7

PWS ANCHOR RODS
VOLUME III

(2011) – 274 Rods

Fabrication Process

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PWS ANCHOR ROD TIMELINE

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ADDITIONAL DOCUMENTS

ASTM A123
ASTM A143
ASTM A153
ASTM A354
ASTM A490
ASTM A788
ASTM F1470
ASME B1.13M

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	5235	60 } 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
							10.0	3035	36								
	2	E2 Shear Key - Connect to Concrete - Above Bent Cap, Under Crossbeam [S3, S4]	rod	Cut	Dyson	3	21.9	6676	96 } 192	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	6902	64		Tension	0.7	4/9/2013	daily check	daily check	daily check	Tensioned to 0.75 Fy, with lockoff at ~ 0.7 Fu
							22.2	6777	32								
	3	E2 Shear Key - Connect to OBG [S1, S2]	rod	Cut	Dyson	3	4.4	1337	96 } 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
							1.8	537	64								
		E2 Shear Key - Connect to Crossbeam [S3, S4]	rod	Cut	Dyson	3	4.3	1312	96								
							1.7	512	64								
	4	E2 Bearing - Connect to OBG [B1, B2, B3, B4]	rod	Cut	Dyson	2	3.6	1105	224	No	Tension	0.7	9/12/2012	4/6/2013	4/17/13 to 4/23/13	5/3/2013	Tensioned to 0.75 Fy, with lockoff at ~ 0.7 Fu
	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	7/14/2012	N/A	N/A	N/A	Load During Construction - Tensioned to 0.5 Fy
												0.68	N/A	4/6/2013	4/19/2013	5/3/2013	Additional tension in tie rods from cable with service load
	9	Turned Rods at Tower Saddle Segment Splices	rod	Cut	Dyson	3 @ Threads [~3-1/16 @ Shank]	1.5	463	100 } 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.
							1.4	415	8		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	4/13/2012	N/A	N/A	N/A	Snug tightened before load transfer
												0.2	N/A	4/7/2013	4/21/2013	5/3/2013	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.

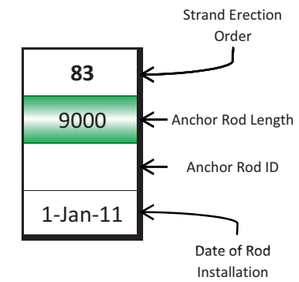
Total = 2306

New information after 5/6/2013 Update is highlighted Red

Load No.	Total Quantity	Release Tag Quantity		METS
		Orange	Blue	
1	44	2	42	released
2	48	19	29	released
3	51	51	0	released
4	sent back	39	16	rejected
5	26	14	12	released
6	26	0	26	released
7	26	0	26	released
8	27	0	27	released
9	24	22	2	released
10	2	2	0	released
TOTAL	**274**			

14W, North Anchorage (Looking East)

132	136	133	137	128	134	122	129	135	123	130	116	124	108	117	109	
9300	9200	9000	8900	8700	8700	8600	8500	8500	8500	8500	8600	8700	8700	8900	9000	
OYP-3	OYO-9	OYL-4	OYN-7	OQY-26	OQX4-30	OQY-17A	OQY-21C	OQY-32	OYP-2	OYL-3	OYH-6	OQY-28	OQY-25	OYN-4	OYK-5	
27-Oct-11	21-Nov-11	21-Nov-11	21-Nov-11	21-Nov-11	21-Nov-11	18-Oct-11	21-Nov-11	21-Nov-11	?	?	?	?	?	?	?	
125	131	126	120	127	113	121	114	106	115	107	99	91	100	92	83	
9300	9200	8900	8900	8700	8700	8600	8500	8500	8500	8500	8600	8700	8700	8900	9000	
OYM-10	OYH-1	OYN-6	OYG-1	OQY-31	OQY-29	OQY-9A	OQY-13C	OOH2-23	OOH2-2	OOH2-20	OQX3-13	OQX4-13	OQY-19	OYL-5	OPY2-26	
27-Oct-11	26-Oct-11	21-Nov-11	21-Nov-11	?	?	17-Oct-11	?	21-Nov-11	21-Nov-11	21-Nov-11	18-Oct-11	18-Oct-11	?	?	18-Oct-11	
118	111	119	112	104	96	105	97	89	98	90	81	72	82	73	64	
9300	9200	8900	8900	8700	8700	8600	8500	8500	8500	8500	8600	8700	8700	8900	9000	
OYJ-10	OYO-3	OYO-8	OPY4-24	OYN-1	OQX4-23	OQX3-5	OQY-19C	OYG-2	OQY-27	OQY-3C	OQY-1A	OQY-2	OQY-15	OYN-5	OPY2-23	
27-Oct-11	26-Oct-11	21-Nov-11	?	27-Oct-11	17-Oct-11	17-Oct-11	21-Nov-11	21-Nov-11	21-Nov-11	21-Nov-11	18-Oct-11	18-Oct-11	18-Oct-11	?	18-Oct-11	
101	110	102	94	103	95	87	78	88	79	70	80	71	62	53	63	54
9300	9200	8900	8900	8700	8700	8600	8500	8500	8500	8500	8600	8700	8700	8900	9000	9300
OYM-7	OYP-5	OYL-6	OYL-9	OYL-8	OQX4-5	OQY-6A	OQY-15C	OQY-18C	OOF2-4	OQY-22C	OQX3-8	OQX4-11	OQX4-24	OYN-3	OPY2-4	OYJ-7
27-Oct-11	26-Oct-11	21-Nov-11	21-Nov-11	?	17-Oct-11	17-Oct-11	21-Nov-11	?	21-Nov-11	21-Nov-11	18-Oct-11	18-Oct-11	18-Oct-11	?	18-Oct-11	25-Oct-11
84	93	85	76	86	77	68	59	69	60	51	61	43	52	44	36	45	37
9300	9200	8900	8900	8700	8700	8600	8500	8500	8500	8500	8600	8700	8700	8900	9000	9300	9400
OOH2-7	OYM-1	OYK-4	OYL-7	OQX4-20	OQX4-17	OQY-12A	OQY-23C	OQY-14C	OQY-20C	OPY3-8	OQX3-16	OQX4-12	OQX4-9	OYG-4	OPY2-38	OYN-10	OTD-2E
27-Oct-11	26-Oct-11	?	27-Oct-11	17-Oct-11	17-Oct-11	17-Oct-11	21-Nov-11	?	21-Nov-11	21-Nov-11	18-Oct-11	18-Oct-11	18-Oct-11	?	18-Oct-11	25-Oct-11	?
74	65	75	66	57	67	48	58	49	41	50	42	34	26	35	27	20	28
9300	9200	8900	8900	8700	8700	8600	8500	8500	8500	8500	8600	8700	8700	8900	9000	9300	9400
R1002-OTD	OYJ-5	OYM-6	OYH-2	OQX4-21	OQY-15A	OQY-10A	OPY2-6	OYM-2	OYG-3	OYI-2	OQY-14A	OQX4-7	OQX4-10	OYN-2	OPY2-10	OOH2-24	OYM-5
27-Oct-11	26-Oct-11	27-Oct-11	27-Oct-11	17-Oct-11	17-Oct-11	17-Oct-11	?	?	?	?	18-Oct-11	18-Oct-11	18-Oct-11	?	18-Oct-11	25-Oct-11	?
55	46	56	30	47	39	31	40	32	24	33	17	25	18	12	19	7	13
9300	9200	8900	8900	8700	8700	8600	8500	8500	8500	8500	8600	8700	8700	8900	9000	9400	9400
OOH2-17	OYH-3	R1008-OQX	OYM-3	OQY-14	OQY-3	OQX3-2	OOH2-16	OOH2-4	OPY2-2	OPY2-7	OQX3-11	OQY-4	OQX4-6	R1007-OOH	OPY2-29	OOF2-2	OOF2-1
25-Oct-11	26-Oct-11	25-Oct-11	27-Oct-11	17-Oct-11	17-Oct-11	17-Oct-11	?	?	?	25-Oct-11	18-Oct-11	18-Oct-11	18-Oct-11	25-Oct-11	18-Oct-11	25-Oct-11	?
29	21	38	14	22	8	15	23	1	9	16	5	10	2	6	11	3	4
9300	9200	8900	8900	8700	8700	8600	8500	8500	8500	8600	8600	8700	8700	8900	9000	9300	9300
OOH2-8	OTD-12	R1010-OTD	R1005-OQW	OQY-16	OQX4-18	OQY-3A	OOF4-4	OTD-13	OPY2-15	OQY-4A	OQX3-7	OQX4-22	OQY-1	R1001-OPY	OPY2-24	OOH2-10	OYO-6
25-Oct-11	25-Oct-11	25-Oct-11	25-Oct-11	17-Oct-11	17-Oct-11	17-Oct-11	?	?	?	18-Oct-11	18-Oct-11	18-Oct-11	18-Oct-11	25-Oct-11	18-Oct-11	25-Oct-11	?



14E, South Anchorage (Looking East)

109	**117**	**100**	**124**	**116**	**130**	**123**	**115**	**135**	**129**	**122**	**134**	**128**	**137**	**133**	**127**	**136**	**132**
9500	9400	9200	9100	9000	8900	8800	8800	8800	8800	8900	8900	9000	9100	9200	9300	9600	9700
OTD-23D	OYG-5	OYJ-6	OPY3-22	OPY2-35	OYJ-4	OQX5-19	OQX5-24	OQX5-28	OQX5-12	OQY-23B	OPY4-21	OPY2-37	OPY3-18	OYO-5	OOH-1E	OYJ-11	OYM-8
?	?	?	6-Oct-11	6-Oct-11	?	7-Oct-11	8-Oct-11	8-Oct-11	8-Oct-11	4-Nov-11	4-Nov-11	10-Oct-11	11-Oct-11	4-Nov-11	?	?	?
83	**92**	**82**	**108**	**91**	**99**	**107**	**98**	**106**	**114**	**105**	**121**	**113**	**120**	**126**	**119**	**131**	**125**
9500	9400	9200	9100	9000	8900	8800	8800	8800	8800	8900	8900	9000	9100	9200	9300	9600	9700
OTD-1D	OYI-4	OYN-11	OPY3-16	OPY2-39	OPY4-17	OQX5-27	OQX5-13	OQX5-22	OQX5-3	OPY4-22	OPY4-19	?	OPY3-9	R1011-OTD	OYJ-9	OOF4-2	OOF5-4
?	?	?	6-Oct-11	6-Oct-11	7-Oct-11	7-Oct-11	8-Oct-11	8-Oct-11	8-Oct-11	4-Nov-11	4-Nov-11	10-Oct-11	11-Oct-11	4-Nov-11	?	?	11-Oct-11
64	**73**	**63**	**72**	**81**	**71**	**90**	**80**	**89**	**97**	**88**	**96**	**104**	**112**	**103**	**111**	**118**	**110**
9500	9400	9200	9100	9000	8900	8800	8800	8800	8800	8900	8900	9000	9100	9200	9300	9600	9700
OYH-7	OYM-4	OYO-4	OPY3-23	OPY2-22	OPY4-16	OQX5-23	OQX5-21	OQX5-15	OQX5-29	OPY4-20	OYI-3	OPY2-33	OPY3-25	OOH-4F	OYP-4	OYI-5	OOF5-1
?	?	?	6-Oct-11	6-Oct-11	7-Oct-11	7-Oct-11	8-Oct-11	8-Oct-11	8-Oct-11	4-Nov-11	4-Nov-11	10-Oct-11	11-Oct-11	4-Nov-11	4-Nov-11	?	11-Oct-11
54	**45**	**53**	**62**	**52**	**61**	**70**	**79**	**69**	**78**	**87**	**77**	**95**	**86**	**94**	**102**	**93**	**101**
9500	9500	9200	9100	9000	8900	8800	8800	8800	8800	8900	8900	9000	9100	9200	9300	9600	9700
OOF3-8	OYM-9	OTD-4	OPY3-20	OPY2-20	OPY4-1	OQX5-11	OQX5-30	OQX5-14	OQX5-4	OPY4-10	OPY4-9	OPY2-28	OPY3-6	OTD-1H	OYO-7	OOF4-9	OOF5-2
?	?	11-Oct-11	6-Oct-11	6-Oct-11	7-Oct-11	6-Oct-11	8-Oct-11	8-Oct-11	8-Oct-11	10-Oct-11	10-Oct-11	10-Oct-11	11-Oct-11	4-Nov-11	4-Nov-11	11-Oct-11	11-Oct-11
37	**28**	**36**	**44**	**35**	**43**	**51**	**60**	**50**	**59**	**68**	**58**	**67**	**76**	**85**	**75**	**84**	
9600	9500	9200	9100	9000	8900	8800	8800	8800	8800	8900	8900	9000	9100	9300	9300	9600	
OYH-8	OYJ-8	OTD-16	OPY3-26	OPY2-18	OPY4-13	OQX5-8	OQX5-18	OQX5-26	OQX5-6	OPY4-7	OPY4-8	OPY2-36	OPY3-27	OOH-2F	OYN-8	OOF4-3	
?	?	5-Oct-11	6-Oct-11	6-Oct-11	6-Oct-11	6-Oct-11	7-Oct-11	8-Oct-11	8-Oct-11	10-Oct-11	10-Oct-11	10-Oct-11	11-Oct-11	4-Nov-11	4-Nov-11	11-Oct-11	
20	**27**	**19**	**26**	**34**	**42**	**33**	**41**	**49**	**40**	**48**	**57**	**66**	**56**	**65**	**74**		
9600	9500	9200	9100	9000	8900	8800	8800	8800	8800	8900	8900	9000	9100	9300	9300		
OYH-9	OTD-2D	OTD-17	OPY3-24	OPY2-9	OQW-5	OQX5-10	OQX5-7	OQX5-25	OQX5-2	OPY4-15	OPY4-11	OPY2-32	OPY3-7	OOH2-19	OOH-3F		
?	?	5-Oct-11	5-Oct-11	5-Oct-11	6-Oct-11	6-Oct-11	7-Oct-11	7-Oct-11	7-Oct-11	10-Oct-11	10-Oct-11	10-Oct-11	11-Oct-11	4-Nov-11	4-Nov-11		
13	**7**	**12**	**18**	**11**	**25**	**17**	**24**	**32**	**23**	**31**	**39**	**47**	**38**	**46**	**55**		
9600	9600	9200	9100	9000	8900	8900	8800	8800	8800	8900	8900	9000	9100	9300	9300		
OOF4-5	OOF4-8	OTD-5	OPY3-2	OPY2-21	OPY4-4	OPY4-12	OQX5-20	OQX5-9	OQX5-1	OPY4-14	OPY4-18	OPY2-34	OPY3-19	OYN-10	OYN-9		
?	5-Oct-11	5-Oct-11	5-Oct-11	5-Oct-11	6-Oct-11	6-Oct-11	7-Oct-11	7-Oct-11	7-Oct-11	10-Oct-11	10-Oct-11	10-Oct-11	11-Oct-11	4-Nov-11	4-Nov-11		
4	**3**	**6**	**2**	**10**	**5**	**16**	**9**	**1**	**15**	**8**	**22**	**14**	**30**	**21**	**29**		
9500	9500	9200	9100	9000	9000	8900	8800	8800	8800	8900	8900	9000	9100	9300	9300		
R1006-OTD	OOF3-4	OTD-18	OPY3-1	OPY2-25	?	OQW-3	OQX5-17	OQX5-16	OQX5-5	OPY4-2	OPY4-6	OPY2-27	OPY3-21	OOH2-22	OOH2-6		
?	5-Oct-11	5-Oct-11	5-Oct-11	5-Oct-11	6-Oct-11	6-Oct-11	7-Oct-11	7-Oct-11	7-Oct-11	10-Oct-11	10-Oct-11	10-Oct-11	11-Oct-11	11-Oct-11	11-Oct-11		

