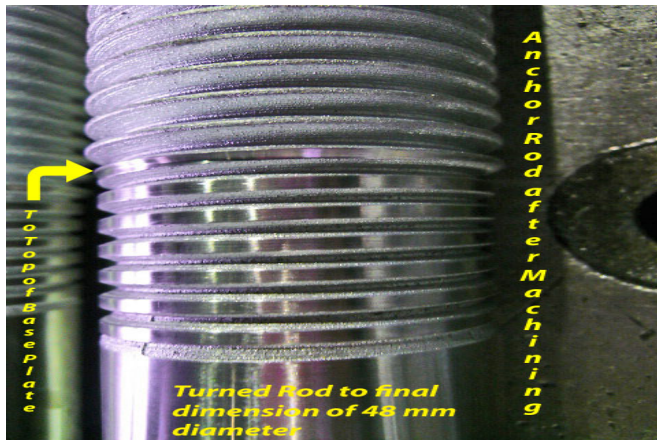
---

## SOURCE INSPECTION REPORT

( Continued Page 3 of 3 )

---

with the applicable contract specifications.



### Summary of Conversations:

No significant conversations were reported on this date.

### Comments

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy at (510) 385-5910, who represents the Office of Structural Materials for your project.

---

<b>Inspected By:</b>	Peterson, Art	Quality Assurance Inspector
<b>Reviewed By:</b>	Edmondson, Fred	QA Reviewer

---

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave. St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 70.15**SOURCE INSPECTION REPORT****Resident Engineer:** Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-002064**Date Inspected:** 21-Apr-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 700**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1730**Contractor:** Japan Steel Works**Location:** Muroran, Japan**Quality Control Contact:** Hideaki Kon**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:** Trial Fit of Divider Plates inside Trough of East Saddles and Machining of Anchor Rods for East Saddles**Bridge No:** 34-0006**Component:** Tower, Jacking, and Deviation Saddles**Bid Item:** 59**Lot No:****Summary of Items Observed:**

On this date, Caltrans OSM Quality Assurance (QA) Inspector Mr. Art Peterson was present during the times noted above for observations relative to the work being performed in Fabrication Shop #4 and the Machine Shop at Japan Steel Works.

Trial Fit of Divider Plates completed on Saddle: East Saddle E2-W1 (Fabrication Shop #4)

The QA Inspector observed that the trial assembly installation of the lower tier divider plates inside of the trough's divider plate grooves was completed on east saddle E2-W1. The JSW personnel set the individual divider plates inside of the troughs' grooves to their final position in regards to the final depth inside the groove and their final position along the grooves' length. The JSW QC personnel have recorded the divider plates' depth inside of the troughs' grooves and any gaps where the divider plates are not fit plumb and true against each other at the segmented joints. The JSW QC personnel also measured and recorded any misalignment of the divider plates greater than the specified tolerance of 0.5 mm. Once the JSW QC personnel have completed the inspection report of recording any mis-alignment of the divider plates, any gaps at the divider plate segmented splice where they are not fit plumb and true against each other and also the actual measurements of the divider plates' depth inside of the troughs' grooves; then afterwards, the JSW personnel will submit a request for information (RFI) to allow any of the above aforementioned deviations to be left as is. The JSW QC Inspection personnel have also verified and recorded the dimensions of the as-built spacing between the divider plates at the saddle compartments to verify that the strand compartments are not too narrow for the parallel wire strand (PWS) installation and JSW personnel will include any dimensional inspection results if the strand compartments are too narrow from the lower tier divider plate trial fit operation. The JSW representative Mr. Kazanori Sato informed the QA Inspector that JSW are preparing the RFI along with the JSW QC inspection report to submit to ABF/JV for disposition of the divider

---

## SOURCE INSPECTION REPORT

( Continued Page 2 of 3 )

---

plate trial fit data that were not in compliance with the contract specifications.

### Trial Fit of Divider Plates in-process on Saddle: East Saddle E2-E1 (Fabrication Shop #4)

The QA Inspector observed that the trial assembly installation of the lower tier divider plates inside of the trough's divider plate grooves were in-process on east saddle E2-E1. The JSW personnel are preliminary setting the individual divider plates inside of the troughs' grooves prior to positioning the divider plates into their final position in regards to the final depth inside the groove and their final position along the grooves' length. The east saddle E2-E1 will have (2) divider plate segments inside of the trough and the JSW personnel will try to ensure that the divider plate segments are fit flush against each other after being placed in their final position. Once the divider plates are in their final position, JSW will verify and record the divider plates' depth inside of the troughs' grooves, verify and record if any of the divider plates are not fit plumb and true against each other at the segmented joints and record any misalignment of the divider plates greater than the specified tolerance of 0.5 mm. If the alignment of the divider plates are outside the specified tolerances, then the JSW personnel will submit a request for information (RFI) to allow any of the aforementioned deviations to be left as is. Afterwards, the JSW QC personnel will verify the dimensions of the as-built spacing between the divider plates at the saddle compartments to verify that the strand compartments are not too narrow for the parallel wire strand (PWS) installation. On this date, the QA Inspector observed that the trial fit assembly of the lower tier divider plates on east saddle E2-E1 were in-process at the end of the QA Inspectors' shift.

### Machining of Anchor Rods completed: East Saddle E2-E1 and East Saddle E2-W1

The QA Inspector visited Nitto-Kikai Company in Muroran, Japan to observe that the machining or turning down operation of a section along the length of the (50) mm diameter anchor rods required for east saddle E2-E1 and east saddle E2-W1 was completed. A total of (33) anchor rods were machined in accordance with reference sheet 789C of 1204 as part of an attachment of the response to ABF-RFI-002111R00 dated April 15, 2010. The (33) anchor rods each have a length of (800) mm with threads on both ends and were turned down to a finished diameter of (48) mm for a length of (150) mm starting from (140) mm from one end of the anchor rod- (measured from the position of the east saddle base plate toward bearing plate). The QA Inspector observed that a (1 to 1) taper was machined into the (33) anchor rods on each end of the turned down (150) mm machined section. The QA Inspector also observed that on one end of the turned down machined section of the anchor rods, a threaded portion of the anchor rod was partially turned down included in the (150) mm length section. The threaded portion was still visible after the machining operation due to the finished diameter being (48) mm of the (50) mm diameter anchor rods. The QA Inspector verified the length of the machined section and the finished diameter of the machined section on a total of (7) out of the (24) anchor rods that were machined and completed on this date using a tape measure and a calibrated micrometer. The QA Inspector observed that the length of the machined section and the finished diameter on the (7) anchor rods inspected appeared to be in compliance with reference sheet 789C of 1204 of the response to ABF-RFI-002111R00. The machining operation of the total of (33) anchor rods required were completed on this date.

Unless otherwise noted in this report, all observations reported on this date appeared to be in general compliance with the applicable contract specifications.

### Summary of Conversations:

No significant conversations were reported on this date.

### Comments

---

## SOURCE INSPECTION REPORT

( Continued Page 3 of 3 )

---

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy at (510) 385-5910, who represents the Office of Structural Materials for your project.

---

<b>Inspected By:</b>	Peterson, Art	Quality Assurance Inspector
<b>Reviewed By:</b>	Edmondson, Fred	QA Reviewer

---

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave.St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 70.15**SOURCE INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-002140**Date Inspected:** 29-Apr-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 700**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1630**Contractor:** Japan Steel Works**Location:** Muroran, Japan**Quality Control Contact:** Hideaki Kon**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:** Curing of Primer Coat on Tower Saddles and Dry Film Thickness Verification on Anchor Rods**Bridge No:** 34-0006**Component:** Tower, Jacking, and Deviation Saddles**Bid Item:** 59**Lot No:****Summary of Items Observed:**

On this date, Caltrans OSM Quality Assurance (QA) Inspector Mr. Art Peterson was present during the times noted above for observations relative to the work being performed in the Paint Shop at Japan Steel Works.

Curing of Primer Coat on Exterior Rib plates and Exterior of the troughs on Saddles: Tower Saddles T1-1, T1-2, and T1-3 (Paint Shop)

The QA Inspector observed that the exterior rib plates and the exterior of the trough on tower saddle segments T1-1, T1-2, and T1-3 have been coated with the inorganic zinc rich primer coat (International Paint Product Interzinc 22). The QA Inspector verified that the environmental conditions in the Paint Shop were suitable for curing of the primer coat as recommended by International Paints' product data sheet for the Interzinc 22 primer coat product. The QA Inspector recorded the ambient temperature on this date at 18.3 degrees Celsius; the surface temperature on tower saddle exterior rib plates was recorded at 13 degrees Celsius; the relative humidity was recorded at 56%; and the dew point was recorded at 7.5 degrees Celsius. The environmental conditions inside of the Paint Shop on this date appeared to be in compliance with International Paints' product data sheet.

Application of Primer Coat on Machined Section of Anchor Rods: East Saddles E2-E1 and E2-W1 (Paint Shop)

The QA Inspector observed that (32) anchor rods for east saddle E2-E1 and E2-W1- (16) for each saddle plus (1) extra anchor rod that previously had their diameters turned down- (machined) for a specified length as per the attached sketch reference sheet no. (789C of 1204) of the response to ABF-RFI-002111R00 dated April 15, 2010 had the turned down- (machined) section epoxy primer coated with International Paint product Interzinc 52. Except for the machined section on the anchor rods, the remainder of the anchor rods are galvanized coated. The QA Inspector performed dry film thickness (DFT) coating verification inspection on (3) anchor rods using a

---

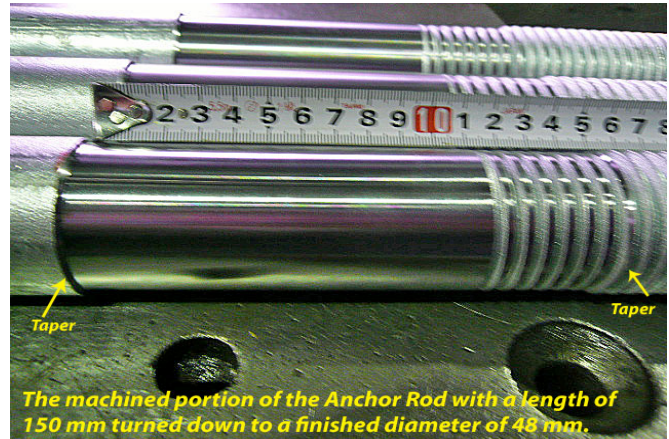
## SOURCE INSPECTION REPORT

( Continued Page 2 of 3 )

---

calibrated Type II magnetic gage and the results of the verification inspection were that the DFT of the epoxy primer coat on the (3) anchor rods were above the minimum DFT coating requirement of 40 micrometers. The QA Inspector also observed that the Interzinc 52 primer coat was applied by the spray method. Next, the JSW personnel will prepare the (32) anchor rods for installation into the bearing plates of east saddle E2-E1 and E2-W1 to position the anchor rods in accordance with the attached sketch reference sheet no. (789C of 1204) in ABF RFI 002111R00.

Unless otherwise noted in this report, all observations reported on this date appeared to be in general compliance with the applicable contract specifications.



### Summary of Conversations:

No significant conversations were reported on this date.

### Comments

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy at (510) 385-5910, who represents the Office of Structural Materials for your project.

---

**Inspected By:** Peterson, Art

Quality Assurance Inspector

---

## SOURCE INSPECTION REPORT

( Continued Page 3 of 3 )

---

**Reviewed By:** Edmondson,Fred

QA Reviewer

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch

690 Walnut Ave.St. 150

Vallejo, CA 94592-1133

(707) 649-5453

(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 70.15**SOURCE INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-002176**Date Inspected:** 15-May-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 700**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1530**Contractor:** Japan Steel Works**Location:** Muroran, Japan**Quality Control Contact:** Hideaki Kon**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:** Trial Fit Assembly of Divider Plates inside Trough of Tower Saddle Segment T1-3**Bridge No:** 34-0006**Component:** Tower, Jacking, and Deviation Saddles**Bid Item:** 59**Lot No:****Summary of Items Observed:**

On this date, Caltrans OSM Quality Assurance (QA) Inspector Mr. Art Peterson was present during the times noted above for observations relative to the work being performed in Fabrication Shop #4 at Japan Steel Works.

Trial Fit Assembly of Divider Plates in-process on Saddle: Tower Saddle Segment T1-3 (Fabrication Shop #4)

The QA Inspector observed the trial fit assembly of the lower tier divider plates inside of the trough are in-process on tower saddle segment T1-3. The JSW personnel are preliminary setting the individual divider plates inside of the troughs' grooves prior to positioning the divider plates into their final position in regards to their final depth inside the groove and their final position along the trough's groove length. The tower saddle segment will have (2) divider plate segments inside of the saddles' trough. The JSW personnel will ensure that the divider plate segments are fit plumb, true, and flush against each other once the divider plates are placed in their final position.

Afterwards, the JSW Quality Control (QC) personnel will verify and record the divider plates' depth inside of the troughs' grooves. The JSW QC personnel will verify that the divider plates are fit plumb and true at the segment joint splice of tower saddle segment T1-2 and record any misalignment of the divider plates greater than the specified tolerance of (0.5) mm. The JSW QC personnel will also verify the dimensions of the as-built spacing between the divider plates at the saddle compartments and at the saddle segment joint splice to verify that the strand compartments are not too narrow for the parallel wire strand (PWS) installation. On this date, the QA Inspector observed that the trial fit assembly of the lower tier divider plates are in-process on tower saddle segment T1-3 at the end of the QA Inspectors' shift.

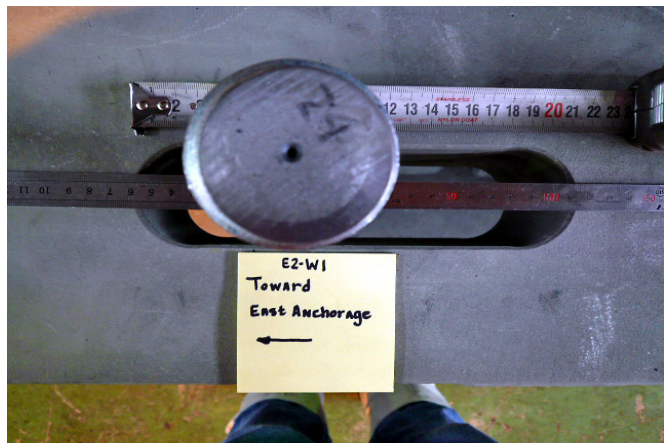
Dimensional Inspection of Anchor Rod's position inside of slotted holes of Base Plate: East Saddle E2-E1 and E2-W1 (Fabrication Shop #4)

# SOURCE INSPECTION REPORT

( Continued Page 2 of 3 )

The QA Inspector observed JSW QC Inspector Mr. R. Kumagai performing dimensional inspection on the (16) anchor rod's (8 on each side of the base plate) position within the slotted holes of the base plate of east saddle E2-E1 and east saddle E2-W1. The east saddles base plate's have been assembled with its bearing plate and rocker forgings and end splay cover plate and will be shipped as a completed assembly. The dimensional inspection was performed for "information only" to verify if the anchor rods were concentric within the slotted hole. The QA Inspector was informed by JSW representative Mr. Hideaki Kon that a dimensional inspection report would be prepared and that JSW would provide a courtesy copy of the report to the QA Inspector for review. The QA Inspector photographed some of the anchor rods position within the slotted hole for review. See photos attached to this report.

Unless otherwise noted in this report, all observations reported on this date appeared to be in general compliance with the applicable contract specifications.

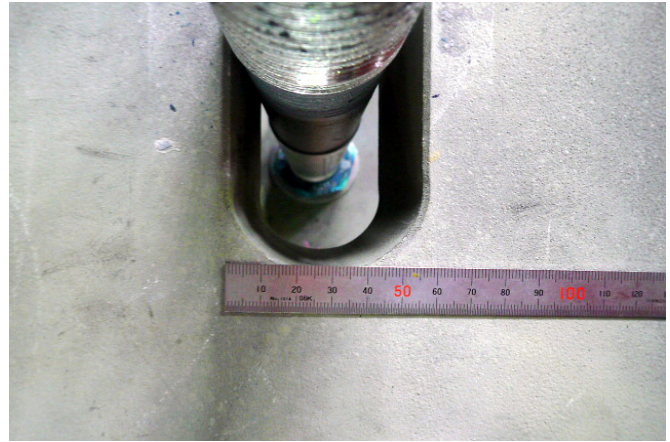
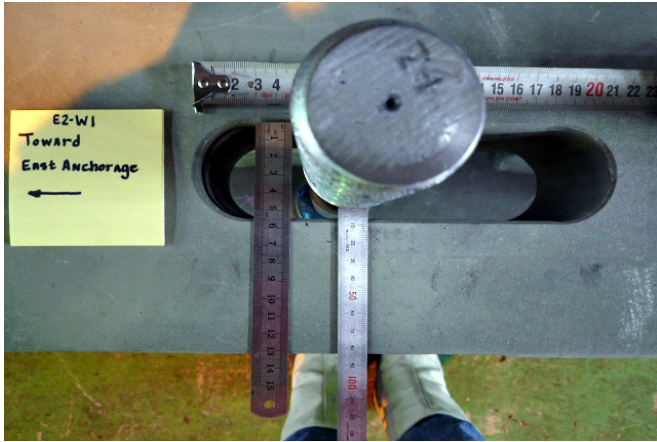


---

## SOURCE INSPECTION REPORT

( Continued Page 3 of 3 )

---



### Summary of Conversations:

No significant conversations were reported on this date.

### Comments

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy at (510) 385-5910, who represents the Office of Structural Materials for your project.

---

<b>Inspected By:</b>	Peterson, Art	Quality Assurance Inspector
<b>Reviewed By:</b>	Edmondson, Fred	QA Reviewer

---

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave. St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 70.15**SOURCE INSPECTION REPORT****Resident Engineer:** Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-002228**Date Inspected:** 26-May-2010**Project Name:** SAS Superstructure**OSM Arrival Time:** 700**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1630**Contractor:** Japan Steel Works**Location:** Muroran, Japan**Quality Control Contact:** Hideaki Kon**Quality Control Present:** Yes No**Material transfer:** Yes No N/A**Sampled Items:** Yes No N/A**Stock Transfer:** Yes No N/A**OK to Cut:** Yes No N/A**Rebar Test Witness:** Yes No N/A**Delayed/Cancelled:** Yes No N/A**Other:** Trial Fit Assembly of Divider Plates inside North and South Trough of T1-1 and Adjustment of Anchor Rods**Bridge No:** 34-0006**Component:** Tower, Jacking, and Deviation Saddles**Bid Item:** 59**Lot No:****Summary of Items Observed:**

On this date, Caltrans OSM Quality Assurance (QA) Inspector Mr. Art Peterson was present during the times noted above for observations relative to the work being performed in Fabrication Shop #4 at Japan Steel Works.

