



5

E2 BEARING ASSEMBLY ANCHOR RODS

(2007-2010) – 96 Rods

Fabrication and Installation Processes

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E2 Bearing Assemblies

2009-2010 TIMELINE

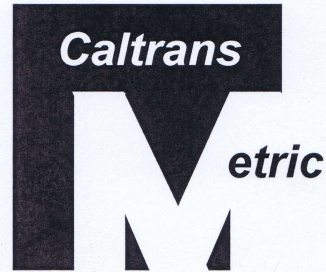
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ADDITIONAL DOCUMENTS

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									
			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 all rods are not accessible 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 -> 32 of 336 bolts are accessible.	
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 0.68	7/14/2012 N/A	N/A 4/6/2013	N/A 4/19/2013	N/A 5/3/2013	Load During Construction - Tensioned to 0.5 Fy 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: Initial Tension complete on 5/20/2011; final tension complete on 3/25/2013.	
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 for KOS for KFM (04-0120E4)	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: Initial Tension Late 2010 through Early 2011; Final Tension 2013	
	13	Tower Anchor Rods - Tower at Footing (4" Dia)	rod	Cut		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: Initial Tension Late 2010 through Early 2011; Final Tension 2013	
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

10-1.47 SPHERICAL BUSHING BEARING (PIER E2)

This work shall consist of fabricating and installing the spherical bushing bearing on Pier E2 in conformance with details shown on the plans and the requirements of these special provisions.

The spherical bushing bearing consists of spherical bushing assembly, bearing top housing, bearing bottom housing, bearing hold down assembly, retaining ring plates, solid shaft, dust cover, base plate, bearing plate, anchor bolts, and assembly bolts. The lubricant shall be self-lubricated and shall be provided for all bronze surfaces and other surfaces as shown on the plans. Bearings shall be anchored in place with high strength non-shrink grout.

Spherical bushing bearings shall be furnished and installed at Pier E2.

GENERAL

Attention is directed to "Steel Structures," of these special provisions for steel casting requirements.

Attention is directed to "Shear Key (Pier E2)," of these special provisions for additional installation requirements.

Attention is directed to "Lubricant and Test," of these special provisions.

The design loads, design rotations, design displacements, and alignment tolerances shall conform to the values as shown on the plans.

WORKING DRAWINGS

The Contractor shall submit working drawings in conformance with the provisions in "Working Drawings," of these special provisions.

Working drawings shall include complete details, information, drawings, and substantiating calculations of the spherical bushing bearing and its components and the method, materials, equipment, and procedures of fabrication and installation that the Contractor proposes to use including the placement of high strength non-shrink grout.

Working drawing submittals shall include the following:

- A. Bearing fabrication plans for all bearings including complete details for each component.
- B. All ASTM, AASHTO, or other material designations including dust cover and its connection to other bearing components, and retaining ring plates.
- C. The bushing wall thickness, fits, and tolerances.
- D. Storage and shipping plans including details of handling and supporting of the bearings. Each bearing shipment shall be accompanied by a Certificate of Compliance in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications. The certificate shall state that the materials and fabrication involved comply in all respects to the specifications and data submitted in obtaining approval.
- E. Installation plans including the following:
 - 1. Method, materials, equipment, sequence, detailed procedures, and temporary support details that the Contractor proposes to use for installation of the spherical bushing bearing. The Contractor's proposed spherical bushing bearing installation including the solid shaft press fit shall not damage the lubricant at any given time during the installation. The Contractor's proposed spherical bushing bearing installation procedures and sequences shall be detailed in the superstructure construction sequences as specified in these special provisions.
 - 2. The Contractor's calculated relative distances for a) relative distance between the centerline of E2 floor beam at box girder (normal to vertical profile) and the centerline of Pier E2 (vertical); distance is measured in the longitudinal direction along the top horizontal surface of concrete crossbeam, and b) relative distance between centerline of longitudinal shear plates (normal to cross slope) and centerline of Pier E2 (vertical); distance is measured in the transverse direction along the top sloped surface of the concrete crossbeam.
- F. Details of lifting locations and mechanisms.

A supplement to the working drawings shall include the following:

- A. The quality control plan (QCP). The QCP of the spherical bushing bearings shall conform to the requirements in "Quality Control" of these special provisions and shall include descriptions, details, and procedures for the fabrication and installation of the spherical bushing bearings, except that the portion of the QCP for welding shall be submitted separately in conformance with "Welding" in these special provisions.
- B. The manufacturer of the spherical bushing bearing shall submit to the Engineer a manual for the bearing inspection, maintenance, and replacement. This manual shall include:
 - 1. A record of spherical bushing bearing for each component including the tracing of all components during the fabrication and installation of spherical bushing bearing.

2. Recommended life expectancy for each bearing component.
3. Recommended frequency for bearing inspection and maintenance schedule.
4. Procedures and details to perform the bearing inspection and maintenance.
5. List of indication of bearing defects and the associated repair methods, if applicable.
6. Procedures and sequences for bearing replacement including locations of temporary support, estimate of jacking load for each temporary support location, sequences and methods of detensioning anchor bolts, method of debonding between concrete and base plates and anchor bolts, method of removing and replacing bearings, a list of equipment to be used for bearing replacement, and traffic, safety, and environmental impact.

Each working drawing and calculation sheet shall be signed by an engineer who is registered as a Civil Engineer or Mechanical Engineer in the State of California. After complete working drawings and supplement are received by the Engineer, the Contractor shall allow the Engineer 40 days to review the submittal.

Upon completion of installation, the Contractor shall submit to the Engineer certification stating that each spherical bushing bearing has been installed in accordance with the approved working drawings and supplements installation procedure.

MATERIALS

The materials specifications of spherical bushing bearing components shall conform to the following table:

Component	ASTM Specifications
Anchor Bolts	A354, Grade BD
Assembly Bolts	A240, Type 316
Bearing Plate	B22-C86300
Spherical Housing	A744, Grade CF-8M
Spherical Ball	B271-C86300
Solid Shaft	Structural Casting, Grade 550
Bearing Bottom Housing	Structural Casting, Grade 550
Bearing Top Housing	Structural Casting, Grade 345
Bearing Hold Down Assembly	Structural Casting, Grade 345

Attention is directed to "Welding" and "Audits" of these special provisions.

Attention is directed to "Lubricant and Test" of these special provisions.

Prestressing operation of anchor bolts shall conform to the requirements in "Prestressing Concrete," elsewhere in these special provisions.

High strength nonshrink grout shall conform to the requirements in "High Strength Nonshrink Grout," elsewhere in these special provisions.

Steel components including plates and anchor bolts shall conform to the details shown on the plans, the provisions in "Steel Structures," of the Standard Specifications, and these special provisions.

Clean and paint spherical bushing bearing shall conform to the requirements in "Clean and Paint Structural Steel (Seismic Joint, Spherical Bushing Bearing, and Shear Key)," of these special provisions.

The bronze alloy for the spherical ball and ring bushing shall be high strength manganese bronze centrifugally cast conforming to the requirements of ASTM Designation: B271-C86300. The stainless steel for the spherical housing shall be centrifugally cast conforming to the requirements of ASTM Designation: A744 Grade CF-8F. All items integral to and for the assembly of the bearing shall be stainless steel conforming to ASTM Designation: A 240, Type 304 or Type 316.

The bushing wall thickness, fits, and tolerances shall be as recommended by the manufacturer and specified in the working drawings and supplement.

QUALITY CONTROL

Quality Control (QC) shall be the responsibility of the Contractor. Quality Control shall be performed by an entity having a line of responsibility distinctly different from that of the manufacturer's fabrication department. As a minimum, the Contractor shall perform inspection and testing prior to fabrication, during fabrication, and after fabrication as specified herein and additionally as necessary to ensure that materials and workmanship conform to the requirements of the contract documents. Quality Control shall apply to each component of the spherical bushing bearing in addition to the assembly, shipping and installation of the bearing.

The QC Inspector shall be the duly designated person who acts for and on behalf of the Contractor for inspection, testing, and quality related matters for all fabrication.

Quality Assurance (QA) is the prerogative of the Engineer. The QA Inspector is the duly designated person who acts for and on behalf of the Engineer.

Each QC Inspector shall be responsible for quality control acceptance or rejection of materials and workmanship.

The Contractor shall provide sufficient number of QC Inspectors to ensure continuous inspection.

The Contractor shall designate in writing a Quality Control Manager (QCM). The QCM shall be responsible directly to the Contractor for the quality of the fabrication, including materials and workmanship, performed by the Contractor and subcontractors.

The QCM shall be the sole individual responsible to the Contractor for submitting and receiving all correspondences, required submittals, and reports to and from the Engineer.

The Contractor shall submit to the Engineer 3 copies of Quality Control Plan (QCP), in conformance with the requirements in "Working Drawings," of these special provisions. As a minimum, each QCP shall include the following:

- A. A manual including equipment, testing procedures, and code of safe practices.
- B. The names, qualifications, and documentation of certifications for the QCM and all QC Inspectors.
- C. An organizational chart showing all QC personnel and their assigned QC responsibilities.
- D. The methods and frequencies for performing all required quality control procedures, including QC inspection forms to be used, as required by the specifications including:
 - 1. All visual inspections.
 - 2. Tests.
 - 3. Calibration procedures and calibration frequency for all equipment.
- E. Forms to be used for Certificates of Compliance, monthly production logs, and monthly reports.
- F. Mill certificates and material certificates.
- G. Shipping plan.
- H. Installation plan.

Prior to submitting the QCP, a pre-fabrication meeting between the Engineer, Contractor, and fabricator, any entity performing spherical bushing bearing component fabrication or subcontractor to the Fabricator, shall be held to discuss the requirements for the QCP. The pre-fabrication meeting shall be held in San Francisco Bay Area.

After a complete QCP is submitted, the Contractor shall allow the Engineer 10 days to review the submittal. An amended QCP or addendum shall be submitted to, and approved in writing by the Engineer, for proposed revisions to the approved QCP. The Contractor shall allow the Engineer 10 days to complete the review of the amended QCP or addendum.

After final approval of the QCP, amended QCP, or addendum, the Contractor shall submit 7 copies to the Engineer of each of these approved documents.

It is expressly understood that the Engineer's approval of the Contractor's QCP shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work in conformity with the requirements of the plans and specifications. The Engineer's approval shall not constitute a waiver of any requirement of the plans and specifications nor relieve the Contractor of any obligation thereunder, and defective work, materials, and equipment may be rejected notwithstanding approval of the QCP.

A monthly production log for fabrication shall be kept by the QCM for each day that fabrication is performed. The monthly report from each QC Inspector shall be included in the log.

The QCM shall sign and furnish to the Engineer, a Certificate of Compliance in conformance with the provisions in Section 6-1.07, "Certificates of Compliance," of the Standard Specifications for each spherical bushing bearing. The certificate shall state that all of the materials and workmanship incorporated in the work, and all required tests and inspections of this work have been performed in conformance with the details shown on the plans and approved working drawings and the provisions of the Standard Specifications and these special provisions.

FABRICATION AND INSTALLATION

Attention is directed to "Steel Structures," of these special provisions for fabrication and installation of spherical bushing bearings at Pier E2. The Contractor shall also conform to the requirements specified herein.

Conformance with the requirements in SSPC-QP 1, SSPC-QP 2, and SSPC-QP 3 of the "SSPC: The Society for Protective Coatings" will not be required for spherical bushing bearings.

Finish coats will not be required on the bearings.

Each bearing shall be marked for location and orientation in conformance with the approved working drawing and supplement. Bearings shall be secured to shipping skids in a manner that assures protection during transportation and off-loading. Each skid shall be wrapped in moisture proof and dust proof covers at all times until immediately before installation.

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.

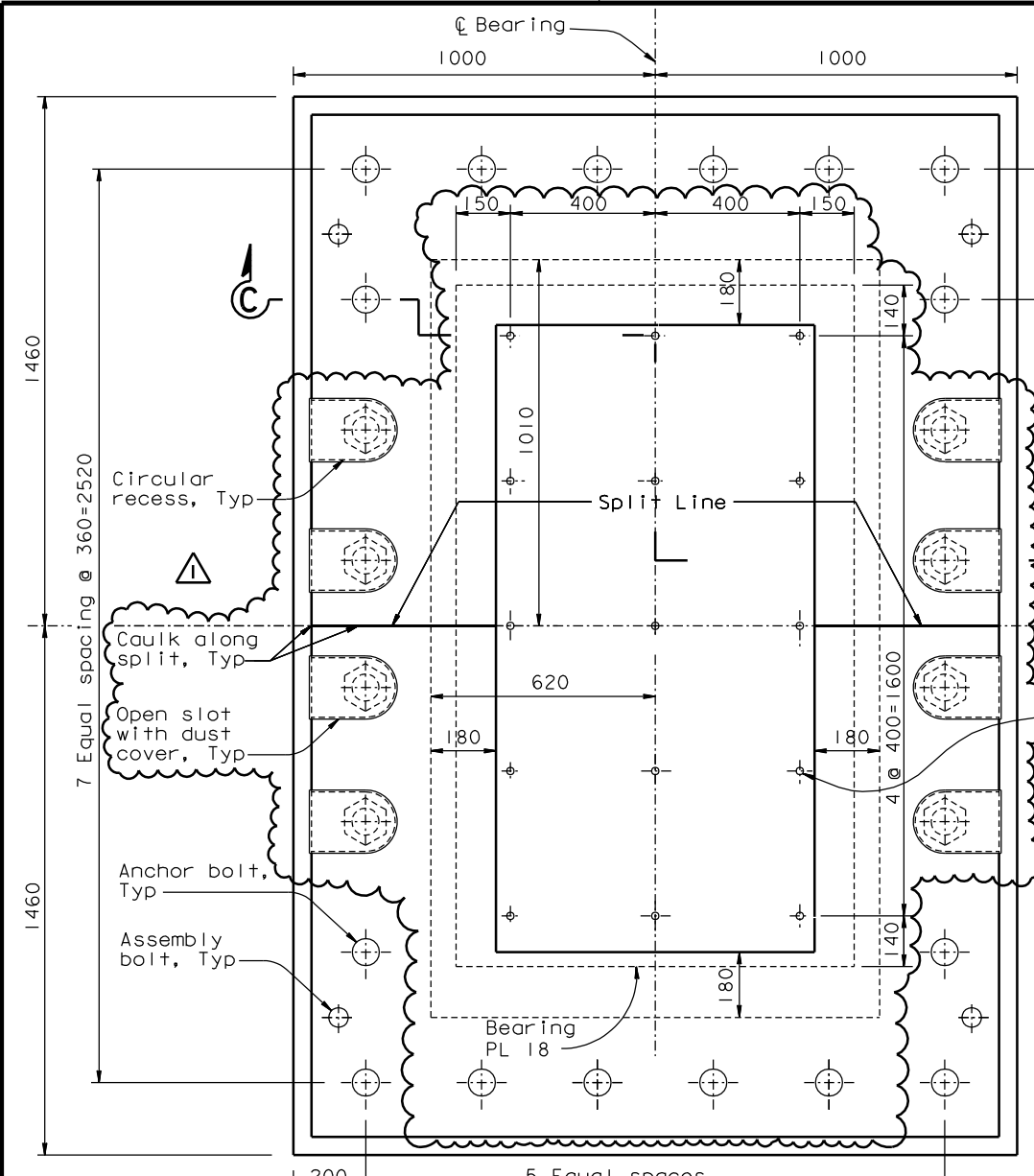
Seismic loading during erection shall conform to the seismic loading requirements specified in "TEMPORARY TOWERS," subsection "TEMPORARY TOWER DESIGN," subsection "Seismic Design Loads," of these special provisions.

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.

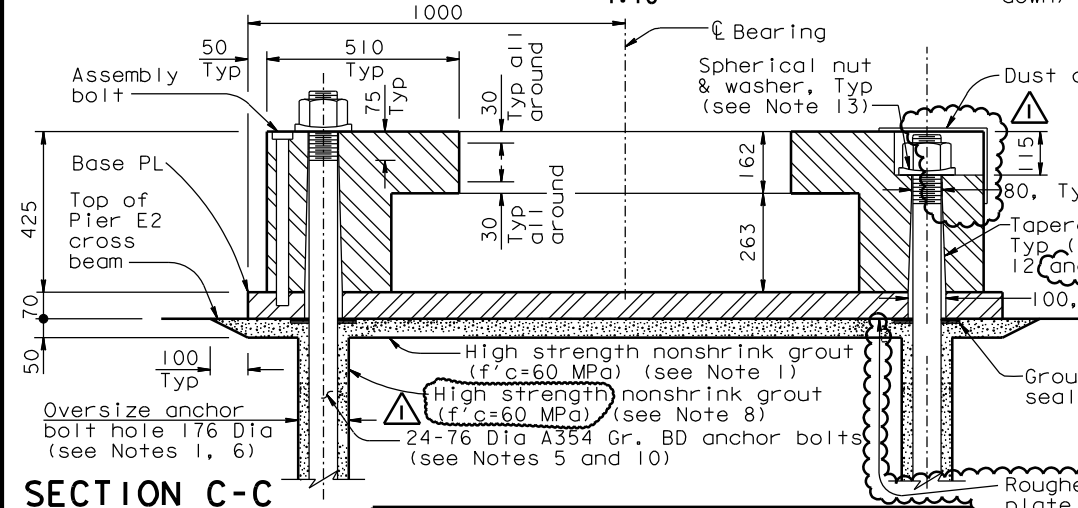
The details of any fastenings which the Contractor may require in any part of the permanent works for erection, and the procedure for their removal, shall be submitted to the Engineer for approval.

Tower

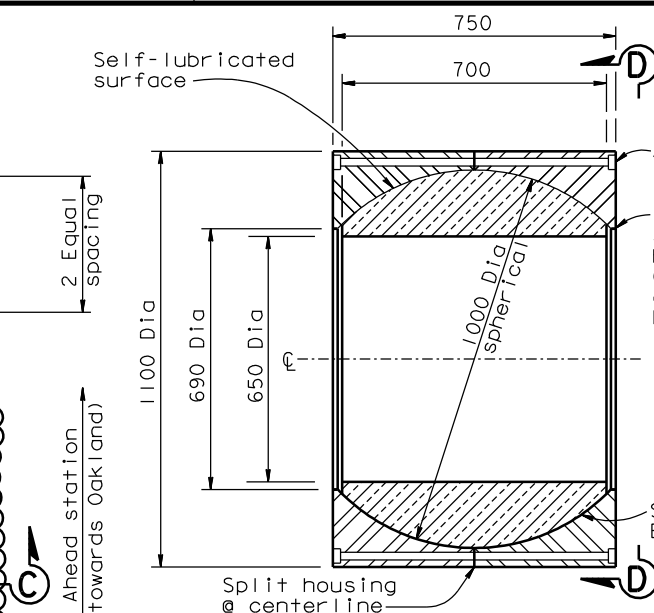
Tower lifts shall be in lengths as indicated on the plans. Exterior plates of the tower shafts shall be fabricated with direction of rolling aligned along the vertical direction of the tower. Within each lift, the number of transverse splices of the



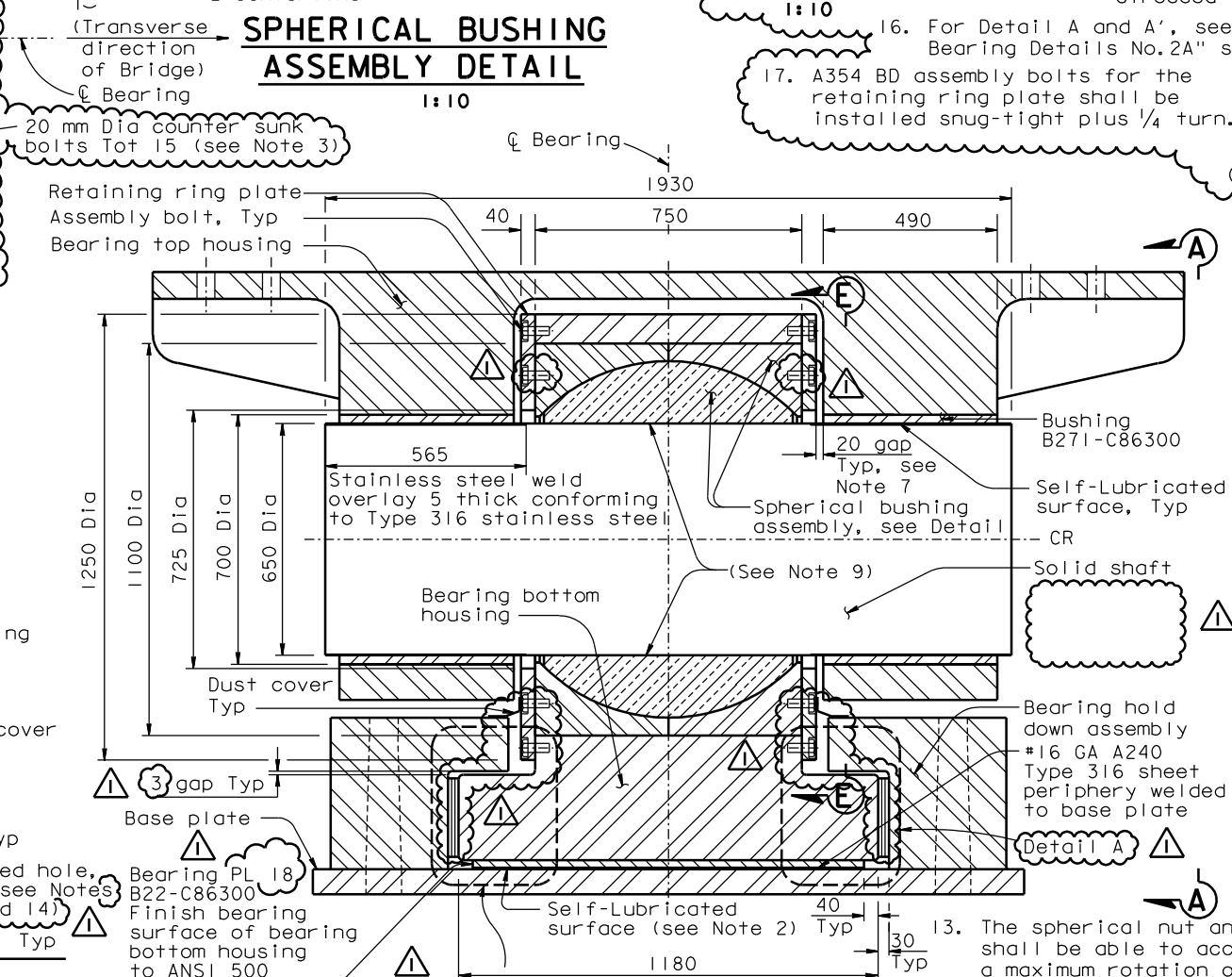
BEARING HOLD DOWN ASSEMBLY PLAN
1:10 (Looking down)