The PWS Anchor Rods for Lift 14E, E-Line Anchorage, for Strands #5 and #113 are both 9000 mm rods. One rod is OPY2-30 and the other rod is OPY2-31. The galvanizing has filled in the rod ID punch marks enough on those two that the ID could not be conclusively determined.

55
9300
1-Jan-11

Strand Erection Order

Anchor Rod Length

Anchor Rod ID

Date of Rod Installation

Total No.	No. by Load	Rod ID No.	Rod length (mm)	Load No.	Tag Release Date - Orange	Tag Release Date - Blue	Jobsite Arrival Date
1	1	OOF2-1	9400	1	-	30-Aug-11	6-Sep-11
2	2	OOF3-4	9500	1	-	30-Aug-11	6-Sep-11
3	3	OOF4-3	9600	1	-	30-Aug-11	6-Sep-11
4	4	OOF4-8	9600	1	-	30-Aug-11	6-Sep-11
5	5	OOF4-9	9600	1	-	30-Aug-11	6-Sep-11
6	6	OOF5-1	9700	1	-	30-Aug-11	6-Sep-11
7	7	OOF5-2	9700	1	-	30-Aug-11	6-Sep-11
8	8	OOF5-4	9700	1	-	30-Aug-11	6-Sep-11
9	9	OOH2-22	9300	1	-	30-Aug-11	6-Sep-11
10	10	OOH2-6	9300	1	-	30-Aug-11	6-Sep-11
11	11	OPY2-10	9000	1	-	30-Aug-11	6-Sep-11
12	12	OPY2-18	9000	1	-	30-Aug-11	6-Sep-11
13	13	OPY2-20	9000	1	-	30-Aug-11	6-Sep-11
14	14	OPY2-21	9000	1	-	30-Aug-11	6-Sep-11
15	15	OPY2-22	9000	1	-	30-Aug-11	6-Sep-11
16	16	OPY2-23	9000	1	-	30-Aug-11	6-Sep-11
17	17	OPY2-24	9000	1	-	30-Aug-11	6-Sep-11
18	18	OPY2-25	9000	1	-	30-Aug-11	6-Sep-11
19	19	OPY2-26	9000	1	-	30-Aug-11	6-Sep-11
20	20	OPY2-4	9000	1	-	30-Aug-11	6-Sep-11
21	21	OPY2-9	9000	1	-	30-Aug-11	6-Sep-11
22	22	OPY3-1	9100	1	-	30-Aug-11	6-Sep-11
23	23	OPY3-2	9100	1	-	30-Aug-11	6-Sep-11
24	24	OPY3-6	9100	1	-	30-Aug-11	6-Sep-11
25	25	OPY3-7	9100	1	-	30-Aug-11	6-Sep-11
26	26	OPY3-9	9100	1	-	30-Aug-11	6-Sep-11
27	27	OPY4-1	8900	1	-	30-Aug-11	6-Sep-11
28	28	OPY4-10	8900	1	-	30-Aug-11	6-Sep-11
29	29	OPY4-11	8900	1	-	30-Aug-11	6-Sep-11
30	30	OPY4-12	8900	1	-	30-Aug-11	6-Sep-11
31	31	OPY4-13	8900	1	-	30-Aug-11	6-Sep-11
32	32	OPY4-2	8900	1	-	30-Aug-11	6-Sep-11
33	33	OPY4-4	8900	1	-	30-Aug-11	6-Sep-11
34	34	OPY4-6	8900	1	-	30-Aug-11	6-Sep-11
35	35	OPY4-7	8900	1	-	30-Aug-11	6-Sep-11
36	36	OPY4-8	8900	1	-	30-Aug-11	6-Sep-11
37	37	OPY4-9	8900	1	-	30-Aug-11	6-Sep-11
38	38	OQW-3	8900	1	30-Aug-11	-	6-Sep-11
39	39	OQW-5	8900	1	30-Aug-11	-	6-Sep-11
40	40	OTD-16	9200	1	-	30-Aug-11	6-Sep-11
41	41	OTD-17	9200	1	-	30-Aug-11	6-Sep-11
42	42	OTD-18	9200	1	-	30-Aug-11	6-Sep-11
43	43	OTD-4	9200	1	-	30-Aug-11	6-Sep-11
44	**44**	OTD-5	9200	1	-	30-Aug-11	6-Sep-11
45	1	OPY2-27	9000	2	-	30-Aug-11	2-Sep-11
46	2	OPY2-28	9000	2	-	30-Aug-11	2-Sep-11
47	3	OPY2-29	9000	2	-	30-Aug-11	2-Sep-11
48	4	OPY2-30	9000	2	-	30-Aug-11	2-Sep-11
49	5	OPY2-31	9000	2	-	30-Aug-11	2-Sep-11

Total No.	No. by Load	Rod ID No.	Rod length (mm)	Load No.	Tag Release Date - Orange	Tag Release Date - Blue	Jobsite Arrival Date
50	6	OPY2-32	9000	2	-	30-Aug-11	2-Sep-11
51	7	OPY2-33	9000	2	-	30-Aug-11	2-Sep-11
52	8	OPY2-34	9000	2	-	30-Aug-11	2-Sep-11
53	9	OPY2-35	9000	2	-	30-Aug-11	2-Sep-11
54	10	OPY2-36	9000	2	-	30-Aug-11	2-Sep-11
55	11	OPY2-37	9000	2	-	30-Aug-11	2-Sep-11
56	12	OPY2-38	9000	2	-	30-Aug-11	2-Sep-11
57	13	OPY2-39	9000	2	-	30-Aug-11	2-Sep-11
58	14	OPY3-16	9100	2	-	30-Aug-11	2-Sep-11
59	15	OPY3-18	9100	2	-	30-Aug-11	2-Sep-11
60	16	OPY3-19	9100	2	-	30-Aug-11	2-Sep-11
61	17	OPY3-20	9100	2	-	30-Aug-11	2-Sep-11
62	18	OPY3-21	9100	2	-	30-Aug-11	2-Sep-11
63	19	OPY3-22	9100	2	-	30-Aug-11	2-Sep-11
64	20	OPY3-23	9100	2	-	30-Aug-11	2-Sep-11
65	21	OPY3-24	9100	2	-	30-Aug-11	2-Sep-11
66	22	OPY3-25	9100	2	-	30-Aug-11	2-Sep-11
67	23	OPY3-26	9100	2	-	30-Aug-11	2-Sep-11
68	24	OPY3-27	9100	2	-	30-Aug-11	2-Sep-11
69	25	OPY4-14	8900	2	-	30-Aug-11	2-Sep-11
70	26	OPY4-15	8900	2	-	30-Aug-11	2-Sep-11
71	27	OPY4-16	8900	2	-	30-Aug-11	2-Sep-11
72	28	OPY4-17	8900	2	-	30-Aug-11	2-Sep-11
73	29	OPY4-18	8900	2	-	30-Aug-11	2-Sep-11
74	30	OQX4-10	8700	2	30-Aug-11	-	2-Sep-11
75	31	OQX4-11	8700	2	30-Aug-11	-	2-Sep-11
76	32	OQX4-12	8700	2	30-Aug-11	-	2-Sep-11
77	33	OQX4-13	8700	2	30-Aug-11	-	2-Sep-11
78	34	OQX4-5	8700	2	30-Aug-11	-	2-Sep-11
79	35	OQX4-6	8700	2	30-Aug-11	-	2-Sep-11
80	36	OQX4-7	8700	2	30-Aug-11	-	2-Sep-11
81	37	OQX4-9	8700	2	30-Aug-11	-	2-Sep-11
82	38	OQX5-1	8800	2	30-Aug-11	-	2-Sep-11
83	39	OQX5-10	8800	2	30-Aug-11	-	2-Sep-11
84	40	OQX5-11	8800	2	30-Aug-11	-	2-Sep-11
85	41	OQX5-2	8800	2	30-Aug-11	-	2-Sep-11
86	42	OQX5-3	8800	2	30-Aug-11	-	2-Sep-11
87	43	OQX5-4	8800	2	30-Aug-11	-	2-Sep-11
88	44	OQX5-5	8800	2	30-Aug-11	-	2-Sep-11
89	45	OQX5-6	8800	2	30-Aug-11	-	2-Sep-11
90	46	OQX5-7	8800	2	30-Aug-11	-	2-Sep-11
91	47	OQX5-8	8800	2	30-Aug-11	-	2-Sep-11
92	**48**	OQX5-9	8800	2	30-Aug-11	-	2-Sep-11
93	1	OQX3-11	8600	3	31-Aug-11	-	6-Sep-11
94	2	OQX3-13	8600	3	31-Aug-11	-	6-Sep-11
95	3	OQX3-16	8600	3	31-Aug-11	-	6-Sep-11
96	4	OQX3-2	8600	3	31-Aug-11	-	6-Sep-11
97	5	OQX3-5	8600	3	31-Aug-11	-	6-Sep-11
98	6	OQX3-7	8600	3	31-Aug-11	-	6-Sep-11

Total No.	No. by Load	Rod ID No.	Rod length (mm)	Load No.	Tag Release Date - Orange	Tag Release Date - Blue	Jobsite Arrival Date
99	7	OQX3-8	8600	3	31-Aug-11	-	6-Sep-11
100	8	OQX4-17	8700	3	31-Aug-11	-	6-Sep-11
101	9	OQX4-18	8700	3	31-Aug-11	-	6-Sep-11
102	10	OQX4-20	8700	3	31-Aug-11	-	6-Sep-11
103	11	OQX4-21	8700	3	31-Aug-11	-	6-Sep-11
104	12	OQX4-22	8700	3	31-Aug-11	-	6-Sep-11
105	13	OQX4-23	8700	3	31-Aug-11	-	6-Sep-11
106	14	OQX4-24	8700	3	31-Aug-11	-	6-Sep-11
107	15	OQX5-12	8800	3	31-Aug-11	-	6-Sep-11
108	16	OQX5-13	8800	3	31-Aug-11	-	6-Sep-11
109	17	OQX5-14	8800	3	31-Aug-11	-	6-Sep-11
110	18	OQX5-15	8800	3	31-Aug-11	-	6-Sep-11
111	19	OQX5-16	8800	3	31-Aug-11	-	6-Sep-11
112	20	OQX5-17	8800	3	31-Aug-11	-	6-Sep-11
113	21	OQX5-18	8800	3	31-Aug-11	-	6-Sep-11
114	22	OQX5-19	8800	3	31-Aug-11	-	6-Sep-11
115	23	OQX5-20	8800	3	31-Aug-11	-	6-Sep-11
116	24	OQX5-21	8800	3	31-Aug-11	-	6-Sep-11
117	25	OQX5-22	8800	3	31-Aug-11	-	6-Sep-11
118	26	OQX5-23	8800	3	31-Aug-11	-	6-Sep-11
119	27	OQX5-24	8800	3	31-Aug-11	-	6-Sep-11
120	28	OQX5-25	8800	3	31-Aug-11	-	6-Sep-11
121	29	OQX5-26	8800	3	31-Aug-11	-	6-Sep-11
122	30	OQX5-27	8800	3	31-Aug-11	-	6-Sep-11
123	31	OQX5-28	8800	3	31-Aug-11	-	6-Sep-11
124	32	OQX5-29	8800	3	31-Aug-11	-	6-Sep-11
125	33	OQX5-30	8800	3	31-Aug-11	-	6-Sep-11
126	34	OQY-1	8700	3	31-Aug-11	-	6-Sep-11
127	35	OQY-10A	8600	3	31-Aug-11	-	6-Sep-11
128	36	OQY-12A	8600	3	31-Aug-11	-	6-Sep-11
129	37	OQY-14	8700	3	31-Aug-11	-	6-Sep-11
130	38	OQY-14A	8600	3	31-Aug-11	-	6-Sep-11
131	39	OQY-15	8700	3	31-Aug-11	-	6-Sep-11
132	40	OQY-15A	8700	3	31-Aug-11	-	6-Sep-11
133	41	OQY-16	8700	3	31-Aug-11	-	6-Sep-11
134	42	OQY-17A	8600	3	31-Aug-11	-	6-Sep-11
135	43	OQY-19	8700	3	31-Aug-11	-	6-Sep-11
136	44	OQY-1A	8600	3	31-Aug-11	-	6-Sep-11
137	45	OQY-2	8700	3	31-Aug-11	-	6-Sep-11
138	46	OQY-3	8700	3	31-Aug-11	-	6-Sep-11
139	47	OQY-3A	8600	3	31-Aug-11	-	6-Sep-11
140	48	OQY-4	8700	3	31-Aug-11	-	6-Sep-11
141	49	OQY-4A	8600	3	31-Aug-11	-	6-Sep-11
142	50	OQY-6A	8600	3	31-Aug-11	-	6-Sep-11
143	**51**	OQY-9A	8600	3	31-Aug-11	-	6-Sep-11
144	1	OOF2-2	9400	5	-	20-Oct-11	24-Oct-11
145	2	OOF3-8	9500	5	20-Oct-11	-	24-Oct-11
146	3	OOF4-2	9600	5	-	20-Oct-11	24-Oct-11
147	4	OOF4-4	8500	5	-	20-Oct-11	24-Oct-11