Trial Fit Assembly of Divider Plates in-process on Saddle: Tower Saddle Segment T1-1 (Fabrication Shop #4)

The QA Inspector observed the trial fit assembly of the lower tier divider plates inside of the trough are in-process on tower saddle segment T1-1. The JSW personnel are preliminary setting the individual divider plates inside of the troughs' grooves prior to positioning the divider plates into their final position in regards to their final depth inside the groove and their final position along the trough's groove length. The tower saddle segment will have (2) divider plate segments inside of the saddles' trough. The JSW personnel will ensure that the divider plate segments are fit plumb, true, and flush against each other once the divider plates are placed in their final position.

Afterwards, the JSW Quality Control (QC) personnel will verify and record the divider plates' depth inside of the troughs' grooves. The JSW QC personnel will verify that the divider plates are fit plumb and true at the segment joint splice of adjoining tower saddle segment T1-2 and record any misalignment of the divider plates greater than the specified tolerance of (0.5) mm. The JSW QC personnel will also verify the dimensions of the as-built spacing between the divider plates at the saddle compartments and at the saddle segment joint splice to verify that the strand compartments are not too narrow for the parallel wire strand (PWS) installation. On this date, the QA Inspector observed that the trial fit assembly of the lower tier divider plates are in-process on tower saddle segment T1-1 at the end of the QA Inspectors' shift.

Adjustment of Anchor Rods within the Slotted Holes of Base Plate: East Saddle E2-E1 and East Saddle E2-W1 (Fabrication Shop #4)

## SOURCE INSPECTION REPORT

( Continued Page 2 of 3 )

The QA Inspector observed that (2) JSW personnel performed the adjustment of the anchor rods within the slotted holes of the base plate of east saddle E2-E1 and E2-W1 on May 25, 2010. The recommendations of which anchor rods to be adjusted were based on ABF-CAL-TRN-003495 dated 20th May, 2010 redlined by Caltrans in conjunction with the erection procedures of the east saddles submitted (Re: ABF-SUB-000777R01) to Caltrans by prime contractor American Bridge / Fluor, a joint venture (ABF/JV). The direction provided by Caltrans to ABF/JV was for JSW to create a clearance between the modified anchor rod (Re: ABF-RFI-002111R00) and the edge of the slotted hole at the specified locations based on the JSW dimensional inspection record of the anchor rods submitted (Re: ABF-CAL-TRN-003495). At locations where a (1) mm or less clearance existed between the modified anchor rod and the edge of the slotted hole in the base plate, the JSW personnel performed the adjustment and moved the specified anchor rods away from the edge of the slotted hole by adjusting the anchor rod position using the available hole clearances in the east saddle bearing plates of E2-E1 and E2-W1. A total of (2) JSW personnel worked (6) hours each performing the adjustment of the specified anchor rods within the bearing plate holes to give the maximum available clearance between the anchor rods and the slotted holes in the base plate of both east saddles E2-E1 and E2-W1 on May 25, 2010. On May 26, 2010, a total of (1) JSW Quality Control Inspector worked (2) hours performing the dimensional inspection after adjustment of the anchor rods to verify the clearance between the anchor rod and the slotted hole in both east saddles E2-E1 and E2-W1. Also, a total of (2) JSW personnel worked (2) hours each performing the re-assembly of the nuts and washer to the anchor rods after the dimensional inspection and tightened the nuts to a "snug tight" condition on both east saddles E2-E1 and E2-W1 on May 26, 2010. JSW will prepare a dimensional inspection record and report the results to ABF/JV in a revised or new transmittal. See attached photo of (1) of the specified anchor rod locations after adjustment on east saddle E2-E1 slot location "E-2" measuring the new clearance between the edge of the slotted hole and anchor rod.

Unless otherwise noted in this report, all observations reported on this date appeared to be in general compliance with the applicable contract specifications.



### Summary of Conversations:

No significant conversations were reported on this date.

### Comments

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact , who represents the Office of Structural Materials for your project.

---

## SOURCE INSPECTION REPORT

( Continued Page 3 of 3 )

---

---

<b>Inspected By:</b>	Peterson, Art	Quality Assurance Inspector
<b>Reviewed By:</b>	Edmondson, Fred	QA Reviewer

---

**DEPARTMENT OF TRANSPORTATION**

DIVISION OF ENGINEERING SERVICES

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch  
690 Walnut Ave.St. 150  
Vallejo, CA 94592-1133  
(707) 649-5453  
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 70.25A**MATERIAL SUITABILITY REPORT****Resident Engineer:**Pursell, Gary**Report No:** MSR-000010**Address:** 333 Burma Road**Report Date:** 02-Jun-2010**City:** Oakland, CA 94607**SMR Authorization #:****Project Name:** SAS Superstructure**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**Date of NCR:****Contractor:** Japan Steel Works**Location:** Moruran, Japan

The following material has been inspected and found not to comply with contract plans and specifications; however, METS has determined this material may be suitable for its intended purpose.

Lot #	Bid Item #	Quantity	Material Description
S53 004-10	59	662,100 kg	Saddles T1-1, T1-2, T1-3, E2-W1, E2-E1, and West Jacking
S53 004-10	77	Ls	Clean and Paint Structural Steel

**Identification:**

Saddles T1-1, T1-2, T1-3, E2-W1, E2-E1, and West Jacking

**Description of Non-Conformance (NCRs):****Summary of Items Observed:**

Saddles T1-1, T1-2, T1-3, E2-W1, E2-E1, and West Jacking Saddles- Items resolved via RFI and/or Submittal process.

BTL 103: RFI 1703R00 Tower Saddle (T1-1, T1-2 and T1-3) castings were examined 100% by dry MT testing. The saddles were re-examined with wet MT examination on 10% of the as-cast level 1 surface.

BTL 108: SUB 643R17 Tower Saddle T1-1 built-up plate section reib plate to base plate CJP weld ID 7Y-9L-2 had an ultrasonic rejectable Class A indication 15mm in lenght in mid point of the weld. It was determined to be acceptable as this is shown to be a low stress area and was previously detailed as a PJP weld.

BTL 113: RFI 1939R00 After final machining of the T1-1 saddle, indications were found on the splice surface and end rib. The indications were described as porosity, slag or lack of fusion in the weld splice surface. Excavations less than 3mm in depth with rounded edges did not require repair. Those greater than 3mm were weld repaired using an approved WPS that did not require PWHT.

BTL 116: RFI 1893R03, deviation of the metalizing operator qualification requirements to correspond with minimum requirement of final product. Submittal 1274R02 (MFSQA) and RFI 1850R02, waiver of SSPC QP-3 certificaion of paint facility after providing proof of equivalence.

---

## MATERIAL SUITABILITY REPORT

( Continued Page 2 of 2 )

---

BTL 121: SUB 643R24, R26, R27, R28 After final machining and final magnetic particle inspection various indications were found on the tower saddles. These indications were of two different classifications, those less than 3mm in depth and those over 3mm in depth after excavation (not exceeding 10mm). Final disposition was to leave excavations less than 3mm as is and fill excavations over 3mm with Belzona 1111.

BTL 124: NCR JSW-004, Tower Saddle Divider Plates currently misaligned by .5 mm or more. After WDC discussion ABF plans to correct alignment issues during installation of Tower Saddles and Main Cable.

### Summary of Conversations:

The SMR Lot number provided for this Blue-Tag release was provided by SMR Jay Dorst during previous release of the first shipment of saddles.

### Comments

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina Choy 510-385-5910, who represents the Office of Structural Materials for your project.

---

<b>Inspected By:</b>	Guest,Kittric	Quality Assurance Inspector
<b>Reviewed By:</b>	Choy,Nina	QA Reviewer

---

**DEPARTMENT OF TRANSPORTATION****DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch

690 Walnut Ave.St. 150

Vallejo, CA 94592-1133

(707) 649-5453

(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 70.25B.yyy**MATERIAL SUITABILITY DOCUMENTATION REPORT****Prime Contractor:** American Bridge/Fluor Enterprises, a JV**Report No:** MSD-000717**Contractor:** Japan Steel Works**Date:** 24-Mar-2010**Location:** Muroran, Japan**BTL Mat Des.:****BTL Item No.:****Initiated By/Why:** ABF-SUB-000643R26;ABF-SUB-000643R27;ABF-SUB-000643R28;ABF-SUB-000643R24;ABF-SUB-000643R25**BTL Summary:**

After final machining and final magnetic particle inspection various indications have been found on the tower saddles. These indications are of two different classifications, those less than 3mm in depth and those over 3mm in depth after excavation (not exceeding 10mm). JSW has requested that all sharp edges be removed on the excavations less than 3mm and left as is. For the excavations greater than 3mm they have requested to repair with a filler material.

**METS Comments****METS Discussion:**

As approved in previous RFI 1768R1 Belzona 1111 would be the approved filler material.

**Proposed Resolution:**

Leave excavations less than 3mm "as is" and fill excavations over 3mm with Belzona 1111.

**Date discussed with the Construction Engineer:****Time:****Various:****Construction Comments****Name of the Construction Engineer involved:****Construction agrees with METS recommendation:** Yes No**Recommendation from Construction (If NO is checked above):**

concur

**Contract Change Order required:** Yes No **If Yes, CCO number:****Designer Comments****Name of Design Engineer involved (if applicable):****Recommendation from the Design Engineer (if applicable):****Screening Team involvement:** Yes No**Issue requires FAST Involvement:** Yes No**Decision by FAST (if YES is checked above):****METS Summary of Final Decision:**

Per Submittal Responses 648R24, R26, R27, R28

1. Excavations greater than 3mm: Although the depth of the excavations exceeds the acceptance criteria, repair welding is not required. The excavations must be ground so that they have

---

## MATERIAL SUITABILITY DOCUMENTATION REPORT

( Continued Page 2 of 2 )

---

rounded edges. Use Belzona 1111 to fill the void in accordance with the response to ABF-RFI-001768R01.

2. Excavations less than 3mm: The excavations do not require welding repairs. Grind the excavations so that they have rounded edges.

**Comments:**

This report is for the purpose of determining conformance with the contract documents and is not for the purpose of making repair or fit for purpose recommendations. Should you require recommendations concerning repairs or remedial efforts please contact Nina, Choy, who represents the Office of Structural Materials for your project.

---

<b>Inspected By:</b>	Choy,Nina	Quality Assurance Inspector
<b>Reviewed By:</b>	Choy,Nina	QA Reviewer

---

**DEPARTMENT OF TRANSPORTATION -Toll Bridge Program**

333 Burma Rd.  
Oakland, CA 94607  
(510) 622-5660, (510) 286-0550 fax



*Flex your power  
Be energy efficient!*

October 06, 2011

Contract No. 04-0120F4  
04-SF-80-13.2 / 13.9  
Self-Anchored Suspension Bridge  
Letter No. 05.03.01-009987

Brian A Petersen  
Project Executive  
American Bridge/Fluor, A JV  
375 Burma Road  
Oakland, CA 94607

Dear Brian Petersen,

**Submittal 1179, Rev. 2 - Saddle Tie Rod and Pipe Sleeve Drawings**

The Department has completed the review of Submittal ABF-SUB-001179R02, "Saddle Tie Rod and Pipe Sleeve Drawings," dated September 21, 2011. The submittal is "Approved As Noted," as outlined by the comment below.

The revisions to Japan Steel Works Drawing JSW-ES-012, Rev. 1 made by ABFJV have been performed to reflect the site modifications made to the "Type L" ASTM A354BD east saddle anchor rods. The length modifications were necessary to provide sufficient clearance between the grillage and the support beam flange to install the east saddle.

The location of the "Type L" anchor rods are shown in Drawing JSW-ES-014-2, Rev. 1 and JSW-ES-015-2, Rev. 1, provided in ABF-SUB-001316R02. Combined, these submittals reflect the as-built condition of the east saddle anchor rods.

**CATEGORY A:**

1. Repair the galvanizing of the ASTM A354BD anchor rod in accordance with Section 75-1.05, "Galvanizing" of the Standard Specifications. Ensure that all sharp edges have been removed from the saw-cut anchor rod as part of the surface preparation prior to painting.

If you have any questions, please contact Brian Boal at (510) 622-5191.

Sincerely,

**<<< ORIGINAL SIGNED >>>**

BRIAN BOAL  
Construction Manager (Cable)

For: WILLIAM S. CASEY  
Resident Engineer

Attachment

file: 05.03.01, 55.1179



A JOINT VENTURE

375 Burma Road Oakland CA 94607  
Phone 510-808-4600 / Fax 510-808-4601

**LETTER OF SUBMITTAL**  
**SAS Superstructure Project**

Run Date 29-Sep-11  
Time 2:33 PM

Dated: 21-Sep-2011

SUBMITTAL No: ABF-SUB-001179 Rev: 2

To: Gary Pursell  
California Department of Transportation  
333 Burma Road  
Oakland CA 94607  
Phone: (510) 622-5100 Fax: (510) 622-5165

Co/Job # 660110  
Contract # 04-0120F4  
Sub/Supplier: JSW  
Sub/Supplier No:

Subject: Saddle Tie Rod and Pipe Sleeve Drawings

Special Provis. (SP) REF: 10-1.59  
Standard Spec. (SS) REF:

**Schedule ID:**

**RESUBMITTAL/SUPPLEMENTAL REF:**

We are sending the following attached items:

☒ Attached

☐ Via Fax

☒ Plans/Dwgs

☐ Design Report

☐ Samples

☐ Certificates of Compliance

☐ Calculations

☐ Payroll

☐ Specs

☐ Copy of Letter

☐ Change Order

☐ Schedule

☐ Invoice

☐ Other

Item	Date	Copies	Description	Drawing No	Rev	Subcon Dwg No	Rev	Status	Pages
01	21-Sep-11	6	Tie Rod & Anchor Rod & Bolt Nut - East Saddle	JSW-04-05-000176	1	JSW-ES-012	1	Pending	1

**These are transmitted as checked below:**

☒ For Approval

☐ For Review/comment

☐ Return For Correction

☐ For Your Use

☐ For Information

☐ Other

**Remarks:**

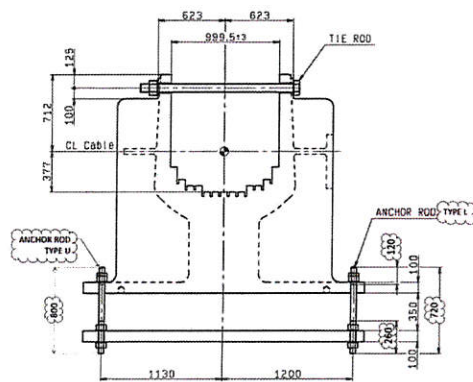
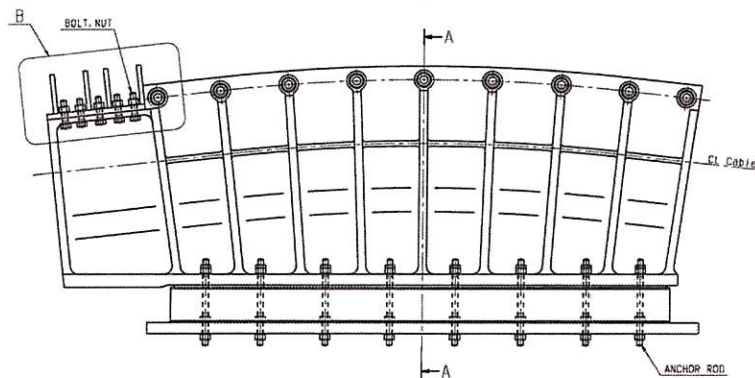
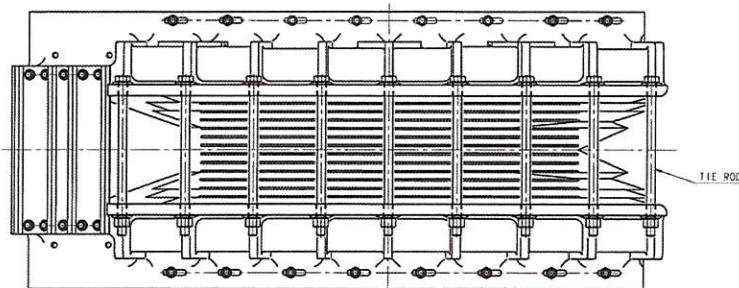
"Field modifications are required to the east saddle anchor rods as indicated in this submittal to provide clearance for the rods between the east saddle grillage and the flange of the east saddle support beams."

**CC:**

Please review / approve by : 05-Oct-2011

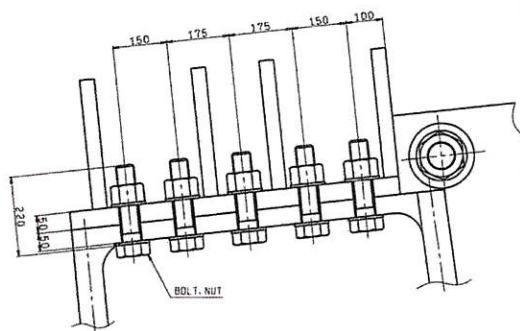
Submitted By: Kevin Smith  
Project Manager

Checked & Sent By: <<< Original Signed >>>  
Document Control



SECTION A-A

S=1:20

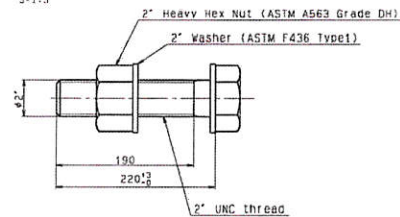


DETAIL B

S=1:6

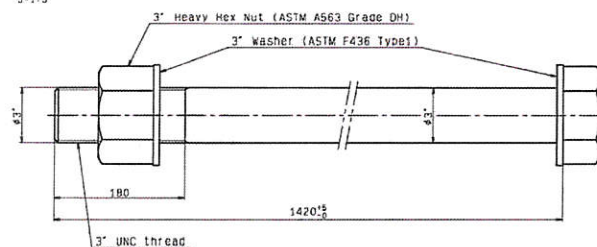
BOLT, NUT : 10sets (ASTM A499)

S=1:3



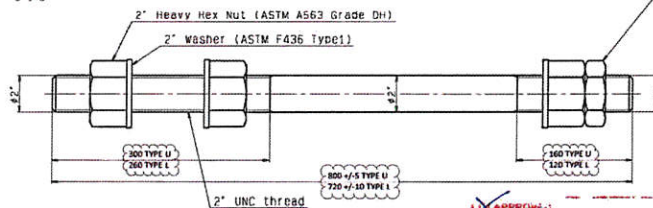
TIE ROD : 9sets (ASTM A354 Grade BD)

S=1:3



ANCHOR ROD : 16sets (ASTM A354 Grade BD)

S=1:3



# NOTES:

1. All dimensions are in millimeters unless otherwise shown.
2. Bolt nut and washer shall be hot dip galvanizing.
3. The thread dimension of bolts and nuts shall be according to applicable ANSI/ASME B1.1.
4. The tolerance of the bolt dimension shall be according to applicable ANSI/ASME B18.2.1.
5. The tolerance of the nuts and jam nuts dimension shall be according to applicable ANSI/ASME B18.2.2.
6. The tolerance of the thread dimension after galvanizing shall be conformed to the requirements in applicable ASTM A354 Para 7.3.3.
7. The tolerance of the shank straightness shall be within 0.25% of shank length or within 2.5mm per 1m.
8. Tie Rods size and Nuts Washers material are approved by ABF-RF1-278 RD, RL-280 RD.
9. Bolts size of ASTM A499 and Anchor Rods size of ASTM A354 Grade BD are approved by ABF-RF1-26 RD.
10. Detail of Anchor Rod (ASTM A354 Grade BD) is approved by ABF-RF1-1459 RD.