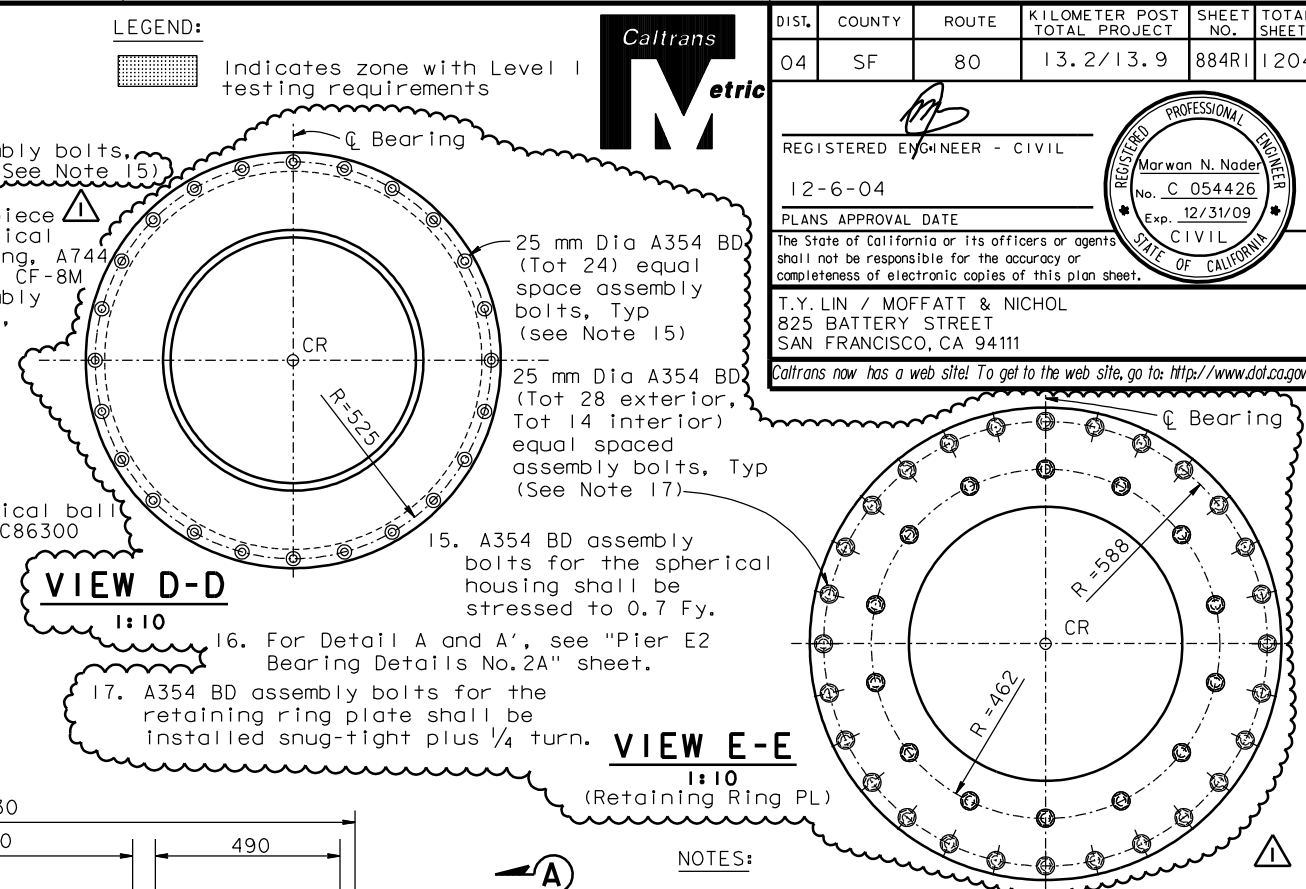
SECTION C-C
1:10



SPHERICAL BUSHING ASSEMBLY DETAIL
1:10



SECTION B-B
1:10



VIEW D-D
1:10

VIEW E-E
1:10 (Retaining Ring PL)

- NOTES:**
- The grout pad thickness is shown for information only. The Contractor shall verify in the field the grout pad thickness required to align the center of rotation of the shear key and bearings at 0.750 m from the bottom surface of the box girder.
 - The lubricant shall be Self-lubricated.
 - Bearing plate shall be fastened to bottom of bottom housing using A240 Type 316 counter sunk bolts.
 - All assembly bolts shall be A240 Type 316 unless noted otherwise.
 - The anchor bolt shall be pretensioned to 70% of ultimate tensile strength. Wherever there is no access from the top, anchor bolt shall be prestressed from the bottom.
 - The oversize anchor bolt holes are provided to accommodate construction tolerances.
 - 20 mm gap \pm 2 mm shall be maintained on both sides during installation.
 - For additional prestressing details, see "Prestressing Notes" sheet.
 - Solid shaft in bushing is press fit.
 - The prestressed anchor bolts shall be wrapped in a PT supplier recommended debonding tape, subject to the review and approval of the Engineer.
 - Grout-tight neoprene seal shown is schematic and is for information only. The seal shall prevent any high strength nonshrink grout from seeping inside the anchor bolt tapered holes during grouting of the base plate. This is necessary for proper stressing of the anchor bolts. The Contractor may propose an alternate detail to suit his erection means and methods, subject to review and approval of the Engineer.
 - For tapered hole details, see "Pier E2 Shear Key Details No. 1" sheet.
 - The spherical nut and washer shall be able to accommodate a maximum rotation of 3 degrees in any direction.
 - At the Contractor's option, the tapered anchor hole may increase to 200 in lieu of the 100 shown on the plans.

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SHOWN

R. Valizadeh/V. Toan/Y.L./W.L./F.C.
DESIGN OVERSIGHT
R. Valizadeh/V. Toan/Y.L./F.C.
SIGN OFF DATE 09/26/08
Rev. Date: 5-18-98

MARK	DATE	DESCRIPTIONS	MN	NV	71
09/26/08	E2 CROSS BEAM				
REVISIONS	BY	CH'D	CCO*		

DESIGN	BY M. Nader	CHECKED L. Rus
DETAILS	BY N. Vo	CHECKED J. Leventini
QUANTITIES	BY N. Vo	CHECKED J. Leventini

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)
PIER E2 BEARING DETAILS NO.2

REVISION DATES (PRELIMINARY STAGE ONLY)	SHEET	OF
04/08/02 01/04/02 12/04/02 05/06/03 12/01/05	467R1	

ORIGINAL SCALE IN MILLIMETERS FOR REDUCED PLANS

CU 04
EA 0120F1

FILE => I:\bb\04-012001\sas\contract plans and cco\cco\in progress\cco\71\original 09-26-08\dgn\akbrg02.dgn

DATE PLOTTED => 08 OCT 2008
100% P&S
USERNAME => p10m

DEPARTMENT OF TRANSPORTATION - District 4 Toll Bridge Program

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



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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



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December 24, 2007

Contract No. 04-0120F4
04-SF-80-13.2 / 13.9
Self-Anchored Suspension Bridge
Letter No. 05.03.01-001044

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

Dear Michael Flowers,

Submittal 27, Rev. 1 – Lubrite MFSQA

The Department has completed review of Submittal ABF-SUB-000027R01, "Lubrite MFSQA," dated December 12, 2007.

The MFSQA addendum has been submitted as a result of Lubrite's change in scope, now that they are performing the painting of bearing components in-house. The submittal is "Approved," with comments provided below to assist the Contractor in meeting the Contract requirements:

1. The QC form provided does not address all the testing that is required by the Contract. Testing to ASTM D4752 "Standard Test Method for Measuring MEK resistance of Ethyl Silicate (Inorganic) Zinc-Rich Primers by Solvent Rub" is required if the Contractor uses a Type 1, solvent based Inorganic Zinc coating such as "Carbozinc 11 VOC." This item was discussed at the pre-painting meeting held on November 29, 2007 and will be reviewed for compliance with the Contract when the PQWP is submitted.
2. Pursuant to section 10-1.70 "CLEAN AND PAINT STRUCTURAL STEEL (MODULAR JOINT SEAL ASSEMBLY, SPHERICAL BUSHING BEARING, AND SHEAR KEY), subsection "PAINTING," submit documentation as required in Section 5.6 of AASHTO Designation M300 if the Contractor intends to use "Carbozinc 11 VOC" or another Type 1, solvent based Inorganic Zinc coating for painting bearing components.

If you have any questions, please contact Dr Mazen Wahbeh at (818) 292 0659

Sincerely,

A handwritten signature in blue ink that reads "Gary Lai" with "for RTM" written below it.

GARY PURSELL
Resident Engineer

cc: Rick Morrow; Brian Boal; Gary Lai; Mazen Wahbeh
file: 05.03.01, 55.0027

DEPARTMENT OF TRANSPORTATION - District 4 Toll Bridge Program

333 Burma Rd.
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February 11, 2009

Contract No. 04-0120F4
04-SF-80-13.2 / 13.9
Self-Anchored Suspension Bridge
Letter No. 05.03.01-003470

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

Dear Michael Flowers,

Submittal 29, Rev. 3 – Department Audit – Hochang (HMI) & Korea Precision (KPC)

The Department has completed review of Submittal ABF-SUB-000029R03, "MFSQA for Hochang Machinery Industries Co., Ltd and Korea Precision Co., Ltd," dated January 28, 2009.

The submittal addresses the audit contingencies as provided in State Letter 05.03.01-000126 and is therefore "Approved." Accordingly both facilities have passed the Department Audit and may perform the operations as outlined in Attachment No. 2 of the submittal.

The Department has recently completed the audits of HMI's Onsan No. 1 and No. 2 facilities. The audit findings for these facilities will be provided in a separate letter.

If you have any questions, please contact Jinesh Mehta (951) 840-0541.

Sincerely,

<<< ORIGINAL SIGNED >>>

GARY PURSELL
Resident Engineer

cc: Rick Morrow
Brian Boal
Gary Lai
Jinesh Mehta
file: 05.03.01, 55.0029

DEPARTMENT OF TRANSPORTATION - District 4 Toll Bridge Program

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February 13, 2009

Contract No. 04-0120F4
04-SF-80-13.2 / 13.9
Self-Anchored Suspension Bridge
Letter No. 05.03.01-003482

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

Dear Michael Flowers,

Submittal 135, Rev. 4 – MFSQA for Stork Herron Testing Laboratory (STHL)

The Department has completed review of Submittal ABF-SUB-000135R04, "Manufacturing and Fabrication Self Qualification Audit (MFSQA) – Stork Herron Testing Laboratory," dated February 13, 2009. The submittal is "Approved," and accordingly, Mr. Shane Levermann may perform NDT (MT) on the Project for the Dyson Corporation.

If you have any questions, please contact Mohammad Fatemi (916) 813-3677.

Sincerely,

<<< ORIGINAL SIGNED >>>

GARY PURSELL
Resident Engineer

cc: Rick Morrow
Brian Boal
Gary Lai
Mohammad Fatemi
file: 05.03.01, 55.0135

DEPARTMENT OF TRANSPORTATION - District 4 Toll Bridge Program

333 Burma Rd.

Oakland, CA 94607

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March 23, 2009

Contract No. 04-0120F4

04-SF-80-13.2 / 13.9

Self-Anchored Suspension Bridge

Letter No. 05.03.01-003683

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

Dear Michael Flowers,

Department Audit - Modern Industries, Inc.

In accordance with Section 8-4.01, "Audits," of the Contract Special Provisions, the Department completed an audit of Modern Industries, Inc. on March 11, 2009. Modern Industries, Inc. is a heat treatment subcontractor for the Dyson Corporation. The facility has demonstrated the capability to perform heat treatment and accordingly has passed the Department Audit.

If you have any questions, please contact Mohammad Fatemi at 916-813-3677.

Sincerely,

A handwritten signature in blue ink that reads 'Gary Purcell'.

GARY PURSELL
Resident Engineer

cc: Rick Morrow
Brian Boal
Gary Lai
Mohammad Fatemi
file: 05.03.01, 55.0975

DEPARTMENT OF TRANSPORTATION - District 4 Toll Bridge Program

333 Burma Rd.

Oakland, CA 94607

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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

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



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October 31, 2008

Contract No. 04-0120F4
04-SF-80-13.2 / 13.9
Self-Anchored Suspension Bridge
Letter No. 05.03.01-002906

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

Dear Michael Flowers,

Authority to Proceed – CCO 91 - Additional Magnetic Particle Testing of Anchor Rods/Bolts

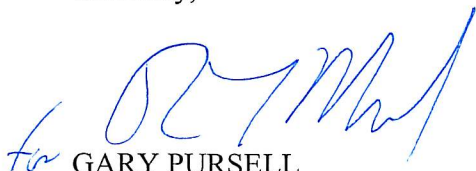
In accordance with Section 4-1.03, "Extra Work," of the Standard Specifications, ABF is directed to perform additional Magnetic Particle Testing (MT) in accordance with ASTM specification A490, on cable bracket anchor rods, main cable anchor rods and other ASTM 354, Grade BD anchor rods and bolts to be tensioned in excess of 0.5Fu. This additional work will be covered under Contract Change Order (CCO) No. 91.

The items requiring additional MT include the following:

1. East Saddle tie rod
2. Pier E2 Shear Key - anchor rods connecting stub to the E2 concrete cross beam
3. Pier E2 Shear Key - anchor bolts connecting OBG with shear key housing
4. Spherical Bushing Bearings (Pier E2) - anchor rods connecting hold down to E2 concrete cross beam
5. Spherical Bushing Bearings (Pier E2) - anchor bolts to OBG
6. Spherical Bushing Bearings (Pier E2) -Spherical bushing assembly bolts
7. Cable bracket anchor rods
8. Main Cable anchor rods

Please contact Brian Boal at 510-622-5191 if you have any questions.

Sincerely,


for GARY PURSELL
Resident Engineer

cc: Rick Morrow, Brian Boal, Gary Lai, Scott Fabel, Jinesh Mehta
file: 05.03.01, 49.091

REQUEST FOR INFORMATION (RFI)

RFI No.: ABF-RFI-001741R00 Submitted By: Smith, Kevin Pages: 2
 RFI Date: 24-April-2009 Contact Name: Smith, Kevin Pages Attached: 0
 Phone No. (412) 631-1000

Subject: CCO 91 Clarification	
References:	
Sub/Sup: ABF	Sub RFI #:
Response Required by: 01-May-2009	
Response affects critical path activity?	

Description:

ABF has received several questions and RFI 's from our subcontractors and suppliers concerning the Departments direction to perform additional Magnetic Particle Testing (MT) of ASTM A354 rods in Department letter No. 2906 . How is ABF supposed to determine which materials require the additional MT testing?

Method A. Review all the Contract Documents and perform the MT testing on all anchor rods and bolts that are ASTM A354, Grade BD and are to be tensioned in excess of 0.5Fu.

Method B. Only perform the testing on the items specifically listed below:

1. East Saddle tie rod
2. Pier E2 Shear Key - anchor rods connecting stub to the E2 concrete cross beam
3. Pier E2 Shear Key - anchor bolts connecting OBG with shear key housing
4. Spherical Bushing Bearings (Pier E2) - anchor rods connecting hold down to E2 concrete cross beam
5. Spherical Bushing Bearings (Pier E2) - anchor bolts to OBG
6. Spherical Bushing Bearings (Pier E2) -Spherical bushing assembly bolts
7. Cable bracket anchor rods
8. Main Cable anchor rods

Method C. Provide MT testing on all items that either meet the criteria in "Method A" above or are listed in "Method B" above.

Please review and advise.

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: 2
 Pages Attached: 0

Use "Method C" to determine MT testing of ASTM A354 Gr. BD Fasteners.

REQUEST FOR INFORMATION (RFI)

Please note that the Tower Saddle Tie Rods must also be MT tested as informed in the response to ABF-RFI-001735R00. This component was inadvertently omitted from the fasteners listed in State Letter 05.03.01-002906.

Administrative Action:

This response resolves the RFI.

Date: 06-May-2009	Respondent: Collins, Warren	Phone No.: 510-622-5661
--------------------------	------------------------------------	--------------------------------

REQUEST FOR INFORMATION (RFI)

RFI No.: ABF-RFI-001741R01 Submitted By: Smith, Kevin Pages: 2
RFI Date: 22-May-2009 Contact Name: Gatsos, Levi Pages Attached: 0
Phone No. 510-808-4600

Subject: CCO 91 Clarification	
References:	
Sub/Sup: ABF	Sub RFI #:
Response Required by: 29-May-2009	
Response affects critical path activity?	

Description:

Per the department's response to ABF-RFI-001741R00, ABF understands the following:

- A. Complete List of Rods to be covered under CCO 91
1. East Saddle tie rod
 2. Pier E2 Shear Key - anchor rods connecting stub to the E2 concrete cross beam, with the exception of the E2 Shear Key rods located over the Pier E2 Columns which were procured prior to the issuing of CCO 91.
 3. Pier E2 Shear Key - anchor bolts connecting OBG with shear key housing
 4. Spherical Bushing Bearings (Pier E2) - anchor rods connecting hold down to E2 concrete cross beam
 5. Spherical Bushing Bearings (Pier E2) - anchor bolts to OBG
 6. Spherical Bushing Bearings (Pier E2) -Spherical bushing assembly bolts
 7. Cable bracket anchor rods
 8. Main Cable anchor rods
 9. Tower Saddle Tie Rods

Please confirm that the above list contains all rods that require additional MT testing per CCO 91.

B.
The Tower Saddle Turned Rods have a required final tension of $0.45 \cdot F_u$, however to achieve this final tension the Tower Saddle Turned Rods will be temporarily tensioned in excess of $0.5 \cdot F_u$. ABF understands the intent of CCO 91 is to test ASTM A354 Grade BD Rods having a required final tension in excess of $0.5 \cdot F_u$, therefore ABF has excluded the Tower Saddle Turned Rods from the above list. Please confirm that the Tower Saddle Turned Rods do not require additional MT testing.

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:** 2**Pages Attached:** 0

A: The list appears to be complete. We are not aware of any other A 354 Gr. BD fasteners requiring MT per CCO No. 91.

B: Confirmed, Tower Saddle turned Rods do not require MT testing.

Administrative Action:

This response resolves the RFI.

REQUEST FOR INFORMATION (RFI)

Date: 04-June-2009	Respondent: Collins, Warren	Phone No.: 510-622-5661
---------------------------	------------------------------------	--------------------------------

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!*

April 23, 2009

Contract No. 04-0120F4
04-SF-80-13.2 / 13.9
Self-Anchored Suspension Bridge
Letter No. 05.03.01-003919

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

Dear Michael Flowers,

Submittal 644, Rev 4 - Pier E2 Spherical Bushing Bearing Manual

The Department has completed review of Submittal ABF-SUB-000644R04, "Pier E2 Spherical Bushing Bearing Manual," dated April 13, 2009. The submittal is "Approved." Please be aware of the following comment:

CATEGORY B:

1. This submittal is partial and only addresses Lubrite's scope of work, which includes the spherical bushing assembly, bearing plate and sleeve bushing. It is understood that ABF will submit the documentation which conforms to the requirements of Special Provision Section 10-1.47, "Spherical Bushing Bearing (Pier E2)," subsection "Working Drawing."

If you have any questions, please call Brian Boal at (510)-286-0308.

Sincerely,

<<< ORIGINAL SIGNED >>>

GARY PURSELL
Resident Engineer

Attachment

cc: Brian Boal
Rick Morrow
file: 05.03.01, 55.0644



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 13-Apr-09
Time 3:05 PM

Dated: 13-Apr-2009

SUBMITTAL No: ABF-SUB-000644 Rev: 4

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: HMI
Sub/Supplier No:

Subject: E2 Spherical Bushing Bearing Manual

Special Provis. (SP) REF: 10-1.47

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	13-Apr-09	6	Pier E2 - Bearing Details	3207033-B	0			Pending	1

These are transmitted as checked below:

☒ For Approval

☐ For Review/comment

☐ Return For Correction

☐ For Your Use

☐ For Information

☐ Other

Remarks:

CC:

Please review / approve by : 27-Apr-2009

Submitted By: Sabrina Levine

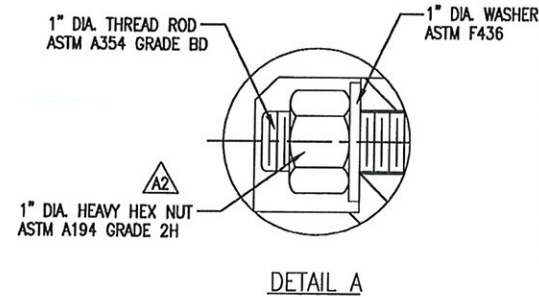
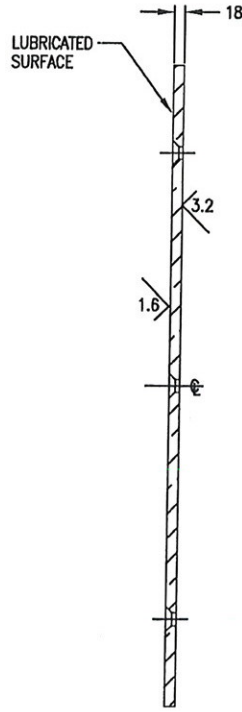
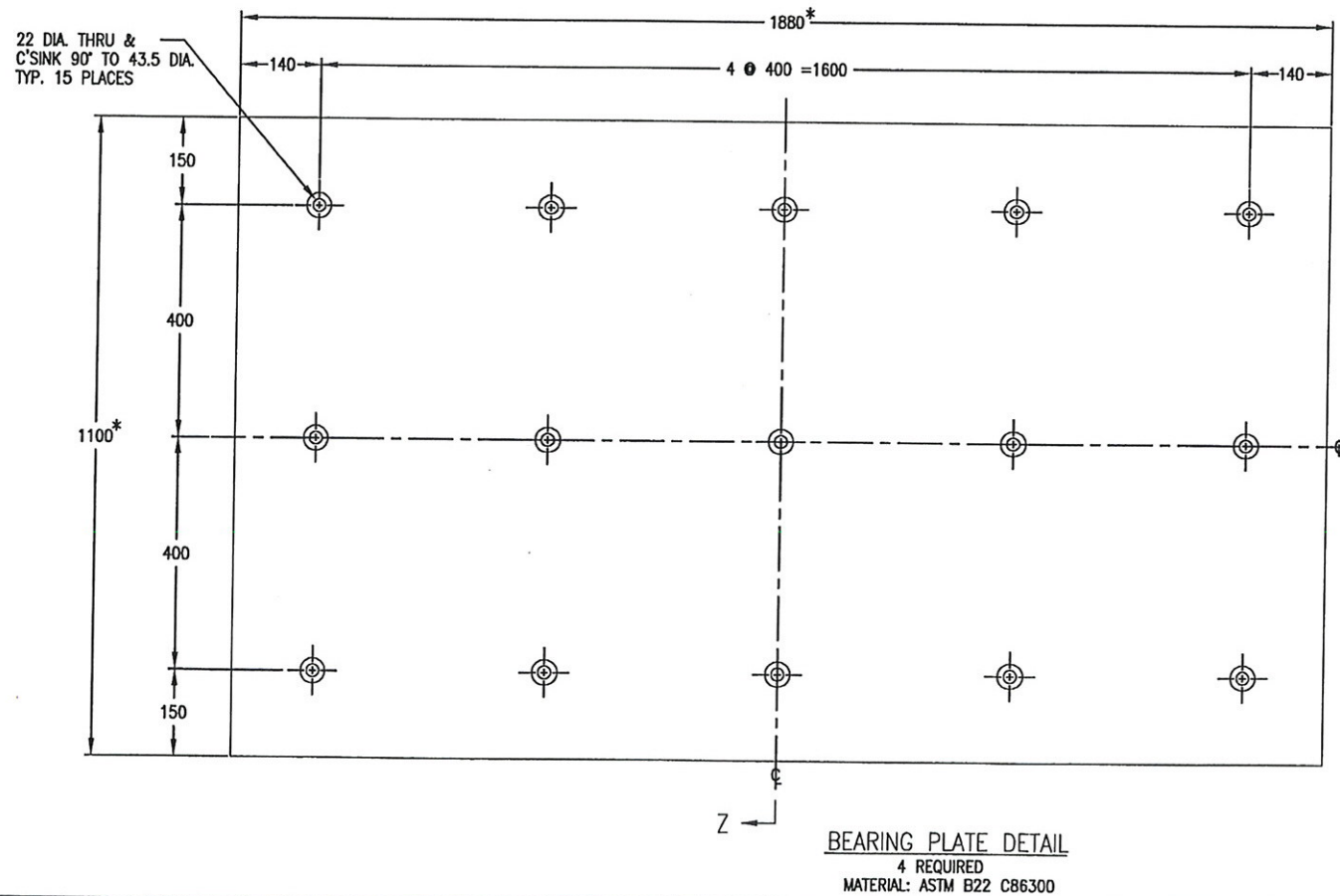
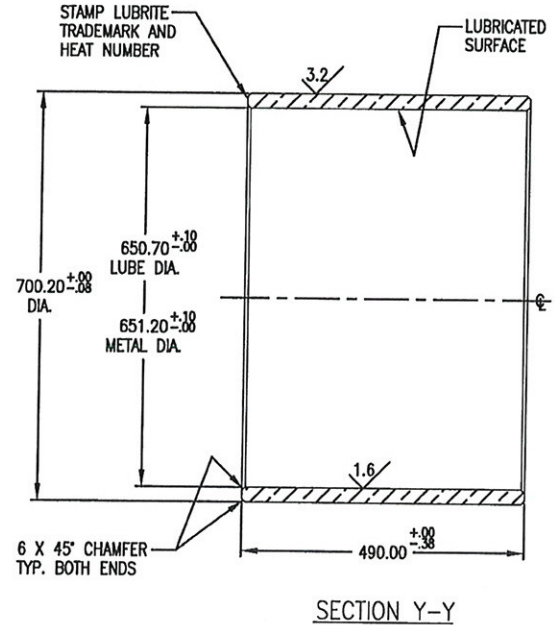
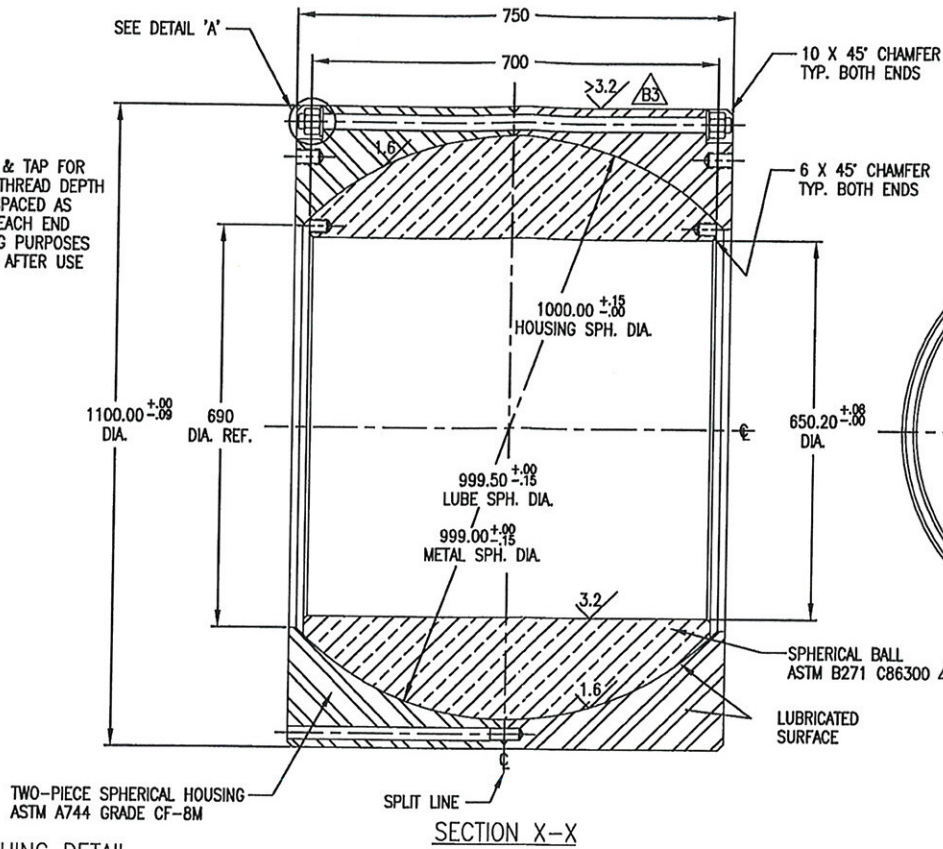
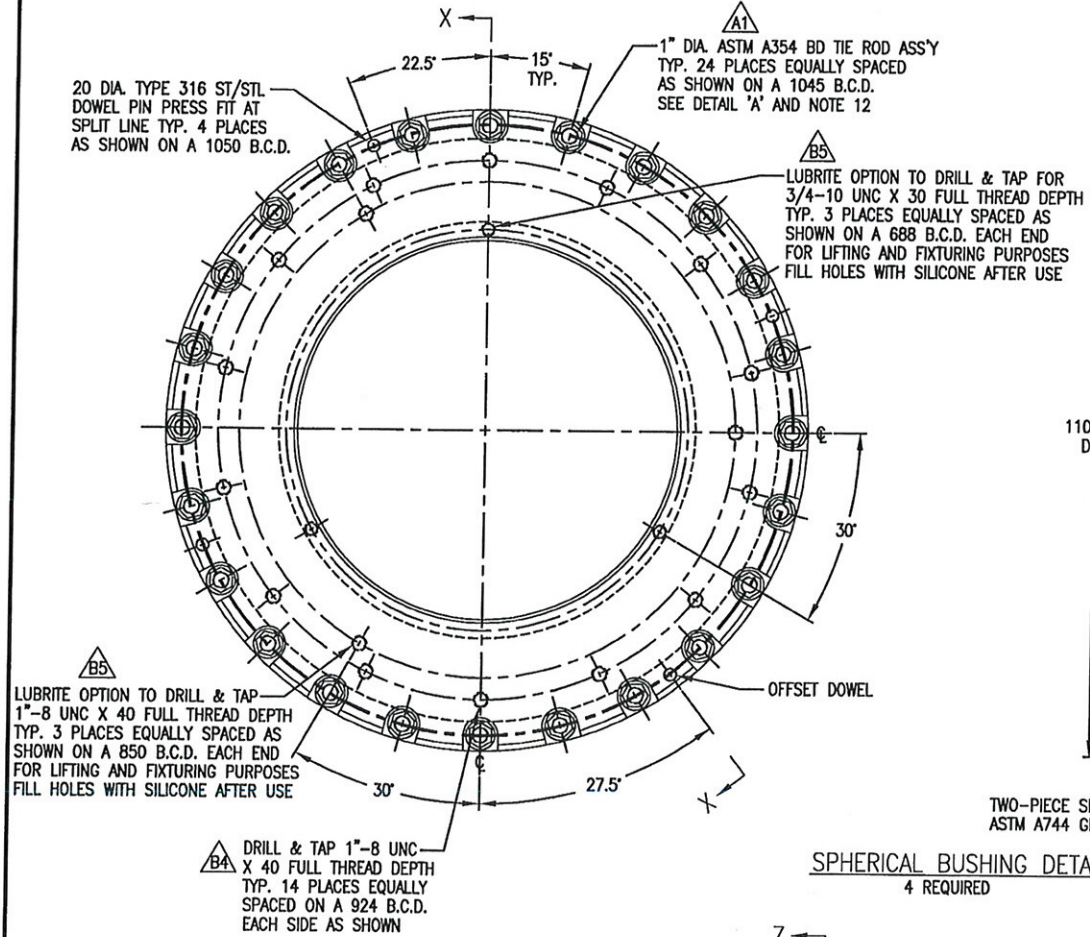
Project Manager

Checked & Sent By:

<<< Original Signed >>>

Document Control

LTR	REVISONS	DATE	DESIGNED BY	APPROV. BY
A1	REVISED NOTE	7/8/08	ESM	
A2	WAS A563 GR. DH JAM NUTS	7/8/08	ESM	
B1	ELIMINATED ASTM B584	4/9/09	ESM	
B2	0.70 Fy WAS 0.50Fy	4/9/09	ESM	
B3	>3.2 WAS 3.2	4/9/09	ESM	
B4	ADDED EACH SIDE AS SHOWN	4/9/09	ESM	
B5	ADDED LIFTING HOLES	4/9/09	ESM	



☒ APPROVED
☐ APPROVED AS NOTED
☐ RETURNED FOR CORRECTION

T-Y-LIN INTERNATIONAL AND MOFFATT & NICHOL, a JV
THE EAST SPAN BRIDGE DESIGN TEAM

APPROVAL PURSUANT TO SECTION 5-1.02 OF THE
STANDARD SPECIFICATIONS OF THE STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION, OF A SPECIFIC ITEM,
SHALL NOT INDICATE APPROVAL PURSUANT TO SECTION
5-1.02 OF AN ASSEMBLY OF WHICH THE ITEM IS A COMPONENT.

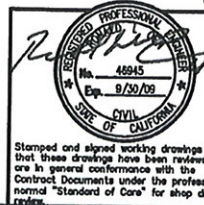
Phan & Co 04/21/09

REVIEWED BY _____ DATE _____

- NOTES
1. CUSTOMER: HOCHANG MACHINERY
 2. REFERENCE: SHEET NO. 884 OF 1204
 3. REMOVE ALL SHARP EDGES
 4. 6.4 RA FINISH ALL OVER U.O.S.
 5. * EDGES MAY BE LEFT AS CAST/CUT
 6. MATERIAL: AS NOTED
 7. LUBRICANT: TYPE G10
 8. SHAFT Ø SLEEVE BUSHINGS: 650.00 ± .008 RECOMMENDED DIAMETER
 9. TOP HOUSING BORE: 700.00 ± .008 RECOMMENDED DIAMETER
 10. BOTTOM HOUSING BORE: 1100.00 ± .008 RECOMMENDED DIAMETER
 11. SHAFT Ø SPHERICAL BUSHING TO BE MACHINED TO SUIT AS BUILT I.D. + 0.05 AT ASSEMBLY. SLEEVE BUSHING TO BE INSTALLED AFTER INSTALLATION OF SHAFT.
 12. ASTM A354 GRADE BD TIE RODS SHALL BE STRESSED TO 0.70 Fy.

SAN FRANCISCO OAKLAND BAY BRIDGE EAST SPAN SEISMIC SAFETY PROJECT
SELF-ANCHORED SUSPENSION BRIDGE
CONTRACT NO. 04-0120F4 04-SF-80-13.2/13.9


DISTRICT 04-SAN FRANCISCO-ROUTE 80-13.2/13.9



**BIGGS CARDOSA
ASSOCIATES INC.**
STRUCTURAL ENGINEERS

865 The Alameda
San Jose, California 95126
408-296-5515

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ITEM NO.		DESCRIPTION AND/OR MATERIAL		DET. NO.		QTY	
TOLERANCES UNLESS OTHERWISE SPEC.		DRAWN ESM 12/20/07 CHECKED BCA 4/10/09 APPROVED _____ MFG. REVIEW _____ REFERENCE:		 LUBRITE® TECHNOLOGIES Hanover, Ma. 02339			
FRACTIONS: $\frac{\quad}{\quad}$ DECIMALS: \pm ANGLES: \pm				PART			
MAT. NOTED		EP#7247		LUBRITE® PIER E2 BEARING DETAILS			
SCALE 0 100 200 300 400 500		DWG. SIZE D		DWG. NO. 3207033		REV. B	

LUBRITE® PIER E2
BEARING DETAILS



Republic

ENGINEERED PRODUCTS

IAC 34531

3049 LAKESHORE-GATE 6
PHONE: 330-438-5694

PAGE 12 OF 28

BUFFALO, NY 1
FAX: 330-438-

CERTIFICATE OF TESTS

REPUBLIC ENGINEERED PRODUCTS

May 29, 2008
PAGE 1

OF 2

CODE MYP

PURCHASE ORD: 11-46873	PURCHASE ORDER DATE: 3/7/2008
PART NUMBER: IAC34331	ACCOUNT NUMBER: 5607-1758-01
ORDER NUMBER: 1374059 - 01	SCHEDULE: 6010-66
HEAT: 8990895	REVISION: 1
SHIP TO	

HY ALLOY STEEL CO DIV
A M CASTLE & CO INC
3400 NORTH WOLF RD
FRANKLIN PARK, IL 60131

HY ALLOY STEEL CO DIV
A M CASTLE & CO INC
C/O H A INDUSTRIES
4527 COLUMBIA AVE
HAMMOND, IN 46327

----- MATERIAL DESCRIPTION -----
H ROLLED STEEL BARS ALLOY ASTM A322-07 FG ASTM A29-05 FG AMS 2301J CASTLE METALS SPEC G41400-208
REVISION 9 DTD 06/29/07 AMS 6382M EXC COND UNS G41400 EF-AISI-4140 FINE GRAIN VACUUM DEGASSED
AIRCRAFT QUALITY 5.00 : 1 RED RATIO
SIZE: RDS 1.0625 DIAM X 20FT 0.0000IN MIN/24FT 0.0000IN MAX
RDS 26.9875MM DIAM X 6096.0000MM MIN/7315.2000MM MAX

LADLE CHEMISTRY %							
C	MN	P	S	SI	CU	NI	CR
0.42	0.91	0.008	0.020	0.24	0.09	0.09	1.00
V	MO	SN	AL	CB	CA	N	
0.004	0.21	0.005	0.024	0.001	0.0001	0.0109	

----- CALCULATED TESTS -----
REDUCTION RATIO 146.6 TO 1
AUSTENITIC GRAIN SIZE 5 OR FINER BASED ON A TOTAL ALUMINUM CONTENT EQUAL TO OR GREATER THAN .020% PER ASTM A29.

----- SEMI - FINISHED RESULTS -----
JOMINY HARDNESS TEST SAE J406/ASTM A255
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 20 22 24 26 28 30 32
59 59 57 58 58 57 56 56 54 54 51 50 48 47 45 44 42 42 41 39 39 37 35 36

MACRO ETCH TEST ASTM E381/MIL STD 430
ETCHANT: HCL TEMPERATURE: 170
S R C
AVG 1 1 1

MAGNETIC PARTICLE TEST AMS 2301 AMS2304 AMS2300
IND AVG IND AVG
FREQ FREQ SEV SEV
PCE 03 0 0 0 0

QA REVIEWED
DATE 5/13/09
BY S.H. K...
T & P to 1" Rd

----- FINISHED SIZE RESULTS -----
DECARBURIZATION TEST SAE J419/ASTM E1077
ETCHANT = NITAL MAGNIFICATION = 100X
TOTAL
DEPTH
INCHES
PCE 01 0.006

----- NOTES -----
REPUBLIC ENGINEERED PRODUCTS HEREBY CERTIFY THAT THE MATERIAL LISTED HEREIN HAS BEEN INSPECTED AND TESTED IN ACCORDANCE WITH THE METHODS PRESCRIBED IN THE GOVERNING SPECIFICATIONS AND BASED UPON THE RESULTS OF SUCH INSPECTION AND TESTING HAS BEEN APPROVED FOR CONFORMANCE TO THE SPECIFICATIONS.

CERTIFICATE OF TESTS SHALL NOT BE REPRODUCED EXCEPT IN FULL.

R. A. NEBIOLO
DIRECTOR QUAL. ASSURANCE
R. A. Nebiolo

BY JANET K. HARTLINE

HOCHANG
REV. Quality Management
WIT. S.H. K...
HOLD. Aug. 10, 2008



Republic

3049 LAKESHORE-GATE 6
PHONE: 330-438-5694

PAGE 13 OF 28

BUFFALO, NY 1
FAX: 330-438-

May 29, 2008
PAGE 2

CERTIFICATE OF TESTS

REPUBLIC ENGINEERED PRODUCTS

OF 2

CODE MYP

PURCHASE ORD: 11-46873
PART NUMBER: IAC34331
ORDER NUMBER: 1374059 - 01
HEAT: 8990895

PURCHASE ORDER DATE: 3/7/2008
ACCOUNT NUMBER: 5607-1758-01
SCHEDULE: 6010-66
REVISION: 1

ALL TESTING HAS BEEN PERFORMED USING THE CURRENT REVISION OF THE TESTING SPECIFICATIONS.

RECORDING OF FALSE, FICTITIOUS OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHED

NOTES (CONTINUED)
AS A FELONY UNDER FED STATUES TITLE 18 CHAPTER 47.

THE MATERIAL WAS NOT EXPOSED TO MERCURY OR ANY METAL ALLOY THAT IS LIQUID AT AMBIENT TEMPERATURE
DURING PROCESSING OR WHILE IN OUR POSSESSION.

NO WELD OR WELD REPAIR WAS PERFORMED ON THIS MATERIAL.

THE RESULTS REPORTED RELATE ONLY TO THE ITEMS TESTED

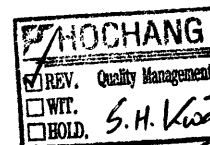
MATERIAL WAS VACUUM DEGASSED.

MANUFACTURED IN THE U.S.A.

SOURCE INFORMATION
MELT SOURCE: CANTON CAST ROLL MELT COUNTRY: U.S.A HOT ROLL SOURCE: LACKAWANNA 13in, U.S.A
MELT METHOD: EF BLOOM RED. RATIO: 146.6

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QA
5/13/09
BYSON
TAP to 1" Rd.



S.H. Kusate
Aug. 10, 2009

R. A. NEBIOLO
DIRECTOR QUAL. ASSURANCE

Rh. Nebiolo

BY JANET K. HARTLINE

HA Industries

Date Recvd 6-4-08
Recvd From Republic
Approved by



Republic

1AC 84331

3049 LAKESHORE-GATE 6
PHONE: 330-438-5694

PAGE 21 OF 44

BUFFALO, NY
FAX: 330-438-

May 29, 2008
PAGE 1

CERTIFICATE OF TESTS

REPUBLIC ENGINEERED PRODUCTS

OF 2

CODE MYP 2

PURCHASE ORD: 11-46873
PART NUMBER: 1AC34331
ORDER NUMBER: 1374059 - 01
HEAT: 8990895

PURCHASE ORDER DATE: 3/7/2008
ACCOUNT NUMBER: 5607-1758-01
SCHEDULE: 6010-66
REVISION: 1

CHARGE ADDRESS

SHIP TO

HY ALLOY STEEL CO DIV
A M CASTLE & CO INC
3400 NORTH WOLF RD
FRANKLIN PARK, IL 60131

HY ALLOY STEEL CO DIV
A M CASTLE & CO INC
C/O H A INDUSTRIES
4527 COLUMBIA AVE
HAMMOND, IN 46327

MATERIAL DESCRIPTION

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IZE: RDS 1.0625 DIAM X 20FT 0.0000IN MIN/24FT 0.0000IN MAX
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	MN	P	S	SI	CU	NI	CR
0.42	0.91	0.008	0.020	0.24	0.09	0.09	1.00
	MO	SN	AL	CB	CA	N	
0.004	0.21	0.005	0.024	0.001	0.0001	0.0109	

CALCULATED TESTS

DOCTION RATIO 146.6 TO 1

STENITIC GRAIN SIZE 5 OR FINER BASED ON A TOTAL ALUMINUM CONTENT EQUAL TO OR GREATER THAN .020% PER
TM A29.

SEMI - FINISHED RESULTS

MINY HARDNESS TEST SAE J406/ASTM A255
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 20 22 24 26 28 30 32
59 57 58 58 57 56 56 54 54 51 50 48 47 45 44 42 42 41 39 39 37 35 36

DRO LICH TEST ASTM E381/MIL STD 430
ETCHANT: HCL TEMPERATURE: 170

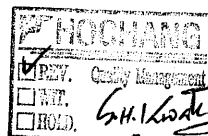
S	R	C
1	1	1

MNETIC PARTICLE TEST AMS 2301 AMS2304 AMS2300
IND AVG IND AVG
FREQ FREQ SEV SEV
03 0 0 0 0

FINISHED SIZE RESULTS

ARBURIZATION TEST SAE J419/ASTM E1077
HANT = NITAL MAGNIFICATION = 100X

TOTAL	DEPTH	INCHES
01	0.006	



NOTES

UBLIC ENGINEERED PRODUCTS HEREBY CERTIFY THAT THE MATERIAL LISTED HEREIN HAS BEEN INSPECTED AND
TED IN ACCORDANCE WITH THE METHODS PRESCRIBED IN THE GOVERNING SPECIFICATIONS AND BASED UPON THE
ULTS OF SUCH INSPECTION AND TESTING HAS BEEN APPROVED FOR CONFORMANCE TO THE SPECIFICATIONS.

IFICATE OF TESTS SHALL NOT BE REPRODUCED EXCEPT IN FULL.

A. NEBIOLO
CTOR QUAL. ASSURANCE

BY JANET K. HARTLINE

Rebio



Republic

3049 LAKESHORE-GATE 6
PHONE: 330-438-5694

PAGE 28 OF 44

BUFFALO, NY 1
FAX: 330-438-

CERTIFICATE OF TESTS

REPUBLIC ENGINEERED PRODUCTS

May 29, 2008
PAGE 2

OF 2

CODE MYP2

PURCHASE ORD: 11-46873
PART NUMBER: IAC34331
ORDER NUMBER: 1374059 - 01
HEAT: 8990895

PURCHASE ORDER DATE: 3/7/2008
ACCOUNT NUMBER: 5607-1758-01
SCHEDULE: 6010-66
REVISION: 1

ALL TESTING HAS BEEN PERFORMED USING THE CURRENT REVISION OF THE TESTING SPECIFICATIONS.

RECORDING OF FALSE, FICTITIOUS OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHED

NOTES (CONTINUED)

IS A FELONY UNDER FED STATUTES TITLE 18 CHAPTER 47.

THE MATERIAL WAS NOT EXPOSED TO MERCURY OR ANY METAL ALLOY THAT IS LIQUID AT AMBIENT TEMPERATURE DURING PROCESSING OR WHILE IN OUR POSSESSION.

NO WELD OR WELD REPAIR WAS PERFORMED ON THIS MATERIAL.

THE RESULTS REPORTED RELATE ONLY TO THE ITEMS TESTED

MATERIAL WAS VACUUM DEGASSED.

MANUFACTURED IN THE U.S.A.

SOURCE INFORMATION

ELT SOURCE: CANTON CAST ROLL MELT COUNTRY: U.S.A HOT ROLL SOURCE: LACKAWANNA 13in, U.S.A
ELT METHOD: EF BLOOM RED. RATIO: 146.6

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WITH SHIPMENT 2 COPIES PRINTED AT SHIPPING AREA
FILE 1 COPY

DATE 5/13/09
DYSON
T+P to 1" Rd.

7/10/09
<input checked="" type="checkbox"/> REV. Quality Management
<input type="checkbox"/> WIT.
<input type="checkbox"/> HOLD. G.H. Kwock

Oct. 27, 2009

A. NEBIOLO
ECTOR QUAL. ASSURANCE

K. Nebiolo

BY JANET K. HARTLINE

HA Industries

Date Recvd 6-4-08
Recvd From Republic
Approved by [Signature]

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-000589**Date Inspected:** 29-May-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 830**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1230**Contractor:** Dyson Corp. & Subs**Location:** Painesville, OH**Quality Control Contact:** Dave Sukenik**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** 1.00" tie rod heat # 8990895**Bid Item:** 45, 61**Lot No:** N/A**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was present at Dyson Corporation to randomly observe and document the operations and Quality Control (QC) functions relative to the project. This QA Inspector met with Dyson's QC Manager, Dave Sukenik who escorted the QA Inspector to the shop floor to view the current work in process. While on site, the QA Inspector noted the following work being performed.