Total No.	No. by Load	Rod ID No.	Rod length (mm)	Load No.	Tag Release Date - Orange	Tag Release Date - Blue	Jobsite Arrival Date
148	5	OOF4-5	9600	5	20-Oct-11	-	24-Oct-11
149	6	OOH2-10	9300	5	20-Oct-11	-	24-Oct-11
150	7	OOH2-16	8500	5	20-Oct-11	-	24-Oct-11
151	8	OOH2-17	9300	5	20-Oct-11	-	24-Oct-11
152	9	OOH2-19	9300	5	-	20-Oct-11	24-Oct-11
153	10	OOH2-24	9300	5	-	20-Oct-11	24-Oct-11
154	11	OOH2-4	8500	5	20-Oct-11	-	24-Oct-11
155	12	OOH2-7	9300	5	-	20-Oct-11	24-Oct-11
156	13	OOH2-8	9300	5	-	20-Oct-11	24-Oct-11
157	14	OPY2-15	8500	5	20-Oct-11	-	24-Oct-11
158	15	OPY2-2	8500	5	-	20-Oct-11	24-Oct-11
159	16	OPY2-6	8500	5	-	20-Oct-11	24-Oct-11
160	17	OPY2-7	8500	5	-	20-Oct-11	24-Oct-11
161	18	OTD-12	9200	5	-	20-Oct-11	24-Oct-11
162	19	OTD-13	8500	5	-	20-Oct-11	24-Oct-11
163	20	R1001-OPY	8900	5	20-Oct-11	-	24-Oct-11
164	21	R1002-OTD	9300	5	20-Oct-11	-	24-Oct-11
165	22	R1005-OQW	8900	5	20-Oct-11	-	24-Oct-11
166	23	R1006-OTD	9500	5	20-Oct-11	-	24-Oct-11
167	24	R1007-OOH	8900	5	20-Oct-11	-	24-Oct-11
168	25	R1008-OQX	8900	5	20-Oct-11	-	24-Oct-11
169	**26**	R1010-OTD	8900	5	20-Oct-11	-	24-Oct-11
170	1	OYG-3	8500	6	-	21-Oct-11	26-Oct-11
171	2	OYG-4	8900	6	-	21-Oct-11	26-Oct-11
172	3	OYG-5	9400	6	-	21-Oct-11	26-Oct-11
173	4	OYH-1	9200	6	-	21-Oct-11	26-Oct-11
174	5	OYH-2	8900	6	-	21-Oct-11	26-Oct-11
175	6	OYH-3	9200	6	-	21-Oct-11	26-Oct-11
176	7	OYH-6	8600	6	-	21-Oct-11	26-Oct-11
177	8	OYI-2	8500	6	-	21-Oct-11	26-Oct-11
178	9	OYJ-10	9300	6	-	21-Oct-11	26-Oct-11
179	10	OYJ-5	9200	6	-	21-Oct-11	26-Oct-11
180	11	OYJ-7	9300	6	-	21-Oct-11	26-Oct-11
181	12	OYL-7	8900	6	-	21-Oct-11	26-Oct-11
182	13	OYL-8	8700	6	-	21-Oct-11	26-Oct-11
183	14	OYM-1	9200	6	-	21-Oct-11	26-Oct-11
184	15	OYM-10	9300	6	-	21-Oct-11	26-Oct-11
185	16	OYM-2	8500	6	-	21-Oct-11	26-Oct-11
186	17	OYM-3	8900	6	-	21-Oct-11	26-Oct-11
187	18	OYM-4	9400	6	-	21-Oct-11	26-Oct-11
188	19	OYM-6	8900	6	-	21-Oct-11	26-Oct-11
189	20	OYM-7	9300	6	-	21-Oct-11	26-Oct-11
190	21	OYN-1	8700	6	-	21-Oct-11	26-Oct-11
191	22	OYN-10	9300	6	-	21-Oct-11	26-Oct-11
192	23	OYN-2	8900	6	-	21-Oct-11	26-Oct-11
193	24	OYO-3	9200	6	-	21-Oct-11	26-Oct-11
194	25	OYP-3	9300	6	-	21-Oct-11	26-Oct-11
195	**26**	OYP-5	9200	6	-	21-Oct-11	26-Oct-11
196	1	OOH-2F	9300	7	-	25-Oct-11	28-Oct-11

Total No.	No. by Load	Rod ID No.	Rod length (mm)	Load No.	Tag Release Date - Orange	Tag Release Date - Blue	Jobsite Arrival Date
197	2	OOH-3F	9300	7	-	25-Oct-11	28-Oct-11
198	3	OPY4-19	8900	7	-	25-Oct-11	28-Oct-11
199	4	OPY4-20	8900	7	-	25-Oct-11	28-Oct-11
200	5	OPY4-21	8900	7	-	25-Oct-11	28-Oct-11
201	6	OPY4-22	8900	7	-	25-Oct-11	28-Oct-11
202	7	OQX4-30	8700	7	-	25-Oct-11	28-Oct-11
203	8	OQY-19C	8500	7	-	25-Oct-11	28-Oct-11
204	9	OQY-20C	8500	7	-	25-Oct-11	28-Oct-11
205	10	OQY-21C	8500	7	-	25-Oct-11	28-Oct-11
206	11	OQY-22C	8500	7	-	25-Oct-11	28-Oct-11
207	12	OQY-23B	8900	7	-	25-Oct-11	28-Oct-11
208	13	OQY-25	8700	7	-	25-Oct-11	28-Oct-11
209	14	OQY-26	8700	7	-	25-Oct-11	28-Oct-11
210	15	OQY-3C	8500	7	-	25-Oct-11	28-Oct-11
211	16	OTD-1H	9200	7	-	25-Oct-11	28-Oct-11
212	17	OYH-7	9500	7	-	25-Oct-11	28-Oct-11
213	18	OYH-9	9600	7	-	25-Oct-11	28-Oct-11
214	19	OYI-3	8900	7	-	25-Oct-11	28-Oct-11
215	20	OYI-4	9400	7	-	25-Oct-11	28-Oct-11
216	21	OYJ-11	9600	7	-	25-Oct-11	28-Oct-11
217	22	OYJ-4	8900	7	-	25-Oct-11	28-Oct-11
218	23	OYJ-6	9200	7	-	25-Oct-11	28-Oct-11
219	24	OYJ-9	9300	7	-	25-Oct-11	28-Oct-11
220	25	OYM-8	9700	7	-	25-Oct-11	28-Oct-11
221	**26**	OYM-9	9500	7	-	25-Oct-11	28-Oct-11
222	1	OOH-1E	9300	8	-	27-Oct-11	31-Oct-11
223	2	OOH-4F	9200	8	-	27-Oct-11	31-Oct-11
224	3	OPY4-24	8900	8	-	27-Oct-11	31-Oct-11
225	4	OQY-13C	8500	8	-	27-Oct-11	31-Oct-11
226	5	OQY-14C	8500	8	-	27-Oct-11	31-Oct-11
227	6	OQY-15C	8500	8	-	27-Oct-11	31-Oct-11
228	7	OQY-18C	8500	8	-	27-Oct-11	31-Oct-11
229	8	OQY-23C	8500	8	-	27-Oct-11	31-Oct-11
230	9	OQY-27	8500	8	-	27-Oct-11	31-Oct-11
231	10	OQY-28	8700	8	-	27-Oct-11	31-Oct-11
232	11	OQY-29	8700	8	-	27-Oct-11	31-Oct-11
233	12	OQY-31	8700	8	-	27-Oct-11	31-Oct-11
234	13	OQY-32	8500	8	-	27-Oct-11	31-Oct-11
235	14	OTD-1D	9500	8	-	27-Oct-11	31-Oct-11
236	15	OTD-23D	9500	8	-	27-Oct-11	31-Oct-11
237	16	OTD-2D	9500	8	-	27-Oct-11	31-Oct-11
238	17	OTD-2E	9400	8	-	27-Oct-11	31-Oct-11
239	18	OYL-5	8900	8	-	27-Oct-11	31-Oct-11
240	19	OYL-6	8900	8	-	27-Oct-11	31-Oct-11
241	20	OYL-9	8900	8	-	27-Oct-11	31-Oct-11
242	21	OYN-10	9300	8	-	27-Oct-11	31-Oct-11
243	22	OYN-11	9200	8	-	27-Oct-11	31-Oct-11
244	23	OYN-3	8900	8	-	27-Oct-11	31-Oct-11
245	24	OYN-4	8900	8	-	27-Oct-11	31-Oct-11

Total No.	No. by Load	Rod ID No.	Rod length (mm)	Load No.	Tag Release Date - Orange	Tag Release Date - Blue	Jobsite Arrival Date
246	25	OYN-5	8900	8	-	27-Oct-11	31-Oct-11
247	26	OYO-4	9200	8	-	27-Oct-11	31-Oct-11
248	**27**	OYO-6	9300	8	-	27-Oct-11	31-Oct-11
249	1	OOF2-4	8500	9	28-Oct-11	-	1-Nov-11
250	2	OOH2-2	8500	9	-	28-Oct-11	1-Nov-11
251	3	OOH2-20	8500	9	-	28-Oct-11	1-Nov-11
252	4	OOH2-23	8500	9	28-Oct-11	-	1-Nov-11
253	5	OPY3-8	8500	9	28-Oct-11	-	1-Nov-11
254	6	OYG-1	8900	9	28-Oct-11	-	1-Nov-11
255	7	OYG-2	8500	9	28-Oct-11	-	1-Nov-11
256	8	OYH-8	9600	9	28-Oct-11	-	1-Nov-11
257	9	OYI-5	9600	9	28-Oct-11	-	1-Nov-11
258	10	OYJ-8	9500	9	28-Oct-11	-	1-Nov-11
259	11	OYK-4	8900	9	28-Oct-11	-	1-Nov-11
260	12	OYK-5	9000	9	28-Oct-11	-	1-Nov-11
261	13	OYL-4	9000	9	28-Oct-11	-	1-Nov-11
262	14	OYM-5	9400	9	28-Oct-11	-	1-Nov-11
263	15	OYN-6	8900	9	28-Oct-11	-	1-Nov-11
264	16	OYN-7	8900	9	28-Oct-11	-	1-Nov-11
265	17	OYN-8	9300	9	28-Oct-11	-	1-Nov-11
266	18	OYN-9	9300	9	28-Oct-11	-	1-Nov-11
267	19	OYO-5	9200	9	28-Oct-11	-	1-Nov-11
268	20	OYO-7	9300	9	28-Oct-11	-	1-Nov-11
269	21	OYO-8	8900	9	28-Oct-11	-	1-Nov-11
270	22	OYO-9	9200	9	28-Oct-11	-	1-Nov-11
271	23	OYP-4	9300	9	28-Oct-11	-	1-Nov-11
272	**24**	R1011-OTD	9200	9	28-Oct-11	-	1-Nov-11
273	1	OYL-3	8500	10	11-Nov-11	-	22-Nov-11
274	**2**	OYP-2	8500	10	11-Nov-11	-	22-Nov-11

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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003727
Date Inspected: 13-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 800
OSM Departure Time: 1630
Location: Painesville, OH

Quality Control Contact: Russell Welsh
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☑ N/A
Sampled Items: ☑ Yes ☐ No ☐ N/A
Stock Transfer: ☐ Yes ☐ No ☑ N/A
OK to Cut: ☐ Yes ☐ No ☑ N/A
Rebar Test Witness: ☐ Yes ☐ No ☑ N/A
Delayed/Cancelled: ☐ Yes ☑ No ☐ N/A
Other:
Bridge No: 34-0006
Component: 3.5" inch Main cable anchor rods
Bid Item: 66
Lot No: B305-036-11,B305-037-11,B305-038-11

Summary of Items Observed:

On this date, Quality Assurance Inspector (QAI) Fred Edmondson was present at the Dyson Corporation in Painesville, OH as requested to monitor the fabrication of various high strength rods, bolts and washers for the San Francisco Oakland Bay Bridge (SFOBB) project.

This QAI met with Dyson Corporation Quality Control Supervisor (QCS) Mr. Russell Welsh and Mr. Mark Roach, KTA inspector.

This QAI randomly observed Stork Herron Testing Laboratories NDT Level II Matt Novak perform wet fluorescent MT testing on 8 ea 3.5” diameter A354 grade BD, Q&T Main Cable Anchor Rods (anchor rods) previously selected by this QA (2 ea from each heat treatment lot require Magnetic Particle Testing (MT)per ASTM A1470. MT was performed in accordance with ASTM E709, per ASTM A490. The anchor rods inspected by MT are identified as follows: OYI-4,OYI-5, OYJ-8, OYJ-11, OYM-5, OYM-9, OYH-8 and OYH-9. MT of the above tested anchor rods did not reveal any discontinuities that would be cause for rejection of any of the anchor rods.

Dyson QCS Welsh and NDT technician Novak relayed to this QAI that copies of completed MT test reports will be forwarded to Dyson tomorrow.