REV	DATE	DESCRIPTION	BY	CHK	APP
1	11/11	11/11	11/11	11/11	11/11
2	11/11	11/11	11/11	11/11	11/11

This stamp indicates that this shop drawing has been reviewed for general conformance with the Project Plans and Special Provisions. This stamp does not constitute that a review of the permanent design has been performed.



FOR REVISION 3 ONLY



SAN FRANCISCO OAKLAND BAY BRIDGE	DATE
EAST SPAN SADDLE	11/11
TIE ROD & ANCHOR ROD & BOLT, NUT	11/11
DETAILS DRAWING	11/11
(FOR 221 & 221)	11/11
THE JAPAN STEEL WORKS LTD. MARIANA PLANT	11/11



# Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products<sup>1</sup>

This standard is issued under the fixed designation A123/A123M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope\*

1.1 This specification covers the requirements for zinc coating (galvanizing) by the hot-dip process on iron and steel products made from rolled pressed and forged shapes, castings, plates, bars, and strips.

1.2 This specification covers both unfabricated products and fabricated products, for example, assembled steel products, structural steel fabrications, large tubes already bent or welded before galvanizing, and wire work fabricated from uncoated steel wire. This specification also covers steel forgings and iron castings incorporated into pieces fabricated before galvanizing or which are too large to be centrifuged (or otherwise handled to remove excess galvanizing bath metal).

NOTE 1—This specification covers those products previously addressed in Specifications A123-78 and A386-78.

1.3 This specification does not apply to wire, pipe, tube, or steel sheet which is galvanized on specialized or continuous lines, or to steel less than 22 gage (0.0299 in.) [0.76 mm] thick.

1.4 The galvanizing of hardware items that are to be centrifuged or otherwise handled to remove excess zinc (such as bolts and similar threaded fasteners, castings and rolled, pressed and forged items) shall be in accordance with Specification **A153/A153M**.

1.5 Fabricated reinforcing steel bar assemblies are covered by the present specification. The galvanizing of separate reinforcing steel bars shall be in accordance with Specification **A767/A767M**.

1.6 This specification is applicable to orders in either inch-pound units (as A123) or SI units (as A123M). Inch-pound units and SI units are not necessarily exact equivalents. Within the text of this specification and where appropriate, SI units are shown in parentheses. Each system shall be used independently of the other without combining values in any way. In the case of orders in SI units, all testing and inspection shall be done using the metric equivalent of the test or

inspection method as appropriate. In the case of orders in SI units, such shall be stated to the galvanizer when the order is placed.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

**A47/A47M** Specification for Ferritic Malleable Iron Castings

**A90/A90M** Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

**A143/A143M** Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement

**A153/A153M** Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

**A384/A384M** Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies

**A385** Practice for Providing High-Quality Zinc Coatings (Hot-Dip)

**A767/A767M** Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement

**A780** Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings

**A902** Terminology Relating to Metallic Coated Steel Products

**B6** Specification for Zinc

**B487** Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section

**B602** Test Method for Attribute Sampling of Metallic and Inorganic Coatings

**B960** Specification for Prime Western Grade-Recycled (PWG-R) Zinc

**E376** Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Testing Methods

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee **A05** on Metallic-Coated Iron and Steel Products and is the direct responsibility of Subcommittee **A05.13** on Structural Shapes and Hardware Specifications.

Current edition approved May 1, 2012. Published July 2012. Originally approved in 1928. Last previous edition approved in 2009 as A123/A123M - 09. DOI: 10.1520/A0123\_A0123M-12.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

\*A Summary of Changes section appears at the end of this standard.

### 3. Terminology (See Fig. 1)

#### 3.1 Definitions:

3.1.1 The following terms and definitions are specific to this specification. Terminology A902 contains other terms and definitions relating to metallic-coated steel products.

#### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *average coating thickness,  $n$* —the average of three specimen coating thicknesses.

3.2.2 *black, adj*—denotes the condition of not galvanized or otherwise coated. For purposes of this specification the word

“black” does not refer to the color or condition of surface, or to a surface deposit or contamination.

3.2.3 *coating thickness grade,  $n$* —the numerical value from Table 1 at the intersection of a material category and a thickness range.

3.2.4 *gross cross inclusions,  $n$* —the iron/zinc intermetallics present in a galvanized coating in a form other than finely dispersed pimples.

3.2.4.1 *Discussion*—These inclusions would create an exposed steel spot if they were removed from the coating. These

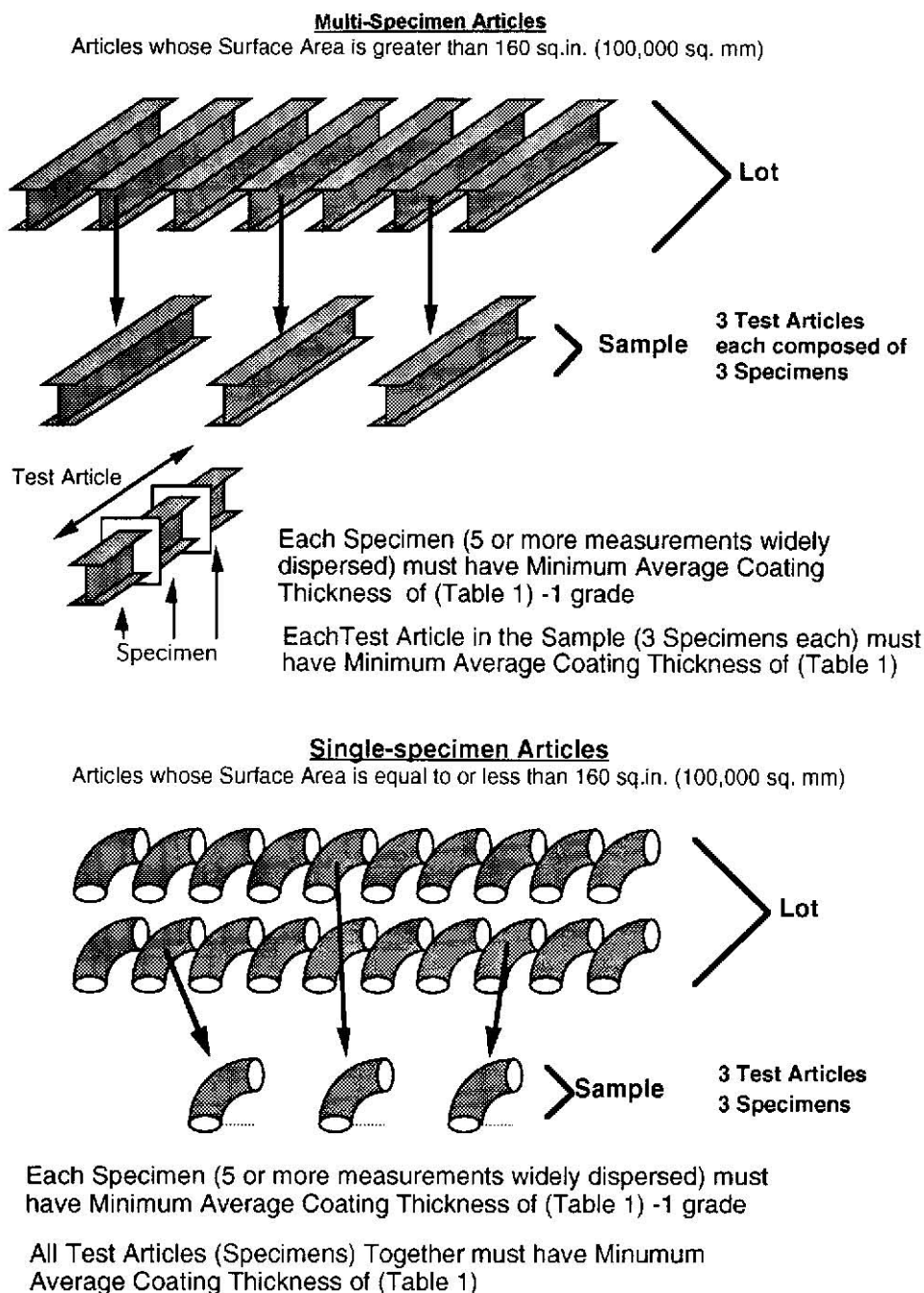


FIG. 1 Single- and Multi-Specimen Articles



TABLE 1 Minimum Average Coating Thickness Grade by Material Category

Material Category	All Specimens Tested				
	Steel Thickness Range (Measured), in. (mm)				
	<1/16 (<1.6)	1/16 to <1/8 (1.6 to <3.2)	1/8 to 3/16 (3.2 to 4.8)	>3/16 to <1/4 (>4.8 to <6.4)	≥1/4 (≥6.4)
Structural Shapes and Plate	45	65	75	75	100
Strip and Bar	45	65	75	75	100
Pipe and Tubing	45	45	75	75	75
Wire	35	50	60	65	80
Reinforcing Bar	...	...	...	...	100

inclusions are raised surfaces and are easily knocked off through contact with lifting straps or chains, tools, fixtures, or other galvanized parts.

3.2.5 *material category, n*—the general class or type of material or process of manufacture, or both, that nominally describes a unit of product, or from which a unit of product is made. For example, bar grating belongs to the category “strip,” handrail belongs to the category “pipe,” etc.

3.2.6 *multi-specimen article, n*—a unit of product whose surface area is greater than 160 in.<sup>2</sup> [100 000 mm<sup>2</sup>]. For thickness testing purposes, articles whose surface area is greater than 160 in.<sup>2</sup> are subdivided into three continuous local sections, nominally equal in surface area, each of which constitutes a specimen. In the case of any such local section containing more than one material category or steel thickness range as delineated in Table 1, that section will contain more than one specimen (see Fig. 1).

3.2.7 *sample, n*—a collection of individual units of product from a single lot selected in accordance with Section 7, and intended to represent that lot for acceptance. If a sample is taken as representing the lot for acceptance, the sample shall be taken at random from the lot without regard to the perceived quality or appearance of any individual unit in the lot being sampled. The sample consists of one or more test articles.

3.2.8 *single-specimen article, n*—a unit of product whose surface area is equal to or less than 160 in.<sup>2</sup> [100 000 mm<sup>2</sup>] or that is centrifuged or otherwise similarly handled in the galvanizing process to remove excess galvanizing bath metal (free zinc). For thickness testing purposes, the entire surface area of each unit of product constitutes a specimen. In the case of any such article containing more than one material category or steel thickness range as delineated in Table 1, that article will contain more than one specimen (see Fig. 1).

3.2.9 *specimen, n*—the surface of an individual test article or a portion of a test article, upon which thickness measurements are to be performed, which is a member of a lot, or a member of a sample representing that lot. For magnetic thickness measurements, specimen excludes any area of the surface which is subject to processes (such as flame cutting, machining, threading, etc.) that can be expected to result in surface conditions not representative of the general surface condition of the test article, or is disqualified by the measurement method. The minimum average coating thickness grade for any specimen shall be one coating grade below that required for the appropriate material category and thickness in Table 1. For a unit of product whose surface area is equal to or less than 160 in.<sup>2</sup> [100 000 mm<sup>2</sup>], the entire surface area of each test article constitutes a specimen. In the case of an article

containing more than one material category or steel thickness range as delineated in Table 1, that article will contain more than one specimen, as appropriate (see Fig. 1).

3.2.10 *specimen coating thickness, n*—the average thickness from no less than five test measurements on a specimen, when each measurement location is selected to provide the widest dispersion (in all applicable directions) of locations for the steel category of the test article within the confines of the specimen volume.

3.2.11 *test article, n*—an individual unit of product that is a member of the sample and that is examined for conformance to a part of this specification.

#### 4. Ordering Information

4.1 Orders for coatings provided under this specification shall include the following:

4.1.1 Quantity (number of pieces to be galvanized) and total weight.

4.1.2 Description (type and size of products) and weight.

4.1.3 ASTM specification designation and year of issue.

4.1.4 Material identification (see 5.1) and surface condition or contamination.

4.1.5 Sampling plan, if different from 7.3.

4.1.6 Special test requirements (see 8.1).

4.1.7 Special requirements (special stacking, heavier coating weight, etc.).

4.1.8 Tagging or piece identification method.

#### 5. Materials and Manufacture

5.1 *Steel or Iron*—The specification, grade, or designation and type and degree of surface contamination of the iron or steel in articles to be galvanized shall be supplied by the purchaser to the hot-dip galvanizer prior to galvanizing.

NOTE 2—The presence in steels and weld metal, in certain percentages, of some elements such as silicon, carbon, and phosphorus tends to accelerate the growth of the zinc-iron alloy layer so that the coating may have a matte finish with little or no outer zinc layer. The galvanizer has only limited control over this condition. The mass, shape, and amount of cold working of the product being galvanized may also affect this condition. Practice A385 provides guidance on steel selection and discusses the effects of various elements in steel compositions (for example, silicon), that influence coating weight and appearance.

5.2 *Fabrication*—The design and fabrication of the product to be galvanized are the responsibilities of the designer and the fabricator. Practices A143/A143M, A384/A384M, and A385 provide guidance for steel fabrication for optimum hot dip galvanizing and shall be complied with in both design and fabrication. Consultation between the designer, fabricator, and

galvanizer at appropriate stages in the design and fabrication process will reduce future problems.

**5.3 Castings**—The composition and heat treatment of iron and steel castings shall conform to specifications designated by the purchaser. Some types of castings have been known to show potential problems with predisposition to being embrittled during the normal thermal cycle of hot-dip galvanizing. It is the responsibility of the purchaser to heat treat or otherwise allow for the possibility of such embrittling phenomena. The requirements for malleable iron castings to be galvanized shall be as stated in Specification A47/A47M.

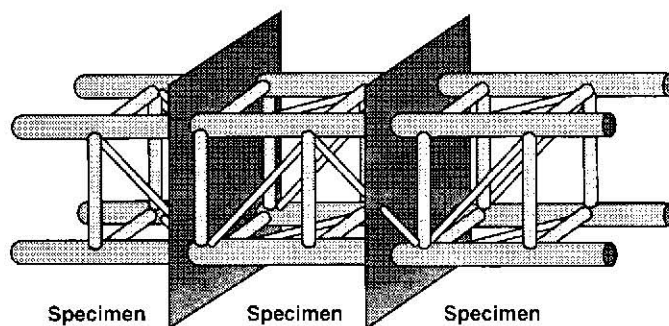
**5.4 Zinc**—The zinc used in the galvanizing bath shall conform to Specification B6, or Specification B960, or both. If a zinc alloy is used as the primary feed to the galvanizing bath, then the base material used to make that alloy shall conform to Specification B6, or Specification B960, or both.

**5.5 Bath Composition**—The molten metal in the working volume of the galvanizing bath shall contain not less than an average value of 98.0 % zinc by weight.

**NOTE 3**—The galvanizer may choose to add trace amounts of certain elements (for example, aluminum, nickel, and tin) to the zinc bath to help in the processing of certain reactive steels or to enhance the cosmetic appearance of the finished product. The use of these trace elements is permitted provided that the bulk chemistry of the galvanizing bath is at least 98.0 % zinc by weight. The elements can be added to the galvanizing bath as part of a pre-alloyed zinc feed, or they can be added to the bath by the galvanizer using a master feed alloy.

## 6. Coating Properties

**6.1 Coating Thickness**—The average thickness of coating for all specimens tested shall conform to the requirements of Table 1 for the categories and thicknesses of the material being galvanized. Minimum average thickness of coating for any individual specimen is one coating grade less than that required in Table 1. Where products consisting of various material thicknesses or categories are galvanized, the coating thickness grades for each thickness range and material category of material shall be as shown in Table 1. In the case of orders in SI units, the values in Table 1, shall be applicable as metric units in micrometres. In the case of orders in inch-pound units, the measured value shall be converted to coating grade units by the use of Table 2. The specification of coating thicknesses heavier than those required by Table 1 shall be subject to mutual agreement between the galvanizer and the purchaser. (Fig. 2 is a graphic representation of the sampling and



**NOTE 1**—Each specimen comprises nominally one third of the total surface area of the article. A minimum of five measurements should be made within the volume of each specimen, as widely dispersed within that volume as is practical, so as to represent as much as possible, the general coating thickness within that specimen volume.

**FIG. 2 Articles Made of Many Components**

specimen delineation steps, and Fig. 3 is a graphic representation of the coating thickness inspection steps.)

**6.1.1** For articles whose surface area is greater than 160 in.<sup>2</sup> [100 000 mm<sup>2</sup>] (multi-specimen articles), each test article in the sample must meet the appropriate minimum average coating thickness grade requirements of Table 1, and each specimen coating thickness grade comprising that overall average for each test article shall average not less than one coating grade below that required in Table 1.

**6.1.2** For articles whose surface area is equal to or less than 160 in.<sup>2</sup> [100 000 mm<sup>2</sup>] (single-specimen articles), the average of all test articles in the sample must meet the appropriate minimum average coating thickness grade requirements of Table 1, and for each test article, its specimen coating thickness shall be not less than one coating grade below that required in Table 1.

**6.1.3** No individual measurement, or cluster of measurements at the same general location, on a test specimen shall be cause for rejection under the coating thickness requirements of this specification provided that when those measurements are averaged with the other dispersed measurements to determine the specimen coating thickness grade for that specimen, the requirements of 6.1.1 or 6.1.2, as appropriate are met.

**NOTE 4**—The coating thickness grades in Table 1 represent the minimum value obtainable with a high level of confidence for the ranges typically found in each material category. While most coating thicknesses

**TABLE 2 Coating Thickness Grade<sup>A</sup>**

Coating Grade	mils	oz/ft <sup>2</sup>	µm	g/m <sup>2</sup>
35	1.4	0.8	35	245
45	1.8	1.0	45	320
50	2.0	1.2	50	355
55	2.2	1.3	55	390
60	2.4	1.4	60	425
65	2.6	1.5	65	460
75	3.0	1.7	75	530
80	3.1	1.9	80	565
85	3.3	2.0	85	600
100	3.9	2.3	100	705

<sup>A</sup> The values in micrometres (µm) are based on the Coating Grade. The other values are based on conversions using the following formulas: mils = µm × 0.03937; oz/ft<sup>2</sup> = µm × 0.02316; g/m<sup>2</sup> = µm × 7.067.