This QA Inspector was requested by Dyson Corporation to travel to Modern Industries, Inc. in Erie, PA and monitor the operations there of the heat treating of 1.00" tie rod heat # 8990895. Upon arriving at Modern Industries this QA Inspector met with Dyson's QC Inspector Dave Sukenik and Lubrite's Production Manager David McWright. The QA Inspector, Mr. Sukenik and Mr. McWright were met in the lobby by Modern Industries' Sales Manager Alan Reppert, who then escorted us to the production area. In the production area Mr. Reppert introduced us to the Manufacturing Supervisor Shawn Sova. Mr. Sova proceeded to take us out to the production floor where the parts were in the process of being heat treated. Mr. Sova explained the process that they use at Modern Industries to heat treat starting the the furnace. Mr. Sova explained that the furnace heated the parts to the required temperature and then the parts were quenched in oil the has a temperature of 184 degrees Fahrenheit all inside the one furnace that was protected by an atmosphere of gas. Mr. Sova also showed that the furnace could be monitored from his office by computer bringing up the temperature and times of the furnace functions. After the parts were quenched in the oil for the proper amount of time they were removed from the furnace and taken to a wash bath to take the quench oil off. Mr. Sova stated that the water bath a water and soap like bath the the parts were submerged into several times and then jets with the water bath mix spray onto the parts as they were removed for the last time from the bath. The parts were then put in a furnace for the temper step. Mr. Sova stated that the

SOURCE INSPECTION REPORT

(Continued Page 2 of 2)

parts would be tempered by air that started at 1,000 degrees Fahrenheit for two hours. The furnace charted the time and temperature on a display attached to the furnace the information was stored to a memory card and could then be placed into a computer and a paper chat generated. Mr. Sovo stated the after the two hour tempering that was required the parts would be tested to insure correct results. See attached photos.



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

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: Webster, Andrew

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-000624**Date Inspected:** 02-Jun-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 700**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1500**Contractor:** Dyson Corp. & Subs**Location:** Painesville, OH**Quality Control Contact:** Dave Sukenik**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** 1.00" tie rods heat # 8990895 & M30 Bolt As**Bid Item:** 45, 61**Lot No:** N/A**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was present at Dyson Corporation to randomly observe and document the operations and Quality Control (QC) functions relative to the project. This QA Inspector met with Dyson's QC Manager, Dave Sukenik who escorted the QA Inspector to the shop floor to view the current work in process. While on site, the QA Inspector noted the following work being performed.

This QA Inspector finalized reports for the work performed on the 28th and 29th of May 2009 at Dyson Corporation. The extent of work done and travel required on the above mentioned days did not allow for ample time for the reports for the days to be finalized. This QA Inspector also finalized the report for the work performed on the 1st of June 2009 at Lubrite Technologies for the same above reason. After completing the reports for the above mentioned dates this QA Inspector reviewed the mill test and high strength reports for the M30 bolt assemblies that were sampled on the 28th of May 2009.

Attached pictures are of the items inspected on the above mentioned days at Dyson Corporation and Lubrite Technologies.

SOURCE INSPECTION REPORT

(Continued Page 2 of 2)



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

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: Webster, Andrew

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



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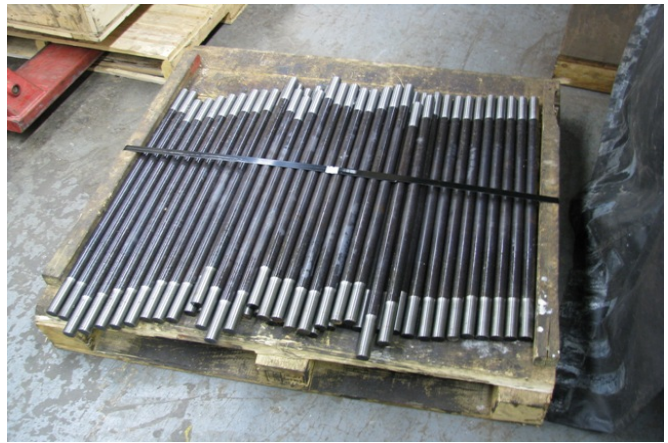
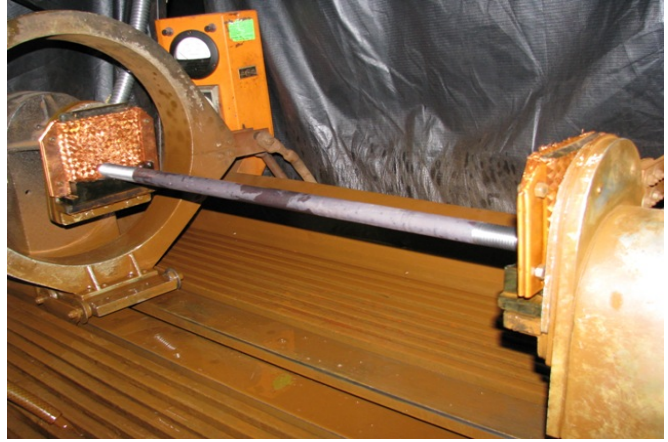
Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 76.15**SOURCE INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-000610**Date Inspected:** 04-Jun-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1300**Contractor:** Dyson Corp. & Subs**Location:** Painesville, OH**Quality Control Contact:** Dave Sukenik**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** 1.00" tie rods heat # 8990895**Bid Item:** 45, 61**Lot No:** N/A**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was requested by Dyson Corporation to observe and document the operations and Quality Control (QC) functions relative to the project at Stork Herron Testing Laboratories, Inc.

This QA Inspector was traveled to Stork Herron Testing Laboratories, Inc. in Cleveland, OH. Upon arriving at the facility This QA Inspector met with Magnetic Particle (MT) Level II Shane Levermann. The QA Inspector noted that the parts to be examined had yet to arrive, this QA Inspector witnessed MT Level II Mr. Levermann prepare the MT bench for the inspection of the parts. This QA Inspector noted 48 pieces of 1.00" tie rods heat # 8990895 arrived at the facility. The QA Inspector witnessed MT Level II Mr. Levermann clean the parts to remove any oil left on the parts from the machining process that had taken place at Dyson, then MT Level II Mr. Levermann place the parts in a dryer to dry the parts prior to inspection. The QA Inspector witnessed the MT of 15 of the 48 parts while at the facility. The 15 parts were acceptable at the time of the inspection. This QA Inspector was informed by the MT Level II Mr. Levermann by phone that all 48 had passed MT and Dyson would be informed. This QA Inspector spoke with the QC Inspector Dave Sukenik with Dyson and was informed that the parts would be going to be galvanized and that this QA Inspector would be needed at Dyson next week to sample the rods to the California Trans Lab. See attached photos.

SOURCE INSPECTION REPORT

(Continued Page 2 of 2)



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

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: Webster, Andrew

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
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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-000646**Date Inspected:** 11-Jun-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1300**Contractor:** Dyson Corp. & Subs**Location:** Painesville, OH

Quality Control Contact: Dave Sukenik
Material transfer: Yes No N/A
Stock Transfer: Yes No N/A
Rebar Test Witness: Yes No N/A

Quality Control Present: Yes No
Sampled Items: Yes No N/A
OK to Cut: Yes No N/A
Delayed/Cancelled: Yes No N/A

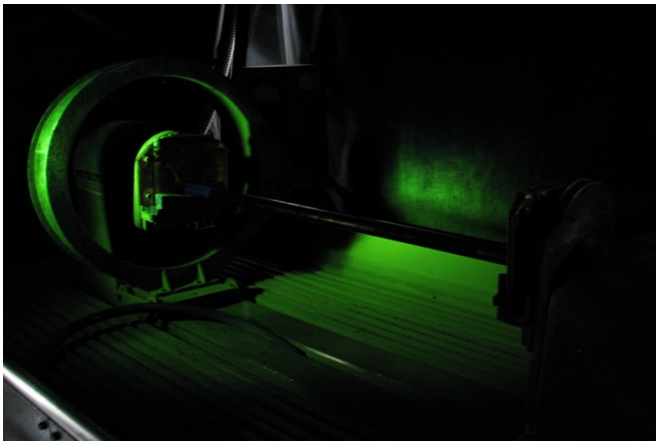
Other: Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** 1.00" tie rods heat # 8990895**Bid Item:** 45, 61**Lot No:** N/A**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was requested by Dyson Corporation to observe and document the operations and Quality Control (QC) functions relative to the project at Stork Herron Testing Laboratories, Inc.

This QA Inspector was traveled to Stork Herron Testing Laboratories, Inc. in Cleveland, OH. Upon arriving at the facility This QA Inspector met with Magnetic Particle (MT) Level II Shane Levermann. The QA Inspector noted that the parts were being cleaned and dried. This QA Inspector noted 108 pieces of 1.00" tie rods heat # 8990895 (for the Pier E2 Bearing Housings) at the facility. The QA Inspector witnessed MT Level II Mr. Levermann clean the parts to remove any oil left on the parts from the machining process that had taken place at Dyson, then MT Level II Mr. Levermann place the parts in a dryer to dry the parts prior to inspection. The QA Inspector witnessed the MT of 36 of the 108 parts while at the facility. The 35 parts were acceptable at the time of the inspection. While at the facility this QA Inspector noted that some of the parts were out of flatness. This QA Inspector contacted OSM Engineer Nina Choy about the discovery. This QA Inspector spoke with the QC Inspector Dave Sukenik with Dyson and was informed that the parts had not passed through their QC department. QC Inspector Mr. Sukenik stated that due to the rush on these parts that they were sent for MT and would be checked for straightness and quality of threads after Stork Herron were done with the MT of the parts. This QA Inspector contacted OSM Engineer Ms. Choy and informed her of what QC Inspector Mr. Sukenik had said. See attached photos.

SOURCE INSPECTION REPORT

(Continued Page 2 of 2)



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

Comments

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Inspected By: Webster, Andrew

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



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(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-000660**Date Inspected:** 15-Jun-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1300**Contractor:** Dyson Corp. & Subs**Location:** Painesville, OH**Quality Control Contact:** Dave Sukenik**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** M30 bolt assemblies & 1.00" galvanized tie rods**Bid Item:** 57 and 45**Lot No:** B201-013-09 and B201-014-09**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was requested by Dyson Corporation to observe and document the operations and Quality Control (QC) functions relative to the project at their facility.

This QA Inspector was traveled to Dyson Corporation and met with QC Inspector Dave Sukenik upon arriving. This QA Inspector reviewed the reports for the M30 galvanized hex bolts (for the bike path) that were ready to be shipped to the job site. After reviewing the reports this QA Inspector preceded to tag the parts for release. This QA Inspector tagged the parts with a Blue Material Suitability Tag (Lot # B201-013-09) per the TL-6013 on these parts. The TL-6013 stated that the nuts failed the go-gage test but the actual components appeared to assemble properly and that is was recommended to accept these high-strength bolt assembly lots as fit-for-purpose. This QA Inspector witnessed the six bolt assemblies get boxed and this QA Inspector places the blue tag on the package. See TL-6014 and attached photos.

This QA Inspector was also asked to sample forty four 1.00"-8UNC-2A x 28.875" galvanized tie rod assemblies heat # 8990895 (for the Pier E2 Bearing Housings). After reviewing the reports for the tie rods, nuts and washers this QA Inspector proceeded to sample five (Lot # B201-014-09) of the forty four assemblies per the Special Provisions page 297 Bolt Sample Size table. This QA Inspector then labeled each sample with the lot number and the date. See TL-101 and attached photos.

SOURCE INSPECTION REPORT

(Continued Page 2 of 2)



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

Comments

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Inspected By: Webster, Andrew

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 Grade BD, A563, F436, A153, TM03. Bolt Lot #MYP, Heat #8990895; Nut Lot #DCGG2, Heat #692675; Washer Lot #MWQ, Heat #L56844

Sample No: SM-09-0548

Date Sampled: 06/15/09

Date Rec'd: 06/19/09

Date Reported: 06/23/09

Lot No: B20101409

TL-101 / SIC No: C725882

Contract/Permit No: 04-0120F4

Material: A354 Grade BD 1"x 28.875" HDG Anchor Bolts w/ Nuts & Washers

Manufacturer: Dyson

Sampler: Andrew Webster

16-24-09

Results: SAMPLES SUBMITTED ARE SATISFACTORY FOR USE

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

6-19 09-0548

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
SAMPLE IDENTIFICATION CARD
TL-0151 (REV. 10/97)

CARD NUMBER
C 725882

FIELD NO.

DIST. LAB NO.

LOT NO.
B201-014-09

P.O. OR REQ. NO.

SHIPMENT NO.

AUTHORIZATION NO.

SAMPLE SENT TO:
☒ HDQTRS. LAB
☐ BRANCH LAB
☐ DIST. LAB

INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☒ TRANS. LAB
☐ SPECIAL TESTS

SAMPLE OF Tie Rod 1.00"-8UN-2A X 28.875" w/ Nut & Washer Heat # 8990895 Galvanized

FOR USE IN

STORR

SAMPLE FROM Dyson Corporation

DEPTH

LOCATION OF SOURCE Dyson Corporation Painesville, OH

THIS SAMPLE IS SHIPPED IN A GROUP OF 5

AND IS ONE OF A GROUP OF 5

SAMPLES REPRESENTING UNITS (BOLTS, NUTS, ETC.) 44

OWNER OR MANUFACTURER Dyson Corporation

TOTAL QUANTITY AVAILABLE 5

TEST RESULTS DESIRED ☐ NORMAL ☐ PRIORITY

REMARKS Test per spec.

COVER ADDITIONAL INFORMATION WITH LETTER

DATE SAMPLED 15-June-2009

BY Andrew Webster

TITLE QA Inspector

DIST. CO. RTE, PM

LIMITS

CONT. NO. 04-0120F4

FED. NO.

RES. ENGR. OR SUPT. Gary Pursell

ADDRESS

CONTRACTOR ABE/Dyson

ENCLOSE WITH SAMPLE

Print

6/19
09-
0548

Caltrans Test Number:		0		Field Inspectors Fastener Assembly Sampling Sheet									
Date Sampled:	6/15/2009	Contractor:	Dyson Corporation	Bid Item No.:		45							
Contract:	04-0120F4	Location Sampled:	Painesville, OH	Contact:		Dave Sukenik							
CT Lot No.	3201-014-09	Sampled By:	Andrew Webster	Sampler's Title:		OSM Inspector							
R. E.'s Name:	Pursell, Gary	Inspectors Office:	Pittsburgh, PA	Phone #:		(724) 378-3900		Fax #:		(724) 378-3940			
R. E.'s Address:	333 Burma Rd.	Co.:	SF	Date Released:		80		Rt.:		PM.: 12.6/13.2			
City St. Zip:	Oakland, CA 94607	Identification:	Assy's gal	Ship To:		Trans Lab		File Loc.:		76 .09			
Sample No.	1	2	3	4	5	6	7	8	9	10			
Assembly or Rocap No.													
Quantity Available	44												
Number of Samples	5												
Bolt Manufacture	Dyson Corp												
Heat Number	8990895												
Mfg. Lot Number	MYP												
Grade/Description	4140 AQ												
Size	8UNC-2A x 28.875												
Finish	galvanized												
Verify Test Reports	Yes												
Pass/Fail	Pass												
Nut Manufacture	Dyson Corp												
Heat Number	692675												
Mfg. Lot Number	DCGG2												
Grade	1045												
Finish	galvanized												
Verify Test Reports	Yes												
Pass/Fail	Pass												
Washer Manufacture	restige Stamping												
Heat Number	L58844												
Mfg. Lot Number	C0819												
Grade	CF436												
Finish	galvanized												
Verify Test Reports	Yes												
Pass/Fail	Pass												
Notes:	5 total assemblies for 1"-8UNC-2A x 28.875" tie rod double end												
Note to TL-29:													

SM Number 09-0548 Lot Number B20101409 Page 1 of Contract 04-0120FY4 TL-0101 Number C725882Date Rec'd. 6/19/09 Date Tested: Bolts: A354 GR. B0 H06Lab Technician: BRUCE

Sample No.	1A	#	1B	1C	1D	1E
Mfg. Lot No.	MYP		MYP	MYP	MYP	MYP
Product Markings	MYP B0					
Size	1"		1"	1"	1"	1"
Pitch Diameter						
Bolt Length	28 7/8"					
Ring Gages/Go Nogo	Go/ok		Go/ok	Go/ok	Go/ok	Go/ok
Zinc Coating Thick.	2.95		2.92	3.18	3.01	2.98
Hardness (Rc)/ Rb						
Wedge Tensile	105285	105	104309		37.05	37.12

Nuts: A563 DIT

Sample No.	1A	1AA	1B	1BB	1C	1CC	1D	1DD	1EE
Mfg. Lot No.	DCGG2								
Product Markings	2H0H 014								
Size	1"								
Go / No-Go	Go/ok								
Zinc Coating	4.32	5.14	4.38	4.39	4.82	5.04	4.73	4.04	4.15
Hardness (Rc)/ Rb		30.55		31.92		31.82			
Nut Proof Load									

Washer: F436

Sample No.	1A	1AA	1B	1BB	1C	1CC	1D	1DD	1EE
Mfg. Lot No.	MWR								
Product Markings	F436 H0								
Zinc Coating	3.67	3.43	3.32	3.58	3.33	3.69	3.40	3.41	3.57
Hardness (Rc)/ Rb		32.18		31.00		32.50			

ASTM A354 BD Threaded Bolts and Nuts



Department of Transportation
Structural Materials Laboratory

SM Number = 09-0548

Sample	Mfg_Lot	Size	Pitch Diameter	Peak Load (lbf)	Peak Stress (lbf)	Comments
1A	MYP	1"		105285		A354
1B	MYP	1"		104309		A354

DEPARTMENT OF TRANSPORTATION**DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch
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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-000722**Date Inspected:** 25-Jun-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 830**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1100**Contractor:** Dyson Corp. & Subs**Location:** Painesville, OH**Quality Control Contact:** Dave Sukenik**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** 1.00"-8UNC-2A galvanized tie rods**Bid Item:** 45**Lot No:** B201-016-09 and B201-017-09**Summary of Items Observed:**

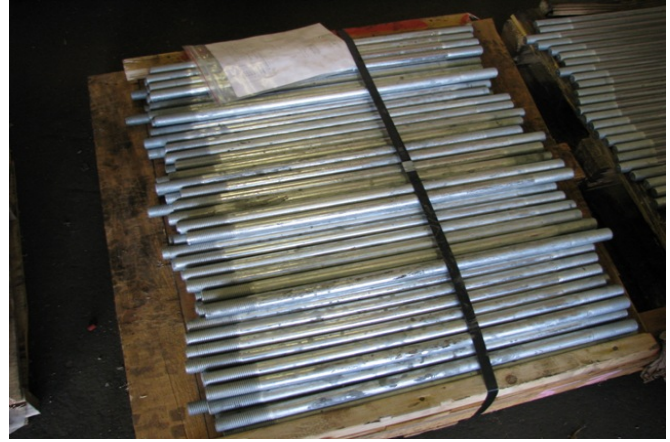
The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was requested by Dyson Corporation to observe and document the operations and Quality Control (QC) functions relative to the project at their facility.

This QA Inspector traveled to Dyson Corporation and met with QC Inspector Dave Sukenik upon arriving. This QA Inspector was requested to sample one hundred two 1.00"-8UNC-2A x 28.875" galvanized tie rod assemblies heat # 8990895 (for the Pier E2 Bearing Housings). After reviewing the reports for the tie rods, nuts and washers this QA Inspector proceeded to sample eight (Lot # B201-016-09) of the one hundred two assemblies per the Special Provisions page 297 Bolt Sample Size table. This QA Inspector then labeled each sample with the lot number and the date. See TL-101 and attached photos.

This QA Inspector was also asked to release thirty nine 1.00"-8UNC-2A x 28.875" galvanized tie rod assemblies heat # 8990895 (for the Pier E2 Bearing Housings). These thirty nine tie rod assemblies were sampled on June 15th 2009. The samples passed the California Tran. Lab testing and the assemblies are being green tagged (Lot # B201-017-09) and released to Lubrite Industries in Meadville, PA. See photos below.

SOURCE INSPECTION REPORT

(Continued Page 2 of 2)



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

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: Webster, Andrew

Quality Assurance Inspector

Reviewed By: Levell, Bill

QA Reviewer

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Office of Structural Materials

Quality Assurance and Source Inspection



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(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-000048**Date Inspected:** 25-Jun-2009**Contractor:** Dyson Corp. & Subs**Location:** Painesville, PA**Bridge No.:** 34-0006**OSM Arrival Time:** 830**OSM Departure Time:** 1100**Component:#** 1"-8UNC-2A Galvanized Tie Rod

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: Lubrite Technologies Meadville, PA

Lot #	Bid Item #	Quantity	Material Description
B201-017-0905		39 ea	1.00"-8UNC-2A x 28.875" galvanized tie rod assemblies heat # 8990895

Identification: One Green Tag placed on the Tie Rod Certificate of Compliance**Summary of Items Observed:**

The galvanized tie rods, nuts and washers were tagged and released to Lubrite Technologies in Meadville, PA.

Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

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: Webster, Andrew

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 BD, A563, F436, A153, TM03; Rod Lot #MYP2, Nut Lot #DCGG2, Washer Lot #C0819

Sample No: SM-09-0569

Date Sampled: 06/25/09

Date Rec'd: 06/30/09

Date Reported: 07/08/09

Lot No: B20101609

TL-101 / SIC No: C725884

Contract/Permit No: 04-0120F4

Material: A354 GR. BD Rods 1" X 28.875, HDG

Manufacturer: Dyson, PTI

Sampler: Andrew Webster

7-8-09

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

CARD NUMBER

TL-0101 (REV. 10/97) **89-0569 C 725884**

<input type="checkbox"/> PRELIMINARY TESTS <input type="checkbox"/> PROCESS TESTS <input checked="" type="checkbox"/> ACCEPTANCE TESTS <input type="checkbox"/> INDEPENDENT ASSURANCE TESTS <input type="checkbox"/> SPECIAL TESTS		SAMPLE SENT TO: <input checked="" 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. B201-016-09 P.O. OR REQ. NO.
SAMPLE OF Tie Rod 100'-8UNC-2A X 28.875" W/HT 4 FOR USE IN Washer Heat # 8990895 Galvanized SAMPLE FROM Dyson Corporation DEPTH LOCATION OF SOURCE Dyson Corporation Painesville, OH				
THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) 1 AND IS ONE OF A GROUP OF 8 SAMPLES REPRESENTING (FROM GALS. BBL'S, STA. ETC.) 102	OWNER OR MANUFACTURER Dyson Corporation TEST RESULTS DESIRED <input type="checkbox"/> NORMAL <input type="checkbox"/> PRIORITY DATE NEEDED	COVER ADDITIONAL INFORMATION WITH LETTER DATE SAMPLED 25 June 2009 BY Andrew Webster TITLE QA Inspector DIST. CO. RTE; PM		
REMARKS Test per Spec				
LIMITS				
CONT. NO. 04-0120F4 FED. NO. RES. ENGR. OR SUPT. Gary Pursell ADDRESS CONTRACTOR ABF/Dyson				

ENCLOSE WITH SAMPLE

Print

Quality Manager

For R.A.