This QAI reviewed MTR’s and galvanizing Certificates of Conformance (COC’s) for 1 ea - 7.00” 4UNC 2A X 3. 50” 4UNC 2B Hex Coupling Nut, A194 Gr. 7,HDG, Heat Number KTA 5109, Dyson Heat Treatment Code OKS2, Lot 3 - 1ea - 3.50”4UNC 2B x 11” Long Coupler Nut,A194 Gr. 7, HDG. with S.S. Set screws,

SOURCE INSPECTION REPORT

(Continued Page 2 of 2)

Heat Number T1313, Dyson Heat treatment Code LNA2 and 1 ea - 3.50“4UNC 2B Heavy Hex Spherical Nuts, A563 Gr. DH, HDG, Heat Number 3M72732, Dyson Heat Treatment Code OKT5. Each sample was assigned a separate Lot Number and recorded on separate TL101’s.

The sampled coupons were placed in separate cardboard boxes and placed on a wood pallet, and secured with steel bands and shrink wrap for shipment to the Caltrans translab.

Current Status - 3.5 inch PWS anchor rods

274 –Required
143 - Shipped to jobsite
33 - to Monnig for galvanize coating repair 10-1-11, (accident)
2 - thread and galvanize coating repair, (accident and to return to Dyson)
14 - scrapped (accident)
34 - shipped to Monnig 10-7-11
8 – Magnetic Particle Testing completed (2 ea from 4 ea Heat Treatment Lots)
80 - In fabrication

Summary of Conversations:
Fundamental conversation, necessary to complete the tasks at hand, occurred between this QAI and Dyson personnel.

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:	Edmondson,Fred	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
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(707) 649-5493

Contract #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003728
Date Inspected: 14-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 800
OSM Departure Time: 1630
Location: Painesville, OH

Quality Control Contact: Russell WSelsh
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☑ N/A
Sampled Items: ☐ Yes ☐ No ☑ N/A
Stock Transfer: ☐ Yes ☐ No ☑ N/A
OK to Cut: ☐ Yes ☐ No ☑ N/A
Rebar Test Witness: ☐ Yes ☐ No ☑ N/A
Delayed/Cancelled: ☐ Yes ☑ No ☐ N/A
Other:

Bridge No: 34-0006
Component: 3.5 inch Main Cable Anchor Rods
Bid Item: 66
Lot No: B305-039-11

Summary of Items Observed:

On this date, Quality Assurance Inspector (QAI) Fred Edmondson was present at the Dyson Corporation in Painesville, OH as requested to monitor the fabrication of various high strength rods, bolts and washers for the San Francisco Oakland Bay Bridge (SFOBB) project.

This QAI met with Dyson Corporation Quality Control Supervisor (QCS) Mr. Russell Welsh, KTA Inspector Mr. Mark Roach, and Production Supervisor Mr. Rob Ruple .

This QAI randomly observed Stork Herron Testing Laboratories NDT Level II Matt Novak perform wet fluorescent MT testing on 8 ea 3.5” diameter A354 grade BD, Q&T Main Cable Anchor Rods (anchor rods) previously selected by this QAI. (2 ea from each heat treatment lot require Magnetic Particle Testing (MT) per ASTM A1470). MT was performed in accordance with ASTM E709, per ASTM A490. The anchor rods inspected by MT are identified as follows:
OYK-4 & 5, OYL-5 & 6, OYN-10 & 11 and OYO 4 & 5. The above tested anchor rods did not reveal any discontinuities that would be cause for rejection of any of the anchor rods.

Dyson QCS welsh and NDT technician Novak relayed to this QAI that copies of completed MT test reports will be forwarded to Dyson Monday.

This QAI reviewed Material Testing Reports (MTR’s), Certificates of Conformance (COC’s) and Magnetic Particle Testing Reports (8 ea MT) for 30 ea 3.5” diameter A354 grade BD, Q&T Main Cable Anchor Rods (anchor rods). The anchor rods are to be shipped, this date, to Monnig Industries, 400 Industrial Drive, Glasgow,

MO for sandblasting and hot-dip galvanizing (HDG).

This QAI performed a random inspection of the anchor rods and observed they appear to be in general conformance with the contract documents. The anchor rods are identified as follows: OYH-1 OYH-2, OYH-3, OYH-6, OYH-7, OYH-8, OYH-9, OYH-10, OYI-2, OYI-3, OYI-4, OYI-5, OYJ-4, OYJ-5, OYJ-6, OYJ-7, OYJ-8 OYJ-9, OYJ-10, OYJ-11, OYM-1, OYM-2, OYM-3, OYM-4, OYM-5, OYM-6, OYM-7, OYM-8, OYM-9 and OYM-10.

This QAI attached a Green Tag (Lot Number B305-039-11, with copies of the above mentioned contract documents, to one bundle of the anchor rods.

Current Status - 3.5 inch PWS anchor rods

274 –Required

143 - Shipped to jobsite
33 - To Monnig for galvanize coating repair 10-1-11, (accident)
2 - Thread and galvanize coating repair, (accident and to return to Dyson)
14 - Scrapped (accident)
34 - Shipped to Monnig 10-7-11
16 – Magnetic Particle Testing completed (2 ea from 8 ea Heat Treatment Lots)
30 – Shipped to Monnig 10-14-11
50 - In fabrication
34- Needed & scheduled to ship 10-17-11

Summary of Conversations:
Fundamental conversation, necessary to complete the tasks at hand, occurred between this QAI and Dyson personnel.

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:	Edmondson,Fred	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.8

COMPONENT MATERIAL INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: CMI-000386
Date Inspected: 14-Oct-2011

Contractor: Dyson Corp. & Subs
Location: Painesville, OH
Bridge No.: 34-0006

OSM Arrival Time: 800
OSM Departure Time: 1600
Component:# 3.5" main cable anchor rods

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: Monnig Industries, 400 Industrial Drive, Glasgow, MO

Lot #	Bid Item #	Quantity		Material Description
B305-039-11	66	30	ea	3.5” diameter A354 grade BD, Q&T Main Cable Anchor Rods

Identification: 3.5” diameter A354 grade BD, Q&T Main Cable Anchor Rods

Summary of Items Observed:

This QAI reviewed Material Testing Reports (MTR’s), Certificates of Conformance (COC’s) and Magnetic Particle Testing Reports (8 ea MT) for 30 ea 3.5” diameter A354 grade BD, Q&T Main Cable Anchor Rods (anchor rods). The anchor rods are to be shipped, this date, to Monnig Industries, 400 Industrial Drive, Glasgow, MO for sandblasting and hot-dip galvanizing (HDG).

This QAI performed a random inspection of the anchor rods. The anchor rods appear to be in general conformance with the contract documents. The anchor rods are identified as follows: OYH-1, OYH-2, OYH-3, OYH-6, OYH-7, OYH-8, OYH-9, OYH-10, OYI-2, OYI-3, OYI-4, OYI-5, OYJ-4, OYJ-5, OYJ-6, OYJ-7, OYJ-8, OYJ-9, OYJ-10, OYJ-11, OYM-1, OYM-2, OYM-3, OYM-4, OYM-5, OYM-6, OYM-7, OYM-8, OYM-9 and OYM-10.

This QAI attached a Green Tag (Lot Number B305-039-11) with copies of the above mentioned contract documents to one bundle of the anchor rods.

Summary of Conversations:

Fundamental conversation, necessary to complete the tasks at hand, occurred between this QAI and Dyson personnel.

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:	Edmondson, Fred	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
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(707) 649-5493

Contract #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003729
Date Inspected: 17-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 800
OSM Departure Time: 1700
Location: Painesville, OH

Quality Control Contact: Russell Welsh
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☑ N/A
Sampled Items: ☐ Yes ☐ No ☑ N/A
Stock Transfer: ☐ Yes ☐ No ☑ N/A
OK to Cut: ☐ Yes ☐ No ☑ N/A
Rebar Test Witness: ☐ Yes ☐ No ☑ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☑ N/A
Other:
Bridge No: 34-0006
Component: 3.5" anchor rods
Bid Item: 66
Lot No: B305-40-11

Summary of Items Observed:

On this date, Quality Assurance Inspector (QAI) Fred Edmondson was present at the Dyson Corporation in Painesville, OH as requested to monitor the fabrication of various high strength rods, bolts and washers for the San Francisco Oakland Bay Bridge (SFOBB) project.

This QAI met with Dyson Corporation Quality Control Supervisor (QCS) Mr. Russell Welsh, KTA inspector Mr. Mark Roach, and Production Supervisor Mr. Rob Ruple.

This QAI reviewed Material Testing Reports (MTR's), Certificates of Conformance (COC's) and Magnetic Particle Testing Reports (8 ea MT) for 34 ea 3.5" diameter A354 grade BD, Q&T Main Cable Anchor Rods (anchor rods). The anchor rods are to be shipped, this date, to Monnig Industries, 400 Industrial Drive, Glasgow, MO for sandblasting and hot-dip galvanizing (HDG).

This QAI performed a random visual inspection of the anchor rods and observed they appear to be in general conformance with the contract documents. The anchor rods are identified as follows: OYG-1, OYG-2, OYG-3, OYG-4, OYG-5, OYK-4, OYK-5, OYL-4, OYL-5, OYL-6, OYL-7 OYL-8, OYL-9, OYN-1, OYN-2, OYN-3, OYN-4, OYN-5, OYN-6, OYN-7, OYN-8, OYN-9, OYN-10, OYN-11, OYO-3, OYO-4, OYO-5, OYO-6, OYO-7, OYO-8, OYO-9, OYP-3, OYP-4,AND OYP-5.

This QAI attached a Green Tag (Lot Number B305-040-11, with copies of the above mentioned contract documents, to one bundle of the anchor rods.

Current Status - 3.5 inch PWS anchor rods

274 –Required

143 - Shipped to jobsite
33 - To Monnig for galvanize coating repair 10-1-11, (accident)
2 - Thread and galvanize coating repair, (accident and to return to Dyson)
14 - Scrapped (accident)
34 - Shipped to Monnig 10-7-11
16 - Magnetic Particle Testing completed (2 ea from 8 ea Heat Treatment Lots)
30 - Shipped to Monnig 10-14-11
34- Shipped to Monnig 10-17-11
16 – Spares at full length and threaded on the tapped end.

Bold numbers equal 274.

Items to green tag to Monnig (sample sent to translab 10-13-11)
49 ea - 3.5”spherical nuts
49 ea - 3.5“ jam nuts

Items to orange tag to Jobsite (sample sent to translab 10-13-11)
2 ea - 7” X 3.5” Heavy Hex Coupling Nuts
6 ea - 3.5” X 11” long Coupling Nuts with S.S. set screws

Summary of Conversations:
Fundamental conversation, necessary to complete the tasks at hand, occurred between this QAI and Dyson personnel.

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:	Edmondson,Fred	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.8

COMPONENT MATERIAL INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: CMI-000387
Date Inspected: 17-Oct-2011

Contractor: Dyson Corp. & Subs
Location: Painesville, OH
Bridge No.: 34-0006

OSM Arrival Time: 800
OSM Departure Time: 1700
Component:# 3.5"anchor rods

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:

Lot #	Bid Item #	Quantity		Material Description
B305-040-11	66	34	ea	3.5” diameter A354 grade BD, Q&T Main Cable Anchor Rods

Identification: 3.5" Main Cable Anchor Rods

Summary of Items Observed:

On this date, Quality Assurance Inspector (QAI) Fred Edmondson was present at the Dyson Corporation in Painesville, OH as requested to monitor the fabrication of various high strength rods, bolts and washers for the San Francisco Oakland Bay Bridge (SFOBB) project.

This QAI met with Dyson Corporation Quality Control Supervisor (QCS) Mr. Russell Welsh, KTA inspector Mr. Mark Roach, and Production Supervisor Mr. Rob Ruple.

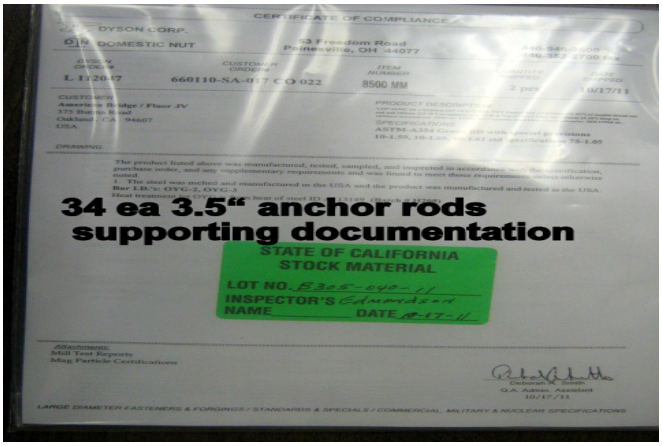
This QAI reviewed Material Testing Reports (MTR’s), Certificates of Conformance (COC’s) and Magnetic Particle Testing Reports (8 ea MT) for 34 ea 3.5” diameter A354 grade BD, Q&T Main Cable Anchor Rods (anchor rods). The anchor rods are to be shipped, this date, to Monnig Industries, 400 Industrial Drive, Glasgow, MO for sandblasting and hot-dip galvanizing (HDG).

This QAI performed a random visual inspection of the anchor rods and observed they appear to be in general conformance with the contract documents. The anchor rods are identified as follows: OYG-1, OYG-2, OYG-3, OYG-4, OYG-5, OYK-4, OYK-5, OYL-4, OYL-5, OYL-6, OYL-7 OYL-8, OYL-9, OYN-1, OYN-2, OYN-3, OYN-4, OYN-5, OYN-6, OYN-7, OYN-8, OYN-9, OYN-10, OYN-11, OYO-3, OYO-4, OYO-5, OYO-6, OYO-7, OYO-8, OYO-9, OYP-3, OYP-4,AND OYP-5.

This QAI attached a Green Tag (Lot Number B305-040-11, with copies of the above mentioned contract documents, to one bundle of the anchor rods.

COMPONENT MATERIAL INSPECTION REPORT

(Continued Page 2 of 2)



Summary of Conversations:

Fundamental conversation, necessary to complete the tasks at hand, occurred between this QAI and Dyson personnel.