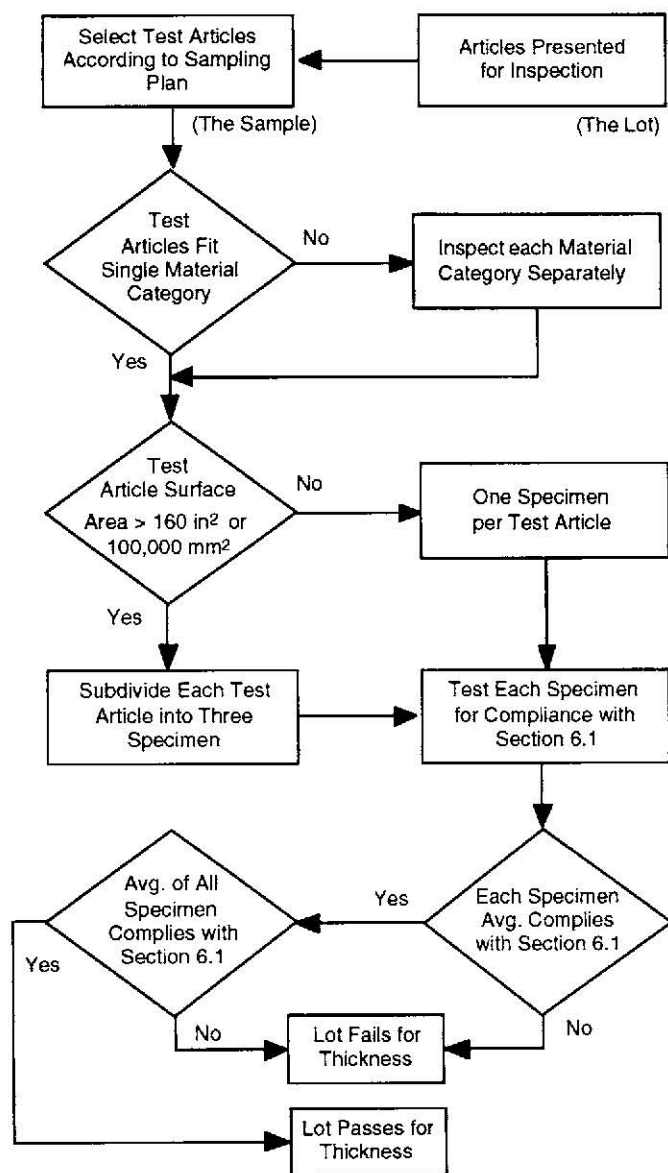


FIG. 3 Coating Thickness Inspection Steps

will be in excess of those values, some materials in each category may be less reactive (for example, because of chemistry or surface condition) than other materials of the steel category spectrum. Therefore, some articles may have a coating grade at or close to the minimum requirement shown in Table 1. In such cases, the precision and accuracy of the coating thickness measuring technique should be taken into consideration when rejecting such articles for coating thickness below that required by this specification. Purchasers desiring a guarantee of heavier coatings than the minimum thicknesses shown herein should use the special requirements (see 4.1.6) to specify coating thickness grades higher than those shown in Table 1. In addition, the purchaser should anticipate the need for test batches or extra preparation steps, or both, such as blasting before galvanizing or other methods, to attempt to reach the higher requirements with consistency. Some higher-than-standard thicknesses may be impractical or unattainable.

**6.2 Finish**—The coating shall be continuous (except as provided below), and as reasonably smooth and uniform in thickness as the weight, size, shape of the item, and necessary handling of the item during the dipping and draining operations

at the galvanizing kettle will permit. Except for local excess coating thickness which would interfere with the use of the product, or make it dangerous to handle (edge tears or spikes), rejection for nonuniform coating shall be made only for plainly visible excess coating not related to design factors such as holes, joints, or special drainage problems (see Note 6). Since surface smoothness is a relative term, minor roughness that does not interfere with the intended use of the product, or roughness that is related to the as-received (un-galvanized) surface condition, steel chemistry, or steel reactivity to zinc shall not be grounds for rejection (see Note 7). Surface conditions related to deficiencies related to design, detailing, or fabrication as addressed by Practice A385 shall not be grounds for rejection. The zinc coating on threaded components of articles galvanized under this specification shall conform to that required in Specification A153/A153M. Surfaces that remain uncoated after galvanizing shall be renovated in accordance with the methods in Practice A780 unless directed by the purchaser to leave the uncoated areas untreated for subsequent renovation by the purchaser.

6.2.1 Each area subject to renovation shall be 1 in. [25 mm] or less in its narrowest dimension.

6.2.2 The total area subject to renovation on each article shall be no more than ½ of 1 % of the accessible surface area to be coated on that article, or 36 in.<sup>2</sup> per short ton [256 cm<sup>2</sup> per metric ton] of piece weight, whichever is less.

NOTE 5—Inaccessible surface areas are those which cannot be reached for appropriate surface preparation and application of repair materials as described in Practice A780. Such inaccessible areas, for example, would be the internal surfaces of certain tanks, poles, pipes, tubes, and so forth.

6.2.3 The thickness of renovation shall be that required by the thickness grade for the appropriate material category and thickness range in Table 1 in accordance with the requirements of 6.1, except that for renovation using zinc paints, the thickness of renovation shall be 50 % higher than that required by Table 1, but not greater than 4.0 mils.

6.2.4 When areas requiring renovation exceed the criteria previously provided, or are inaccessible for repair, the coating shall be rejected.

NOTE 6—The requirements for the finish of a galvanized product address themselves to a visual type of inspection. They do not address the matter of measured coating thickness variations that can be encountered because of different steels or different thicknesses of a given steel being used in an assembly.

NOTE 7—Items which are prepared for galvanizing by abrasive cleaning will generally develop a thicker coating with a moderately rougher surface.

**6.3 Threaded Components in Assemblies**—The zinc coating on external threads shall not be subjected to a cutting, rolling, or finishing tool operation, unless specifically authorized by the purchaser. Internal threads are not prohibited from being tapped or retapped after galvanizing. Coatings shall conform to the requirements of Specification A153/A153M.

**6.4 Appearance**—Upon shipment from the galvanizing facility, galvanized articles shall be free from uncoated areas, blisters, flux deposits, and gross gross inclusions. Lumps, projections, globules, or heavy deposits of zinc which will interfere with the intended use of the material will not be



permitted. Plain holes of ½-in. [12.5-mm] diameter or more shall be clean and reasonably free from excess zinc. Marks in the zinc coating caused by tongs or other items used in handling the article during the galvanizing operation shall not be cause for rejection unless such marks have exposed the base metal and the bare metal areas exceed allowable maximums from 6.2.1 and 6.2.2. The pieces shall be handled so that after galvanizing they will not freeze together on cooling.

NOTE 8—Depending upon product design or material thickness, or both, filming or excess zinc buildup in plain holes of less than ½-in. [12.5-mm] diameter may occur that requires additional work to make the holes usable as intended.

6.5 *Adherence*—The zinc coating shall withstand handling consistent with the nature and thickness of the coating and the normal use of the article, without peeling or flaking.

NOTE 9—Although some material may be formed after galvanizing, in general the zinc coating on the articles covered by this specification is too heavy to permit severe bending without damaging the coating.

## 7. Sampling

7.1 Sampling of each lot shall be performed for conformance with the requirements of this specification.

7.2 A lot is a unit of production or shipment from which a sample is taken for testing. Unless otherwise agreed upon between the galvanizer and the purchaser, or established within this specification, the lot shall be as follows: For testing at a galvanizer's facility, a lot is one or more articles of the same type and size comprising a single order or a single delivery load, whichever is the smaller, or any number of articles identified as a lot by the galvanizer, when these have been galvanized within a single production shift and in the same bath. For test by the purchaser after delivery, the lot consists of the single order or the single delivery load, whichever is the smaller, unless the lot identity, established in accordance with the above, is maintained and clearly indicated in the shipment by the galvanizer.

7.3 The method of selection and number of test specimens shall be agreed upon between the galvanizer and the purchaser. Otherwise, the test specimens shall be selected at random from each lot. In this case, the minimum number of specimens from each lot shall be as follows:

Number of Pieces in Lot	Number of Specimens
3 or less	all
4 to 500	3
501 to 1 200	5
1 201 to 3 200	8
3 201 to 10 000	13
10 001 and over	20

NOTE 10—Where a number of identical items are to be galvanized, a statistical sampling plan may be desired. Such a plan is contained in Test Method B602 which addresses sampling procedures for the inspection of electrodeposited metallic coatings and related finishes. If Test Method B602 is used, the level of sampling shall be agreed upon between the galvanizer and the purchaser at the time the coating order is placed.

7.4 A test specimen which fails to conform to a requirement of this specification shall not be used to determine the conformance to other requirements.

## 8. Test Methods

8.1 *Test Requirements*—The following tests shall be conducted to ensure that the zinc coating is being furnished in accordance with this specification. The specifying of tests for adhesion and embrittlement shall be subject to mutual agreement between the galvanizer and purchaser. Visual inspection of the coating shall be made for compliance with the requirements.

8.2 *Thickness of Coating Test*—The thickness of coating is determined by one or more of the three methods described as follows.

8.2.1 *Magnetic Thickness Measurements*—The thickness of the coating shall be determined by magnetic thickness gage measurements in accordance with Practice E376 unless the methods described in 8.2.2, 8.2.3, or 8.2.4 are used. For each specimen (as described in 3.2.9) five or more measurements shall be made at points widely dispersed throughout the volume occupied by the specimen so as to represent as much as practical, the entire surface area of the test specimen. The average of the five or more measurements thus made for each specimen is the specimen coating thickness.

8.2.1.1 For articles whose surface area is greater than 160 in.<sup>2</sup> [100 000 mm<sup>2</sup>] (multi-specimen articles as described in 3.2.6), the average of the three specimen coating thickness grades comprising each test article is the average coating thickness for that test article. A specimen must be evaluated for each steel category and material thickness within the requirements for each specimen of the test article.

8.2.1.2 For articles whose surface area is equal to or less than 160 in.<sup>2</sup> [100 000 mm<sup>2</sup>] (single-specimen articles as described in 3.2.8), the average of all specimen coating thickness grades is the average coating thickness for the sample.

8.2.1.3 In the case of threaded components, the thickness of coating shall be made on a portion of the article that does not include any threads.

8.2.1.4 The use of magnetic measurement methods is appropriate for larger articles, and is appropriate for smaller articles when there is sufficient flat surface area for the probe tip to sit flat on the surface using Practice E376.

8.2.2 *Stripping Method*—The average weight of coating shall be determined by stripping a test article, a specimen removed from a test article, or group of test articles in the case of very small items such as nails, etc., in accordance with Test Method A90/A90M unless the methods described in 8.2.1, 8.2.3, or 8.2.4 are used. The weight of coating per unit area thus determined is converted to equivalent coating thickness values in accordance with Table 2 (rounding up or down as appropriate). The thickness of coating thus obtained is the test article coating thickness, or in the case of a specimen removed from a test article, is the specimen average coating thickness.

8.2.2.1 The stripping method is a destructive test and is appropriate for single specimen articles, but is not practical for multi-specimen articles.

8.2.3 *Weighing Before and After Galvanizing*—The average weight of coating shall be determined by weighing articles before and after galvanizing, subtracting the first weight from the second and dividing the result by the surface area unless the



methods described in 8.2.1, 8.2.2, or 8.2.4 are used. The first weight shall be determined after pickling and drying and the second after cooling to ambient temperature. The weight of coating per unit area thus determined is converted to equivalent coating thickness values according to Table 2 (rounding up or down as appropriate). The thickness of coating thus obtained is the test article coating thickness.

8.2.3.1 The weighing before and after method is appropriate for single-specimen articles, but is not practical for multi-specimen articles.

NOTE 11—Both the stripping method and the weighing before and after method do not take into account the weight of iron reacted from the article that is incorporated into the coating. Thus, the methods may underestimate coating weight (and therefore the calculated thickness) by up to 10 %. The accuracy of both methods will be influenced by the accuracy to which the surface area of the articles tested can be determined.

8.2.4 *Microscopy*—The thickness of coating shall be determined by cross-sectional and optical measurement in accordance with Test Method B487 unless the methods described in 8.2.1, 8.2.2, or 8.2.3 are used. The thickness thus determined is a point value. No less than five such measurements shall be made at locations on the test article which are as widely dispersed as practical, so as to be representative of the whole surface of the test article. The average of no less than five such measurements is the specimen coating thickness.

8.2.4.1 The microscopy method is a destructive test and is appropriate for single-specimen articles, but is not practical for multi-specimen articles.

8.2.5 *Referee Method*—In the event of a dispute over thickness of coating measurements, the dispute shall be resolved as follows:

8.2.5.1 For multi-specimen articles, a new sample shall be taken randomly from the lot of material, which has twice the number of test articles as the sample which failed to conform to this specification. If the lot size is such that the sample size cannot be doubled, then the sample size shall be as previous, but the number of widely dispersed sites at which measurements were made shall be doubled, and these sites will constitute the new sample. This new sample shall be measured using magnetic thickness gages which have been calibrated for accuracy against reference material thickness standards. If the lot is found to be nonconforming by the new sample, the galvanizer has the right to sort the lot for conforming articles by individual test, to re-galvanize non-conforming articles, or to renovate the nonconforming articles in accordance with 6.2.

8.2.5.2 For single-specimen articles, a new sample shall be taken randomly from the lot of material, which has twice the number of test articles as the sample which failed to conform to this specification. The test method for the new sample shall be selected by mutual agreement between the purchaser and galvanizer. If the lot is found to be nonconforming by the new sample, the galvanizer has the right to sort the lot for conforming articles by individual test, to re-galvanize non-conforming articles, or to renovate the nonconforming articles in accordance with 6.2.

8.3 *Adhesion*—Determine adhesion of the zinc coating to the surface of the base metal by cutting or prying with the point of a stout knife, applied with considerable pressure in a manner

tending to remove a portion of the coating. The adhesion shall be considered inadequate if the coating flakes off in the form of a layer of the coating so as to expose the base metal in advance of the knife point. Do not use testing carried out at edges or corners (points of lowest coating adhesion) to determine adhesion of the coating. Likewise, do not use removal of small particles of the coating by paring or whittling to determine failure.

8.4 *Embrittlement*—Test for embrittlement shall be made in accordance with Practice A143/A143M. These tests shall not be required unless strong evidence of embrittlement is present.

## 9. Inspection, Rejection, and Retest

9.1 *Inspection by the Galvanizer*—It is the responsibility of the galvanizer to ensure compliance with this specification. This shall be achieved by an in-plant inspection program designed to maintain the coating thickness, finish, and appearance within the requirements of this specification unless the inspection is performed in accordance with 9.2.

9.2 *Inspection By the Purchaser*—The purchaser shall accept or reject material by inspection either through the galvanizer's inspector, the purchaser's inspector, or an independent inspector. The inspector representing the purchaser shall have access at all times to those areas of the galvanizer's facility which concern the application of the zinc coating to the material ordered while work on the contract of the purchaser is being performed. The galvanizer shall afford the inspector all reasonable facilities to satisfy him that the zinc coating is being furnished in accordance with this specification.

9.3 *Location*—The material shall be inspected at the galvanizer's plant prior to shipment. However, by agreement the purchaser is not prohibited from making tests which govern the acceptance or rejection of the materials in his own laboratory or elsewhere.

9.4 *Reinspection*—When inspection of materials to determine conformity with the visual requirements of 6.2 warrants rejection of a lot, the galvanizer is not prohibited from sorting the lot and submit it once again for acceptance after he has removed any nonconforming articles and replaced them with conforming articles.

9.5 The sampling plan that was used when the lot was first inspected shall be used for resampling of a sorted lot. By mutual agreement, the galvanizer is not prohibited from submitting the lot remaining after sorting and removing nonconforming articles without replacement of the nonconforming articles. In such case, the now-smaller lot shall be treated as a new lot for purposes of inspection and acceptance.

9.6 Materials that have been rejected for reasons other than embrittlement are not prohibited from being stripped and regalvanized and again submitted for inspection and test at which time they shall conform to the requirements of this specification.

## 10. Certification

10.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each lot have been either tested or inspected as directed by this specification and the requirements have been met.



When specified in the purchase order or contract, a report of the test results shall be furnished.

## 11. Keywords

11.1 coatings—zinc; galvanized coatings; steel products—metallic coated; zinc coatings—steel products

## SUMMARY OF CHANGES

Committee A05 has identified the location of selected changes to this standard since the last issue (A123/A123M - 09) that may impact the use of this standard. (May 15, 2012)

(I) Revised **Table 1**.

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the ASTM website (www.astm.org/COPYRIGHT/).*

Copyright ASTM International  
Provided by IHS under license with ASTM  
No reproduction or networking permitted without license from IHS



# Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement<sup>1</sup>

This standard is issued under the fixed designation A 143/A 143M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope

1.1 This practice covers procedures that can be followed to safeguard against the possible embrittlement of steel hot-dip galvanized after fabrication, and outlines test procedures for detecting embrittlement. Conditions of fabrication may induce a susceptibility to embrittlement in certain steels that can be accelerated by galvanizing. Embrittlement is not a common occurrence, however, and this discussion does not imply that galvanizing increases embrittlement where good fabricating and galvanizing procedures are employed. Where history has shown that for specific steels, processes and galvanizing procedures have been satisfactory, this history will serve as an indication that no embrittlement problem is to be expected for those steels, processes, and galvanizing procedures.

1.2 This practice is applicable in either inch-pounds or SI units. Inch-pounds and SI units are not necessarily exact equivalents. Within the text of this practice and where appropriate, SI units are shown in brackets.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee A05 on Metallic-Coated Iron and Steel Products and is the direct responsibility of Subcommittee A05.13 on Structural Shapes and Hardware Specifications.

Originally Prepared by Subcommittee A05.10 on Embrittlement Investigation of Committee A05 on Corrosion of Iron and Steel and based on an investigation made by Battelle Memorial Institute under American Society for Testing and Materials' sponsorship. See *Proceedings*, Am. Soc. Testing Mats., Vol 31, Part I, 1931, p. 211; also paper by Samuel Epstein, "Embrittlement of Hot-Dip Galvanized Structural Steel," see *Proceedings*, Am. Soc. Testing Mats., Vol 32, Part II, 1932, p. 293.

Current edition approved May 1, 2007. Published June 2007. Originally approved in 1932. Last previous edition approved in 2003 as A 143/A 143M - 03.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

F 606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

## 3. Terminology

### 3.1 Definition:

3.1.1 *embrittlement, n*—the loss or partial loss of ductility in a steel where an embrittled product characteristically fails by fracture without appreciable deformation; types of embrittlement usually encountered in galvanized steel are related to aging phenomena, cold working, and absorption of hydrogen.

## 4. Factors in Embrittlement

4.1 Embrittlement or loss of ductility in steel is often associated with strain-aging. Strain-aging refers to the delayed increase in hardness and strength, and loss of ductility and impact resistance which occur in susceptible steels as a result of the strains induced by cold working. The aging changes proceed slowly at room temperature, but proceed at an accelerated rate as the aging temperature is raised and may occur rapidly at the galvanizing temperature of approximately 850°F [455°C].