6/30
09-
0569

Caltrans Test Number:		0		Field Inspectors Fastener Assembly Sampling Sheet									
Date Sampled:	6/25/2009	Contractor:	Dyson Corporation	Bid Item No.:		45							
Contract:	04-0120F4	Location Sampled:	Painesville, OH	Contact:		Dave Sukenik							
GT Lot No.:	B201-016-08	Sampled By:	Andrew Webster	Inspector's Title:		OSM Inspector							
R. E.'s Name:	Pursell, Gary	Inspectors Office:	Pittsburgh, PA	Phone #:	(724) 378-3900	Fax #:	(724) 378-3940						
R. E.'s Address:	333 Burma Rd.	Co.:	SF	Date Released:		Rt.:	80						
City St. Zip:	Oakland, CA 94607	Identification:	Assy's gal	File Loc.:		Ship To:	Trans Lab						
Sample No.	1	2	3	4	5	6	7	8	9	10			
Assembly or Rocap No.													
Quantity Available	102												
Number of Samples	8												
Bolt Manufacture	Dyson Corp												
Heat Number	8990895												
Mfg. Lot Number	MYP2												
Grade/Discription	4140 AQ												
Size	8UNC-2A x 28.875												
Finish	galvanized												
Verify Test Reports	Yes												
Pass/Fail	PHS												
Nut Manufacture	Dyson Corp												
Heat Number	692675												
Mfg. Lot Number	DCGG2												
Grade	1045												
Finish	galvanized												
Verify Test Reports	Yes												
Pass/Fail	PHS												
Washer Manufacture	restige Stamping												
Heat Number	L56844												
Mfg. Lot Number	C0819												
Grade	CF436												
Finish	galvanized												
Verify Test Reports	Yes												
Pass/Fail	PHS												
Notes:	8 total assemblies for 1"-8UNC-2A x 28.875" tie rod double end												
Note to TL-29:													

A354 BD



State of California
Department of Transportation
Structural Materials Testing Laboratory
UTM: SATEC 400

SM Number = 09-0569

Sample	Size	Area (in ²)	Peak Load (lbf)	Tensile Strength (psi)	Stress at Offset (psi)	Comments
1A	1"	0.606	98848	163116	162805	
1B	1"	0.606	98124	161921	161599	
		OK	OK	OK	OK	

B. Johnson

SM Number 09-0569 Lot Number B20/01409 Page 1 of 1

Contract 04-0120F4 TL-0101 Number ~~04-0120F4~~ 04-0125084 Date Rec'd. 6/30/09 Date Tested: 9/06/09

Bolls: A35A H.O.6.

Lab Technician:

Sample No.	1A	1B	1C
Mfg. Lot No.	0990895		
Product Markings	BOM MXP2		
Size	1 1/8"		
Pitch Diameter			
Bolt Length	28".675"		
Ring Gages/Go Nogo	60/OK		✓
Zinc Coating Thick.	5.97	6.20	5.51 ✓
Hardness Rc / Rb	3A.20	33.32	✓
Wedge Tensile	16.3, 116.0	16.19-21	✓

Note: 4563

Nuls: A563

Sample No.	1A	1B	1C						
Mfg. Lot No.	8990895								
Product Markings	D/N								
Size	1"								
Go / No-Go	Go / OK								
Zinc Coating	4.34	4.10	5.77						
Hardness Rc / Rb	31.32		30.92						
Nut Proof Load	Proof Load	with	BAR						

Washer: F 436

Sample No.	1A	1B	1C						
Mfg. Lot No.	L56844								
Product Markings	MWO								
Zinc Coating	3.59	3.81	3.02						
Hardness Rc/Rb	27.60	32.69							

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Quality Assurance and Source Inspection



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(707) 649-5453
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 72.15**SOURCE INSPECTION REPORT****Resident Engineer:** Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-000724**Date Inspected:** 10-Jul-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1400**Contractor:** Lubrite**Location:** Meadville, PA**Quality Control Contact:** Brad McWright**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** Pier E2 Bearings**Bid Item:** 45, 61**Lot No:** B201-021-09**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was present at Lubrite Technologies to randomly observe and document the operations and Quality Control (QC) functions relative to the casting of the E2 bearings project. This QA Inspector met with Lubrite's QC Manager, Brad McWright who escorted the QA Inspector to the shop floor to view the current work in process. As previously reported Lubrite's internal policy mandates that agency inspectors/visitors must be accompanied by a Lubrite representative during all phase of shop inspection activities and/or the taking of digital images. While on site, the QA Inspector noted the following work being performed.

Bronze Plates: (4 required and 4 complete) This QA Inspector green tagged for shipping on 22 May 2009. Lubrite is waiting shipping instructions from Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

Sleeve Bushings: (8 required and 8 complete) This QA Inspector green tagged for shipping on 22 May 2009. Lubrite is waiting shipping instructions from Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

Bronze Spherical Bushings (4 required and 4 cast): The QA Inspector noted that three of the spherical bushings heat # 080972, 080951 and 080962 were done with final machining. This QA Inspector was informed by the Production Manager David McWright that one spherical bushing had been final assembled with two housing halves and tie rods. The completed bearing (Lot # B201-021-09) is HMIC ID Number B1-08; this bearing consists of one bronze spherical bushing heat # 080972, two stainless steel spherical housing halves heat # 090290 and # 090300, twenty four galvanized tie rods heat # 8990895 forty eight galvanized washers heat # L56844, forty eight galvanized nuts heat # 692675 and four stainless steel dowel pins heat # 217895. See TL-6011. This QA Inspector

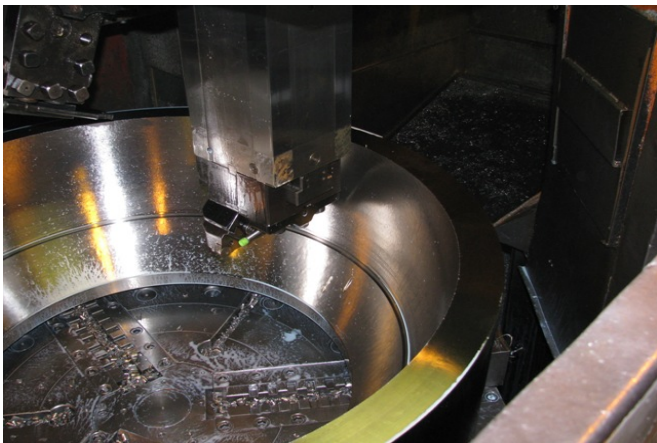
SOURCE INSPECTION REPORT

(Continued Page 2 of 3)

was also informed by the Production Manager Mr. McWright that spherical bushing heat # 080947 had the new lubricant and was waiting to be remachined. See photo below:

Stainless Steel Spherical Housing: (Qty of 8 required with 8 cast): As noted above housing heat # 090290 and # 090300 are bolted around the spherical bushing heat # 080972 to make bearing # B1-08. This QA Inspector noted housing heat # 090112 was being rough machined in preparation for the bolt holes to be drilled into it. This QA Inspector was informed that the remaining housings would be machined in the same manner at the first two. The QA Inspector also informed that upon completion of the rough machining of the housings that the final spherical bushing would have the lubricant final machined off. See photo below:

Shear Key Half Castings: (Qty of 8 required with 8 cast): This QA Inspector noted that shear key halves heat # 090198 and # 090209 were having the lubricant holes cut into the bore of the two halves. This QA Inspector was informed by the Production Manager Mr. McWright that these were the last shear key halves to need the lubricant holes. The QA Inspector was also informed that once these two shear key halves were done that the final machining could take place followed by the lubricant application and then the machining of the lubricant. See photo below:



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

SOURCE INSPECTION REPORT

(Continued Page 3 of 3)

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:	Webster,Andrew
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Quality Assurance Inspector

Reviewed By:	Levell,Bill
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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
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(707) 649-5453
(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 72.8**COMPONENT MATERIAL INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** CMI-000049**Date Inspected:** 10-Jul-2009**Contractor:** Lubrite**Location:** Meadville, PA**Bridge No.:** 34-0006**OSM Arrival Time:** 900**OSM Departure Time:** 1400**Component:#** Pier E2 Self-Aligning Spherical B

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: Hochang Machinery Industries Co., Ltd., Ulsan, Korea

Lot #	Bid Item #	Quantity	Material Description
B201-021-09 45		1 ea	Self-Aligning Spherical Bushing Bearing HMIC ID # B1-08

Identification: One Green Tags placed on the Certificate of Compliance for the B1-08 Bearing.**Summary of Items Observed:**

The Final Visual Inspection for the B1-08 Bearing was done prior to this Quality Assurance (QA) Inspector arrival at the facility by the Quality Control (QC) Manager Brad McWright. This QA Inspector looked over the B1-08 bearing and the material sheets that went along with the bearing and it appeared to be in compliance at the time of the inspection. The material is released to Hochang Machinery in Ulsan, Korea.

Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

Comments

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Inspected By: Webster, Andrew

Quality Assurance Inspector

Reviewed By: Levell, Bill

QA Reviewer

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Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 72.15**SOURCE INSPECTION REPORT****Resident Engineer:** Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-000780**Date Inspected:** 17-Jul-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1500**Contractor:** Lubrite**Location:** Meadville, PA**Quality Control Contact:** Brad McWright**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** Pier E2 Bearings**Bid Item:** 45, 61**Lot No:** N/A**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was present at Lubrite Technologies to randomly observe and document the operations and Quality Control (QC) functions relative to the casting of the E2 bearings project. This QA Inspector met with Lubrite's QC Manager, Brad McWright who escorted the QA Inspector to the shop floor to view the current work in process. As previously reported Lubrite's internal policy mandates that agency inspectors/visitors must be accompanied by a Lubrite representative during all phase of shop inspection activities and/or the taking of digital images. While on site, the QA Inspector noted the following work being performed.

Bronze Plates: (4 required and 4 complete) This QA Inspector was informed by the QC Inspector that these parts were shipped out by truck on the 16th of July 2009 heading for Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

Sleeve Bushings: (8 required and 8 complete) This QA Inspector was informed by the QC Inspector that these parts were shipped out by truck on the 16th of July 2009 heading for Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

Self-Aligning Spherical Bushing Bearing: (4 required and 1 complete) This QA Inspector was informed by the QC Inspector that this part (B1-08) was shipped out by truck on the 16th of July 2009 heading for Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

Bronze Spherical Bushings (4 required and 3 complete): The QA Inspector noted that there was no change from

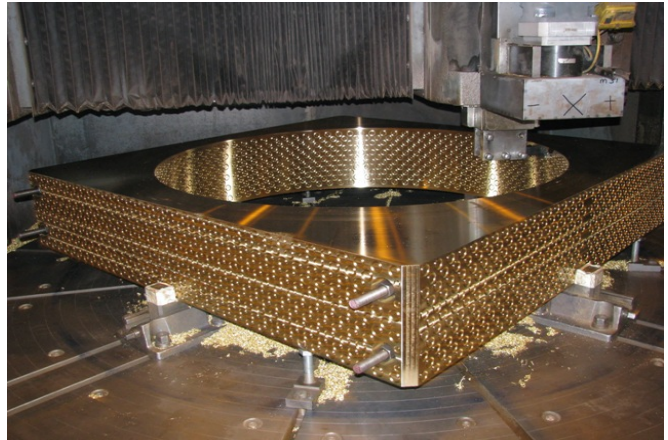
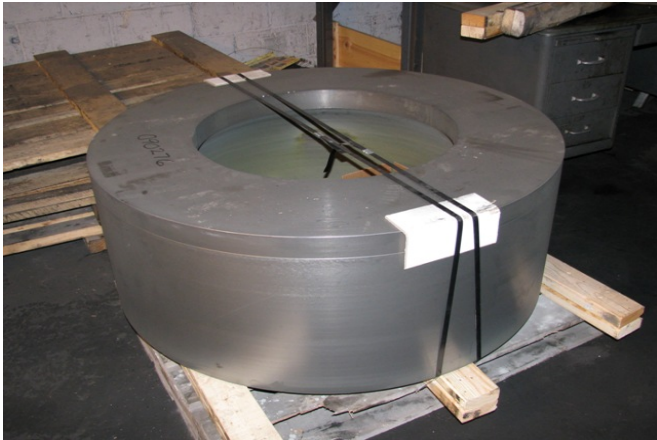
SOURCE INSPECTION REPORT

(Continued Page 2 of 3)

the inspection on July 15th 2009. Two of the spherical bushings heat # 080951 and 080962 were still waiting final inspection and assembly into their housing. This QA Inspector also noted that spherical bushing heat # 080947 was still waiting to be remachined. The QC Inspector informed this QA Inspector that the final housing was getting ready to have the rough machining done and then the machine would be switched over to run this final spherical bushing heat # 080947. See photo below:

Stainless Steel Spherical Housing: (Qty of 8 required with 8 cast): This QA Inspector noted housing heat # 090191 had the rough machining complete upon arrival. This QA Inspector was informed by the QC Inspector that housing heat # 090276 was the final housing half that needed to be rough machined and that after it was done the final spherical bushing would be machined. This QA Inspector also noted that housing heat # 090286 had all the tie rod holes drilled and housing heat # 090181 was in process of having the tie rod holes drilled into it. See photo below:

Shear Key Half Castings: (Qty of 8 required with 8 cast): This QA Inspector noted that a set of shear keys heat # 090209 and 090198 were in process of being final machined. This QA Inspector was informed by the QC Inspector that after the final machining was complete the lubricant would be applied and then the machining of the lubricant would take place. See photo below:



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

SOURCE INSPECTION REPORT

(Continued Page 3 of 3)

Comments

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Inspected By:	Webster,Andrew
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Quality Assurance Inspector

Reviewed By:	Levell,Bill
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QA Reviewer

DEPARTMENT OF TRANSPORTATION**DIVISION OF ENGINEERING SERVICES**

Office of Structural Materials

Quality Assurance and Source Inspection



Bay Area Branch

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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-000782**Date Inspected:** 21-Jul-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1300**Contractor:** Dyson Corp. & Subs**Location:** Painesville, OH**Quality Control Contact:** Dave Sukenik**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** 1.00"-8UNC-2A galvanized tie rods**Bid Item:** 45**Lot No:** B201-023-09**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was requested by Dyson Corporation to observe and document the operations and Quality Control (QC) functions relative to the project at their facility.

This QA Inspector traveled to Dyson Corporation and met with QC Inspector Dave Sukenik. This QA Inspector was also asked to release eighty one 1.00"-8UNC-2A x 28.875" galvanized tie rod assemblies heat # 8990895 (for the Pier E2 Bearing Housings). These eighty one tie rod assemblies were sampled on June 25th 2009. The samples passed the California Tran. Lab testing and the assemblies are being green tagged (Lot # B201-023-09) and released to Lubrite Industries in Meadville, PA. See photos below.



SOURCE INSPECTION REPORT

(Continued Page 2 of 2)



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

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: Webster, Andrew

Quality Assurance Inspector

Reviewed By: Levell, Bill

QA Reviewer

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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-000053**Date Inspected:** 21-Jul-2009**Contractor:** Dyson Corp. & Subs**Location:** Painesville, PA**Bridge No.:** 34-0006**OSM Arrival Time:** 900**OSM Departure Time:** 1300**Component:#** 1"-8UNC-2A Galvanized Tie Rod

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: Lubrite Technologies Meadville, PA

Lot #	Bid Item #	Quantity	Material Description
B201-023-09 45		81 ea	1.00"-8UNC-2A x 28.875" galvanized tie rod assemblies heat # 8990895

Identification: One Green Tag placed on the Tie Rod Certificate of Compliance**Summary of Items Observed:**

The galvanized tie rods, nuts and washers were tagged and released to Lubrite Technologies in Meadville, PA.

Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

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: Webster, Andrew

Quality Assurance Inspector

Reviewed By: Levell, Bill

QA Reviewer

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(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 72.15**SOURCE INSPECTION REPORT****Resident Engineer:** Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-000783**Date Inspected:** 22-Jul-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1500**Contractor:** Lubrite**Location:** Meadville, PA**Quality Control Contact:** Brad McWright**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** Pier E2 Bearings**Bid Item:** 45, 61**Lot No:** N/A**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was present at Lubrite Technologies to randomly observe and document the operations and Quality Control (QC) functions relative to the casting of the E2 bearings project. This QA Inspector met with Lubrite's QC Manager, Brad McWright who escorted the QA Inspector to the shop floor to view the current work in process. As previously reported Lubrite's internal policy mandates that agency inspectors/visitors must be accompanied by a Lubrite representative during all phase of shop inspection activities and/or the taking of digital images. While on site, the QA Inspector noted the following work being performed.

Bronze Plates: (4 required and 4 complete) These parts were shipped out by truck on the 16th of July 2009 heading for Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

Sleeve Bushings: (8 required and 8 complete) These parts were shipped out by truck on the 16th of July 2009 heading for Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

Self-Aligning Spherical Bushing Bearing: (4 required and 1 complete) This part (B1-08) was shipped out by truck on the 16th of July 2009 heading for Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

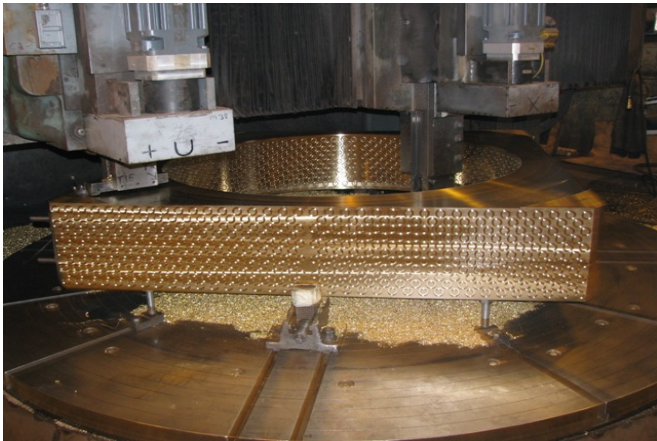
Bronze Spherical Bushings: (4 required and 3 complete): The QA Inspector noted that spherical bushing heat # 080947 was in the process of having the lubricant final machined. This is the last spherical bushing to need the lubricant final machined and then it can be final inspected. The two other spherical bushings heat # 080951 and 080962 have the final inspection done and are waiting to be assembled into their housing. See photo below:

SOURCE INSPECTION REPORT

(Continued Page 2 of 3)

Stainless Steel Spherical Housing: (Qty of 8 required with 8 cast): This QA Inspector noted that all of the housings have the rough machining done. This QA Inspector also noted the housing heat # 090112 was in the process of having the tie rod holes drilled. This QA Inspector noted that housing heat # 090181 and # 090286 were bolted together. The QC Inspector informed this QA Inspector that these two housings make a pair and will be final machined as such after the spherical bushing was finished. See photo below:

Shear Key Half Castings: (Qty of 8 required with 8 cast): This QA Inspector noted that the final set of shear keys heat # 090206 and 090195 was in the process of being final machined. This QA Inspector was informed by the QC Inspector that all of the shear key sets would have the lubricant applied to the bores and then final machined after which the out side of the shear keys will have lubricant applied and then final machined to size. After these steps the shear keys will be ready for final inspection. See photo below:



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

Comments

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SOURCE INSPECTION REPORT

(Continued Page 3 of 3)

Inspected By:	Webster,Andrew	Quality Assurance Inspector
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Reviewed By:	Levell,Bill	QA Reviewer
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Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 72.15**SOURCE INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-000795**Date Inspected:** 27-Jul-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 830**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1430**Contractor:** Lubrite**Location:** Meadville, PA**Quality Control Contact:** Brad McWright**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** Pier E2 Bearings**Bid Item:** 45, 61**Lot No:** N/A**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was present at Lubrite Technologies to randomly observe and document the operations and Quality Control (QC) functions relative to the casting of the E2 bearings project. This QA Inspector met with Lubrite's QC Manager, Brad McWright who escorted the QA Inspector to the shop floor to view the current work in process. As previously reported Lubrite's internal policy mandates that agency inspectors/visitors must be accompanied by a Lubrite representative during all phase of shop inspection activities and/or the taking of digital images. While on site, the QA Inspector noted the following work being performed.

Bronze Plates: (4 required and 4 shipped on July 16th 2009), Sleeve Bushings: (8 required and 8 shipped on July 16th 2009), Self-Aligning Spherical Bushing Bearing: (4 required and 1 (B1-08) complete and shipped on July 16th 2009) all of these parts have been shipped to Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

Bronze Spherical Bushings: (4 required and 3 complete): The QA Inspector noted that all of the spherical bushings heat # 080947, # 080951 and # 080962 were done with final machining of the lubricant. This QA Inspector was informed by to the QC Inspector that the final inspection on spherical bushing heat # 080947 was done after this QA Inspector had left the facility on Friday July 24th 2009. The QC Inspector stated that this was done so the R9 break-in lubricant could be applied and be allowed to set so this bushing would be ready for assembly into the housing. The two other spherical bushings heat # 080951 and # 080962 have also had the final inspection done and are waiting for the R9 break-in lubricant to be applied before assembled into their housing. See photo below:

Stainless Steel Spherical Housing: (Qty of 8 required with 8 cast): This QA Inspector noted that housing heat #

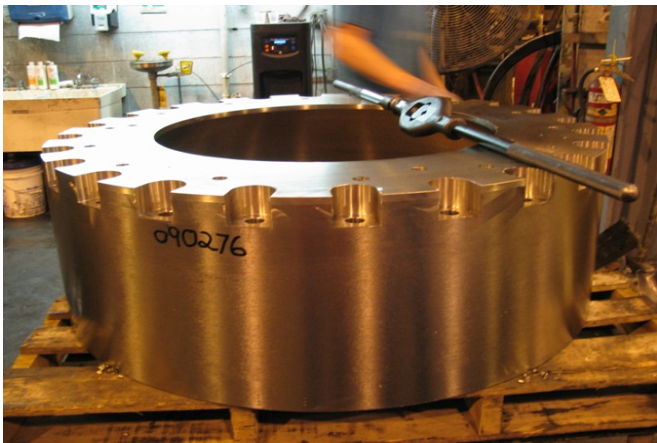
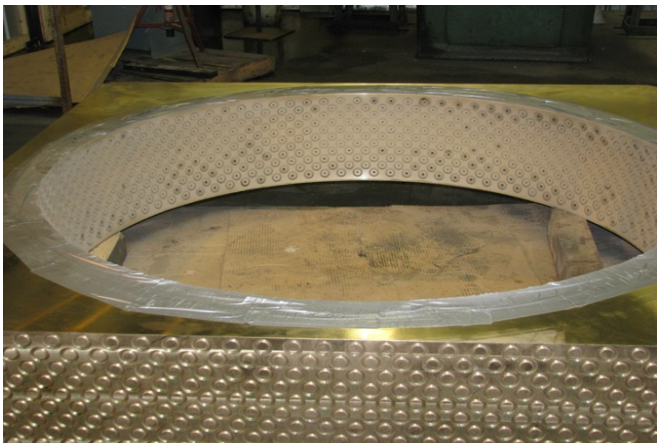
SOURCE INSPECTION REPORT

(Continued Page 2 of 3)

090181 and # 090286 were in the process of being final machined. The QA Inspector also noted that housing heat # 090276 had the tie rod holes drilled into it and that it would be fit with housing heat # 090112 for the next set to be final machined. The QC Inspector informed this QA Inspector that housing heat # 090296 was being drilled with the tie rod holes which leave housing heat # 090191 as the final housing to be drilled. See photo below:

Shear Key Half Castings: (Qty of 8 required with 8 cast): This QA Inspector noted that shear keys heat # 090206 and # 090195 and heat # 090209 and # 090198 were sandblasted and ready to have the lubricant applied. See photo below:

This QA Inspector met with Caltrans Engineer Ajay Sehgal and discussed the operations at the Lubrite facility to date. Caltrans Engineer Mr. Sehgal and the QA Inspector along with Lubrite manager Thomas Seringer toured the facility to give Caltrans Engineer Mr. Sehgal an idea of the process it took to make the parts for the Pier E2 Bearings. After the tour of the facility This QA Inspector and Caltrans Engineer Mr. Sehgal went through pictures that this QA Inspector had taken during the inspections at the facility. The QA Inspector and Caltrans Engineer Mr. Sehgal discussed the inspections that have taken place. Caltrans Engineer Mr. Sehgal requested some of the pictures that the QA Inspector had taken for use in the documentary.