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:	Edmondson, Fred	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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(707) 649-5493

Contract #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003733
Date Inspected: 18-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 800
OSM Departure Time: 1600
Location: Painesville, OH

Quality Control Contact: Russell Welsh
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☑ N/A
Sampled Items: ☐ Yes ☐ No ☑ N/A
Stock Transfer: ☐ Yes ☐ No ☑ N/A
OK to Cut: ☐ Yes ☐ No ☑ N/A
Rebar Test Witness: ☐ Yes ☐ No ☑ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☑ N/A
Other:
Bridge No: 34-0006
Component: 3.50" Main Cable Anchor Rod Nuts
Bid Item: 66
Lot No:

Summary of Items Observed:

On this date, Quality Assurance Inspector (QAI) Fred Edmondson was present at the Dyson Corporation in Painesville, OH as requested to monitor the fabrication of various high strength rods, bolts and washers for the San Francisco Oakland Bay Bridge (SFOBB) project.

This QAI met with Dyson Corporation Quality Control Supervisor (QCS) Mr. Russell Welsh, KTA inspector Mr. Mark Roach, and Production Supervisor Mr. Rob Ruple.

This QAI reviewed Material Testing Reports (MTR's), Certificates of Conformance (COC's) and Hot Dip Galvanizing Certificates of Conformance (COC's) for 49 ea 3.50"– 4UNC 2B Heavy Hex Jam Nuts, HDG (jam nuts) and 49 ea 3.50"– 4UNC 2B Heavy Hex Spherical Nuts, HDG (spherical nuts). The jam nuts and spherical nuts are to be shipped, to Monnig Industries, 400 Industrial Drive, Glasgow, MO for assembly onto 3.50" diameter anchor rods prior to shipping to the job site.

Prior to shipping, Dyson is waiting on the test results, from the Caltrans translab, regarding the spherical nut sample sent the translab 10-13-11. The jam nuts have been previously tested and approved for use by the translab.

Current Status - 3.5 inch PWS anchor rods

274 –Required
143 - Shipped to jobsite
33 - To Monnig for galvanize coating repair 10-1-11, (accident)

2 - Thread and galvanize coating repair, (accident and to return to Dyson)
14 - Scrapped (accident)
34 - Shipped to Monnig 10-7-11
16 - Magnetic Particle Testing completed (2 ea from 8 ea Heat Treatment Lots)
30 - Shipped to Monnig 10-14-11
34- Shipped to Monnig 10-17-11
16 – Spares at full length and threaded on the tapped end.

Items to green tag to Monnig (sample sent to translab 10-13-11)
49 ea - 3.5”spherical nuts
49 ea - 3.5“ jam nuts

Items to orange tag to Jobsite (sample sent to translab 10-13-11)
2 ea - 7” X 3.5” Heavy Hex Coupling Nuts
6 ea - 3.5” X 11” long Coupling Nuts with S.S. set screws

Summary of Conversations:
Fundamental conversation, necessary to complete the tasks at hand, occurred between this QAI and Dyson personnel.

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:	Edmondson,Fred	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003758
Date Inspected: 18-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 700
OSM Departure Time: 1530
Location: Glasgow, MO

Quality Control Contact: Ryan Monnig
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☐ N/A
Sampled Items: ☐ Yes ☐ No ☐ N/A
Stock Transfer: ☐ Yes ☐ No ☐ N/A
OK to Cut: ☐ Yes ☐ No ☐ N/A
Rebar Test Witness: ☐ Yes ☐ No ☐ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☐ N/A
Other: N/A
Bridge No: 34-0006
Component: PWS Anchor Rods
Bid Item: 68
Lot No: N/A

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to monitor, at random intervals, the galvanizing of Parallel Wire Strand (PWS) High Strength Rods from Dyson Corporation for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA met with Monnig Industries General Manager Ryan Monnig and was informed of the following status regarding the galvanizing of the PWS Anchor Rods:

The following rods were listed for the next shipment and at the current time with in various stages of the galvanizing process.
R1001-OPY, R1008-OQX, OOH2-20, OOF3-8, OTD-12, OOF4-2, R1002-OTD, R1010-OTD, OOH2-4, OOH2-7, OOH2-8, R1005-OQW, OPY2-6, OOF4-4, OOH2-10, OOH2-17, R1006-OTD, OTD-13, OPY2-15, OOH2-24, OOH2-19, R1007-OOH, OOH2-16, OPY2-7, OOF4-5, and OOF2-2

This QA performed a visual verification at random intervals of Parallel Wire Strand (PWS) High Strength Rods during and after completion of the glvanizing process. This QA Inspector observed the galvanizing process was performed within 4 hours of the blasting and appeared to comply with the contract requirements.
Attached to this report are photographs representative ofvarious stages of the galvanizing process and/or loading and tagged of completed rods.

This QA Inspector spoke with Monnig Industries representative Andrew Monnig and was informed by Mr.

Monnig that the truck that is to transport load #5 has been scheduled to arrive at the Monnig facility some time after noon (12pm) tommorow (10-19-11).

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.

Summary of Conversations:

This QA Inspector had general conversations with Monnig General Manager Ryan Monnig and other Monnig personnel. Unless noted above there were no other notable conversations.

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:	Clifford,William	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003759
Date Inspected: 19-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 700
OSM Departure Time: 1530
Location: Glasgow, MO

Quality Control Contact: Ryan Monnig
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☐ N/A
Sampled Items: ☐ Yes ☐ No ☐ N/A
Stock Transfer: ☐ Yes ☐ No ☐ N/A
OK to Cut: ☐ Yes ☐ No ☐ N/A
Rebar Test Witness: ☐ Yes ☐ No ☐ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☐ N/A
Other: N/A
Bridge No: 34-0006
Component: PWS Anchor Rods
Bid Item: 68
Lot No: N/A

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to monitor, at random intervals, the galvanizing of Parallel Wire Strand (PWS) High Strength Rods from Dyson Corporation for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA met with Monnig Industries General Manager Ryan Monnig and was informed of the following status regarding the galvanizing of the PWS Anchor Rods:

The following rods are currently in various stages of the galvanizing process:
OYH-1, OYM-2, OYL-7, OYG-2, OYM-10, OYP-5, OYM-1, OYH-6, OYP-3, OYN-10, OYM-4, OYM-3, OYO-3, OYN-1, OYJ-10, OYM-6, OYJ-6, OYO-5, OYN-2, OYM-7, OYH-2, OYI-2, OYG-4, OYH-3, OYJ-7, and ???-?.

The following rods were listed for the 1st shipment and at the current time completed.
Orange Tag: R1001-OPY, R1008-OQX, OOF3-8, R1002-OTD, R1010-OTD, OOH2-4, R1005-OQW, OOH2-10, OOH2-17, R1006-OTD, OPY2-15, R1007-OOH, OOH2-16, and OOF4-5.
Blue Tag: OOH2-20, OTD-12, OOF4-2, OOH2-7, OOH2-8, OPY2-6, OOF4-4, OTD-13, OOH2-24, OOH2-19, OPY2-7, and OOF2-2.

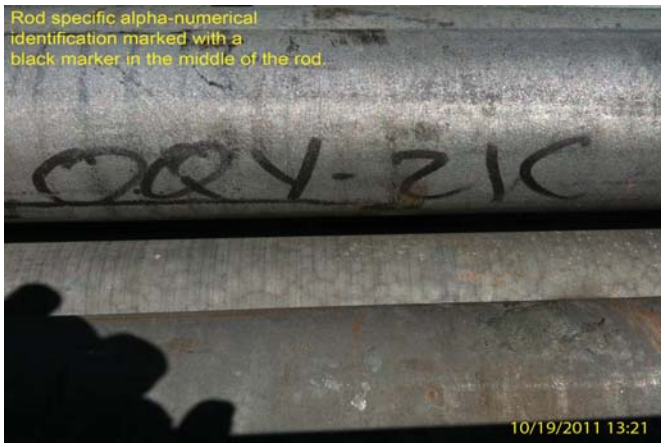
This QA performed a visual verification at random intervals of Parallel Wire Strand (PWS) High Strength Rods during and after completion of the glvanizing process. This QA Inspector observed the galvanizing process was

performed within 4 hours of the blasting and appeared to comply with the contract requirements.

Attached to this report are photographs representative ofvarious stages of the galvanizing process and/or loading and tagged of completed rods.

This QA Inspector spoke with Monnig Industries representative Andrew Monnig and was informed by Mr. Monnig that the truck scheduled for Wednesday (10/19/11) had been delayed in transit and that it would now arrive tomorrow, Thursday (10/20/11) to transport the material to the job site.

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.



Summary of Conversations:

This QA Inspector had general conversations with Monnig General Manager Ryan Monnig and other Monnig personnel. Unless noted above there were no other notable conversations.

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:	Clifford,William	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003760
Date Inspected: 20-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 700
OSM Departure Time: 1530
Location: Glasgow, MO

Quality Control Contact: Ryan Monnig
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☐ N/A
Sampled Items: ☐ Yes ☐ No ☐ N/A
Stock Transfer: ☐ Yes ☐ No ☐ N/A
OK to Cut: ☐ Yes ☐ No ☐ N/A
Rebar Test Witness: ☐ Yes ☐ No ☐ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☐ N/A
Other: N/A
Bridge No: 34-0006
Component: PWS Anchor Rods
Bid Item: 68
Lot No: N/A

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to monitor, at random intervals, the galvanizing of Parallel Wire Strand (PWS) High Strength Rods from Dyson Corporation for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA met with Monnig Industries General Manager Ryan Monnig and was informed of the following status regarding the galvanizing of the PWS Anchor Rods:

This QA Inspector observed the following PWS Rods were part of load - #5:

Of the 26 rods in this shipment fourteen (14) were Orange Tagged and twelve (12) were Blue Tagged for delivery to the job site.
Orange Tag: R1001-OPY, R1008-OQX, OOF3-8, R1002-OTD, R1010-OTD, OOH2-4, R1005-OQW, OOH2-10, OOH2-17, R1006-OTD, OPY2-15, R1007-OOH, OOH2-16, and OOF4-5.

The SMR authorization S54-022-11 has been included in this report.
Blue Tag: OOH2-20, OTD-12, OOF4-2, OOH2-7, OOH2-8, OPY2-6, OOF4-4, OTD-13, OOH2-24, OOH2-19, OPY2-7, and OOF2-2.

1. This QA Inspector observed a dimensional report from Dyson Corporation accepting the rods was submitted for the heat treatment lots.

2. This QA Inspector observed a Certificate Of Compliance (COC), Material Test Report (MTR), Magnetic Particle Testing reports per material heat and shipper were submitted from Dyson Corporation.
3. This QA Inspector observed a COC and QC reports for blasting and galvanizing were submitted from Monnig Industries.

These documents submitted appeared to comply with the contract requirements.

This QA Inspector observed a spherical nut and regular nut were threaded full length and shipped as such.

The following rods were listed for the next shipment and at the current time with in various stages of the galvanizing process.
OYH-1, OYM-2, OYL-7, OYG-2, OYM-10, OYP-5, OYM-1, OYH-6, OYP-3, OYN-10, OYM-4, OYM-3, OYO-3, OYN-1, OYJ-10, OYM-6, OYJ-6, OYO-5, OYN-2, OYM-7, OYH-2, OYI-2, OYG-4, OYH-3, OYJ-7, and OYL-8.

This QA performed a visual verification at random intervals of Parallel Wire Strand (PWS) High Strength Rods during and after completion of the glvanizing process. This QA Inspector observed the galvanizing process was performed within 4 hours of the blasting and appeared to comply with the contract requirements.

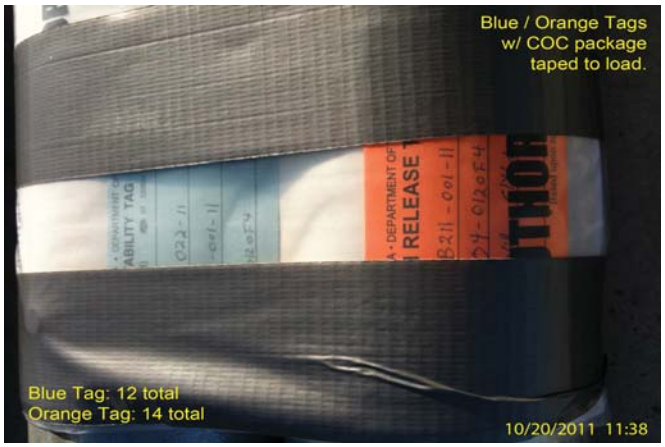
This QA Inspector spoke with Monnig Industries representative Andrew Monnig and was informed by Mr. Monnig that the truck that is to transport load #6 has been scheduled to arrive at the Monnig facility some time after noon (12pm) tommorow (10-21-11).

Attached to this report are photographs representative of various stages of the galvanizing process and/or loading and tagged of completed rods.

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.

Summary of Conversations:

This QA Inspector had general conversations with Monnig General Manager Ryan Monnig and other Monnig personnel. Unless noted above there were no other notable conversations.



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:	Clifford,William	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 1.9

REPORT OF INSPECTION OF MATERIAL

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: RIM-000107
Date Inspected: 20-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Monnig Industries

OSM Arrival Time: 700
OSM Departure Time: 1330
Location: Glasgow, MO

The following material has been inspected in accordance with Section 6 of the Standard Specifications and found to substantially comply* with contract plans and specifications.

Item	Lot #	Bid Item#	Quantity	Material Description
1	B211-001-11	68	14	PWS Anchor Rods - load #5

Identification: One Tag Attached to Load
Shipped to: Job Site

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to release the Parallel Wire Strand (PWS) High Strength Anchor Rods for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA Inspector met with Monnig Industries General Manager Ryan Monnig and was informed all PWS Anchor Rods had been galvanized, passed QC inspections, spherical and regular nuts had been threaded on all rods and that all rods had been packaged for shipment.

This QA Inspector observed the following PWS Rods were part of load: R1001-OPY, R1008-OQX, OOF3-8, R1002-OTD, R1010-OTD, OOH2-4, R1005-OQW, OOH2-10, OOH2-17, R1006-OTD, OPY2-15, R1007-OOH, OOH2-16, and OOF4-5.