4.2 Hydrogen embrittlement may also occur due to the possibility of atomic hydrogen being absorbed by the steel. The susceptibility to hydrogen embrittlement is influenced by the type of steel, its previous heat treatment, and degree of previous cold work. In the case of galvanized steel, the acid pickling reaction prior to galvanizing presents a potential source of hydrogen. However, the heat of the galvanizing bath partially expels hydrogen that may have been absorbed. In practice hydrogen embrittlement of galvanized steel is usually of concern only if the steel exceeds approximately 150 ksi [1100 MPa] in ultimate tensile strength, or if it has been severely cold worked prior to pickling.

4.3 Loss of ductility of cold-worked steels is dependent on many factors including the type of steel (strength level, aging characteristics), thickness of steel, and degree of cold work, and is accentuated by areas of stress concentration such as caused by notches, holes, fillets of small radii, sharp bends, etc.

4.4 Low temperatures increase the risk of brittle failure of all plain carbon steels including steel that has been galvanized. The rate at which this temperature loss of ductility occurs varies for different steels. The expected service temperature should thus be taken into account when selecting the steel.

## 5. Steels

5.1 Open-hearth, basic-oxygen, and electric-furnace steels shall be used for galvanizing. Other materials that can be galvanized include continuous cast slabs, steel or iron castings, and wrought iron.

## 6. Cold Working and Thermal Treatment

6.1 For intermediate and heavy shapes, plates, and hardware, cold bend radii should not be less than that which is proven satisfactory by practice or by the recommendations of the steel manufacturer. These criteria generally depend on the direction of grain, strength, and type of steel. A cold bending radius of three times (3×) the section thickness, or as recommended in *AISC Manual of Steel Construction*,<sup>3</sup> will ordinarily ensure satisfactory properties in the final product. Although sharper bending on thin sections can usually be tolerated, embrittlement may occur if cold bending is especially severe. If the design requires sharper bending than discussed herein, the bending should be done hot, or if done cold the material should be subsequently annealed or stress relieved as noted in 6.3.

6.2 Smaller shapes, including thickness up to ¼ in. [6.4 mm] may be cold worked by punching without subsequent annealing or stress-relieving. Shapes ⅝ to 1½ in. [8 to 18 mm] in thickness are not seriously affected as to serviceability by cold punching or if the punching is done under good shop practice. The heavier shapes, ¾ in. [19 mm] and over, shall be reamed with at least ⅛ in. [1.6 mm] of metal removed from the periphery of the hole after punching, or shall be drilled, or thermally treated prior to galvanizing as noted in 6.3.

6.3 Fabrication in accordance with the principles outlined in 6.1 and 6.2 will normally obviate the need for thermal treatment. However, if required, proper thermal treatment shall precede galvanizing of the steel. For heavy cold deformation exemplified by cold rolling, sheared edges, punched holes, or cold-formed rods and bolts, subcritical annealing at temperatures from 1200 to 1300°F [650 to 705°C] should be employed. For less severe cold deformation typified by cold bending, roll forming, etc., it is advisable to limit the thermal treatment to stress relieving at a maximum of 1100°F [595°C] to avoid excessive grain growth or alternatively to fully normalize the steel at temperatures from 1600 to 1700°F [870 to 925°C]. The time at temperature should be approximately 1 h/in. [24 min/cm] of section thickness.

6.4 Flame cut copes on structural beams shall have a minimum radius of 1 in. [2.5 cm]. After cutting, the cut surface shall be ground to remove notches, grooves, and irregular surface features to leave the surface smooth.

## 7. Preparation for Galvanizing

7.1 Hydrogen can be absorbed during pickling and in some instances, as noted in 4.2, may contribute to embrittlement of the galvanized product. The likelihood of this, or of surface cracking occurring, is increased by excessive pickling temperature, prolonged pickling time, and poor inhibition of the pickling acid. Heating to 300°F [150°C] after pickling and before galvanizing in most cases results in expulsion of hydrogen absorbed during pickling.

7.2 Abrasive blast cleaning followed by flash pickling may also be employed when over-pickling is of concern or when very high strength steel, ultimate tensile strength higher than 150 ksi [1100 MPa], must be galvanized. The abrasive blast cleaning does not generate hydrogen while it is cleaning the surface of the steel. The flash pickling after abrasive blast cleaning is used to remove any final traces of blast media before hot-dip galvanizing.

## 8. Responsibility for Avoiding Embrittlement

8.1 Design of the product and selection of the proper steel to withstand normal galvanizing operations without embrittlement are the responsibility of the designer. The fabricator shall be responsible for employing suitable fabrication procedures. The galvanizer shall employ proper pickling and galvanizing procedures.

## 9. Testing for Embrittlement of Steel Shapes, Steel Castings, Threaded Articles, and Hardware Items

9.1 Subject to base material and dimensional limitations, the tests given in 9.2, 9.3, 9.4, or 9.5, or a combination thereof, shall apply. If one test specimen should be found embrittled by these tests, two additional specimens should be tested. Failure of either the second or the third specimen shall be cause for rejection of the lot (see Note 1) that the samples represent.

NOTE 1—A lot is a unit of production from which a sample may be taken for testing. Unless otherwise agreed upon by the manufacturer and the purchaser, or established within this practice, the lot shall be as follows: For test at a manufacturer's facility, a lot is one or more articles of the same type and size comprising a single order or a single delivery load, whichever is the smaller, or a smaller number of articles identified as a lot by the manufacturer, when these have been galvanized within a single production shift. For test by purchaser after delivery, the lot consists of the single order or the single delivery load, whichever is the smaller, unless the lot identity, established in accordance with the above, is maintained and clearly indicated in the shipment by the manufacturer.

9.2 A bend test for embrittlement of galvanized steel hardware such as bolts, pole and tower steps, braces, rods, reinforcing bars, etc., consists of bending the article and comparing the degree of bending to that which is obtained on a similar ungalvanized article. The article, before and after galvanizing, may be clamped in a vise and using a lever if necessary, bent until cracking of the base steel occurs, or to 90° whichever is less. The galvanized article should withstand a degree of bending substantially the same as the ungalvanized article. Flaking or spalling of the galvanized coating is not to be construed as an embrittlement failure. For threaded articles, the test shall be made on the unthreaded portion.

9.3 Small steel castings and steel hardware of such shape or size that do not permit bending may be struck a sharp blow

<sup>3</sup> Available from American Institute of Steel Construction (AISC), One East Wacker Drive, Suite 3100, Chicago, IL 60601-2001. 9<sup>th</sup> Edition.

with a 2-lb [1-kg] hammer and the results for both galvanized and ungalvanized samples compared. If the article withstands such a blow in the ungalvanized condition, but after galvanizing cracks under the blow, it shall be considered embrittled.

9.4 A test for embrittlement of galvanized steel angles is detailed as follows:

9.4.1 *Test Specimen*—A test specimen with a length determined by the table in 9.4.2.1 and by Fig. 1 shall be cut from the steel angle before galvanizing. A hole shall be made in the test specimen at its midlength, using the same procedure as will be employed in the fabricated material which the specimen represents, whether this be by punching, punching and reaming, or drilling. The dimensional values, diameter, and location of hole shall be not less than those employed in the structural details. Care should be taken not to place the hole near stamped or rolled-in identification marks. The specimen shall then be galvanized. For determining the elongation after fracture, a 2-in. [51-mm] gage length (Fig. 1) shall be prick-punched in the middle of the edge of the vertical leg of the galvanized angle along a line parallel to its length and centered directly under the hole. For specimens under ½ in. [13 mm] in thickness, or those in which the distance from the edge of the hole to the edge of the angle is less than ⅜ in. [10 mm], a 1-in. [25-mm] gage length shall be used.

#### 9.4.2 Procedure:

9.4.2.1 The test shall be made in a universal testing machine, or by other means such as a press with the load applied slowly, until fracture of the galvanized test specimen occurs. The length of the test specimen and the distance between the supports are shown in the following table:

Leg of Angle, <i>l</i> , in. [mm] (see Fig. 1)	Length Between Supports, <i>L</i> <sub>1</sub> , in. [mm]	Minimum Length, <i>L</i> <sub>2</sub> , in. [mm]
Up to 4 [102], incl	14 [356]	18 [457]
Over 4 to 6 [102 to 152], incl	20 [508]	24 [610]
Over 6 to 8 [152 to 203], incl	30 [762]	36 [914]

9.4.2.2 After the test, the distance along the gage length from each punch mark to the corresponding edge of the fracture shall be measured to 0.01 in. [0.25 mm] with a flexible scale and the percentage of elongation calculated from the sum of these distances.

9.4.2.3 For determining the percentage reduction of thickness after fracture, the reduction shall be measured with a ball-point micrometer at the three locations indicated in Fig. 2: namely *a*, outer side of hole; *b*, inner side of hole; and *c*, middle of leg. The percentage reduction of thickness shall be calculated on the basis of the original thickness of the angle and the average of the three values at *a*, *b*, and *c*.

9.4.2.4 The test shall be made upon galvanized specimens having a temperature not below 60°F [16°C] and not over 90°F [32°C] when tested.

9.4.3 *Requirements*—The elongation measured in accordance with 9.4.2.2 shall be not less than 5 % with the following exception: when the specimen does not show 5 % elongation, the reduction in thickness shall be measured in accordance with 9.4.2.3. The sum of the percentage of elongation plus the average percentage reduction of thickness shall not be less than 10.

9.5 For hot-dip galvanized externally threaded fasteners, an alternate test to Section 9.2 for embrittlement is detailed in Test Method F 606.

## 10. Keywords

10.1 coatings-zinc; galvanized coatings; steel products-metallic coated; zinc coatings-steel products

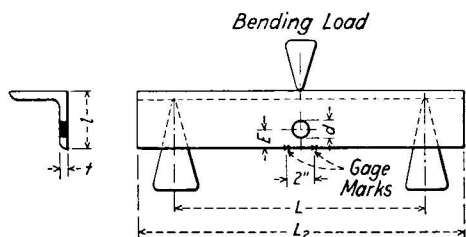


FIG. 1 Specimen for Elongation after Fracture

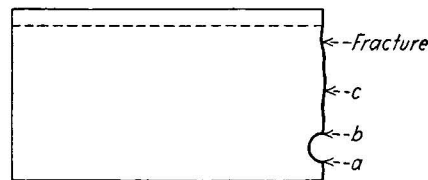


FIG. 2 Measurement of Reduction of Thickness after Fracture

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).



## Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware<sup>1</sup>

This standard is issued under the fixed designation A 153/A 153M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

### 1. Scope\*

1.1 This specification covers zinc coatings applied by the hot-dip process on iron and steel hardware. The hot-dip galvanizing process consists of parts being immersed in molten zinc for a sufficient time to allow a metallurgical reaction between iron from the steel surface and the molten zinc, resulting in the formation of Zn/Fe alloy layers bonding the coating to the steel surface.

1.2 This specification is intended to be applicable to hardware items that are centrifuged or otherwise handled to remove excess galvanizing bath metal (free zinc). Coating thickness grade requirements reflect this.

1.3 This specification is applicable to orders in either inch-pound units (as A 153) or in SI units (as A 153M). Inch-pound units and SI units are not necessarily exact equivalents. Within the text of this specification and where appropriate, SI units are shown in brackets. Each system shall be used independently of the other without combining values in any way. In the case of orders in SI units, all testing and inspection shall be done using the metric equivalent of the test or inspection method as appropriate. In the case of orders in SI units, such shall be stated to the galvanizer when the order is placed.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

- A 90/A 90M Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
- A 143/A 143M Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
- A 780 Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
- A 902 Terminology Relating to Metallic Coated Steel Products
- B 6 Specification for Zinc
- B 487 Test Method for Measurement of Metal and Oxide Coating Thickness by Microscopical Examination of Cross Section
- B 960 Specification for Prime Western Grade-Recycled (PWG-R) Zinc
- E 376 Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Examination Methods
- F 1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection
- F 1789 Terminology for F16 Mechanical Fasteners

### 3. Terminology

#### 3.1 Definitions:

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee A05 on Metallic-Coated Iron and Steel Products and is the direct responsibility of Subcommittee A05.13 on Structural Shapes and Hardware Specifications.

Current edition approved May 1, 2009. Published May 2009. Originally approved in 1933. Last previous edition approved in 2005 as A 153/A 153M - 05.

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

\*A Summary of Changes section appears at the end of this standard.

3.1.1 The following terms and definitions are specific to this specification. Terminology **A 902** contains other terms and definitions relating to metallic-coated steel products. Terminology **F 1789** contains other terms and definitions relating to mechanical fasteners.

**3.2 Definitions of Terms Specific to This Standard:**

3.2.1 *average coating thickness, n*—the average of the specimen coating thickness values for the samples in an inspection lot.

3.2.2 *bare spots, n*—uncoated areas on the surface of the steel part that contain no measurable zinc coating.

3.2.3 *dross inclusions, n*—the iron/zinc intermetallics present in a galvanized coating in a form other than the layer growth of the coating.

3.2.4 *individual measurement, n*—the reading from a magnetic thickness gauge of a single coating spot thickness, or the microscopic reading of a coating thickness as seen in an optical microscope at one spot.

3.2.5 *inspection lot, n*—the quantity of identical parts cleaned, fluxed and galvanized together at one time in an appropriate container that is being submitted for acceptance as a group.

3.2.6 *malleable casting, n*—a steel article that has been subjected to a prolonged anneal to decarburize or graphitize the part to remove as much of the carbon as possible or to convert the carbon to graphite, which permits plastic deformation in compression without rupture.

3.2.7 *sample, n*—a collection of individual units of product from a single inspection lot selected in accordance with Section 6 and intended to represent that inspection lot for acceptance.

3.2.8 *specimen, n*—an individual test article upon which thickness measurements or weight determinations are performed.

3.2.9 *specimen coating thickness, n*—the average thickness from no less than five test measurements on a specimen, when each measurement location is selected to provide the widest dispersion (in all applicable directions) of locations within the specimen volume.

3.2.10 *threaded areas, n*—the sections of a steel part that have threads formed before hot-dip galvanizing.

**4. Materials and Manufacture**

4.1 *Steel or Iron*—Ferrous articles to be hot-dip zinc coated shall conform to specifications designated by the purchaser.

4.2 *Zinc*—The zinc used for the coating shall conform to Specification **B 6**, or Specification **B 960**, or both, and shall be at least equal to the grade designated as “Prime Western.”

4.2.1 If a zinc alloy is used as the primary feed for the galvanizing bath, then the base material used to make that alloy shall conform to Specification **B 6** or Specification **B 960**, or both.

4.2.2 The molten metal in the working volume of the galvanizing bath shall contain not less than an average value of 98.0 % zinc by weight [mass].

NOTE 1—The galvanizer may choose to add trace amounts of certain elements (for example, aluminum, nickel, bismuth, or tin) to the zinc bath to help in the processing of certain reactive steels or to enhance the cosmetic appearance of the finished product. The elements can be added to the galvanizing bath as a master feed alloy, or they can be added to the bath by the galvanizer as individual feeds.

4.3 *Minimum Coating Weight [Mass] or Minimum Coating Thickness*—The minimum coating weight [mass] or the minimum coating thickness shall conform to the requirements prescribed in **Table 1** for the material category and thickness of material in which the article belongs.

4.4 *Threaded Articles*—The zinc coating on threads shall not be subjected to a cutting, rolling, or finishing-tool operation, unless specifically authorized by the purchaser. In order to meet overlapping allowances, tapping the threads of nuts or tapped holes after galvanizing is not prohibited.

4.5 *Touch-up and Repair*—Bare spots that are found on parts after galvanizing shall be renovated by use of the methods found in Practice **A 780** if the following criteria are met. The bare spots shall have an area totalling not more than 1 % of the surface area to be coated excluding threaded areas of the piece and the bare spots shall not include any threaded areas of the

**TABLE 1 Thickness or Weight [Mass] of Zinc Coating for Various Classes of Material**

NOTE 1—Length of the piece, stated in Classes B-1, B-2, and B-3, refers to the finished dimension of the piece after fabrication.

Class of Material	Weight [Mass] of Zinc Coating, oz/ft <sup>2</sup> [g/m <sup>2</sup> ] of Surface, Minimum		Coating Thickness, mils [microns], Minimum	
	Average of Specimens Tested	Any Individual Specimen	Average of Specimens Tested	Any Individual Specimen
<i>Class A</i> —Castings—Malleable Iron, Steel	2.00 [610]	1.80 [550]	3.4 [86]	3.1 [79]
<i>Class B</i> —Rolled, pressed, and forged articles (except those which would be included under Classes C and D):				
B-1— $\frac{3}{16}$ in. [4.76 mm] and over in thickness and over 15 in. [381 mm] in length	2.00 [610]	1.80 [550]	3.4 [86]	3.1 [79]
B-2—under $\frac{3}{16}$ in. [4.76 mm] in thickness and over 15 in. [381 mm] in length	1.50 [458]	1.25 [381]	2.6 [66]	2.1 [53]
B-3—any thickness and 15 in. [381 mm] and under in length	1.30 [397]	1.10 [336]	2.2 [56]	1.9 [48]
<i>Class C</i> —Fasteners over $\frac{3}{16}$ in. [9.52 mm] in diameter and similar articles. Washers $\frac{3}{16}$ in. and $\frac{1}{4}$ in. [4.76 and 6.35 mm] in thickness	1.25 [381]	1.00 [305]	2.1 [53]	1.7 [43]
<i>Class D</i> —Fasteners $\frac{3}{16}$ in. [9.52 mm] and under in diameter, rivets, nails and similar articles. Washers under $\frac{3}{16}$ in. [4.76 mm] in thickness	1.00 [305]	0.85 [259]	1.7 [43]	1.4 [36]

piece. The thickness of the repair shall be equal to the surrounding galvanized coating except for repairs made by paints containing zinc dust in which case the thickness of the repair shall be 50 % greater than the thickness of the galvanized coating required for the class of material, but shall not be greater than 4.0 mils [100 µm]. Repair thickness measurements shall be made in accordance with Practice **A 780**. The galvanizer shall make repairs unless directed by the purchaser to deliver items unrepaired for subsequent renovation by the purchaser.

## 5. Workmanship, Finish, and Appearance

5.1 The zinc-coated articles shall be free from uncoated areas, blisters, flux deposits, dross inclusions, and other types of projections that would interfere with the intended use of the articles, or other defects not consistent with good galvanizing practice.

5.2 The zinc coating shall be smooth and reasonably uniform in thickness.

**NOTE 2**—Smoothness of surface is a relative term. Minor roughness that does not interfere with the intended use of the part, or roughness that is related to the as-received (ungalvanized) surface condition of the part, shall not be grounds for rejection.