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

SOURCE INSPECTION REPORT

(Continued Page 3 of 3)

Comments

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Inspected By:	Webster,Andrew
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Quality Assurance Inspector

Reviewed By:	Levell,Bill
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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 #: 72.15**SOURCE INSPECTION REPORT****Resident Engineer:** Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-000798**Date Inspected:** 30-Jul-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 900**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1500**Contractor:** Lubrite**Location:** Meadville, PA**Quality Control Contact:** Brad McWright**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** Pier E2 Bearings**Bid Item:** 45, 61**Lot No:** N/A**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was present at Lubrite Technologies to randomly observe and document the operations and Quality Control (QC) functions relative to the casting of the E2 bearings project. This QA Inspector met with Lubrite's QC Manager, Brad McWright who escorted the QA Inspector to the shop floor to view the current work in process. As previously reported Lubrite's internal policy mandates that agency inspectors/visitors must be accompanied by a Lubrite representative during all phase of shop inspection activities and/or the taking of digital images. While on site, the QA Inspector noted the following work being performed.

Bronze Plates: (4 required and 4 shipped on July 16th 2009), Sleeve Bushings: (8 required and 8 shipped on July 16th 2009), Self-Aligning Spherical Bushing Bearing: (4 required and 1 (B4-08) complete and 1 (B1-08) complete and shipped on July 16th 2009) all of these parts except the self-aligning spherical bushing bearing (B4-08) have been shipped to Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

Bronze Spherical Bushings: (4 required and 3 complete): The QA Inspector noted that spherical bushing heat # 080947 had been assembled into its housing and labeled (B4-08) prior to this QA Inspectors arrival. This QA Inspector also noted that spherical bushings heat # 080951 and # 080962 had the R9 break-in lubricant applied to them. See photo below:

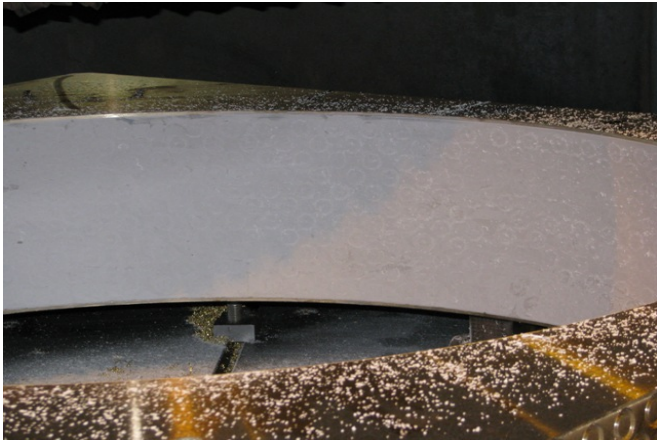
Stainless Steel Spherical Housing: (Qty of 8 required with 8 cast): This QA Inspector noted that housing heat # 090181 and # 090286 had spherical bushing heat # 080947 in corporate into them to make self-aligning spherical bushing bearing (B4-08). The QA Inspector also noted that housing heat # 090276 and # 090112 were bolted

SOURCE INSPECTION REPORT

(Continued Page 2 of 3)

together and were in the process of having the dowel pin holes drilled into them before going for final machining. The QA Inspector noted that housing heat # 090191 was having some bolt holes tabbed and then would be ready to be bolted to housing heat # 090296 for final machining. See photo below:

Shear Key Half Castings: (Qty of 8 required with 8 cast): This QA Inspector noted that shear keys heat # 090209 and # 090198 had the lubricant on the bore of the part machined to final dimensions prior to this QA Inspectors arrival at the facility today. This shear key is now ready to have lubricant applied to the outside of the part and then have the outside final machined. This QA Inspector also noted that shear key heat # 090195 and # 090206 was ready for the final machining of the lubricant on the bore of the part. This QA Inspector was informed by the QC Inspector that shear key heat # 090188 and # 090196 still needed the lubricant holes on the bore cut deeper. See photo below:



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

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 3 of 3)

Inspected By: Webster,Andrew

Quality Assurance Inspector

Reviewed By: Levell,Bill

QA Reviewer

DEPARTMENT OF TRANSPORTATION**DIVISION OF ENGINEERING SERVICES**

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Vallejo, CA 94592-1133
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(707) 649-5493

Contract #: 04-0120F4Cty: SF/ALA Rte: 80 PM: 13.2/13.9File #: 72.15**SOURCE INSPECTION REPORT****Resident Engineer:** Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** SIR-000875**Date Inspected:** 14-Aug-2009**Project Name:** SAS Superstructure**OSM Arrival Time:** 830**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**OSM Departure Time:** 1330**Contractor:** Lubrite**Location:** Meadville, PA**Quality Control Contact:** Brad McWright**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:** Quality Surveillance of Machining Activities**Bridge No:** 34-0006**Component:** Pier E2 Bearings**Bid Item:** 45, 61**Lot No:** B201-026-09**Summary of Items Observed:**

The Caltrans Office of Structural Materials (OSM) Quality Assurance (QA) Inspector Andrew Webster was present at Lubrite Technologies to randomly observe and document the operations and Quality Control (QC) functions relative to the casting of the E2 bearings project. This QA Inspector met with Lubrite's QC Manager, Brad McWright who escorted the QA Inspector to the shop floor to view the current work in process. As previously reported Lubrite's internal policy mandates that agency inspectors/visitors must be accompanied by a Lubrite representative during all phase of shop inspection activities and/or the taking of digital images. While on site, the QA Inspector noted the following work being performed.

Bronze Plates: (4 required and 4 shipped on July 16th 2009), Sleeve Bushings: (8 required and 8 shipped on July 16th 2009) have been shipped to Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

Self-Aligning Spherical Bushing Bearing: (4 required and 4 complete and 1 (B1-08) shipped on July 16th 2009) The self-aligning spherical bushing bearings (B2-08, B3-08 and B4-08) are complete and were released by this QA Inspector to be shipped to Hochang Machinery Industries Co., Ltd. of Ulsan, Korea.

Bronze Spherical Bushings: (4 required and 4 complete): The QA Inspector noted that all of the spherical bushing have been assembled into a set of stainless steel housings. See photo below:

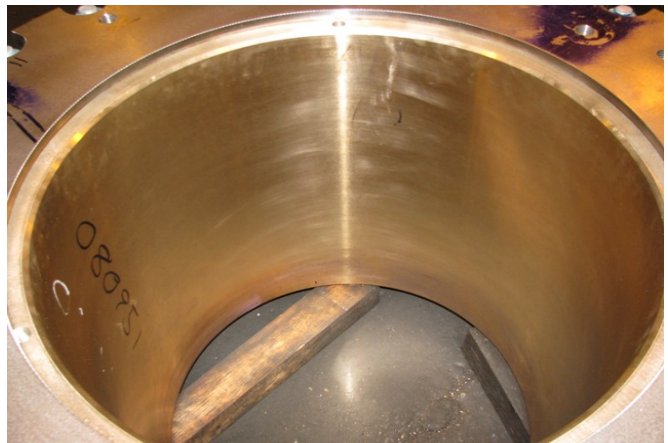
Stainless Steel Spherical Housing: (Qty of 8 required and 8 complete): This QA Inspector noted that all of the stainless steel housings were completed and assembled around a spherical bushing. See photo below:

SOURCE INSPECTION REPORT

(Continued Page 2 of 3)

Shear Key Half Castings: (Qty of 8 required with 8 complete): This QA Inspector noted that all of the shear keys were also complete and ready to be shipped.

This QA Inspector reviewed all of the documents for the remaining self-aligning spherical bushing bearings and the shear keys. The self-aligning spherical bushing bearings consisted of B2-08 containing bronze spherical bushing heat # 080951 and stainless steel housing set heat # 090112 and # 090276, B3-08 containing bronze spherical bushing heat # 080962 and stainless steel housing set heat # 090191 and # 090296 and B4-08 containing bronze spherical bushing heat # 080947 and stainless steel housing set heat # 090181 and # 090286. All of the self-aligning spherical bushings are held together with stainless steel dowel pins heat # 217895, galvanized tie rods heat # 8990895, galvanized washers heat # L56844 and galvanized nuts heat # 692675. The shear keys consisted of S1-08 containing two halves heat # 090198 and # 090209, S2-08 containing two halves heat # 090196 and # 090188, S3-08 containing two halves heat # 090012 and # 090161 and S4-08 containing two halves heat # 090195 and # 090206. Included with each set of shear keys are stainless steel tie rods heat # 4VE4, stainless steel washers heat # 135088, stainless steel nuts heat # 421762 and stainless steel dowel pins heat # 152840. After reviewing all of the documents this QA Inspector green tag released (Lot # B201-026-09) all of the components to Hochang Machinery Industries Co., Ltd. of Ulsan, Korea. See photos below.



Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

SOURCE INSPECTION REPORT

(Continued Page 3 of 3)

Comments

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Inspected By:	Webster,Andrew
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Quality Assurance Inspector

Reviewed By:	Levell,Bill
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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 #: 72.8**COMPONENT MATERIAL INSPECTION REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** CMI-000063**Date Inspected:** 14-Aug-2009**Contractor:** Lubrite**Location:** Meadville, PA**Bridge No.:** 34-0006**OSM Arrival Time:** 830**OSM Departure Time:** 1330**Component:#** Pier E2 Self-Aligning Spherical B

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: Hochang Machinery Industries Co., Ltd., Ulsan, Korea

Lot #	Bid Item #	Quantity	ea	Material Description
B201-026-09 45		3	ea	Self-Aligning Spherical Bushing Bearing HMIC ID # B2-08, B3-08 and B4-08
B201-026-09 61		4	ea	Shear Keys HMIC ID # S1-08, S2-08, S3-09 and S4-08

Identification: One Green Tags placed on the Certificate of Compliance for the Spherical Bushing and Shear Keys

Summary of Items Observed:

The Final Visual Inspection for the Bearings and Shear Keys was done prior to this Quality Assurance (QA) Inspector arrival at the facility by the Quality Control (QC) Manager Brad McWright. This QA Inspector looked over the bearings, shear keys and the material sheets that went along with each and it appeared to be in compliance at the time of the inspection. The material is released to Hochang Machinery in Ulsan, Korea.

Summary of Conversations:

As noted in the body of the report above. Other basic communication was performed between the QA Inspector and the QC Inspector during the observations.

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: Webster, Andrew

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 #: 73.25A**MATERIAL SUITABILITY REPORT****Resident Engineer:**Pursell, Gary**Address:** 333 Burma Road**City:** Oakland, CA 94607**Report No:** MSR-000014**Report Date:** 30-Mar-2010**SMR Authorization #:****Project Name:** SAS Superstructure**Prime Contractor:** American Bridge/Fluor Enterprises, a JV**Contractor:** HoChang, Korea**Date of NCR:****Location:** HoChang, Korea

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
54-001-10	45	4 ea	Furnish and Install Spherical Bushing Bearing (Pier E2)

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

Pier E2 Spherical Bushing Bearings - Items resolved via RFI and/or Submittal review process:

BTL 109: ABF-SUB-000540R03, AWS D1.6 Section 4.6.11.4 requires guided bend tests specimens for PQR qualification of stainless steel welding. The submittal was accepted without guided bend tests as the weld is being used as an overlay.

BTL 115: ABF-RFI-002015R00, ABF-RFI-002015R01, Rotation around one of the orthogonal axes on the bearings is approximately 15% less than +/-2 degrees as required per Section 10-1.47 of the Special Provisions. This was accepted as fit for purpose.

Summary of Conversations:

Each of the above items was reviewed by Caltrans, and per RFI and/or Submittal response resolved accordingly by the Contractor.

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.

MATERIAL SUITABILITY REPORT

(Continued Page 2 of 2)

Inspected By: Guest,Kittric

Quality Assurance Inspector

Reviewed By: Choy,Nina

QA Reviewer

CERTIFICATE OF COMPLIANCE**Lubrite® Technologies**

Subsidiary of U.S. Bronze Foundry & Machine, Inc.
P.O. BOX 458 18649 BRAKE SHOE ROAD
MEADVILLE PA, 16335
PH: 814-337-4234 FAX: 814-724-2660
EMAIL: bmcwright@usbfdmi.com

Date: 2 July, 2009

Shipment Date: 14 July, 2009

Customer: **Hochang Machinery**
 Purchase Order Number: **HMIC-SFOBB-PO-001**
 Caltrans Contract Number: **04-0120F4**
 Caltrans Special Provisions: **Conformed Through Addendum No. 7; May 25, 2006 Edition**
 Caltrans Standard Specifications: **July 1999 Edition**
 Assembly Drawing Number: **3207033 Rev. B**

Lubrite S.O. Number: **L-1777**

Item: Lubrite® Self-Aligning Spherical Bushing Bearing
 (Section 10-1.47 Spherical Bushing Bearing (Pier E2))
 Quantity: 1 Assembly

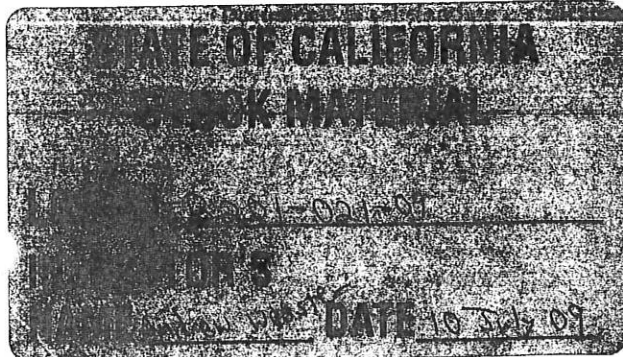
Material Listing and Traceability:

HMIC ID Number: B1-08				
Description	Material Designation	Heat/Lot/Batch Number	Lubrite ID Number	Quantity
Spherical Ball	ASTM B271-06 UNS C86300	080972	1S-E2	1
Lubricant	Lubrite® Type G10	Part A - 1100128300007 Part B - 2100082700007	NA	Spherical OD Only
Housing	ASTM A744-06 Grade CF8M	Top Half - 090290 Bottom Half - 090300	Top - 1AH-E2 Bottom - 1BH-E2	2 Halves
Housing Heat Treat	ASTM A744-06 Grade CF8M	Top Half - H021632 Bottom Half - H021638	NA	NA
Tie Rods	ASTM A354-07a Grade BD	8990895 Lot MYP	NA	24
Hex Nuts	ASTM A563-07a Grade DH	692675 Lot DCGG2	NA	48
Washers	ASTM F436-07a Type 1	L56844 Lot MWQ	NA	48
Dowel Pins	Type 316 St/Sl	217895	NA	4

We certify that the materials and fabrication shipped herewith, have been inspected and are in full compliance with the requirements of drawings, processes, and / or specifications of the referenced purchase order and contract 04-0120F4.

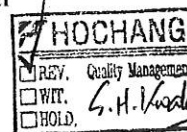
Material made and manufactured in the United States.

Materials are also available in Lubrite® Technologies files.



Brad J. McWright
 Brad J. McWright
 Quality Control Manager

7-2-09
 Date Signed



Aug 10, 2009

MATERIAL TEST REPORT

PAGE 2 OF 28

LUBRITE® TECHNOLOGIES

DATE: 1 July, 2009

Subsidiary of U.S. Bronze Foundry & Machine, Inc.
P.O. BOX 458 18649 BRAKE SHOE ROAD
MEADVILLE PA, 16335
PH: 814-337-4234 FAX: 814-724-2660
EMAIL: bmcwright@usbfdmi.com

Customer: **Hochang Machinery**
Purchase Order No: **HMIC-SFOBB-PO-001**
Caltrans Contract No: **04-0120F4**
Caltrans Special Provisions: **Conformed Through Addendum No. 7; May 25, 2006 Edition**
Caltrans Standard Specifications: **July 1999 Edition**
Drawing Number: **3207033 Rev. B and 3208037**
Bushing ID Number: **1S-E2**
HMIC ID Number: **B1-08**

LUBRITE S.O. NO: **L-1777 / 14359**

ITEM: 1 Lubrite® Bronze Self-Lubricating Spherical Ball Bushing
650.20mm Spherical O.D. x 650.20mm I.D. x 700.00mm Length
Material: ASTM B271-06 UNS C86300 / Type G10 Lubrite® Lubricant on Spherical O.D. Only
Finish: All Over

CHEMICAL COMPOSITION

HEAT NUMBER: 080972	<u>SPECIFICATION REQUIREMENTS</u>	<u>ACTUAL PROPERTIES</u>
COPPER (As Remainder)	60.0 – 66.0	62.45
TIN	0.20 max	0.014
LEAD	0.20 max	0.050
IRON	2.0 – 4.0	2.78
NICKEL (Including Cobalt)	1.0 max	0.042
ZINC	22.0 – 28.0	24.633
ALUMINUM	5.0 – 7.5	5.62
MANGANESE	2.5 – 5.0	4.41

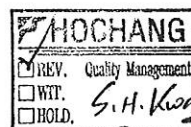
MECHANICAL PROPERTIES

	<u>RANGES</u>	<u>ACTUAL</u>
TENSILE STRENGTH (ksi)	110.0 min	118.2
YIELD STRENGTH (ksi)	60.0 min	76.2
ELONGATION (%in 2")	12% min	24.0%

WE CERTIFY THAT THE MATERIALS AND FABRICATION SHIPPED HERewith, HAVE BEEN INSPECTED AND ARE IN FULL COMPLIANCE WITH THE REQUIREMENTS OF DRAWINGS, PROCESSES, AND / OR SPECIFICATIONS OF THE REFERENCED PURCHASE ORDER AND CONTRACT 04-0120F4.

MATERIAL MADE AND MANUFACTURED IN THE UNITED STATES.


BRAD J. MCWRIGHT
QUALITY CONTROL MANAGER



CERTIFIED MATERIAL TEST REPORT

PAGE 11 OF 28

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
L 101923	13926-K	1 of 3	39 pcs	6/25/09

CUSTOMER
Lubrite Technologies
PO Box 458
Meadville, PA 16355

PRODUCT DESCRIPTION
1.00"-8UNC-2A x 28.875" lg special double end stud,
HDG per ASTM A123-08. Dimensions per Dwg.
DMS050709.

A

DRAWING

SPECIFICATIONS
ASTM-A354-07a Grade BD with magnetic particle
inspection per ASTM A490-08a; Special provisions
10-1.59, 10-1.60, 10-1.61 std specifications 75-1.05
apply

STARTING MATERIAL	DIA	GRADE	QTY	LOT CODE	HEAT NO.	ORIGINAL MILL
Round Bar	1.000	4140 AQ	39	MYP	8990895	Republic

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.

1. The steel was melted and manufactured in the USA and the product was manufactured and tested in the USA.

STATE OF CALIFORNIA STOCK MATERIAL

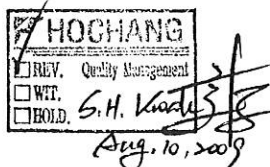
LOT NO. B201-D17-09

INSPECTOR'S

NAME Andrew Webster DATE 25 June 2009

Attachments:

Mill Test Report
Mechanical Test Report
N.D.E. Report
Galvanizing Certification



Deborah A. Smith
Q.A. Admin. Assistant
6/25/09



Republic

IAC 34551

3049 LAKESHORE-GATE 6
PHONE: 330-438-5694

PAGE 12 OF 28

BUFFALO, NY 1
FAX: 330-438-

CERTIFICATE OF TESTS

REPUBLIC ENGINEERED PRODUCTS

May 29, 2008
PAGE 1

OF 2

CODE MYP

PURCHASE ORD: 11-46873
PART NUMBER: IAC34331
ORDER NUMBER: 1374059 - 01
HEAT: 8990895

PURCHASE ORDER DATE: 3/7/2008
ACCOUNT NUMBER: 5607-1758-01
SCHEDULE: 6010-66
REVISION: 1

CHARGE ADDRESS

SHIP TO

HY ALLOY STEEL CO DIV
A M CASTLE & CO INC
3400 NORTH WOLF RD
FRANKLIN PARK, IL 60131

HY ALLOY STEEL CO DIV
A M CASTLE & CO INC
C/O H A INDUSTRIES
4527 COLUMBIA AVE
HAMMOND, IN 46327

MATERIAL DESCRIPTION

H ROLLED STEEL BARS ALLOY ASTM A322-07 FG ASTM A29-05 FG AMS 2301J CASTLE METALS SPEC G41400-208
REVISION 9 DTD 06/29/07 AMS 6382M EXC COND UNS G41400 EF-AISI-4140 FINE GRAIN VACUUM DEGAISED
AIRCRAFT QUALITY 5.00 : 1 RED RATIO
SIZE: RDS 1.0625 DIAM X 20FT 0.0000IN MIN/24FT 0.0000IN MAX
RDS 26.9875MM DIAM X 6096.0000MM MIN/7315.2000MM MAX

LADLE CHEMISTRY %

C	MN	P	S	SI	CU	NI	CR
0.42	0.91	0.008	0.020	0.24	0.09	0.09	1.00
V	MO	SN	AL	CB	CA	N	
0.004	0.21	0.005	0.024	0.001	0.0001	0.0109	

CALCULATED TESTS

REDOCTION RATIO 146.6 TO 1

AUSTENITIC GRAIN SIZE 5 OR FINER BASED ON A TOTAL ALUMINUM CONTENT EQUAL TO OR GREATER THAN .020% PER ASTM A29.

SEMI - FINISHED RESULTS

JOMINY HARDNESS TEST SAE J406/ASTM A255
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 20 22 24 26 28 30 32
59 59 57 58 58 57 56 56 54 54 51 50 48 47 45 44 42 42 41 39 39 37 35 36

MACRO ETCH TEST ASTM E381/MIL STD 430
ETCHANT: HCL TEMPERATURE: 170
S R C
AVG 1 1 1

MAGNETIC PARTICLE TEST AMS 2301 AMS2304 AMS2300
IND AVG IND AVG
FREQ FREQ SEV SEV
PCE 03 0 0 0 0

FINISHED SIZE RESULTS

DECARBURIZATION TEST SAE J419/ASTM E1077
ETCHANT = NITAL MAGNIFICATION = 100X

TOTAL
DEPTH
INCHES
PCE 01 0.006

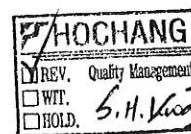
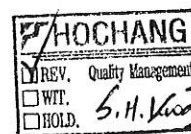
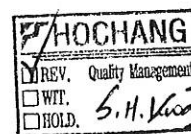
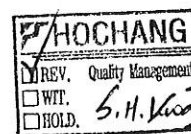
NOTES

REPUBLIC ENGINEERED PRODUCTS HEREBY CERTIFY THAT THE MATERIAL LISTED HEREIN HAS BEEN INSPECTED AND TESTED IN ACCORDANCE WITH THE METHODS PRESCRIBED IN THE GOVERNING SPECIFICATIONS AND BASED UPON THE RESULTS OF SUCH INSPECTION AND TESTING HAS BEEN APPROVED FOR CONFORMANCE TO THE SPECIFICATIONS.

CERTIFICATE OF TESTS SHALL NOT BE REPRODUCED EXCEPT IN FULL.