This QA Inspector was provided a Certificate of Compliance (COC), Material Test Reports (MTR's), Magnetic Particle Testing (MT) inspection reports per material heat, Thread Dimension reports and a shipper from Dyson Corporation for the PWS Anchor Rods in load package.

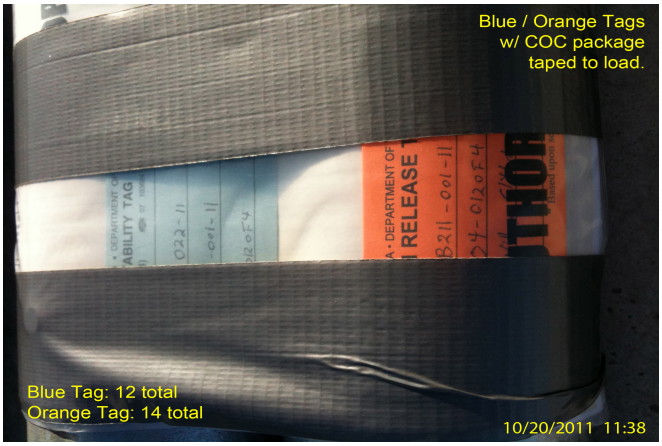
This QA Inspector was provided a COC, Quality Control (QC)Blasting report and QC inspection report for galvanizing thicknesses from Monnig Industries for the PWS Anchor Rods in load package.

This QA Inspector had previously confirmed with Structural Material Representative (SMR) Kittric Guest that all material check samples had been accepted.

The documents provided appeared to comply with the contract requirements therefore an Orange Tag was placed in a plastic pouch and attached to the load.

REPORT OF INSPECTION OF MATERIAL

This QA Inspector randomly observed as the material listed above was loaded onto each truck. See photos of documentation package and overall truck loaded shipment below.



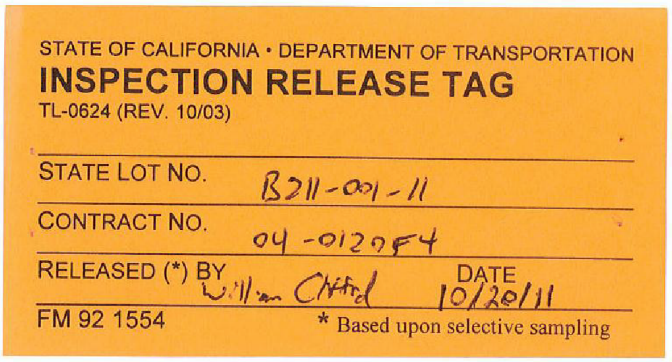
Summary of Conversations:

General conversations as noted above.

Comments

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

Inspected By:	Clifford, William	Quality Assurance Inspector
Reviewed By:	Levell, Bill	QA Reviewer



STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
INSPECTION RELEASE TAG
TL-0624 (REV. 10/03)
STATE LOT NO. B211-001-11
CONTRACT NO. 04-0120F4
RELEASED (*) BY William Clifford DATE 10/20/11
FM 92 1554 * Based upon selective sampling

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
INSPECTION RELEASE TAG
TL-0624 (REV. 10/03)
B211-001-11
STATE LOT NO. 04-0120F4
CONTRACT NO. William Clifford 10/20/11
RELEASED (*) BY DATE
FM 92 1554 * Based upon selective sampling

Monnig Industries, Inc.

HOT DIP & MECHANICAL GALVANIZING
P.O. BOX 98
GLASGOW, MO 65254
PH. 660-338-2242 FAX: 660-338-5199

OCTOBER 19, 2011

DYSON CORPORATION
50 FREEDOM ROAD
PAINESVILLE, OH 44077

RE: GALVANIZING CERTIFICATE-CALTRAN

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE ATTACHED SPREADSHEET MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS.

26 PWS ANCHOR RODS

ROD ID/MIL THICKNESS MEASUREMENTS

R1001-OPY/5.66	R1002-OTD/8.00	R1005-OQW/7.70	R1006-OTD/6.39	R1007-OOH/7.03
R1008-OQX/8.34	R1010-OTD/8.97	OPY2-6/6.98	OTD-13/6.96	OOH2-16/7.40
OOH2-20/9.34	OOH2-4/10.64	OOF4-4/6.95	OPY2-15/5.43	OPY2-7/5.65
OOF3-8/5.69	OOH2-7/6.69	OOH2-10/9.79	OOH2-24/7.44	OOF4-5/7.55
OTD-12/5.57	OOH2-8/9.13	OOH2-17/5.54	OOH2-19/6.94	OOF2-2/6.90
OOF4-2/7.05				

PATRICIA S. WESTHUES
NOTARY PUBLIC STATE OF MISSOURI
HOWARD COUNTY
MY COMMISSION EXP. APR. 18, 2012

Actual supplied rod ID is OPY2-2, not OOH2-20.
- Bob Brignano, CT

John Monnig
JOHN MONNIG, PRESIDENT

Patricia S Westhues
PATRICIA S. WESTHUES,
NOTARY PUBLIC

Phoenix Manufacturing, Inc.
P.O. BOX 330
26666 Von Holten Rd.
Cole Camp, MO. 65325
660-668-2611
660-668-3160 (fax)

SSPC-SP10 Near White Metal Blast

Near-White Blast Cleaning - Removal of nearly all mill scale, rust, rust scale, paint, or foreign matter by the use of abrasives propelled through nozzles or by centrifugal wheels to the degree hereafter specified. A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides, or light, tight residues of paint or coating that may remain. At least 95 percent of each square inch of surface area shall be free of all visible residues, and the remainder shall be limited to the light discoloration mentioned above

R1001-OPY	R1002-OTD	R1005-OQW	R1006-OTD	R1007-OOH
R1008-OQX	R1010-OTD	OPY2-6	OTD-13	OOH2-16
OOH2-20	OOH2-4	OOF4-4	OPY2-15	OPY2-7
OOF3-8	OOH2-7	OOH2-10	OOH2-24	OOF4-5
OTD-12	OOH2-8	OOH2-17	OOH2-19	OOF2-2
OOF4-2				

Actual supplied rod ID is OPY2-2, not OOH2-20.

- Bob Brignano, CT

Kelly Nm

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112047	660110-SA-017 CO 022	8500 MM	15 pcs	10/7/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. HDG per ASTM-A153 w/white metal blast prior to galvanize. BID ITEM 66 -

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OPY2-2, OPY2-6, OPY3-8, OTD-13, OOH2-23, OOH2-16, OOH2-20, OOH2-2, OOH2-4, OOF2-4, OOF4-4, OPY2-13, OPY2-15, OPY2-3, OPY2-7

Heat treatment lot OPY is from heat of steel ID 3M75738-2
Heat treatment lot OTD is from heat of steel ID 4M76368-1
Heat treatment lot OOH is from heat of steel ID 4M76368-3
Heat treatment lot OOF is from heat of steel ID 4M76368-2

Attachments:
Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/6/11

CERTIFICATE OF COMPLIANCE

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 112051	660110-SA-017 CO 022	8900 MM	5 pcs	10/7/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8900mm OAL PWS anchor rod w/1850mm of useable thread one end and 280mm (13.78") on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end, HDG per ASTM-A153 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OPY-R1001, OQW-R1005, OOH-R1007, OQX-R1008, OTD-R1010

Heat treatment lot OPY is from heat of steel ID 3M75738-2
Heat treatment lot OQW is from heat of steel ID 3M75738-1
Heat treatment lot OOH is from heat of steel ID 4M76368-3
Heat treatment lot OQX is from heat of steel ID 4M76367-2
Heat treatment lot OTD is from heat of steel ID 4M76368-1

Attachments:

Mill Test Reports
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/6/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112051	660110-SA-017 CO 022	8900 MM	5 pcs	10/19/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8900mm OAL PWS anchor rod w/1850mm of useable thread one end and 280mm (13.78") on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end, HDG per ASTM-A153 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OPY-R1001, OQW-R1005, OOH-R1007, OQX-R1008, OTD-R1010

Heat treatment lot OPY is from heat of steel ID 3M75738-2
Heat treatment lot OQW is from heat of steel ID 3M75738-1
Heat treatment lot OOH is from heat of steel ID 4M76368-3
Heat treatment lot OQX is from heat of steel ID 4M76367-2
Heat treatment lot OTD is from heat of steel ID 4M76368-1

Attachments:

Mill Test Reports
Mag Particle Certifications
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/19/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.
DN 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 112055	660110-SA-017 CO 022	9300 MM	7 pcs	10/7/11

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

PRODUCT DESCRIPTION
3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

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

DRAWING

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.

Bar I.D.'s: OOH2-17, OOH2-8, OOH2-19, OOH2-24, OOH2-7, OOH2-10, R1002-OTD
Heat treatment lot OTD is from heat of steel ID 4M76368
Heat treatment lot OOH is from heat of steel ID 4M76368

Attachments:
Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/6/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112055	660110-SA-017 CO 022	9300 MM	7 pcs	10/19/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

RAWING

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.

Bar I.D.'s: OOH2-17, OOH2-8, OOH2-19, OOH2-24, OOH2-7, OOH2-10, R1002-OTD
Heat treatment lot OTD is from heat of steel ID 4M76368
Heat treatment lot OOH is from heat of steel ID 4M76368

Attachments:

Mill Test Reports
Mag Particle Certifications
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/19/11

CERTIFICATE OF COMPLIANCE

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 112057	660110-SA-017 CO 022	9500 MM	2 pcs	10/7/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9500mm OAL PWS Anchor Rod w/1850mm (72.83") of usable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A153 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OOF3-8, OTD-R1006
Heat treatment lot OOF is from heat of steel ID 4M76368-2
Heat treatment lot OTD is from heat of steel ID 4M76368-1

Attachments:
Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah R. Smith
Q.A. Admin. Assistant
10/6/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112057	660110-SA-017 CO 022	9500 MM	2 pcs	10/19/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9500mm OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OOF3-8, OTD-R1006

Heat treatment lot OOF is from heat of steel ID 4M76368-2

Heat treatment lot OTD is from heat of steel ID 4M76368-1

Attachments:

Mill Test Report
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/19/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.
DN 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 112058	660110-SA-017 CO 022	9600 MM	2 pcs	10/7/11

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

PRODUCT DESCRIPTION
3.50"-4UNC-2A x 9600mm OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

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

DRAWING

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.

Bar I.D.'s: OOF4-5, OOF4-2

Heat treatment lot OOF is from heat of steel ID 4M76368

Attachments:
Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/6/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112058	660110-SA-017 CO 022	9600 MM	2 pcs	10/19/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9600mm OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"4.5UNC-2A x 60mm deep on 1850mm threaded end, HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OOF4-5, OOF4-2

Heat treatment lot OOF is from heat of steel ID 4M76368

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/19/11

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

Date Received: 6/3/2011

Test Report No.: DYS006-11-06-26885-1 *REVISED

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

P.O. No.: 78333 / 78375

TEST REPORT
ITAR-CONTROLLED DATA

Sample Description: MT On-Site Wet Fluorescent Cal Trans Witness of Anchor Rods Representing 3.50"-4UNC 2A x Random Lengths*, 6/6/2011, Heat#/Heat Codes: 4M76368/OOF and 4M76368/OOH *

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM F788-06 (Acceptance Criteria)
Procedure:	SOP 42.03 /ASTM E1444 (Method) per ASTM A 490/ Caltran Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05

METHOD

☐ Dry	☒ Wet

PARTICLES

Magnaflux Particles:	*Part Preparation:	Wet Particle Carrier:
☐ 8A Red ☐ 14A ☐ 3A Black ☒ 14AM ☐ 1 Gray ☐ Other Batch No. 09D02K	☐ None Required ☐ Solvent Clean ☐ Grinding ☒ Other: Precleaned by Customer	☐ Magnaflux Carrier II ☒ Pre Mixed ☐ Concentration MI Batch No.

CURRENT

☐ AC	☐ FWDC
☐ Central Conductor (AMPS)	☐ Head Shot (AMPS)
☐ Coil (AMPS)	☐ Prods (AMPS/Spacing)

Field Verified by: ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe

EQUIPMENT

☐ Magnaflux H-720 S/N: Cal Due Date:

☒ Yoke ☐ AC ☒ DC S/N: 3005 Spacing: 4" – 6" Cal Due Date: 12/1/11

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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 Baumiller
Customer Services Manager

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

Date Received: 6/3/2011

Test Report No.: DYS006-11-06-26885-1 *REVISED

P.O. No.: 78333 / 78375

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
ITAR-CONTROLLED DATA

INSPECTION RESULTS	
Quantity*	**Results***
4 PCS OOH Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
4 PCS OOF Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
Comments: "ID of tube only"- Magnetic Flux Field cannot be verified for sensitivity; thus only a cursory examination was performed for informational purposes only.* Marking Requirements: Demag and post cleaning requirements:	
Inspected by: Matthew Novak	Certification: ASNT-SNT-TC-1A Level ☐ II ☒ III

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)
This document contains technical data whose export and re-export/re-transfer is subject to control by the U.S. Department of State under the Arms Export Control Act and the International Traffic in Arms Regulations. The Department of State's prior written approval is required for the export or re-export/re-transfer of such technical data to any foreign person, foreign entity or foreign organization whether in the United States or abroad.

*REVISED: Corrected quantity/sample descriptions (6/13/11).
Corrected part preparation and standard/ procedure (6/14/11).
Added Heat Number, Code, Lengths, Comments and expanded Results (8/01/11).

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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 Baumiller
Customer Services Manager

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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.25A

MATERIAL SUITABILITY REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: MSR-000059
Report Date: 20-Oct-2011
SMR Authorization #:

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

Date of NCR:
Location: Glasgow, MO

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
B211-001-11	68	12	ea	PWS High Strength Anchor Rods - load - #5

Identification:
One Blue Tag attached to the load.
Description of Non-Conformance (NCRs):

Summary of Items Observed:
The SMR authorization S54-022-11 has been included in this report.