**NOTE 3**—Since this specification is applicable to items that are centrifuged or otherwise handled to remove excess bath metal (see **1.2**), irregular coating distribution is not normally encountered. Drainage problems, which manifest themselves as local excess coating thickness that would interfere with function or as edge tears or spikes that present a safety hazard because of their sharpness, are grounds for rejection under the terms of **5.1**.

5.3 Embrittlement is a potential condition of steel that is cold-worked, depending on such factors as the steel type (strength level, aging characteristics), thickness, degree of cold work, and galvanizing process. The galvanizer, the designer and the fabricator shall take precautions against embrittlement. The precautions to fabricate properly and prepare the material for galvanizing to prevent embrittlement are described in Practice **A 143/A 143M**.

**NOTE 4**—Low service temperatures increase the risk of brittle failure of all plain carbon steels including those which have been galvanized. This temperature embrittling effect varies with type of steel. The expected service temperature should thus be taken into account when selecting steels for galvanizing.

5.4 Malleable castings shall be of such composition as will preclude the possibility that they become embrittled by the galvanizing process, or they shall be either cooled from the anneal, or subsequently heat-treated so as to immunize them against embrittlement.

5.5 The zinc coating shall adhere tenaciously to the surface of the base metal.

5.6 If the galvanized material covered by this specification is bent or otherwise fabricated to the degree that causes the zinc coatings to stretch or compress beyond the limit of elasticity, any cracking or flaking of the coating resulting from the bending or fabricating shall not be cause for rejection.

## 6. Sampling

6.1 Test specimens shall be selected at random from each inspection lot.

6.2 The method of selection and sample size shall be agreed upon between the galvanizer and the purchaser. Otherwise, the sample size selected from each lot shall be as follows:

Number of Pieces in Lot	Sample Size
3 or less	all
4 to 500	3
501 to 1200	5
1201 to 3200	8
3201 to 10 000	13
10 001 and over	20

6.3 A specimen that fails to conform to a requirement of this specification shall not be used to determine the conformance to other requirements.

6.4 The method of sampling for fasteners that are required to meet the standards of the Fastener Quality Act is described in Guide **F 1470**. Sample quantities and definitions of terminology are included in the referenced specification.

## 7. Test Methods

7.1 Tests shall be made to ensure that the zinc coating is being furnished in accordance with this specification and as specified for the following:

7.1.1 Minimum coating weight [mass] or minimum coating thickness in **4.3**.

7.1.2 Finish and appearance in **5.1** and **5.2**.

7.1.3 Embrittlement in **5.3** and **5.4**.

7.1.4 Adherence in **5.5**.

7.2 *Average Weight [Mass] of Coating:*

7.2.1 The average weight [mass] of the zinc coating shall be determined by weighing specimens after pickling and drying and again after galvanizing unless the method described in **7.2.2** is used. The number of specimens that are used to determine the average of an inspection lot shall be derived from Section **6**.

**NOTE 5**—This method does not take into account the weight [mass] of iron reacted from the article that is incorporated into the coating. It will thus underestimate coating weight [mass] by up to approximately 10 %. Base metal reactivity will affect the extent of underestimation.

7.2.2 In the case of materials inspected after galvanizing, the average weight [mass] of coating shall be determined by stripping the number of specimens derived in Section **6** in accordance with Test Method **A 90/A 90M**, and averaging the results of the individual specimens, unless the method described in **7.2.1** is used.

7.3 *Average Thickness of Coating:*

7.3.1 In the case of fasteners such as bolts, nuts, and screws, the determination of the thickness of coating shall be made on a portion of the article that does not include any threads.

7.3.2 The average thickness of coating shall be determined by magnetic thickness gage in accordance with Practice **E 376** unless the method described in **7.3.3** is used. The thickness shall be measured on at least five widely separated spots on a specimen. No individual spot measurement shall be cause for rejection. If an individual spot does not provide a coating thickness reading, this spot must be repaired in accordance with **4.5**. The five or more individual coating thickness measurements on a specimen must be averaged to determine the specimen average coating thickness. The average coating thickness for the inspection lot is determined by averaging the

specimen average coating thickness values for the number of specimens derived from Section 6.

7.3.3 The thickness of coating shall be determined by cross section and optical measurement in accordance with Test Method B 487, unless the method described in 7.3.2 is used. The thickness thus determined is a point value. No less than five such measurements shall be made at locations on the specimen, which are as widely dispersed as practical, so as to be representative of the whole surface of the specimen. The average of no less than five such measurements is the specimen average coating thickness. The average coating thickness for the inspection lot is determined by averaging the specimen average coating thickness values for the number of specimens derived from Section 6.

7.4 *Finish and Appearance*—The test for finish and appearance shall be conducted through visual inspection without additional magnification.

7.5 *Embrittlement*—Hardware that is susceptible to embrittlement shall be tested in accordance with Practice A 143/A 143M. The tests shall be performed through agreement between the galvanizer and the purchaser.

7.6 *Adherence*—Determine adherence of the zinc coating to the surface of the base metal by cutting or prying with the point of a stout knife, applied with considerable pressure in a manner tending to remove a portion of the coating. The adherence shall be considered inadequate if the coating delaminates in the form of a layer of skin so as to expose the base metal in advance of the knife point. Do not use testing carried out at edges or corners (points of lowest coating adherence) to determine adherence of coating. Likewise, do not use removal of small particles of the coating by paring or whittling to determine failure.

## 8. Inspection

8.1 The inspector representing the purchaser shall have access at all times while work on the contract of the purchaser is being performed, to those areas of the manufacturer's work which concern the application of the zinc coating to the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the zinc coating is being furnished in accordance with this specification. All inspection and tests shall be made at the place of manufacture

prior to shipments, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

## 9. Rejection and Retest

9.1 For all galvanized articles except those fasteners that must meet the requirements of the Fastener Quality Act, the following sections are used to determine rejection and retesting.

9.2 When partial inspection of materials to determine conformity with visual requirements of Section 5 warrants rejection of a lot, the galvanizer is not prohibited from sorting the lot and submitting it once again for inspection.

9.3 The number of specimens in a sample of a lot permitted to fail to conformance tests shall be agreed upon between the galvanizer and the purchaser.

9.4 If a set of test specimens fails to conform to the requirements of this specification, two additional sets shall be tested, both of which shall conform to the requirements in every respect, or the lot of material represented by the specimens shall be rejected.

9.5 Materials that have been rejected for reasons other than embrittlement are not prohibited from being stripped, regalvanized, and resubmitted for test and inspection. They shall then conform to the requirements of this specification.

## 10. Packaging

10.1 The supplier shall employ such methods of packaging zinc-coated articles as shall be required to ensure their receipt by the purchaser in satisfactory condition, with the use to be made of the article being taken into consideration.

## 11. Certification

11.1 When specified in the purchase order or contract, the purchaser shall be furnished certification that samples representing each inspection lot have been either tested or inspected as directed by this specification and the requirements have been met. When specified in the purchase order or contract, a report of the test results shall be furnished.

## 12. Keywords

12.1 coatings, zinc; galvanized coatings; steel hardware, zinc coated; steel products, metallic coated; zinc coatings, steel products

**SUMMARY OF CHANGES**

Committee A05 has identified the location of selected changes to this standard since the last issue, A 153/A 153M - 05, that may impact the use of this standard. (May 1, 2009)

(I) Revised 4.2 and 4.2.1 to add new zinc standard B 960.

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or [service@astm.org](mailto:service@astm.org) (e-mail); or through the ASTM website ([www.astm.org](http://www.astm.org)).*



# Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners<sup>1</sup>

This standard is issued under the fixed designation A354; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope\*

1.1 This specification<sup>2</sup> covers the chemical and mechanical requirements of quenched and tempered alloy steel bolts, studs, and other externally threaded fasteners 4 in. and under in diameter for application at normal atmospheric temperatures, where high strength is required and for limited application at elevated temperature (**Note 1**). Any alloy steel capable of meeting the minimum mechanical and chemical properties set forth in this specification may be used.

**NOTE 1**—For bolts, studs, or other externally threaded fasteners, to be used at elevated temperatures, refer to Specification **A193/A193M**.

1.2 Two levels of bolting strength are covered, designated Grades BC and BD. Selection will depend upon design and the stresses and service for which the product is to be used.

**NOTE 2**—Quenched and tempered alloy steel bolts for structural steel joints up through 1½ in. in diameter are covered in Specification **A490**. Alloy steel bolts, studs, and other externally threaded fasteners (that is, heavy hex-structural bolts over 1½ in., hex bolts, anchor bolts, and countersunk bolts) exhibiting similar mechanical properties to bolts conforming to Specification **A490** shall be covered by Grade BD of this specification.

When bolts of Grade BD of this specification are considered for pretensioned applications in excess of 50 % of the bolt tensile strength, the additional requirements of head size, maximum tensile strength, nut size and strength, washer hardness, tests, and inspections contained in Specification **A490** should be carefully considered.

1.3 Nuts are covered in Specification **A563**. Unless otherwise specified, the grade and style of nut for each grade of fastener shall be as follows:

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee **F16** on Fasteners and is the direct responsibility of Subcommittee **F16.02** on Steel Bolts, Nuts, Rivets and Washers.

Current edition approved Dec. 15, 2011. Published December 2011. Originally approved in 1952. Last previous edition approved in 2007 as A354 – 07a. DOI: 10.1520/A0354-11.

<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SA-354 in Section II of that Code.

Grade of Fastener and Surface Finish	Nut Grade and Style <sup>A</sup>
BC, plain (or with a coating of insufficient thickness to require over-tapped nuts)	C, heavy hex
BC, zinc-coated (or with a coating thickness requiring over-tapped nuts)	DH, heavy hex
BD, all finishes	DH, heavy hex

<sup>A</sup> Nuts of other grades and styles having specified proof load stresses (Specification **A563**, Table 3) greater than the specified grade and style of nut are suitable.

1.4 The values stated in inch-pound units are to be regarded as the standard.

1.5 Terms used in this specification are defined in Terminology **F1789** unless otherwise defined herein.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

**A193/A193M** Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications  
**A490** Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength  
**A563** Specification for Carbon and Alloy Steel Nuts  
**A751** Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products  
**B695** Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel  
**D3951** Practice for Commercial Packaging  
**F436** Specification for Hardened Steel Washers  
**F606** Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

\*A Summary of Changes section appears at the end of this standard.

**F788/F788M** Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series

**F1470** Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

**F1789** Terminology for F16 Mechanical Fasteners

**F2329** Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

2.2 *ASME Standards*.<sup>4</sup>

**B1.1** Unified Screw Threads

**B18.2.1** Square and Hex Bolts and Screws, Inch Series

**B18.24** Part Identifying Number (PIN) Code System Standard for B18 Fastener Products

### 3. Ordering Information

3.1 Orders for bolts and studs (including nuts and accessories) under this specification shall include the following:

3.1.1 ASTM designation and year of issue,

3.1.2 Name of product (that is, bolt or stud),

3.1.3 Grade (that is, BC or BD),

3.1.4 Quantities (number of pieces by size, including nuts),

3.1.5 Size and length,

3.1.6 Washers—Specify quantity and size (separate from bolts) (4.3),

3.1.7 *Zinc Coating*—When zinc-coated Grade BC fasteners are required, specify the zinc-coating process required, for example hot-dip, mechanically deposited, or no preference (see 4.4).

3.1.8 *Other Finishes*—Specify other protective finish, if required.

3.1.9 Specify if inspection at point of manufacture is required,

3.1.10 Specify if Certification (Section 14) is required, and

3.1.11 Specify additional testing (Section 9) or special requirements.

3.1.12 For establishment of a part identifying system, see ASME **B18.24**.

### 4. Materials and Manufacture

4.1 The steel shall be made by the open-hearth, electric-furnace, or basic-oxygen process.

4.2 All fasteners shall be heat-treated. At the option of the manufacturer, heat treatment may be performed on the raw material, during the manufacturing operations, or after final machining. Heat treatment shall consist of quenching in a liquid medium (except Grade BD sizes 1½ in. and smaller shall be quenched in oil) from above the transformation temperature and then tempering by reheating to a temperature of not less than 800°F (427°C) for Grade BC and for Grade BD.

4.3 When used, suitable hardened washers shall be quenched and tempered (non-carburized) in accordance with Specification **F436**.

4.4 *Zinc Coatings, Hot-Dip and Mechanically Deposited:*

4.4.1 When zinc-coated fasteners are required, the purchaser shall specify the zinc coating process, for example, hot-dip, mechanically deposited, or no preference.

4.4.2 When “hot-dip” is specified, the fasteners shall be zinc coated by the hot-dip process in accordance with the requirements of Specification **F2329**.

4.4.3 When mechanically deposited is specified, the fasteners shall be zinc-coated by the mechanical-deposition process in accordance with the requirements of Class 55 of Specification **B695**.

4.4.4 When no preference is specified, the supplier may furnish either a hot-dip zinc coating in accordance with Specification **F2329**, or a mechanically deposited zinc coating in accordance with Specification **B695**, Class 55. Threaded components (bolts and nuts) shall be coated by the same zinc-coating process and the supplier’s option is limited to one process per item with no mixed processes in a lot.

NOTE 3—When the intended application requires that assembled tension exceeds 50 % of minimum bolt proof load, an anti-galling lubricant may be needed. Application of such a lubricant to nuts and a test of the lubricant efficiency are provided in Supplementary Requirement S1 of Specification **A563** and should be specified when required.

4.5 Zinc-coated bolts and nuts shall be shipped in the same container unless specifically requested otherwise by the purchaser.

NOTE 4—Research conducted on bolts of similar material and manufacture indicates that hydrogen-stress cracking or stress cracking corrosion may occur on hot-dip galvanized Grade BD bolts.

### 5. Chemical Composition

5.1 All fasteners shall be made from alloy steel conforming to the chemical composition requirements in accordance with **Table 1**. The steel shall contain sufficient alloying elements to qualify it as an alloy steel.

NOTE 5—Steel is considered to be alloy, by the American Iron and Steel Institute, when the maximum of the range given for the content of alloying elements exceeds one or more of the following limits: manganese, 1.65 %; silicon, 0.60 %; copper, 0.60 %; or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels: aluminum, chromium up to 3.99 %, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other alloying elements added to obtain a desired alloying effect.

5.2 Product analysis may be made by the purchaser from finished material representing each lot of fasteners. The chemical composition thus determined shall conform to the requirements given in **Table 1**. Choice of alloy steel composition necessary to ensure meeting the specified mechanical requirements shall be made by the manufacturer and shall be reported to the purchaser for information purposes only.

5.3 Application of heats of steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be permitted.

5.4 Chemical analyses shall be performed in accordance with Test Methods, Practices, and Terminology **A751**.

### 6. Mechanical Properties

6.1 Fasteners shall not exceed the maximum hardness specified in **Table 2**. Fasteners less than three diameters in length

<sup>4</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.



TABLE 1 Chemical Requirements

Alloy Steel		
Element	Heat Analysis, %	Product Analysis, %
Carbon:		
For sizes through 1½ in.	0.30 to 0.53	0.28 to 0.55
For sizes larger than 1½ in.	0.35 to 0.53	0.33 to 0.55
Manganese, min	0.60	0.57
Phosphorus, max	0.035	0.040
Sulfur, max	0.040	0.045
Alloying Elements	A	A
Alloy Steel with Boron Addition		
Element	Heat Analysis, %	Product Analysis, %
Carbon		
For sizes through 1½ in.	0.30-0.48	0.28-0.50
For sizes larger than 1½ in.	0.35-0.53	0.35-0.55
Manganese, min	0.60	0.57
Phosphorus, max	0.040	0.045
Sulfur, max	0.040	0.045
Boron	0.0005-0.003	0.0005-0.003
Alloying Elements	A	A

<sup>A</sup>Steel, as defined by the American Iron and Steel Institute, shall be considered to be alloy when the maximum of the range given for the content of alloying elements exceeds one or more of the following limits: Manganese, 1.65 %; silicon, 0.60 %; copper, 0.60 % or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels: aluminum, chromium up to 3.99 %, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other alloying elements added to obtain a desired alloying effect.

TABLE 2 Hardness Requirements for Full-Size Fasteners

Size, in.	Grade	Hardness			
		Brinell		Rockwell C	
		Minimum	Maximum	Minimum	Maximum
¼ to 2½	BC	255	331	26	36
Over 2½	BC	235	311	22	33
¼ to 2½	BD	311	363	33	39
Over 2½	BD	293	363	31	39

and studs less than four diameters in length shall have hardness values not less than the minimum nor more than the maximum hardness limits required in Table 2, as hardness is the only requirement.

6.2 Fasteners 1⅜ in. in diameter or less for Grade BC and 1¼ in. in diameter or less for Grade BD, other than those excepted in 6.1, shall be tested full size and shall conform to the tensile strength and either the proof load or the yield strength requirements in accordance with Table 3.

6.3 Fasteners larger than 1⅜ in. in diameter for Grade BC and fasteners larger than 1¼ in. in diameter for Grade BD, other than those excepted in 6.1, shall preferably be tested full size and when so tested, shall conform to the tensile strength and either the proof load or yield strength requirements in accordance with Table 3. When equipment of sufficient capacity for full-size testing is not available, or when the length of the fastener makes full-size testing impractical, machined specimens shall be tested and shall conform to the requirements in accordance with Table 4. In the event that fasteners

are tested by both full-size and by the machined test specimen methods, the full-size test shall govern if a controversy between the two methods exists.

6.4 For fasteners on which both hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence in the event that there is controversy over low readings of hardness tests.

## 7. Dimensions

7.1 *Bolts*—Unless otherwise specified, the bolts shall be Hex Head with dimensions conforming to the latest issue of ASME B18.2.1.

7.2 *Studs*—Studs shall have dimensions conforming to those specified by the purchaser.

7.3 *Threads*:

7.3.1 Unless otherwise specified, threads shall be the Unified National Coarse Thread Series as specified in B1.1, and shall have Class 2 A tolerances.

7.3.2 When specified, threads shall be the Unified National Fine Thread Series, 8-Pitch Thread Series for sizes over 1 in. or 14-Pitch UNS on 1 in. size as specified in ANSI B1.1 and shall have Class 2A tolerances.

7.3.3 Unless otherwise specified, bolts and studs to be used with nuts or tapped holes that have been tapped oversize, in accordance with Specification A563, shall have Class 2A threads before hot dip or mechanically deposited zinc coating. After zinc coating, the maximum limit of pitch and major diameter may exceed the Class 2A limit by the following amount:

Diameter, in.	Oversize Limit, in. (mm) <sup>A</sup>
¼	0.016
⅝, ¾	0.017
⅞, 1	0.018
1¼ to 1½, incl	0.020
1½	0.022
1.0 to 1¼, incl	0.024
1⅝, 1½	0.027
1¾ to 4.0, incl	0.050

<sup>A</sup> These values are the same as the overlapping required for zinc-coated nuts in Specification A563.

## 8. Workmanship

8.1 Surface discontinuity limits shall be in accordance with Specification F788/F788M.

## 9. Number of Tests

9.1 *Testing Responsibility*:

9.1.1 Each lot shall be tested by the manufacturer prior to shipment in accordance with the lot identification control quality assurance plan in 9.2 through 9.6.