R. A. NEBIOLO
DIRECTOR QUAL. ASSURANCE

BY JANET K. HARTLINE





Republic

3049 LAKESHORE-GATE 6
PHONE: 330-438-5694

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BUFFALO, NY 1
FAX: 330-438-

CERTIFICATE OF TESTS

REPUBLIC ENGINEERED PRODUCTS

May 29, 2008
PAGE 2

OF 2

CODE MYP

PURCHASE ORD: 11-46873
PART NUMBER: IAC34331
ORDER NUMBER: 1374059 - 01
HEAT: 8990895

PURCHASE ORDER DATE: 3/7/2008
ACCOUNT NUMBER: 5607-1758-01
SCHEDULE: 6010-66
REVISION: 1

ALL TESTING HAS BEEN PERFORMED USING THE CURRENT REVISION OF THE TESTING SPECIFICATIONS.

RECORDING OF FALSE, FICTITIOUS OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHED

NOTES (CONTINUED)
AS A FELONY UNDER FED STATUES TITLE 18 CHAPTER 47.

THE MATERIAL WAS NOT EXPOSED TO MERCURY OR ANY METAL ALLOY THAT IS LIQUID AT AMBIENT TEMPERATURE DURING PROCESSING OR WHILE IN OUR POSSESSION.

NO WELD OR WELD REPAIR WAS PERFORMED ON THIS MATERIAL.

THE RESULTS REPORTED RELATE ONLY TO THE ITEMS TESTED

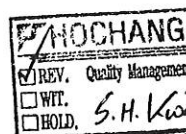
MATERIAL WAS VACUUM DEGASSED.

MANUFACTURED IN THE U.S.A.

SOURCE INFORMATION
MELT SOURCE: CANTON CAST ROLL MELT COUNTRY: U.S.A HOT ROLL SOURCE: LACKAWANNA 13in, U.S.A
MELT METHOD: EF BLOOM RED. RATIO: 146.6

END OF DATA CC END OF DATA
WITH SHIPMENT 2 COPIES PRINTED AT SHIPPING AREA
FILE 1 COPY

5/13/09
Dyson
T+P to 1" Rd.



Aug. 10, 2009

R. A. NEBIOLO
DIRECTOR QUAL. ASSURANCE

R.A. Nebiolo

BY JANET K. HARTLINE

HA Industries
Date Recvd 6-4-08
Recvd From Republic
Approved by [Signature]

CERTIFICATE OF MATERIAL TEST REPORTS



H-A Industries
A Division of A. M. Castle & Co.
4527 Columbia Avenue
Hammond, IN 46327

CUSTOMER

CASTLE METALS CLEVELAND
P.O. BOX 5787

BEDFORD HEIGHTS OH 44101-0787 USA

H-A INDUSTRIES CERTIFIES THAT APPROPRIATE
INFORMATION IS TAKEN FROM TEST REPORTS FURNISHED
TO US BY OUR SUPPLIER AND WHICH ARE ON FILE IN OUR
OFFICE.

CODE MYP

MANUFACTURER (MILL) REPUBLIC ENGINEERED PRODS,			CUST. ORDER NO. STOCK-06335		CUST. REQUISITION NO.	
IAC 11648	HEAT NO. 8990895C4294	ORDER NO. 325906	LINE NO. 1	SHIP QTY. 20,438.0	SHIP DATE	

DESCRIPTION

1.0000 RD E4140 CF ANN AQ AMS 6382 10/13

*		* * *	CHEMICAL ELEMENTS				* * *		
C	MN	P	S	SI	NI	CR	MO	AL	
.42	.91	.008	.02	.24	.09	1.00	.21	.024	
CU	V	N	CB						
.09	.004	.0109	.001						

* * * **MECHANICAL PROPERTIES** * * *

HARDENS HB 192/ 192, FREQ .000, SEVER .000, GRAIN = FINE, GRAIN 5/ 5

MACRO - S1 R1 C1, R.R. 146.6

CAST = BLOOM, MERCURY FREE, WELD FREE, MEETS NAFTA = Y

* **J O M I N Y** *

1	2	3	4	5	6	7	8	12	16	20	24	28	32
59	59	57	58	58	57	56	56	50	44	42	39	37	36

* * * **INDUSTRY SPECIFICATIONS** * * *

A.I.S.I.-4140 (OR LATEST REVISIONS), AMS-2301J, AMS-6382M, ASTM-A108-07

ASTM-A29-05, UNS#-G41400

VACUUM DEGASSED AIRCRAFT Q RD# 4853 6-4-08 LAMELLAR ANNEAL DECARB - NIL ** T6

P @ HA IND ** FROM IAC 34331 9-11-08

H-A Industries certifies that in processing the metal which is the subject
of this Certification it was not exposed to any mercury or mercury
containing compound nor was it exposed to any radioactive source.

H-A INDUSTRIES A DIVISION OF A. M. CASTLE & CO.	
JAN L. CARUSO	
Name	MANAGER OF TECHNICAL SERVICES
Title	<i>Jan L. Caruso</i>
Signature	

END

Material does not contain any polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE)

CERTIFICATION FORM

PAGE 14 OF 28

MODERN INDUSTRIES, INC. - HEAT TREATING DIVISION

Page 1 of 1

PHONE 814/455-8061 - 814/455-8065 after 5 P.M. and Weekends FAX # 814/453-4382 613 WEST 11TH STREET, P.O. BOX 399, ERIE, PA 16512

CUST Dyson Corporation

PART # A354 GRBD

P.O. # 66382

MATERIAL 4140

SPEC CORE HARDNESS

SPEC SURFACE HARDNESS 35/37 HRC

SPECIFIED CASE DEPTH

PROCESS ID # 33387

ORDER QUANTITY 48

QUANTITY APPROVED 48

QUANTITY CHECKED 11

OF READING PER PIECE 1

OF CONTAINERS 1

V JAL INSPEC Inspection Dept

CUST SPEC: 1.11-2 REV 2

CUST SPEC: 800/1100 TEMPER

MILITARY: 10-1.59, 10-1.60

MILITARY: 10-1.61, 75-1.05

SCALE TYPE HRC

DESCRIPTION

INSPECTOR

2849 05/30/09 01:18

INSPECTION RESULTS

PC# RESULT PC# RESULT PC# RESULT

OF READING 11

LO SURF HARDNESS 35.2

HI SURF HARDNESS 36.2

RANGE 1.0

STANDARD DEVIATION

AVERAGE 35.70

ACTUAL CASE DEPTH

ACTUAL CORE HARDNESS

HEAT CYCLE

TEMPERATURE

TIME

QUENCH MEDIA

COMMENTS

CASE HARDEN
TEMPER

1550 DEGF
1000 DEGF

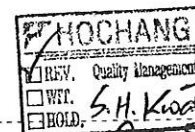
2.00
2.00

OIL
OIL

180 DEG OIL TEM

HT PER DQP 1011-2 REV 02, SOP SA354/A354 GR BD.35/37 HRC
CALTRAN SPECIAL PROVISIONS 10-1059, 10-1.60 & 10-1.61; PLUS CALTRANS STANDARD SPEC
75-1.05 APPLY TO THIS WORK.

TIMES / TEMPERATURES REQUIRED ON CERTIFICATIONS



The recording of false, fictitious or fraudulent statements or entries on this document may be punishable as a felony under Federal Statute.

There are no known mercury compounds in our plant which could come in contact with these parts.

I, hereby certify that the above listed part number has been processed and inspected and the results are in accordance with your above listed specification as instructed in your purchase order referenced above.

NAME Jeffery L Fridley

TITLE INSP

DATE 5/30/09

S/O L101923

STORK
Materials Technology

Stork Herron Testing Laboratories

6/3/2009

Debbie Smith
Dyson Corp
53 Freedom Rd
Painesville, OH 44077-1232

Date Received: 6/1/2009

Test Report No.: DYS006-09-06-83024-1

Material Testing and Non-Destructive
Testing

5405 E. Schaaf Road
Cleveland, OH 44131
USA

Telephone : (216) 524-1450

Fax : (216) 524-1459

Website : www.storkherron.com

TEST REPORT

P.O. No.: 66470

Sample Description: One (1) 1.00" x 6.00" lg. Test Pc., Material: Per AISI 4140, ASTM -A-354-(07a)
Grade BD, Modern HT PO# 66382, Customer PO#: 13926-K, Job #: L101923, Heat
#/Heat Code 8990895/ MYP

TENSILE TEST PER ASTM E8M-08, ASTM A370-08b

	Dia. (in)	Yield Strength .2% offset (ksi)	Ultimate Strength (ksi)	Elongation in A5 (%)	Reduction of Area (%)
1	.503	157	170	17	55
Required	-	130 min	150 min	14 min	40 min

CONFORMANCE

The samples meet the tensile requirements of ASTM A354, Grade BD.

QUALITY ASSURANCE STATEMENT

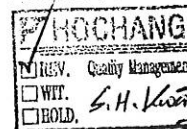
The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition #1, Revision 2 dated 1/30/07 as audited and approved by Dyson Corporation on 3/12/07.

This material was not contaminated by mercury or chlorinated solvents during the handling and processing at Stork-Herron Testing Laboratories facilities.

The reported results represent the actual attributes of the material tested and indicate full compliance with all applicable specification and contract requirements.

EXPORT CONTROLLED (ITAR)

THE TECHNICAL DATA AND / OR MATERIALS ASSOCIATED WITH THIS ORDER FALLS WITHIN THE DEFINITION OF THE INTERNATIONAL TRAFFIC IN ARMS REGULATIONS (ITAR) AND IS SUBJECT TO THE EXPORT CONTROL LAWS OF THE U.S. GOVERNMENT. TRANSFER OF THIS DATA BY ANY MEANS TO A FOREIGN PERSON OR FOREIGN ENTITY, WHETHER IN THE UNITED STATES OR ABROAD, WITHOUT AN EXPORT LICENSE, ITAR EXEMPTION OR OTHER APPROVAL FROM THE U.S. DEPARTMENT OF STATE, IS PROHIBITED.



The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 2 dated 1/30/07. Information and statements in this report are derived from material, information and/or specifications furnished by the client and exclude any expressed or implied warranties as to the fitness of the material tested or analyzed for any particular purpose or use. This report is the confidential property of our client and may not be used for advertising purposes. This report shall not be reproduced except in full, without written approval of this laboratory. The recording of false, fictitious or fraudulent statements or entries on this document may be punished as a felony under Federal Statutes.

Sample remnants are held for a minimum of 30 days following issuance of test results, at which point they will be discarded unless notified in writing by the client. This material was not contaminated by mercury or chlorinated solvents during the handling and processing at Stork-Herron Testing Laboratories facilities.

Karen Baumliller
Customer Services Manager

STORK
Materials Technology

Stork Herron Testing Laboratories

6/4/2009

Debbie Smith
Dyson Corp
53 Freedom Rd
Painesville, OH 44077-1232

Material Testing and Non-Destructive
Testing

5405 E. Schaaf Road
Cleveland, OH 44131
USA

Date Received: 6/1/2009

Telephone : (216) 524-1450
Fax : (216) 524-1459
Website : www.storkherron.com

Test Report No.: DYS006-09-06-83025-1

TEST REPORT

P.O. No.: 66467

Sample Description: One (1) Lot (48) Pcs., 1.00" x 28.875" lg. Blank Special Studs., Material: Per 4140AQ, Heat Treated To Meet ASTM-A354, Grade BD (Rc 36) Hardness, ASTM A490-08a, Customer PO#: 13926-K, Job #: 101923, Heat #/Heat Code 8990895/MYP

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM A490-08A	
Procedure:	SOP 42.03	
METHOD		
<input type="checkbox"/> Dry		<input checked="" type="checkbox"/> Wet
PARTICLES		
Magnaflux Particles: <input type="checkbox"/> 8A Red <input checked="" type="checkbox"/> 14A <input type="checkbox"/> 3A Black <input type="checkbox"/> 14AM <input type="checkbox"/> 1 Gray <input type="checkbox"/> Other Batch No. 95A069	Part Preparation: <input checked="" type="checkbox"/> None Required <input checked="" type="checkbox"/> Solvent Clean 07L020 <input type="checkbox"/> Grinding <input type="checkbox"/> Other	Wet Particle Carrier: <input checked="" type="checkbox"/> Magnaflux Carrier II <input type="checkbox"/> Pre Mixed <input type="checkbox"/> Concentration MI Batch No. 07C066
CURRENT		
<input type="checkbox"/> AC		<input checked="" type="checkbox"/> FWDC
<input type="checkbox"/> Central Conductor (AMPS)		<input checked="" type="checkbox"/> Head Shot (AMPS) 500
<input checked="" type="checkbox"/> Coil (AMPS) 600		<input type="checkbox"/> Prods (AMPS/Spacing)
Field Verified by: <input checked="" type="checkbox"/> Pie Gage <input type="checkbox"/> QQI <input type="checkbox"/> Hall Effect Probe		
EQUIPMENT		
<input checked="" type="checkbox"/> Magnaflux H-720 S/N: 81471 Cal Due Date: 9/24/2009		



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Karen Baumbler
Customer Services Manager

6/4/2009

Debbie Smith
Dyson Corp
53 Freedom Rd
Painesville, OH 44077-1232

Date Received: 6/1/2009

Test Report No.: DYS006-09-06-83025-1

Material Testing and Non-Destructive
Testing

5405 E. Schaaf Road
Cleveland, OH 44131
USA

Telephone : (216) 524-1450
Fax : (216) 524-1459
Website : www.storkherron.com

TEST REPORT

P.O. No.: 66467

MAGNETIC PARTICLE INSPECTION RESULTS	
Quantity	Results
48 1"X28.875 Blank Studs Material ASTM 4140AQ	Acceptable
Comments:	
Marking Requirements:	
Demag and post cleaning requirements: < 2 Gauss	
Inspected by: Shane Levermann	Certification: ASNT-SNT-TC-1A Level <input checked="" type="checkbox"/> II <input type="checkbox"/> III

QUALITY ASSURANCE STATEMENT

The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition #1, Revision 2 dated 1/30/07 as audited and approved by Dyson Corporation on 3/12/07.

This material was not contaminated by mercury or chlorinated solvents during the handling and processing at Stork-Herron Testing Laboratories facilities.

The reported results represent the actual attributes of the material tested and indicate full compliance with all applicable specification and contract requirements.

EXPORT CONTROLLED (ITAR)

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Karen Baumiller
Customer Services Manager

6/15/2009

Dave Sukenik
Dyson Corp.
53 Freedom Road
53 Freedom Rd
PAINESVILLE, OH 44077-1232

Date Received: 6/9/2009

Test Report No.: DYS006-09-06-83514-1

**Material Testing and Non-Destructive
Testing**

5405 E. Schaaf Road
Cleveland, OH 44131
USA

Telephone : (216) 524-1450
Fax : (216) 524-1459
Website : www.storkherron.com

TEST REPORT

P.O. No.: 66609

Sample Description: One (1) Lot (4 pcs.) 1.00"-8UNC-2A X 28.875" Special Double End Studs,
Material per ASTM A354-07a, Grade BD, Job# L101923A, Customer PO #
13926K, Heat #/Code 8990895/MYP, ASTM F606-08

HYDROGEN EMBRITTLEMENT TEST PER ASTM F606-08

Three (3) samples were lubed and torqued to determine torque values needed to achieve 75% of sample specified tensile load.

Four (4) lubed samples had torques of 577 ft-lbs applied to achieve a load of 68175 lbs and held for 48 hours.

Post test samples were examined at 20x magnification for cracking, none was observed.

QUALITY ASSURANCE STATEMENT

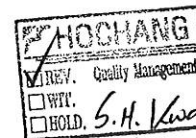
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Paula Tesar
Quality Administrator

DATE	6/29/2009											
THE ART GALVANIZING WKS., INC. 3936 VALLEY ROAD-CLEVELAND, OHIO 44109 PHONE 216-749-0020												
PACKING SLIP/CERTIFICATIONS												
TO	DYSON CORP				PO#	66561						
NOTE:	THE FOLLOWING MATERIAL HAS BEEN HOT DIP GALVANIZED TO ASTM A 153 OR ASTM A 123 (LATEST REVISION) SPECIFICATION AS APPLICABLE. A COPY OF OF THE ABOVE PURCHASE ORDER IS AN INTERNAL PART OF THIS CERTIFICATION AND SHOULD BE ATTACHED.											
1.00"-8 UNC2A X28.875 DES												
MYP HT#8990895												
GALV WEIGHT		301#	GALV WEIGHT		GALV WEIGHT		GALV WEIGHT					
INCHES	OZ/SQ FT		INCHES	OZ/SQ FT	INCHES	OZ/SQ FT	INCHES	OZ/SQ FT				
0.0022	1.29		0	0.00		0	0.00					
0.0024	1.41		0	0.00		0	0.00					
0.0026	1.53		0	0.00		0	0.00					
0.0028	1.65		0	0.00		0	0.00					
0.003	1.75		0	0.00		0	0.00					
AVG	1.53		AVG	0.00		AVG	0.00					
GALV WEIGHT			GALV WEIGHT		GALV WEIGHT		GALV WEIGHT					
INCHES	OZ/SQ FT		INCHES	OZ/SQ FT	INCHES	OZ/SQ FT	INCHES	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					
0	0.00		0	0.00		0	0.00					
AVG	0.00		AVG	0.00		AVG	0.00					
GALV WEIGHT			GALV WEIGHT		GALV WEIGHT		GALV WEIGHT					
INCHES	OZ/SQ FT		INCHES	OZ/SQ FT	INCHES	OZ/SQ FT	INCHES	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					
0	0.00		0	0.00		0	0.00					
AVG	0.00		AVG	0.00		AVG	0.00					

CERTIFIED MATERIAL TEST REPORT

PAGE 6 OF 44

DYSON CORP.

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
L 101923	13926-K	1 of 3	81 pcs	7/21/09

CUSTOMER
Lubrite Technologies
PO Box 458
Millsville, PA 16355
USA

PRODUCT DESCRIPTION
1.00"-8UNC-2A x 28.875" lg special double end stud,
HDG per ASTM A123-08. Dimensions per Dwg.
DMS050709.

DRAWING

SPECIFICATIONS
ASTM-A354-07a Grade BD with magnetic particle
inspection per ASTM A490-08a; Special provisions
10-1.59, 10-1.60, 10-1.61 std specifications 75-1.05
apply

STARTING MATERIAL	DIA	GRADE	QTY	LOT CODE	HEAT NO.	ORIGINAL MILL
Round Bar	1.000	4140 AQ	81	MYP2	8990895	Republic

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.

1. The steel was melted and manufactured in the USA and the product was manufactured and tested in the USA.

STATE OF CALIFORNIA STOCK MATERIAL

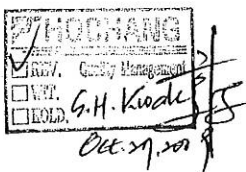
LOT NO. B201-023-09


INSPECTOR'S

NAME Andrew Webster DATE 21 July 09

Attachments:

Mill Test Report
Mechanical Test Report
N.D.E. Report
Galvanizing Certification




Deborah A. Smith
Q.A. Admin. Assistant
7/21/09



Republic

IAC 34331

3049 LAKESHORE-GATE 6
PHONE: 330-438-5694

PAGE 21 OF 44

BUFFALO, NY
FAX: 330-438-

CERTIFICATE OF TESTS

REPUBLIC ENGINEERED PRODUCTS

May 29, 2008
PAGE 1

OF 2

CODE MYP 2

PURCHASE ORD: 11-46873	PURCHASE ORDER DATE: 3/7/2008
PART NUMBER: IAC34331	ACCOUNT NUMBER: 5607-1758-01
ORDER NUMBER: 1374059 - 01	SCHEDULE: 6010-66
HEAT: 8990895	REVISION: 1

CHARGE ADDRESS SHIP TO

HY ALLOY STEEL CO DIV
A M CASTLE & CO INC
3400 NORTH WOLF RD
FRANKLIN PARK, IL 60131

HY ALLOY STEEL CO DIV
A M CASTLE & CO INC
C/O H A INDUSTRIES
4527 COLUMBIA AVE
HAMMOND, IN 46327

MATERIAL DESCRIPTION

OT ROLLED STEEL BARS ALLOY ASTM A322-07 FG ASTM A29-05 FG AMS 2301J CASTLE METALS SPEC G41400-208
EVISION 9 DTD 06/29/07 AMS 6382M EXC COND UNS G41400 EF-AISI-4140 FINE GRAIN VACUUM DEGASSED
IRCRAFT QUALITY 5.00 : 1 RED RATIO
IZE: RDS 1.0625 DIAM X 20FT 0.0000IN MIN/24FT 0.0000IN MAX
RDS 26.9875MM DIAM X 6096.0000MM MIN/7315.2000MM MAX

LADLE CHEMISTRY %							
	MN	P	S	SI	CU	NI	CR
0.42	0.91	0.008	0.020	0.24	0.09	0.09	1.00
	MO	SN	AL	CB	CA	N	
0.004	0.21	0.005	0.024	0.001	0.0001	0.0109	

CALCULATED TESTS

DOCTION RATIO 146.6 TO 1

STENITIC GRAIN SIZE 5 OR FINER BASED ON A TOTAL ALUMINUM CONTENT EQUAL TO OR GREATER THAN .020% PER TM A29.

SEMI - FINISHED RESULTS

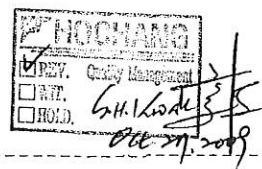
MINIY HARDNESS TEST SAE J406/ASTM A255
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 18 20 22 24 26 28 30 32
59 57 58 58 57 56 56 54 54 51 50 48 47 45 44 42 42 41 39 39 37 35 36

ETCH TEST ASTM E381/MIL STD 430
ETCHANT: HCL TEMPERATURE: 170
S R C
1 1 1

METIC PARTICLE TEST AMS 2301 AMS2304 AMS2300
IND AVG IND AVG
FREQ FREQ SEV SEV
03 0 0 0 0

FINISHED SIZE RESULTS

ARBORIZATION TEST SAE J419/ASTM E1077
HANT = NITAL MAGNIFICATION = 100X
TOTAL
DEPTH
INCHES
01 0.006



NOTES

UBLIC ENGINEERED PRODUCTS HEREBY CERTIFY THAT THE MATERIAL LISTED HEREIN HAS BEEN INSPECTED AND
TED IN ACCORDANCE WITH THE METHODS PRESCRIBED IN THE GOVERNING SPECIFICATIONS AND BASED UPON THE
ILTS OF SUCH INSPECTION AND TESTING HAS BEEN APPROVED FOR CONFORMANCE TO THE SPECIFICATIONS.

IFICATE OF TESTS SHALL NOT BE REPRODUCED EXCEPT IN FULL.

A. NEBIOLO
CTOR QUAL. ASSURANCE
Nebio

BY JANET K. HARTLINE



Republic

3049 LAKESHORE-GATE 6
PHONE: 330-438-5694

PAGE 28 OF 44

BUFFALO, NY 1
FAX: 330-438-

CERTIFICATE OF TESTS

REPUBLIC ENGINEERED PRODUCTS

May 29, 2008
PAGE 2

OF 2

CODE MYP2

PURCHASE ORD: 11-46873
PART NUMBER: IAC34331
ORDER NUMBER: 1374059 - 01
HEAT: 8990895

PURCHASE ORDER DATE: 3/7/2008
ACCOUNT NUMBER: 5607-1758-01
SCHEDULE: 6010-66
REVISION: 1

ALL TESTING HAS BEEN PERFORMED USING THE CURRENT REVISION OF THE TESTING SPECIFICATIONS.