This QA Inspector observed the following PWS Rods were part of load - #5:
MSD 784: OOH2-20, OTD-12, OOF4-2, OOH2-7, OOH2-8, OPY2-6, OOF4-4, OTD-13, OOH2-24, OOH2-19, OPY2-7, and OOF2-2.

BTL item: Heat treatment lots OOF, OOH, OTD and OPY contained some rods with thread sizes outside the specified range. Per RFI 2502 it was determined that oversized threads would be fit for purposes provided the nut is able to thread freely down the bar/rod after galvanizing.?

This QA Inspector observed a spherical nut and regular nut were threaded full length and shipped as such.

This QA Inspector observed a Certificate Of Compliance (COC), Material Test Report (MTR), Magnetic Particle Testing reports per material heat and shipper were submitted from Dyson Corporation.

This QA Inspector observed a COC and QC reports for blasting and galvanizing were submitted from Monnig Industries.

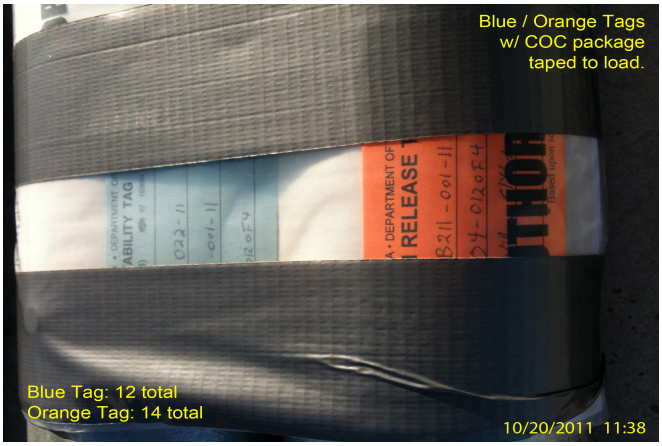
The documents submitted appeared to comply with the contract requirements.

MATERIAL SUITABILITY REPORT

(Continued Page 2 of 2)

Summary of Conversations:

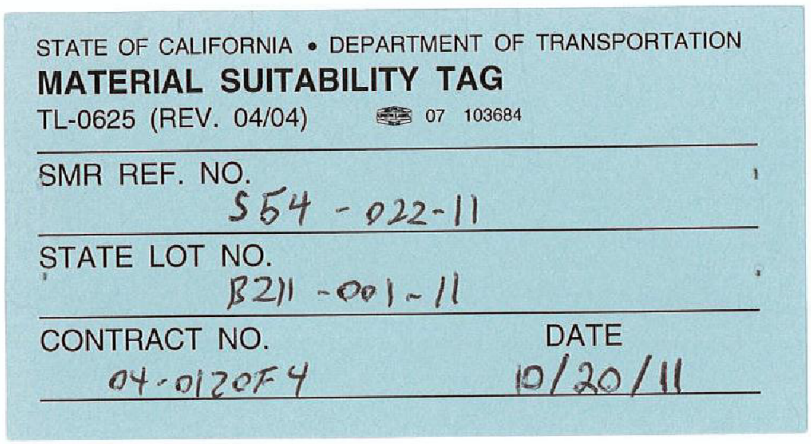
This QA Inspector had general conversations with Monnig Industries personnel and the SMR. Except as described above there were no other notable conversations.



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:	Clifford,William	Quality Assurance Inspector
Reviewed By:	Levell,Bill	QA Reviewer


STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
MATERIAL SUITABILITY TAG
TL-0625 (REV. 04/04) 07 103684
SMR REF. NO. S54 - 022-11
STATE LOT NO. B211 - 001 - 11
CONTRACT NO. 04-012OF4
DATE 10/20/11

Monnig Industries, Inc.

HOT DIP & MECHANICAL GALVANIZING
P.O. BOX 98
GLASGOW, MO 65254
PH. 660-338-2242 FAX: 660-338-5199

OCTOBER 19, 2011

DYSON CORPORATION
50 FREEDOM ROAD
PAINESVILLE, OH 44077

RE: GALVANIZING CERTIFICATE-CALTRAN

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE ATTACHED SPREADSHEET MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS.

26 PWS ANCHOR RODS

ROD ID/MIL THICKNESS MEASUREMENTS

R1001-OPY/5.66	R1002-OTD/8.00	R1005-OQW/7.70	R1006-OTD/6.39	R1007-OOH/7.03
R1008-OQX/8.34	R1010-OTD/8.97	OPY2-6/6.98	OTD-13/6.96	OOH2-16/7.40
OOH2-20/9.34	OOH2-4/10.64	OOF4-4/6.95	OPY2-15/5.43	OPY2-7/5.65
OOF3-8/5.69	OOH2-7/6.69	OOH2-10/9.79	OOH2-24/7.44	OOF4-5/7.55
OTD-12/5.57	OOH2-8/9.13	OOH2-17/5.54	OOH2-19/6.94	OOF2-2/6.90
OOF4-2/7.05				

PATRICIA S. WESTHUES
NOTARY PUBLIC STATE OF MISSOURI
HOWARD COUNTY
MY COMMISSION EXP. APR. 18, 2012

Actual supplied rod ID is OPY2-2, not OOH2-20.
- Bob Brignano, CT

John Monnig
JOHN MONNIG, PRESIDENT

Patricia S Westhues
PATRICIA S. WESTHUES,
NOTARY PUBLIC

Phoenix Manufacturing, Inc.
P.O. BOX 330
26666 Von Holten Rd.
Cole Camp, MO. 65325
660-668-2611
660-668-3160 (fax)

SSPC-SP10 Near White Metal Blast

Near-White Blast Cleaning - Removal of nearly all mill scale, rust, rust scale, paint, or foreign matter by the use of abrasives propelled through nozzles or by centrifugal wheels to the degree hereafter specified. A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides, or light, tight residues of paint or coating that may remain. At least 95 percent of each square inch of surface area shall be free of all visible residues, and the remainder shall be limited to the light discoloration mentioned above

R1001-OPY	R1002-OTD	R1005-OQW	R1006-OTD	R1007-OOH
R1008-OQX	R1010-OTD	OPY2-6	OTD-13	OOH2-16
OOH2-20	OOH2-4	OOF4-4	OPY2-15	OPY2-7
OOF3-8	OOH2-7	OOH2-10	OOH2-24	OOF4-5
OTD-12	OOH2-8	OOH2-17	OOH2-19	OOF2-2
OOF4-2				

Actual supplied rod ID is OPY2-2, not OOH2-20.

- Bob Brignano, CT

Kelly Nm

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112047	660110-SA-017 CO 022	8500 MM	15 pcs	10/7/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. HDG per ASTM-A153 w/white metal blast prior to galvanize. BID ITEM 66 -

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OPY2-2, OPY2-6, OPY3-8, OTD-13, OOH2-23, OOH2-16, OOH2-20, OOH2-2, OOH2-4, OOF2-4, OOF4-4, OPY2-13, OPY2-15, OPY2-3, OPY2-7

Heat treatment lot OPY is from heat of steel ID 3M75738-2
Heat treatment lot OTD is from heat of steel ID 4M76368-1
Heat treatment lot OOH is from heat of steel ID 4M76368-3
Heat treatment lot OOF is from heat of steel ID 4M76368-2

Attachments:
Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/6/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

D|N 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 112047	660110-SA-017 CO 022	8500 MM	8 pcs	10/19/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"-4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 -

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OPY2-6, OPY3-8, OOH2-23, OOH2-2, OOF2-4, OPY2-13, OPY2-3

Heat treatment lot OPY is from heat of steel ID 3M75738-2
Heat treatment lot OOH is from heat of steel ID 4M76368-3
Heat treatment lot OOF is from heat of steel ID 4M76368-2

Attachments:

Mill Test Reports
Mag Particle Certifications
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/19/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112054	660110-SA-017 CO 022	9200 MM	2 pc	10/7/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9200mm OAL PWS anchor rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OTD-12, R1011-OTD

Heat treatment lot OTD is from heat of steel ID 4M76368

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/6/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112054	660110-SA-017 CO 022	9200 MM	1 pc	10/19/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9200mm OAL PWS anchor rod w/1850mm of usable thread one end & 280mm on opposite end, Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OTD-12

Heat treatment lot OTD is from heat of steel ID 4M76368

Attachments:

Mill Test Reports
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/19/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.
DN 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 112055	660110-SA-017 CO 022	9300 MM	7 pcs	10/7/11

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

PRODUCT DESCRIPTION
3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

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

DRAWING

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.

Bar I.D.'s: OOH2-17, OOH2-8, OOH2-19, OOH2-24, OOH2-7, OOH2-10, R1002-OTD
Heat treatment lot OTD is from heat of steel ID 4M76368
Heat treatment lot OOH is from heat of steel ID 4M76368

Attachments:
Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/6/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112055	660110-SA-017 CO 022	9300 MM	7 pcs	10/19/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

RAWING

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.

Bar I.D.'s: OOH2-17, OOH2-8, OOH2-19, OOH2-24, OOH2-7, OOH2-10, R1002-OTD
Heat treatment lot OTD is from heat of steel ID 4M76368
Heat treatment lot OOH is from heat of steel ID 4M76368

Attachments:

Mill Test Reports
Mag Particle Certifications
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/19/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112056	660110-SA-017 CO 022	9400 MM	1 pc	10/19/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-1UNC-2A x 9400mm (30'-10.08") OAL PWS Anchor Rod w/1850mm of usable thread one end & 280mm on opposite end. Drill & tap 2".4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

RAWING

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.

Bar I.D.: OOF2-2

Heat treatment lot OOF is from heat of steel ID 4M76368

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/19/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.
DN 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 112058	660110-SA-017 CO 022	9600 MM	2 pcs	10/7/11

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

PRODUCT DESCRIPTION
3.50"-4UNC-2A x 9600mm OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

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

DRAWING

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.

Bar I.D.'s: OOF4-5, OOF4-2

Heat treatment lot OOF is from heat of steel ID 4M76368

Attachments:
Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/6/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112058	660110-SA-017 CO 022	9600 MM	2 pcs	10/19/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9600mm OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"4.5UNC-2A x 60mm deep on 1850mm threaded end, HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OOF4-5, OOF4-2

Heat treatment lot OOF is from heat of steel ID 4M76368

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/19/11

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

Date Received: 6/3/2011

Test Report No.: DYS006-11-06-26885-1 *REVISED

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

P.O. No.: 78333 / 78375

TEST REPORT
ITAR-CONTROLLED DATA

Sample Description: MT On-Site Wet Fluorescent Cal Trans Witness of Anchor Rods Representing 3.50"-4UNC 2A x Random Lengths*, 6/6/2011, Heat#/Heat Codes: 4M76368/OOF and 4M76368/OOH *

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM F788-06 (Acceptance Criteria)
Procedure:	SOP 42.03 /ASTM E1444 (Method) per ASTM A 490/ Caltran Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05

METHOD

☐ Dry	☒ Wet

PARTICLES

Magnaflux Particles:	*Part Preparation:	Wet Particle Carrier:
☐ 8A Red ☐ 14A ☐ 3A Black ☒ 14AM ☐ 1 Gray ☐ Other Batch No. 09D02K	☐ None Required ☐ Solvent Clean ☐ Grinding ☒ Other: Precleaned by Customer	☐ Magnaflux Carrier II ☒ Pre Mixed ☐ Concentration MI Batch No.

CURRENT

☐ AC	☐ FWDC
☐ Central Conductor (AMPS)	☐ Head Shot (AMPS)
☐ Coil (AMPS)	☐ Prods (AMPS/Spacing)

Field Verified by: ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe

EQUIPMENT

☐ Magnaflux H-720 S/N: Cal Due Date:

☒ Yoke ☐ AC ☒ DC S/N: 3005 Spacing: 4" – 6" Cal Due Date: 12/1/11

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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 Baumiller
Customer Services Manager

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

Date Received: 6/3/2011

Test Report No.: DYS006-11-06-26885-1 *REVISED

P.O. No.: 78333 / 78375

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
ITAR-CONTROLLED DATA

INSPECTION RESULTS	
Quantity*	**Results***
4 PCS OOH Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
4 PCS OOF Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
Comments: "ID of tube only"- Magnetic Flux Field cannot be verified for sensitivity; thus only a cursory examination was performed for informational purposes only.* Marking Requirements: Demag and post cleaning requirements:	
Inspected by: Matthew Novak	Certification: ASNT-SNT-TC-1A Level ☐ II ☒ III

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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*REVISED: Corrected quantity/sample descriptions (6/13/11).
Corrected part preparation and standard/ procedure (6/14/11).
Added Heat Number, Code, Lengths, Comments and expanded Results (8/01/11).

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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 Baumiller
Customer Services Manager

STORK
Materials Technology

Stork Herron Testing Laboratories

6/17/2011

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

Date Received: 6/15/2011

Test Report No.: DYS006-11-06-27669-1
REVISED

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

P.O. No.: 78540

TEST REPORT
ITAR-CONTROLLED DATA

Sample Description: MT On-site Wet Fluorescent Exam of Anchor Rods Representing 3.50"-4UNC 2A x Random Lengths*, 6/16/11, ASTM E 1444 SOP 42.03, ASTM F788, Heat#/Heat Code: 4M76368/OTD*

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM F788-06 (Acceptance Criteria)	
Procedure:	SOP 42.03 /ASTM E1444 (Method) per ASTM A490 Caltran Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05	
METHOD		
☐ Dry	☒ Wet	
PARTICLES		
Magnaflux Particles: ☐ 8A Red ☐ 14A ☐ 3A Black ☒ 14AM ☐ 1 Gray ☐ Other Batch No. 09D02K	**Part Preparation:** ☐ None Required ☐ Solvent Clean ☐ Grinding ☒ Other Precleaned by Customer	**Wet Particle Carrier:** ☐ Magnaflux Carrier II ☒ Pre Mixed ☐ Concentration MI Batch No.
CURRENT		
☐ AC	☐ FWDC	
☐ Central Conductor (AMPS)	☐ Head Shot (AMPS)	
☐ Coil (AMPS)	☐ Prods (AMPS/Spacing)	
Field Verified by: ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe		
EQUIPMENT		
☐ Magnaflux H-720 S/N: Cal Due Date:		
☒ Yoke ☐ AC ☒ DC S/N: 3005 Spacing: 4" – 6" Cal Due Date: 12/1/11		

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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.