9.1.2 When fasteners are furnished by a source other than the manufacturer, the responsible party as defined in 12.1 shall be responsible for ensuring that all tests have been performed and the fasteners comply with the requirements of this specification.

9.2 *Purpose of Lot Inspection*—The purpose of a lot inspection program is to ensure that each lot conforms to the requirements of this specification. For such a plan to be fully effective it is essential that secondary processors, distributors,



TABLE 3 Tensile Requirements for All Full-Size Fasteners—Inch-Pound Units

Bolt Size, in.	Threads per inch	Stress Area, <sup>A</sup> in. <sup>2</sup>	Grade BC			Grade BD		
			Tensile Strength, min, lbf <sup>B</sup>	Proof Load, min, lbf <sup>C</sup>	Yield Strength (0.2 % offset), min, lbf <sup>D</sup>	Tensile Strength, min, lbf <sup>E</sup>	Proof Load, min, lbf <sup>F</sup>	Yield Strength (0.2 % offset), min, lbf <sup>G</sup>
1	2	3	4	5	6	7	8	9
¼	20	0.0318	4 000	3 350	3 450	4 750	3 800	4 100
¼	28	0.0364	4 550	3 820	3 950	5 450	4 350	4 700
⅝	18	0.0524	6 550	5 500	5 700	7 850	6 300	6 800
⅝	24	0.0580	7 250	6 090	6 300	8 700	6 950	7 500
¾	16	0.0775	9 700	8 150	8 450	11 650	9 300	10 075
¾	24	0.0878	11 000	9 220	9 550	13 200	10 500	11 400
7/16	14	0.1063	13 300	11 150	11 600	15 950	12 750	13 850
7/16	20	0.1187	14 840	12 470	12 900	17 800	14 200	15 400
½	13	0.1419	17 750	14 900	15 450	21 300	17 050	18 500
½	20	0.1599	19 990	16 790	17 400	24 000	19 200	20 750
9/16	12	0.182	22 750	19 100	19 850	27 300	21 850	23 600
9/16	18	0.203	25 400	21 400	22 100	30 400	24 400	26 350
5/8	11	0.226	28 250	23 750	24 650	33 900	27 100	29 400
5/8	18	0.256	32 000	26 800	27 900	38 400	30 700	33 250
¾	10	0.334	41 750	35 050	36 400	50 100	40 100	43 400
¾	16	0.373	46 600	39 100	40 650	56 000	44 800	48 450
7/8	9	0.462	57 750	48 500	50 350	69 300	55 450	60 100
7/8	14	0.509	63 600	53 400	55 450	76 400	61 100	66 150
1	8	0.606	75 750	63 650	66 050	90 900	72 700	78 800
1	12	0.663	82 900	69 700	72 250	99 400	79 600	86 150
1	14 UNS	0.679	84 900	71 300	74 400	101 900	81 500	88 250
1 1/8	7	0.763	95 400	80 100	83 150	114 450	91 550	99 200
1 1/8	8	0.790	98 750	82 950	86 200	118 500	94 800	102 700
1 1/8	12	0.856	107 000	89 800	93 300	128 400	102 700	111 250
1 1/4	7	0.969	121 150	101 750	105 600	145 350	116 300	126 000
1 1/4	8	1.000	125 000	105 000	109 000	150 000	120 000	130 000
1 1/4	12	1.073	134 100	112 600	116 950	161 000	128 800	139 450
1 3/8	6	1.155	144 400	121 300	125 900	173 250	138 600	150 200
1 3/8	8	1.233	154 150	129 450	134 400	185 000	148 000	160 300
1 3/8	12	1.315	164 400	138 100	143 300	197 200	157 800	170 950
1 1/2	6	1.405	175 650	147 550	153 150	210 750	168 600	182 500
1 1/2	8	1.492	186 500	156 650	162 250	233 800	175 050	194 000
1 1/2	12	1.581	197 600	166 000	172 300	237 200	189 700	205 500
1 3/4	5	1.90	237 500	199 500	207 100	285 000	228 000	247 000
1 3/4	8	2.08	260 000	218 400	226 700	312 000	249 600	270 000
2	4 1/2	2.50	312 500	262 500	272 500	375 000	300 000	325 000
2	8	2.77	346 250	290 850	301 950	415 000	332 400	360 000
2 1/4	4 1/2	3.25	406 250	341 250	354 250	487 000	390 000	422 500
2 1/4	8	3.56	445 000	373 800	388 050	534 000	422 200	462 800
2 1/2	4	4.00	500 000	420 000	436 000	600 000	480 000	520 000
2 1/2	8	4.44	550 000	466 200	483 950	666 000	532 800	577 200
2 3/4	4	4.93	566 950	468 350	488 050	690 200	517 650	566 950
2 3/4	8	5.43	624 450	515 850	537 550	750 200	570 150	624 450
3	4	5.97	686 550	567 150	591 050	835 800	626 850	686 550
3	8	6.51	748 650	618 450	644 500	911 400	683 550	748 650
3 1/4	4	7.10	816 500	674 500	702 900	994 000	745 500	816 500
3 1/4	8	7.69	884 350	730 550	761 300	1 076 600	807 650	884 350
3 1/2	4	8.33	957 950	791 350	824 650	1 166 200	874 650	957 950
3 1/2	8	8.96	1 030 400	851 200	887 050	1 254 400	940 800	1 030 400
3 3/4	4	9.66	1 110 900	917 700	956 350	1 352 400	1 014 300	1 110 900
3 3/4	8	10.34	1 199 100	983 300	1 023 650	1 447 600	1 085 700	1 189 100
4	4	11.08	1 274 200	1 052 600	1 096 900	1 551 200	1 163 400	1 274 200
4	8	11.81	1 358 200	1 122 000	1 169 200	1 653 400	1 240 050	1 358 150

<sup>A</sup> Stress Area, in.<sup>2</sup> = 0.7854 [ $D - 0.9743/\eta$ ]<sup>2</sup> where  $D$  = nominal diameter, in., and  $\eta$  = threads/in.

<sup>B</sup> Based on 125 000 psi for sizes ¼ to 2 ½ in., inclusive, and on 115 000 psi for sizes over 2 ½ to 4 in., inclusive.

<sup>C</sup> Based on 105 000 psi for sizes ¼ to 2 ½ in., inclusive, and on 95 000 psi for sizes over 2 ½ to 4 in., inclusive.

<sup>D</sup> Based on 109 000 psi for sizes ¼ to 2 ½ in., inclusive, and on 99 000 psi for sizes over 2 ½ to 4 in., inclusive.

<sup>E</sup> Based on 150 000 psi for sizes ¼ to 2 ½ in., inclusive, and on 140 000 psi for sizes over 2 ½ to 4 in., inclusive.

<sup>F</sup> Based on 120 000 psi for sizes ¼ to 2 ½ in., inclusive, and on 105 000 psi for sizes over 2 ½ to 4 in., inclusive.

<sup>G</sup> Based on 130 000 psi for sizes ¼ to 2 ½ in., inclusive, and on 115 000 psi for sizes over 2 ½ to 4 in., inclusive.



TABLE 4 Mechanical Requirements for Machined Specimens

Grade	Size, in.	Tensile Strength min, psi	Yield Strength (0.2 % offset), min, psi	Elonga- tion in 2 in., min, %	Reduc- tion of Area, min, %
BC	¼ to 2½, incl	125 000	109 000	16	50
BC	Over 2½	115 000	99 000	16	45
BD	¼ to 2½, incl	150 000	130 000	14	40
BD	Over 2½	140 000	115 000	14	40

and purchasers maintain the identification and integrity of each lot until the product is installed.

**9.3 Lot Processing**—All fasteners shall be processed in accordance with a lot identification-control quality assurance plan. The manufacturer, secondary processors, and distributors shall identify and maintain the integrity of each lot of fasteners from raw-material selection through all processing operations and treatments to final packing and shipment. Each lot shall be assigned its own lot-identification number, each lot shall be tested, and the inspection test reports for each lot shall be retained.

**9.4 Lot Definition**—A lot is a quantity of a uniquely identified fastener product of the same nominal size and length produced consecutively at the initial operation from a single mill heat of material and heat treatment lot and processed at one time, by the same process, in the same manner so that statistical sampling is valid. The identity of the lot is maintained throughout all subsequent operations and packaging.

**9.5 Number of Tests**—The minimum number of tests from each production lot for the tests specified below shall be in accordance with Guide F1470.

Hardness  
Tensile

Coating Weight/Thickness  
Workmanship (Surface Disconti-  
nuities Section 8)

Proof Load

**9.5.1** The number of tests for dimensional and thread fit compliance shall be in accordance with the quality assurance provisions of the referenced dimensional standards.

**9.6** If any test specimen shows defective machining it may be discarded and another specimen substituted.

## 10. Test Methods

**10.1** Test methods shall be conducted in accordance with Test Methods F606.

**10.2** Proof load, rather than yield strength determination is preferred and shall be the arbitration method for fasteners 1¼ in. and under in diameter.

**10.3** Hexagon bolts shall be tested by the wedge tension method. Fracture shall be in the body or threads of the bolt without any fracture at the junction of the head and body.

**10.3.1** At the option of the manufacturer, the yield strength test (Method 2, Yield Strength paragraph of Test Methods F606) and the wedge tension test (Wedge Tension Testing of Full-Size Product paragraph, both from the Test Method section of Test Methods F606) may be accomplished concurrently to satisfy 10.2 and 10.3.

**10.4** Studs and bolts other than those in 10.3 shall be tested by the axial tension method.

**10.4.1** At the option of the manufacturer, the yield strength test and the axial tension test may be accomplished concurrently to satisfy 10.2 and 10.4.

**10.5** The speed of testing determined with a free running crosshead shall be a maximum of ⅛ in. (3.2 mm)/min for the bolt proof load (or yield strength) determination and a maximum of 1 in. (25.4 mm)/min for the tensile strength determination.

## 11. Inspection

**11.1** If the inspection described in 11.2 is required by the purchaser, it shall be specified in the inquiry and contract or purchase order.

**11.2** The inspector representing the purchaser shall have free entry to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspections required by the specification that are requested by the purchaser's representative shall be made before shipment, and shall be conducted as not to interfere unnecessarily with the operation of the works.

## 12. Responsibility

**12.1** The party responsible for the fastener shall be the organization that supplies the fastener to the purchaser.

## 13. Rejection and Rehearing

**13.1** Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

## 14. Certification

**14.1** When specified on the purchase order, the manufacturer or supplier, whichever is the responsible party in accordance with Section 12, shall furnish the purchaser a test report which includes the following:

**14.1.1** Product description, grade, quantity, ASTM Specification Number and issue date,

**14.1.2** Alloy grade (AISI, SAE, UNS, etc.), heat analysis, and heat number, and type of quench,

**14.1.3** Results of hardness, tensile, and proof load tests, as applicable,

**14.1.4** Statement of compliance to Protective Coating Specification (if applicable),

**14.1.5** Statement of compliance with the surface discontinuity requirements of Specification F788/F788M,

**14.1.6** Statement of compliance dimensionally,

**14.1.7** Report, describe, or illustrate manufacturer's markings and their location,

**14.1.8** Lot number, purchase order number, and date shipped,

**14.1.9** Country of origin, and

**14.1.10** Title and signature of the individual assigned certification responsibility by the company officers, with complete mailing address.

14.2 Failure to include all the required information on the test report shall be cause for rejection.

## 15. Product Marking

15.1 *Manufacturers Identification*—All products shall be marked by the manufacturer with a unique identifier to identify the manufacturer or private label distributor, as appropriate.

### 15.2 *Grade Identification*:

15.2.1 All Grade BC products shall be marked “BC”.

15.2.2 All Grade BD products shall be marked “BD”. In addition to the “BD” marking, the product may be marked with 6 radial lines 60° apart if manufactured from alloy steel conforming to the requirements of this specification.

### 15.3 *Marking Location and Methods*:

15.3.1 Bolts shall be marked on the top of the bolt head.

15.3.2 Where studs have both coarse and fine threads, all markings shall appear on the coarse thread end or, if preferred, the manufacturer’s identification shall appear on the fine thread end and the grade marking on the coarse thread end.

15.3.3 Continuous thread studs may be marked on either end.

15.3.4 All markings may be raised or depressed at the manufacturer’s option.

15.3.5 Grade and manufacturer’s or private label distributor’s identification shall be separate and distinct. The two identifications shall preferably be in different locations and when on the same level shall be separated by at least two spaces.

## 16. Packaging and Package Marking

### 16.1 *Packaging*:

16.1.1 Unless otherwise specified, packaging shall be in accordance with Practice **D3951**.

16.1.2 When special packaging requirements are required, they shall be defined at the time of the inquiry and order.

### 16.2 *Package Marking*:

16.2.1 Each shipping unit shall include or be plainly marked with the following information:

16.2.1.1 ASTM designation and grade,

16.2.1.2 Size,

16.2.1.3 Name and brand or trademark of the manufacturer,

16.2.1.4 Number of pieces,

16.2.1.5 Purchase order number, and

16.2.1.6 Country of origin.

## 17. Keywords

17.1 alloy steel; bolts; steel; studs

## SUPPLEMENTARY REQUIREMENTS

### S1. Marking

S1.1 Studs that are continuously threaded with the same class of thread shall be marked on each end with the marking in accordance with Section **15**.

S1.2 Marking small sizes (customarily less than 0.375 in. (9.525 mm)) may not be practical. Consult the producer for the minimum size that can be marked.

## SUMMARY OF CHANGES

Committee F16 has identified the location of selected changes to this standard since the last issue (A354-07a) that may impact the use of this standard. (Approved Dec. 15, 2011.)

(I) *Revised*—**Table 1**.

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the ASTM website (www.astm.org/COPYRIGHT/).*



# Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength<sup>1</sup>

This standard is issued under the fixed designation A490; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope\*

1.1 This specification covers two types of quenched and tempered, alloy steel, heavy hex structural bolts having a tensile strength of 150 to 173 ksi.

1.2 These bolts are intended for use in structural connections. These connections are covered under the requirements of the Specification for Structural Joints Using Specification A325 or A490 bolts, approved by the Research Council on Structural Connections; endorsed by the American Institute of Steel Construction and by the Industrial Fastener Institute.<sup>2</sup>

1.3 The bolts are furnished in sizes ½ to 1½ in., inclusive. They are designated by type denoting chemical composition as follows:

Type	Description
Type 1	Medium carbon alloy steel
Type 2	Withdrawn in 2002
Type 3	Weathering steel

1.4 This specification provides that heavy hex structural bolts shall be furnished unless other dimensional requirements are specified on the purchase order.

1.5 Terms used in this specification are defined in Terminology F1789 unless otherwise defined herein.

1.6 For metric bolts, see Specification A490M Classes 10.9 and 10.9.3

1.7 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.8 The following safety hazards caveat pertains only to the Test Methods portion, Section 12 of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user*

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.02 on Steel Bolts, Nuts, Rivets and Washers.

Current edition approved April 1, 2012. Published April 2012. Originally approved in 1964. Last previous edition approved in 2011 as A490 – 11. DOI: 10.1520/A0490-12.

<sup>2</sup> Available from American Institute of Steel Construction (AISC), One E. Wacker Dr., Suite 700, Chicago, IL 60601-2001, <http://www.aisc.org>.

*of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>3</sup>

A194/A194M Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

A325 Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

A354 Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

A490M Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)

A563 Specification for Carbon and Alloy Steel Nuts

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

D3951 Practice for Commercial Packaging

E384 Test Method for Knoop and Vickers Hardness of Materials

E709 Guide for Magnetic Particle Testing

E1444 Practice for Magnetic Particle Testing

F436 Specification for Hardened Steel Washers

F606 Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

F788/F788M Specification for Surface Discontinuities of Bolts, Screws, and Studs, Inch and Metric Series

F959 Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners

F1136 Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners

F1470 Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

\*A Summary of Changes section appears at the end of this standard.

- F1789** Terminology for F16 Mechanical Fasteners  
**F2328** Test Method for Determining Decarburization and Carburization in Hardened and Tempered Threaded Steel Bolts, Screws and Studs  
**F2833** Specification for Corrosion Protective Fastener Coatings with Zinc Rich Base Coat and Aluminum Organic/Inorganic Type  
**G101** Guide for Estimating the Atmospheric Corrosion Resistance of Low-Alloy Steels  
 2.2 *ASME Standards*.<sup>4</sup>  
**B1.1** Unified Screw Threads  
**B18.2.6** Fasteners for Use in Structural Applications  
**B18.24** Part Identification Number (PIN) Code System Standard for B18 Fastener Products  
 2.3 *IFI Standard*.<sup>5</sup>  
**IFI 144** Test Evaluation Procedures for Coating Qualification Intended for Use on High-Strength Bolts

### 3. Ordering Information

- 3.1 Orders for heavy hex structural bolts under this specification shall include the following:
- 3.1.1 Quantity (number of pieces of bolts and accessories);
  - 3.1.2 Size, including nominal bolt diameter, thread pitch, and bolt length. The thread length shall not be changed;
  - 3.1.3 Name of product: heavy hex structural bolts, or other such bolts as specified;
  - 3.1.4 Type of bolt (Type 1 or 3). When type is not specified, either Type 1 or Type 3 shall be furnished at the supplier's option;
  - 3.1.5 ASTM designation and year of issue,
  - 3.1.6 Other components such as nuts, washers, and washer-type direct tension indicators, if required;
  - 3.1.7 Test Reports, if required (see Section 15); and
  - 3.1.8 Protective coating per Specification **F1136**, Grade 3, if required. See 4.3.
  - 3.1.9 Protective coating per Specification **F2833**, Grade 1, if required. See 4.3.
  - 3.1.10 Special requirements.
  - 3.1.11 For establishment of a part identifying system, see ASME **B18.24**.

NOTE 1—A typical ordering description follows: 1000 pieces 1–8 in. dia × 4 in. long heavy hex structural bolt, Type 1, *ASTM A490 – 02*; each with two hardened washers, ASTM **F436** Type 1; and one heavy hex nut, ASTM **A563** Grade DH.

#### 3.2 Recommended Nuts:

3.2.1 Nuts conforming to the requirements of Specification **A563** are the recommended nuts for use with Specification A490 heavy hex structural bolts. The nuts shall be of the class and have a surface finish for each type of bolt as follows:

Bolt Type and Finish	Nut Class and Finish
1, plain (uncoated)	<b>A563</b> —DH, DH3 plain (uncoated)

1, coated in accordance with Specification **F1136**, Grade 3 or Specification **F2833**, Grade 1.

**A563**—coated in accordance with Specification **F1136**, Grade 5 or Specification **F2833**, Grade 1.

3, weathering steel

**A563**—DH3, weathering steel

3.2.2 Alternatively, nuts conforming to Specification **A194/A194M** Gr. 2H plain (uncoated) are considered a suitable substitute for use with Specification A490 Type 1 heavy hex structural bolts.