RECORDING OF FALSE, FICTITIOUS OR FRAUDULENT STATEMENTS OR ENTRIES ON THIS DOCUMENT MAY BE PUNISHED

NOTES (CONTINUED)
AS A FELONY UNDER FED STATUES TITLE 18 CHAPTER 47.

THE MATERIAL WAS NOT EXPOSED TO MERCURY OR ANY METAL ALLOY THAT IS LIQUID AT AMBIENT TEMPERATURE DURING PROCESSING OR WHILE IN OUR POSSESSION.

NO WELD OR WELD REPAIR WAS PERFORMED ON THIS MATERIAL.

THE RESULTS REPORTED RELATE ONLY TO THE ITEMS TESTED

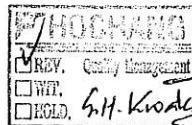
MATERIAL WAS VACUUM DEGASSED.

MANUFACTURED IN THE U.S.A.

SOURCE INFORMATION
ELT SOURCE: CANTON CAST ROLL MELT COUNTRY: U.S.A HOT ROLL SOURCE: LACKAWANNA 13in, U.S.A
ELT METHOD: EF BLOOM RED. RATIO: 146.6

END OF DATA
WITH SHIPMENT 2 COPIES PRINTED AT SHIPPING AREA
FILE 1 COPY

DATE 5/13/09
DYSOM
T+P to 1" R.



Oct 27, 2009

HA Industries

A. NEBIOLO
DIRECTOR QUAL. ASSURANCE
R. N. Scob

BY JANET K. HARTLINE

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STORK
Materials Technology

Stork Herron Testing Laboratories

6/12/2009

Steve Marsh
Dyson Corp.
53 Freedom Road
53 Freedom Rd
PAINESVILLE, OH 44077-1232

Material Testing and Non-Destructive
Testing

5405 E. Schaaf Road
Cleveland, OH 44131
USA

Date Received: 6/11/2009

Telephone : (216) 524-1450

Test Report No.: DYS006-09-06-83647-1

Fax : (216) 524-1459

Website : www.storkherron.com

TEST REPORT

P.O. No.: 66639

Sample Description: Two (2) 1.00"-8UNC-2A x 28.875" Special Double End Studs, Material: ASTM A354-07a, Grade BD, Modern HT PO# 66519, Customer PO#: 13926-K, Job # L101923, Heat #/Heat Code 8990895/ MYP2

TENSILE TEST PER ASTM E8-08, ASTM A370-08b/ASME SA-370 ('07)

	Dia. (in.)	Yield Strength .2% offset (ksi)	Ultimate Strength (ksi)	Elongation in 4D (%)	Reduction of Area (%)
1	.5015	146	161	19.5	60
2	.5015	147	162	17	53
Specification		130 Min.	150 Min.	14 Min.	40 Min.

CONFORMANCE

The samples meet the tensile requirements of ASTM A354-07a, Grade BD.

QUALITY ASSURANCE STATEMENT

The material and services furnished were supplied in accordance with our Quality Manual Edition 1, Revision 2, dated 01/30/07, which was audited and approved by Nova Machine. Testing was performed in accordance with Procedure NP-2200, Rev. 5. 10CFR21 Applies.



The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 2 dated 1/30/07. Information and statements in this report are derived from material, information and/or specifications furnished by the client and exclude any expressed or implied warranties as to the fitness of the material tested or analyzed for any particular purpose or use. This report is the confidential property of our client and may not be used for advertising purposes. This report shall not be reproduced except in full, without written approval of this laboratory. The recording of false, fictitious or fraudulent statements or entries on this document may be punished as a felony under Federal Statutes. Sample remnants are held for a minimum of 30 days following issuance of test results, at which point they will be discarded unless notified in writing by the client. This material was not contaminated by mercury or chlorinated solvents during the handling and processing at Stork-Herron Testing Laboratories facilities.

Paula Tesar

Paula Tesar
Quality Administrator

10000

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Telephone : (216) 524-1450
Fax : (216) 524-1459
Website : www.storkherron.com

Date Received: 6/11/2009

Test Report No.: DYS006-09-06-83620-1

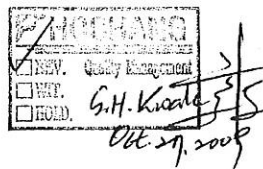
TEST REPORT

P.O. No.: 66640

Sample Description: One (1) Lot (108 Pcs) 1.00" X 8 UNC x 28.875" Lg. Special Double End Studs, with 2.9375" of usable thread on each end, Material: Per ASTM A354-07a Grade BD, ASTM A490-08a, Caltrans special Provisions 10.1.59, 10-1.60, and 10-1.61 plus Caltrans Standard Spec 75-1.05, Customer PO#: 13926-K, Job #: L101923, Heat #/Heat Code 8990895/MYP

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM A490-08a	
Procedure:	SOP 42.03	
METHOD		
<input type="checkbox"/> Dry		<input checked="" type="checkbox"/> Wet
PARTICLES		
Magnaflux Particles:	Part Preparation:	Wet Particle Carrier:
<input type="checkbox"/> 8A Red <input checked="" type="checkbox"/> 14A	<input type="checkbox"/> None Required	<input checked="" type="checkbox"/> Magnaflux Carrier II
<input type="checkbox"/> 3A Black <input type="checkbox"/> 14AM	<input checked="" type="checkbox"/> Solvent Clean	<input type="checkbox"/> Pre Mixed
<input type="checkbox"/> 1 Gray <input type="checkbox"/> Other	<input type="checkbox"/> Grinding	<input type="checkbox"/> Concentration MI
Batch No. 95A069	<input type="checkbox"/> Other	Batch No. 07C066
CURRENT		
<input type="checkbox"/> AC		<input checked="" type="checkbox"/> FWDC
<input type="checkbox"/> Central Conductor (AMPS)		<input checked="" type="checkbox"/> Head Shot (AMPS) 500
<input checked="" type="checkbox"/> Coil (AMPS) 600		<input type="checkbox"/> Prods (AMPS/Spacing)
Field Verified by: <input checked="" type="checkbox"/> Pie Gage <input type="checkbox"/> QQI <input type="checkbox"/> Hall Effect Probe		
EQUIPMENT		
<input checked="" type="checkbox"/> Magnaflux H-720 S/N: 81471 Cal Due Date: 9/24/2009		



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6/12/2009

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Telephone : (216) 524-1450
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Website : www.storkherron.com

Date Received: 6/11/2009

Test Report No.: DYS006-09-06-83620-1

TEST REPORT

P.O. No.: 66640

MAGNETIC PARTICLE INSPECTION RESULTS	
Quantity	Results
108	Acceptable no relevant indications present
Comments: Parts tested at Stork Herron Testing Laboratories. Gauges/machine marks were showing during inspection Stork Herron is not the Engineering Authority who would determine acceptability of the gouges/machine marks. Marking Requirements: Demag and post cleaning requirements: < 2 Gauss	
Inspected by: Shane Levermann	Certification: ASNT-SNT-TC-1A Level <input checked="" type="checkbox"/> II <input type="checkbox"/> III

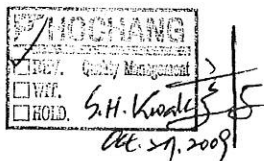
QUALITY ASSURANCE STATEMENT

The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition #1, Revision 2 dated 1/30/07 as audited and approved by Dyson Corporation on 3/12/07.

The reported results represent the actual attributes of the material tested and indicate full compliance with all applicable specification and contract requirements.

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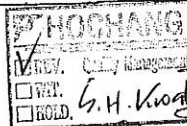


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Paula Tesar

Paula Tesar
Quality Administrator

DATE	6/29/2009									
THE ART GALVANIZING WKS., INC. 3935 VALLEY ROAD-CLEVELAND, OHIO 44109 PHONE 216-749-0020										
PACKING SLIP/CERTIFICATIONS										
TO	DYSON CORP				PO#	66732				
NOTE:	THE FOLLOWING MATERIAL HAS BEEN HOT DIP GALVANIZED TO ASTM A 153 OR ASTM A 123 (LATEST REVISION) SPECIFICATION AS APPLICABLE. A COPY OF OF THE ABOVE PURCHASE ORDER IS AN INTERNAL PART OF THIS CERTIFICATION AND SHOULD BE ATTACHED.									
1.00"-8UNC-2AX28.875" DES										
MYP2 HT#8990895										
GALV WEIGHT		677#		GALV WEIGHT		GALV WEIGHT				
INCHES	OZ/SQ FT			INCHES	OZ/SQ FT	INCHES	OZ/SQ FT	INCHES	OZ/SQ FT	
0.003	1.76			0	0.00			0	0.00	
0.0032	1.88			0	0.00			0	0.00	
0.0034	2.00			0	0.00			0	0.00	
0.0036	2.12			0	0.00			0	0.00	
0.0028	1.65			0	0.00			0	0.00	
AVG	1.88			AVG	0.00			AVG	0.00	
GALV WEIGHT				GALV WEIGHT		GALV WEIGHT				
INCHES	OZ/SQ FT			INCHES	OZ/SQ FT	INCHES	OZ/SQ FT	INCHES	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	
0	0.00			0	0.00			0	0.00	
AVG	0.00			AVG	0.00			AVG	0.00	
GALV WEIGHT				GALV WEIGHT		GALV WEIGHT				
INCHES	OZ/SQ FT			INCHES	OZ/SQ FT	INCHES	OZ/SQ FT	INCHES	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	
0	0.00			0	0.00			0	0.00	
AVG	0.00			AVG	0.00			AVG	0.00	



Pat Maloney

STORK
Materials Technology

Stork Herron Testing Laboratories

6/22/2009

Material Testing and Non-Destructive
Testing

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Date Received: 6/19/2009

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Fax : (216) 524-1459
Website : www.storkherron.com

Test Report No.: DYS006-09-06-84181-1

TEST REPORT

P.O. No.: 66801

Sample Description: One (1) Lot (6 Pcs) 1.00"-8UNC-2A X 28.875" Special Double End Studs,
Material per ASTM A354-07a, Grade BD, SO # L101923, Customer PO #
13926-K, Heat #/Code 8990895/MYP2

MECHANICAL TESTING PER ASTM F606-08

Hydrogen Embrittlement Test 4° Wedge Torque Method	
48 Hours	577 In. Lbs.
1	Visually Satisfactory
2	Visually Satisfactory
3	Visually Satisfactory
4	Visually Satisfactory
5	Visually Satisfactory
6	Visually Satisfactory

QUALITY ASSURANCE STATEMENT

The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition #1, Revision 2 dated 1/30/07 as audited and approved by Dyson Corporation on 3/12/07.

This material was not contaminated by mercury or chlorinated solvents during the handling and processing at Stork-Herron Testing Laboratories facilities.

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PAID
VND. 0000000000
MR. G.H. Kwaak
FIELD. 06.27.2009

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Paula Tesar

Paula Tesar
Quality Administrator

13926



Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products¹

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:²

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

¹ 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.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at 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

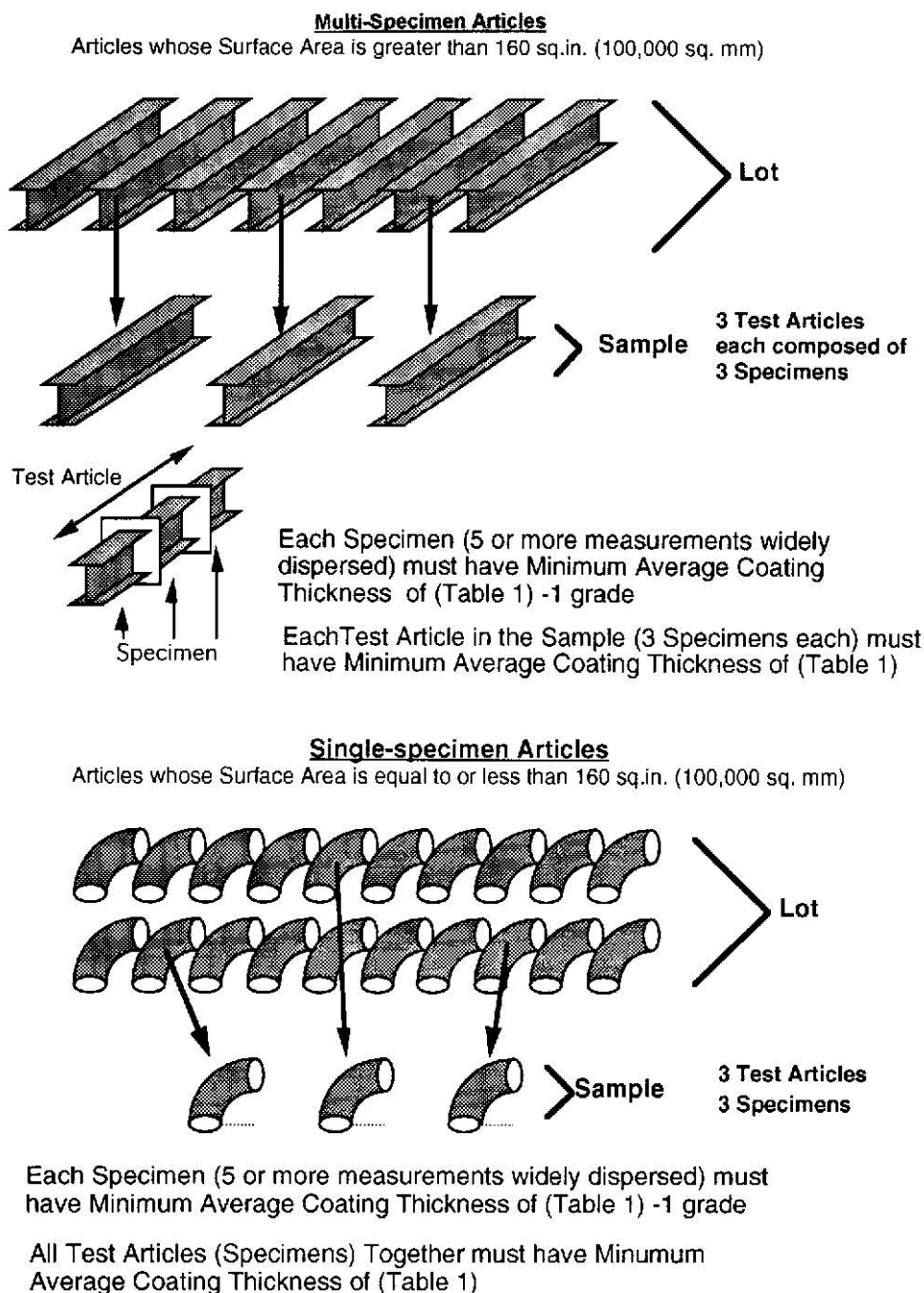




TABLE 1 Minimum Average Coating Thickness Grade by Material Category

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)	$\geq 1/4$ (≥ 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.² [100 000 mm²]. For thickness testing purposes, articles whose surface area is greater than 160 in.² 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.² [100 000 mm²] 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.² [100 000 mm²], 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.

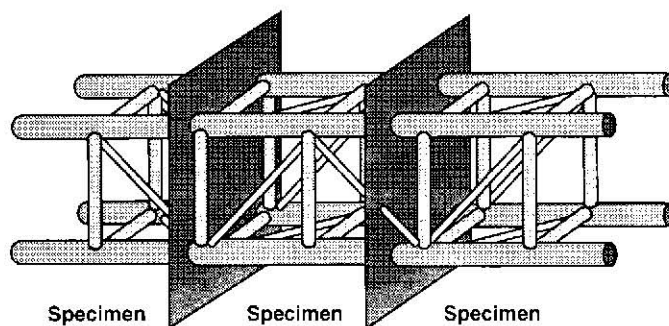
5.4 Zinc—The zinc used in the galvanizing bath shall conform to Specification B6, or Specification B960, or both. If a zinc alloy is used as the primary feed to the galvanizing bath, then the base material used to make that alloy shall conform to Specification B6, or Specification B960, or both.

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.² [100 000 mm²] (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.² [100 000 mm²] (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^A

Coating Grade	mils	oz/ft ²	μm	g/m ²
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

^A 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/ft² = μm × 0.02316; g/m² = μm × 7.067.

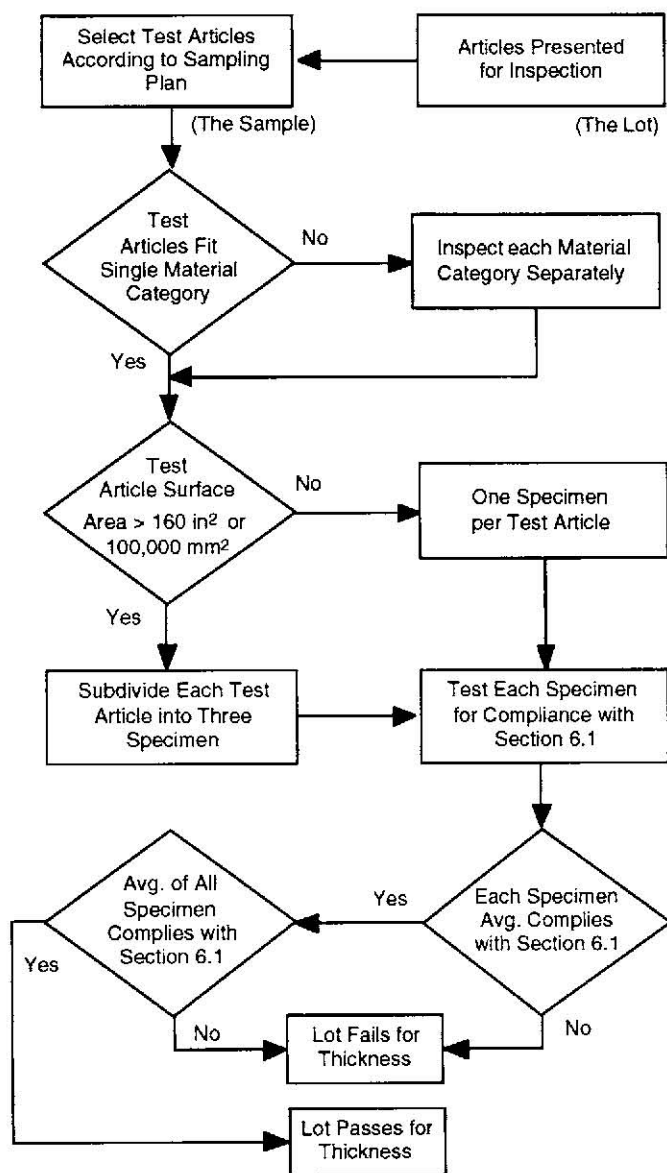


FIG. 3 Coating Thickness Inspection Steps

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.² per short ton [256 cm² 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.² [100 000 mm²] (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.² [100 000 mm²] (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**.

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Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement¹

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:²

¹ 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.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at 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*,³ 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

³ Available from American Institute of Steel Construction (AISC), One East Wacker Drive, Suite 3100, Chicago, IL 60601-2001. 9th 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> ₁ , in. [mm]	Minimum Length, <i>L</i> ₂ , 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

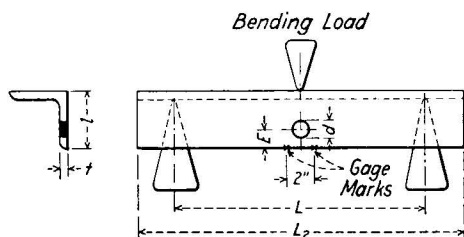


FIG. 1 Specimen for Elongation after Fracture

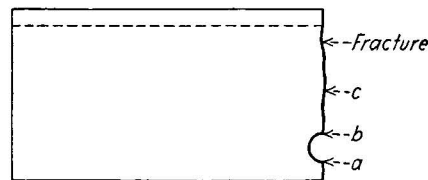


FIG. 2 Measurement of Reduction of Thickness after Fracture

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Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware¹

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 (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 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:²

- 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:

¹ 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.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at 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 ² [g/m ²] 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.

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Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners¹

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 specification² 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:

¹ 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.

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² 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 ^A
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

^A 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*:³

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

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at 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*.⁴

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

⁴ 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

^ASteel, 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) ^A
¼	0.016
⅝, ⅜	0.017
⅞, ½	0.018
⅞ to ¾, incl	0.020
¾	0.022
1.0 to 1¼, incl	0.024
1⅝, 1½	0.027
1¾ to 4.0, incl	0.050

^A 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, ^A in. ²	Grade BC			Grade BD		
			Tensile Strength, min, lbf ^B	Proof Load, min, lbf ^C	Yield Strength (0.2 % offset), min, lbf ^D	Tensile Strength, min, lbf ^E	Proof Load, min, lbf ^F	Yield Strength (0.2 % offset), min, lbf ^G
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
5/16	18	0.0524	6 550	5 500	5 700	7 850	6 300	6 800
5/16	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 ½	6	1.405	175 650	147 550	153 150	210 750	168 600	182 500
1 ½	8	1.492	186 500	156 650	162 250	233 800	175 050	194 000
1 ½	12	1.581	197 600	166 000	172 300	237 200	189 700	205 500
1 ¾	5	1.90	237 500	199 500	207 100	285 000	228 000	247 000
1 ¾	8	2.08	260 000	218 400	226 700	312 000	249 600	270 000
2	4 ½	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 ¼	4 ½	3.25	406 250	341 250	354 250	487 000	390 000	422 500
2 ¼	8	3.56	445 000	373 800	388 050	534 000	422 200	462 800
2 ½	4	4.00	500 000	420 000	436 000	600 000	480 000	520 000
2 ½	8	4.44	550 000	466 200	483 950	666 000	532 800	577 200
2 ¾	4	4.93	566 950	468 350	488 050	690 200	517 650	566 950
2 ¾	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 ¼	4	7.10	816 500	674 500	702 900	994 000	745 500	816 500
3 ¼	8	7.69	884 350	730 550	761 300	1 076 600	807 650	884 350
3 ½	4	8.33	957 950	791 350	824 650	1 166 200	874 650	957 950
3 ½	8	8.96	1 030 400	851 200	887 050	1 254 400	940 800	1 030 400
3 ¾	4	9.66	1 110 900	917 700	956 350	1 352 400	1 014 300	1 110 900
3 ¾	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

^A Stress Area, in.² = 0.7854 [$D - 0.9743/\eta$]² where D = nominal diameter, in., and η = threads/in.

^B 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.

^C 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.

^D 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.

^E 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.

^F 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.

^G 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**.

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Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength¹

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.²

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*

¹ 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.

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² 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:³

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

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at 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*.⁴
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*.⁵
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)	A563 —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 F1136 , Grade 3 or F2833 , Grade 1.	plain, coated in accordance with F1136 , Grade 3 or F2833 , 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**.⁶

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.

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

⁵ Available from Industrial Fastener Institute, (IFI), 6363 Oak Tree Boulevard, Independence, OH 44131. <http://www.industrial-fasteners.org>.

⁶ 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	^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 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	^A	^A

^ASteel, 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, ^A in. ²	Tensile Load, ^B lbf		Proof Load, ^B lbf	Alternative Proof Load, ^B 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

^A The stress area is calculated as follows:

$$A_s = 0.7854 [D - (0.9743/n)]^2$$

where:

A_s = stress area, in.²
 D = nominal bolt size, and
 n = threads per inch.

^B 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 F1470
Surface discontinuities	Specification F788/F789M
Magnetic particle inspection	Specification F788/F789M
Dimensions and thread fit	ASME B18.2.6

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^{e1}) 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

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