3.3 *Recommended Washers*—Washers conforming to Specification **F436** are the recommended washers for use with Specification A490 heavy hex structural bolts. The washers shall have a surface finish for each type of bolt as follows:

Bolt Type and Finish	Washer Finish
1, plain (uncoated)	plain (uncoated)
1, coated in accordance with <b>F1136</b> , Grade 3 or <b>F2833</b> , Grade 1.	plain, coated in accordance with <b>F1136</b> , Grade 3 or <b>F2833</b> , Grade 1.
3, weathering steel	weathering steel

3.4 *Other Accessories*—When compressible washer type direct tension indicators are specified to be used with these bolts, they shall conform to Specification **F959** Type 490.

### 4. Materials and Manufacture

4.1 *Heat Treatment*—Type 1 and Type 3 bolts shall be heat treated by quenching in oil from the austenitic temperature and then tempered by reheating to a temperature of not less than 800°F.

4.2 *Threading*—The threads shall be cut or rolled.

4.3 *Protective Coatings*:

4.3.1 When a protective coating is required and specified, the bolts shall be coated with Zinc/Aluminum Corrosion Protective Coatings in accordance with Specification **F1136**, Grade 3 or Specification **F2833**, Grade 1. These coatings have been qualified based on the findings of an investigation founded on **IFI 144**.<sup>6</sup>

4.3.2 No other metallic coatings are permitted unless authorized by Committee F16. Future consideration of any coating will be based on results of testing performed in accordance with the procedures in **IFI 144**, and submitted to Committee F16 for review (See note 2).

NOTE 2—For more detail see the H. E. Townsend Report “Effects of Zinc Coatings on Stress Corrosion Cracking and Hydrogen Embrittlement of Low Alloy Steel,” published in Metallurgical Transactions, Vol. 6, April 1975.

### 5. Chemical Composition

5.1 Type 1 bolts shall be alloy steel conforming to the chemical composition specified in Table 1. The steel shall contain sufficient alloying elements to qualify it as an alloy steel (see Table 1, footnote A.).

5.2 Type 3 bolts shall be weathering steel conforming to the chemical composition requirements in Table 2. See Guide **G101** for methods of estimating the atmospheric corrosion resistance of low alloy steel.

<sup>4</sup> Available from American Society of Mechanical Engineers (ASME), ASME International Headquarters, Three Park Ave., New York, NY 10016-5990, <http://www.asme.org>.

<sup>5</sup> Available from Industrial Fastener Institute, (IFI), 6363 Oak Tree Boulevard, Independence, OH 44131. <http://www.industrial-fasteners.org>.

<sup>6</sup> Supporting data have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR:F16-1001.

**TABLE 1 Chemical Requirements for Type 1 Bolts**

Alloy Steel		
Element	Heat Analysis, %	Product Analysis, %
Carbon		
For sizes through 1½ in.	0.30–0.48	0.28–0.50
For size 1½ in.	0.35–0.53	0.33–0.55
Phosphorus, max	0.040	0.045
Manganese, min	0.60	0.57
Sulfur, max	0.040	0.045
Alloying Elements	<sup>A</sup>	<sup>A</sup>
Alloy Steel with Boron Addition		
Element	Heat Analysis, %	Product Analysis, %
Carbon		
For sizes through 1½ in.	0.30–0.48	0.28–0.50
For size 1½ in.	0.35–0.53	0.35–0.55
Manganese, min	0.60	0.57
Phosphorus, max	0.040	0.045
Sulfur, max	0.040	0.045
Boron	0.0005–0.003	0.0005–0.003
Alloying Elements	<sup>A</sup>	<sup>A</sup>

<sup>A</sup>Steel, as defined by the American Iron and Steel Institute, shall be considered to be alloy when the maximum of the range given for the content of alloying elements exceeds one or more of the following limits: Manganese, 1.65 %; silicon, 0.60 %; copper, 0.60 % or in which a definite range or a definite minimum quantity of any of the following elements is specified or required within the limits of the recognized field of constructional alloy steels: aluminum, chromium up to 3.99 %, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, or any other alloying elements added to obtain a desired alloying effect.

**TABLE 2 Chemical Requirements for Type 3 Bolts**

Element	Heat Analysis, %	Product Analysis, %
Carbon		
Sizes 0.75 in. and smaller	0.20–0.53	0.19–0.55
Sizes larger than 0.75 in.	0.30–0.53	0.28–0.55
Manganese, min	0.40	0.37
Phosphorus, max	0.035	0.040
Sulfur, max	0.040	0.045
Copper	0.20–0.60	0.17–0.63
Chromium, min	0.45	0.42
Nickel, min	0.20	0.17
or		
Molybdenum, min	0.15	0.14

5.3 Product analyses made on finished bolts representing each lot shall conform to the product analysis requirements specified in **Tables 1 and 2**, as applicable.

5.4 Heats of steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be used for bolts furnished to this specification. Compliance with this requirement shall be based on certification that steels having these elements intentionally added were not used.

5.5 Chemical analyses shall be performed in accordance with Test Methods, Practices, and Terminology **A751**.

## 6. Mechanical Properties

6.1 *Hardness*—The bolts shall conform to the hardness specified in **Table 3**.

6.2 *Tensile Properties*:

6.2.1 Except as permitted in **6.2.1.1** for long bolts and **6.2.1.2** for short bolts, sizes 1.00 in. and smaller having a nominal length of  $2\frac{1}{4}D$  and longer and sizes larger than 1.00 in. having a nominal length of  $3D$  and longer shall be wedge tested full size and shall conform to the minimum and maximum wedge tensile load, and proof load or alternative proof load specified in **Table 4**. The load achieved during proof load testing shall be equal to or greater than the specified proof load.

6.2.1.1 When the length of the bolt makes full-size testing impractical, machined specimens shall be tested and shall conform to the requirements specified in **Table 5**. When bolts are tested by both full-size and machined specimen methods, the full-size test shall take precedence.

6.2.1.2 Sizes 1.00 in. and smaller having a nominal length shorter than  $2\frac{1}{4}D$  down to  $2D$ , inclusive, that cannot be wedge tensile tested shall be axially tension tested full size and shall conform to the minimum tensile load and proof load or alternate proof load specified in **Table 4**. Sizes 1.00 in. and smaller having a nominal length shorter than  $2D$  and sizes larger than 1.00 in. with nominal lengths shorter than  $3D$  that cannot be axially tensile tested shall be qualified on the basis of hardness.

6.2.2 For bolts on which hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence in the event of low hardness readings.

## 7. Carburization/Decarburization

7.1 This test is intended to evaluate the presence or absence of carburization and decarburization as determined by the difference in microhardness near the surface and core.

7.2 *Requirements*:

7.2.1 *Carburization*—The bolts shall show no evidence of a carburized surface when evaluated in accordance with **12.2**.

7.2.2 *Decarburization*—Hardness value differences shall not exceed the requirements set forth for decarburization in Test Method **F2328** materials when evaluated in accordance with **12.2**.

## 8. Dimensions

8.1 *Head and Body*:

**TABLE 3 Hardness Requirements for Bolts  
½ to 1½ in. Nominal Size**

Size, in.	Nominal Length, in.	Brinell		Rockwell C	
		min	max	min	max
½ to 1, incl.	Less than $2D$	311	352	33	38
	$2D$ and longer	...	352	...	38
Over 1 to 1½, incl.	Less than $3D$	311	352	33	38
	$3D$ and longer	...	352	...	38

**TABLE 4 Tensile Load Requirements for Bolts Tested Full-Size**

Bolt Size, Threads per Inch, and Series Designation	Stress Area, <sup>A</sup> in. <sup>2</sup>	Tensile Load, <sup>B</sup> lbf		Proof Load, <sup>B</sup> lbf	Alternative Proof Load, <sup>B</sup> lbf
		min	max	Length Measurement Method	Yield Strength Method
Column 1	Column 2	Column 3	Column 4	Column 5	Column 6
½-13 UNC	0.142	21 300	24 600	17 050	18 500
⅝-11 UNC	0.226	33 900	39 100	27 100	29 400
¾-10 UNC	0.334	50 100	57 800	40 100	43 400
7⁄8-9 UNC	0.462	69 300	79 950	55 450	60 100
1-8 UNC	0.606	90 900	104 850	72 700	78 800
1⅛-7 UNC	0.763	114 450	132 000	91 550	99 200
1¼-7 UNC	0.969	145 350	167 650	116 300	126 000
1⅜-6 UNC	1.155	173 250	199 850	138 600	150 200
1½-6 UNC	1.405	210 750	243 100	168 600	182 600

<sup>A</sup> The stress area is calculated as follows:

$$A_s = 0.7854 [D - (0.9743/n)]^2$$

where:

$A_s$  = stress area, in.<sup>2</sup>  
 $D$  = nominal bolt size, and  
 $n$  = threads per inch.

<sup>B</sup> Loads tabulated and loads to be used for tests of full-size bolts larger than 1½ in. in diameter are based on the following:

Bolt Size	Column 3	Column 4	Column 5	Column 6
½ to 1½ in., incl	150 000 psi	173 000 psi	120 000 psi	130 000 psi

**TABLE 5 Tensile Strength Requirements for Specimens Machined from Bolts**

Bolt Size, in.	Tensile Strength, psi		Yield Strength (0.2 % offset), min, psi	Elongation in 2 in. or 50 mm, min, %	Reduction of Area, min, %
	min	max			
½ to 1½ in., incl	150 000	173 000	130 000	14	40

8.1.1 Unless otherwise specified, bolts shall conform to the dimensions for heavy hex structural bolts specified in ASME B18.2.6.

8.1.2 The thread length shall not be changed from that specified in ASME B18.2.6 for heavy hex structural bolts. Bolts requiring thread lengths other than those required by this specification shall be ordered under Specification A354 Gr. BD.

8.2 *Threads*—Threads shall be the Unified Coarse Thread Series as specified in ASME B1.1 and shall have Class 2A tolerances.

## 9. Workmanship

9.1 The allowable limits, inspection, and evaluation of the surface discontinuities, quench cracks, forging cracks, head bursts, shear bursts, seams, folds, thread laps, voids, tool marks, nicks, and gouges shall be in accordance with Specification F788/F788M.

## 10. Magnetic Particle Inspection for Longitudinal Discontinuities and Transverse Cracks

### 10.1 Requirements:

10.1.1 Each sample representative of the lot shall be magnetic particle inspected for longitudinal discontinuities and transverse cracks.

10.1.2 The lot, as represented by the sample, shall be free from nonconforming bolts, as defined in Specification F788/F788M, when inspected in accordance with 10.2.1-10.2.3.

### 10.2 Inspection Procedure:

10.2.1 The inspection sample shall be selected at random from each lot in accordance with Practice F1470 and examined for longitudinal discontinuities and transverse cracks.

10.2.2 Magnetic particle inspection shall be conducted in accordance with Guide E709 or Practice E1444. Guide E709 shall be used for referee purposes. If any nonconforming bolt is found during the manufacturer's examination of the lot selected in 10.2.1, the lot shall be 100 % magnetic particle inspected, and all nonconforming bolts shall be removed and scrapped or destroyed.

10.2.3 Eddy current or liquid penetrant inspection shall be an acceptable substitute for the 100 % magnetic particle inspection when nonconforming bolts are found and 100 % inspection is required. On completion of the eddy current or liquid penetrant inspection, a random sample selected from each lot in accordance with Practice F1470 shall be re-examined by the magnetic particle method. In case of controversy, the magnetic particle test shall take precedence.

10.2.4 Magnetic particle indications of themselves shall not be cause for rejection. If in the opinion of the quality assurance

representative the indications may be cause for rejection, a sample taken in accordance with Practice **F1470** shall be examined by microscopic examination or removal by surface grinding to determine if the indicated discontinuities are within the specified limits.

## 11. Number of Tests and Retests

### 11.1 Testing Responsibility:

11.1.1 Each lot shall be tested by the manufacturer prior to shipment in accordance with the lot identification control quality assurance plan in **11.2-11.5**.

11.1.2 When bolts are furnished by a source other than the manufacturer, the Responsible Party as defined in **16.1** shall be responsible for assuring all tests have been performed and the bolts comply with the requirements of this specification.

11.2 *Purpose of Lot Inspection*—The purpose of a lot inspection program shall be to ensure that each lot as represented by the samples tested conforms to the requirements of this specification. For such a plan to be fully effective, it is essential that secondary processors, distributors, and purchasers maintain the identification and integrity of each lot until the product is installed.

11.3 *Lot Method*—All bolts shall be processed in accordance with a lot identification-control quality assurance plan. The manufacturer, secondary processors, and distributors shall identify and maintain the integrity of each lot of bolts from raw-material selection through all processing operations and treatments to final packing and shipment. Each lot shall be assigned its own lot-identification number, each lot shall be tested, and the inspection test reports for each lot shall be retained.

11.4 *Lot Definition*—A lot shall be a quantity of uniquely identified heavy hex structural bolts of the same nominal size and length produced consecutively at the initial operation from a single mill heat of material and processed at one time, by the same process, in the same manner, so that statistical sampling is valid. The identity of the lot and lot integrity shall be maintained throughout all subsequent operations and packaging.

### 11.5 Number of Tests:

11.5.1 The minimum number of tests from each lot for the tests specified below shall be as follows:

Tests	Number of Tests in Accordance with
Hardness, tensile strength, proof load	Practice <b>F1470</b>
Surface discontinuities	Specification <b>F788/F789M</b>
Magnetic particle inspection	Specification <b>F788/F789M</b>
Dimensions and thread fit	ASME <b>B18.2.6</b>

11.5.2 For carburization and decarburization tests, not less than one sample unit per manufactured lot shall be tested for microhardness.

## 12. Test Methods

### 12.1 Tensile, Proof Load, and Hardness:

12.1.1 Tensile, proof load, and hardness tests shall be conducted in accordance with Test Methods **F606**.

12.1.2 Tensile strength shall be determined using the Wedge or Axial Tension Testing Method of Full Size Product Method or the Machined Test Specimens Method, depending on size and nominal length as specified in **6.2.1-6.2.2**. Fracture on

full-size tests shall be in the body or threads of the bolt without a fracture at the junction of the head and body.

12.1.3 Proof load shall be determined using Method 1, Length Measurement, or Method 2, Yield Strength, at the option of the manufacturer.

12.2 *Carburization/Decarburization*—Tests shall be conducted in accordance with Test Method **F2328** Hardness Method.

12.3 *Microhardness*—Tests shall be conducted in accordance with Test Method **E384**.

12.4 *Magnetic Particle*—Inspection shall be conducted in accordance with Section **10**.

## 13. Inspection

13.1 If the inspection described in **13.2** is required by the purchaser, it shall be specified in the inquiry and contract or order.

13.2 The purchaser's representative shall have free entry to all parts of manufacturer's works or supplier's place of business that concern the manufacture of the material ordered. The manufacturer or supplier shall afford the purchaser's representative all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspections required by the specification that are requested by the purchaser's representative shall be made before shipment, and shall be conducted as not to interfere unnecessarily with the operation of the manufacturer's works or supplier's place of business.

## 14. Rejection and Rehearing

14.1 Disposition of nonconforming material shall be in accordance with Practice **F1470** section titled "Disposition of Nonconforming Lots."

## 15. Certification

15.1 When specified on the purchase order, the manufacturer or supplier, whichever is the responsible party as defined in Section **16** shall furnish the purchaser a test report that includes the following:

15.1.1 Heat analysis, heat number, and a statement certifying that heats having bismuth, selenium, tellurium, or lead intentionally added were not used to produce the bolts;

15.1.2 Results of hardness, tensile, and proof load tests;

15.1.3 Results of magnetic particle inspection for longitudinal discontinuities and transverse cracks;

15.1.4 Results of tests and inspections for surface discontinuities including visual inspection for head bursts;

15.1.5 Results of carburization and decarburization tests;

15.1.6 Statement of compliance with dimensional and thread fit requirements;

15.1.7 Lot number and purchase order number;

15.1.8 Complete mailing address of responsible party; and

15.1.9 Title and signature of the individual assigned certification responsibility by the company officers.

15.2 Failure to include all the required information on the test report shall be cause for rejection.

## 16. Responsibility

16.1 The party responsible for the fastener shall be the organization that supplies the fastener to the purchaser.

## 17. Product Marking

17.1 *Manufacturer's Identification*—All Type 1 and Type 3 bolts shall be marked by the manufacturer with a unique identifier to identify the manufacturer or private label distributor, as appropriate.

### 17.2 *Grade Identification*:

17.2.1 Type 1 bolts shall be marked “A490.”

17.2.2 Type 3 bolts shall be marked “A490” underlined.

17.3 *Marking Location and Methods*—All marking shall be located on the top of the bolt head and shall be either raised or depressed at the manufacturer's option.

17.4 *Acceptance Criteria*—Bolts that are not marked in accordance with these provisions shall be considered nonconforming and subject to rejection.

17.5 Type and manufacturer's or private label distributor's identification shall be separate and distinct. The two identifi-

cations shall preferably be in different locations and, when on the same level, shall be separated by at least two spaces.

## 18. Packaging and Package Marking

### 18.1 *Packaging*:

18.1.1 Unless otherwise specified, packaging shall be in accordance with Practice **D3951**.

18.1.2 When special packaging requirements are required, they shall be defined at the time of the inquiry and order.

### 18.2 *Package Marking*:

18.2.1 Each shipping unit shall include or be plainly marked with the following information:

18.2.1.1 ASTM designation and type,

18.2.1.2 Size,

18.2.1.3 Name and brand or trademark of the manufacturer,

18.2.1.4 Number of pieces,

18.2.1.5 Lot number,

18.2.1.6 Purchase order number, and

18.2.1.7 Country of origin.

## 19. Keywords

19.1 bolts; alloy steel; steel; structural; weathering steel

## SUMMARY OF CHANGES

Committee F16 has identified the location of selected changes to this standard since the last issue (A490–11) that may impact the use of this standard. (Approved April 1, 2012.)

(1) *Revised*—Section **2** to include protective coating **F2833** grade 1.

(2) *Revised*—**3.1** to include protective coating **F2833** grade 1.

(3) *Revised*—**3.2.1** to include protective coating **F2833** grade 1.

(4) *Revised*—**3.3** to include protective coating **F2833** grade 1.

(5) *Revised*—**4.3.1** to include protective coating **F2833** grade 1.

Committee F16 has identified the location of selected changes to this standard since the last issue (A490–10a<sup>e1</sup>) that may impact the use of this standard. (Approved Dec. 15, 2011.)

(1) *Revised*—**Table 1**.

Committee F16 has identified the location of selected changes to this standard since the last issue (A490–10) that may impact the use of this standard. (Approved Dec. 1, 2010.)

(1) *Revised*—In **Table 3**, reduced maximum Rockwell C hardness from 39 to 38 HRC

*ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.*

*This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.*

*This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the ASTM website (www.astm.org/COPYRIGHT).*