Michael R. Gaydos
General Manager, COO

STORK
Materials Technology

Stork Herron Testing Laboratories

6/17/2011

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

Date Received: 6/15/2011

Test Report No.: DYS006-11-06-27669-1
REVISED

P.O. No.: 78540

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
ITAR-CONTROLLED DATA

INSPECTION RESULTS	
Quantity	**Results**
3 PCS **OTD, Heat# 4M76368*** **3.50"-4UNC-2A X Random Lengths* PWS Anchor Rod**	**O.D. only was inspected and found to be acceptable***
Comments: "ID of tube only"- Magnetic Flu Field cannot be verified for sensitivity; thus only a cursory examination was performed for informational purposes only.* Marking Requirements: Demag and post cleaning requirements:	
Inspected by: Matthew Novak	Certification: ASNT-SNT-TC-1A Level ☐ II ☒ III

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)

This document contains technical data whose export and re-export/re-transfer is subject to control by the U.S. Department of State under the Arms Export Control Act and the International Traffic in Arms Regulations. The Department of State's prior written approval is required for the export or re-export/re-transfer of such technical data to any foreign person, foreign entity or foreign organization whether in the United States or abroad.

*REVISED (08/01/11): Added Heat Number, Length, Comments and expanded Results.

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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.

Michael R. Gaydos
General Manager, COO

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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003761
Date Inspected: 21-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 700
OSM Departure Time: 1530
Location: Glasgow, MO

Quality Control Contact: Ryan Monnig
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☐ N/A
Sampled Items: ☐ Yes ☐ No ☐ N/A
Stock Transfer: ☐ Yes ☐ No ☐ N/A
OK to Cut: ☐ Yes ☐ No ☐ N/A
Rebar Test Witness: ☐ Yes ☐ No ☐ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☐ N/A
Other: N/A
Bridge No: 34-0006
Component: PWS Anchor Rods
Bid Item: 68
Lot No: N/A

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to monitor, at random intervals, the galvanizing of Parallel Wire Strand (PWS) High Strength Rods from Dyson Corporation for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA met with Monnig Industries General Manager Ryan Monnig and was informed of the following status regarding the galvanizing of the PWS Anchor Rods:

The following rods were listed for the next shipment and at the current time completed or with in the galvanizing process.

The SMR authorization S54-023-11 has been included in this report.

This QA Inspector observed the following PWS Rods were part of load - #8:
Of the 26 rods in this shipment twenty-six (26) were Blue Tagged.
MSD 786: OYH-1, OYM-2, OYL-7, OYG-2, OYM-10, OYP-5, OYM-1, OYH-6, OYP-3, OYN-10, OYM-4, OYM-3, OYO-3, OYN-1, OYJ-10, OYM-6, OYJ-6, OYO-5, OYN-2, OYM-7, OYH-2, OYI-2, OYG-4, OYH-3, OYJ-7, and OYL-8.

1. This QA Inspector observed a dimensional report from Dyson Corporation accepting the rods was submitted for the heat treatment lots.

2. This QA Inspector observed a Certificate Of Compliance (COC), Material Test Report (MTR), Magnetic Particle Testing reports per material heat and shipper were submitted from Dyson Corporation.
3. This QA Inspector observed a COC and QC reports for blasting and galvanizing were submitted from Monnig Industries.

These documents submitted appeared to comply with the contract requirements.

This QA Inspector observed a spherical nut and regular nut were threaded full length and shipped as such.

The following rods were listed for the next shipment and at the current time with in various stages of the galvanizing process.
OQY-18C, OQY-13C, OQY-15C, OQY-23C, OQY-20C, OQY-22C, OQY-3C, OQY-31, OQY-28, OQY-29, OPY4-24, OPY4-22, OPY4-21, OQY-23B, OPY4-20, OPY4-19, OTD-1H, OOH-2F, OTD-2E, OTD-23D, OTD-1D, OTD-2D, OQY-27, OQY-21C, OQY-25, OQY-26, OQX4-30, and OOH-3F.

This QA performed a visual verification at random intervals of Parallel Wire Strand (PWS) High Strength Rods during and after completion of the glvanizing process. This QA Inspector observed the galvanizing process was performed within 4 hours of the blasting and appeared to comply with the contract requirements.

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.

Summary of Conversations:

This QA Inspector had general conversations with Monnig General Manager Ryan Monnig and other Monnig personnel. Unless noted above there were no other notable conversations.

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:	Clifford,William	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.25A

MATERIAL SUITABILITY REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: MSR-000058
Report Date: 21-Oct-2011
SMR Authorization #:

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

Date of NCR:
Location: Glasgow, MO

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
B211-002-11	68	26	ea	PWS High Strength Anchor Rods - load - #6

Identification:
One Blue Tag attached to load.
Description of Non-Conformance (NCRs):

Summary of Items Observed:
The SMR authorization S54-023-11 has been included in this report.

This QA Inspector observed the following PWS Rods were part of load - #6:
MSD 786: OYH-1, OYM-2, OYL-7, OYG-2, OYM-10, OYP-5, OYM-1, OYH-6, OYP-3, OYN-10, OYM-4, OYM-3, OYO-3, OYN-1, OYJ-10, OYM-6, OYJ-6, OYO-5, OYN-2, OYM-7, OYH-2, OYI-2, OYG-4, OYH-3, OYJ-7, and OYL-8.

This QA Inspector observed a spherical nut and regular nut were threaded full length and shipped as such.

This QA Inspector observed a Certificate Of Compliance (COC), Material Test Report (MTR), Magnetic Particle Testing reports per material heat and shipper were submitted from Dyson Corporation.

This QA Inspector observed a COC and QC reports for blasting and galvanizing were submitted from Monnig Industries.

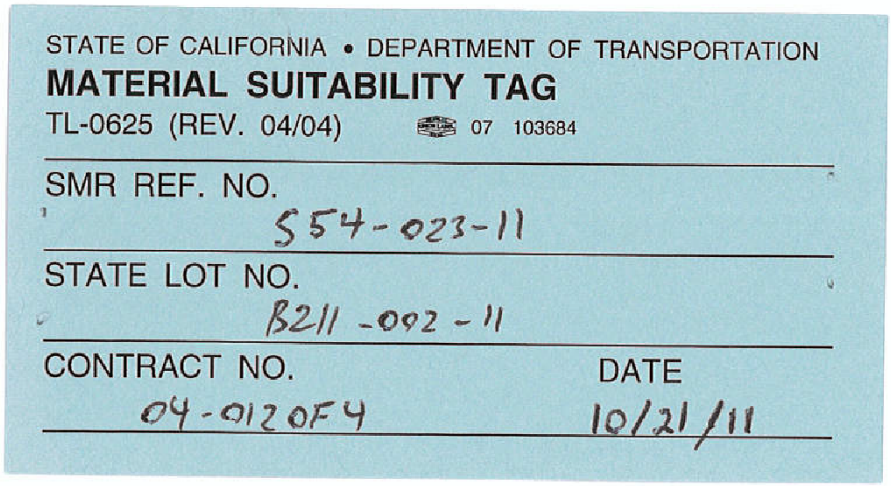
The documents submitted appeared to comply with the contract requirements.
Summary of Conversations:
This QA Inspector had general conversations with Monnig Industries personnel and the SMR. Except as described above there were no other notable conversations.

MATERIAL SUITABILITY REPORT

Comments

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

Inspected By:	Clifford,William	Quality Assurance Inspector
Reviewed By:	Levell,Bill	QA Reviewer


STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
MATERIAL SUITABILITY TAG
TL-0625 (REV. 04/04) 07 103684
SMR REF. NO.
S54-023-11
STATE LOT NO.
B211-092-11
CONTRACT NO.
04-012OF4
DATE
10/21/11

Monnig Industries, Inc.

HOT DIP & MECHANICAL GALVANIZING
P.O. BOX 98
GLASGOW, MO 65254
PH. 660-338-2242 FAX: 660-338-5199

OCTOBER 21, 2011

DYSON CORPORATION
50 FREEDOM ROAD
PAINESVILLE, OH 44077

RE: GALVANIZING CERTIFICATE-CALTRAN

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE ATTACHED SPREADSHEET MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS.

26 PWS ANCHOR RODS

ROD ID/MIL THICKNESS MEASUREMENTS

OYH-1/10.96	OYM-1/8.19	OYM-4/8.34	OYM-6/13.01	OYH-2/11.07
OYM-2/9.19	OYH-6/6.73	OYM-3/11.95	OYJ-6/7.87	OYI-2/10.46
OYL-7/5.56	OYL-8/8.97	OYO-3/5.70	OYO-5/6.20	OYG-4/10.90
OYG-2/7.87	OYP-3/10.91	OYN-1/7.38	OYN-2/11.61	OYH-3/8.18
OYM-10/5.57	OYN-10/9.90	OYJ-10/7.86	OYM-7/10.53	OYJ-7/7.58
OYP-5/5.48				

Actual supplied rod ID is OYG-5, not OYO-5
-Bob Brignano, CT

PATRICIA S. WESTHUES
NOTARY PUBLIC STATE OF MISSOURI
HOWARD COUNTY
MY COMMISSION EXP. APR. 18, 2012

John Monnig
JOHN MONNIG, PRESIDENT

Patricia S. Westhues
PATRICIA S. WESTHUES,
NOTARY PUBLIC

Phoenix Manufacturing, Inc.
P.O. BOX 330
26666 Von Holten Rd.
Cole Camp, MO. 65325
660-668-2611
660-668-3160 (fax)

SSPC-SP10 Near White Metal Blast

Near-White Blast Cleaning - Removal of nearly all mill scale, rust, rust scale, paint, or foreign matter by the use of abrasives propelled through nozzles or by centrifugal wheels, to the degree hereafter specified. A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides, or light, tight residues of paint or coating that may remain. At least 95 percent of each square inch of surface area shall be free of all visible residues, and the remainder shall be limited to the light discoloration mentioned above.

OYH-1	OYM-1	OYM-4	OYM-6	OYH-2
OYM-2	OYH-6	OYM-3	OYJ-6	OYI-2
OYL-7	OYL-8	OYO-3	OYO-5	OYG-4
OYG-2	OYP-3	OYN-1	OYN-2	OYH-3
OYM-10	OYN-10	OYJ-10	OYM-7	OYJ-7
OYP-5				

Actual supplied rod ID is OYG-5, not OYO-5.
- Bob Brignano, CT

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112047	660110-SA-017 CO 022	8500 MM	2 pcs	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. HDG per ASTM-A153 w/white metal blast prior to galvanize. BID ITEM 66 -

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYM-2, OYI-2

Heat treatment lot OYM is from heat of steel ID A113151 **(Batch # H214)**
Heat treatment lot OYI is from heat of steel ID A113149 **(Batch # H222)**

Attachments:
Mill Test Reports
Mag Particle Certifications

Deborah A. Smith
Q.A. Admin. Assistant
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112047	660110-SA-017 CO 022	8500 MM	2 pcs	10/17/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 -

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYG-2, OYG-3

Heat treatment lot OYG is from heat of steel ID A113149 **(Batch # H208)**

STATE OF CALIFORNIA
STOCK MATERIAL

LOT NO. B305-040-11
INSPECTOR'S NAME Edmondson DATE 10-17-11

Attachments:

Mill Test Reports
Mag Particle Certifications

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112048	660110-SA-017 CO 022	8600 MM	1 pcs	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8600mm (28'-2.58") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. Material per ASTM-A354, gr BD; Hot Dipped Galvanized per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYH-6

Heat treatment lot OYH is from heat of steel ID A113149 (Batch # H210)

Attachments:

Mill Test Report
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/14/11

CERTIFICATE OF COMPLIANCE

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 112049	660110-SA-017 CO 022	8700 MM	2 pcs	10/17/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8700mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & Tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYL-8, OYN-1

Heat treatment lot OYL is from heat of steel ID A113151 **(Batch # H211)**
Heat treatment lot OYN is from heat of steel ID A113151 **(Batch # H215)**

Attachments:
Mill Test Report
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

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 112051	660110-SA-017 CO 022	8900 MM	5 pcs	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8900mm OAL PWS anchor rod w/1850mm of useable thread one end and 280mm (13.78") on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end, HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYM-3, OYM-6, OYJ-4, OYI-3, OYH-~~3~~2 10/14/11

Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)
Heat treatment lot OYJ is from heat of steel ID A113151 (Batch# H207)
Heat treatment lot OYI is from heat of steel ID A113149 (Batch# H222)
Heat treatment lot OYH is from heat of steel ID A113149 (Batch# H210)

Attachments:
Mill Test Reports
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

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 112051	660110-SA-017 CO 022	8900 MM	14 pcs	10/17/11

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

PRODUCT DESCRIPTION
3.50"-4UNC 2A x 8900mm OAL PWS anchor rod w/1850mm of usable thread one end and 280mm (13.78") on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end, HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

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

DRAWING

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.

Bar I.D.'s: OYL-7, OYK-4, OYL-6, OYL-9, OYN-6, OYN-4, OYN-5, OYN-3, OYN-2, OYG-4, OYO-8, OYN-7, OYL-5, OYG-1

Heat treatment lot OYL is from heat of steel ID A113151 **(Batch# H211)**
Heat treatment lot OYK is from heat of steel ID A113151 **(Batch# H208)**
Heat treatment lot OYN is from heat of steel ID A113151 **(Batch# H215)**
Heat treatment lot OYG is from heat of steel ID A113149 **(Batch# H208)**
Heat treatment lot OYO is from heat of steel ID A113151 **(Batch# H217)**

Attachments:
Mill Test Reports
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112054	660110-SA-017 CO 022	9200 MM	5 pc	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9200mm OAL PWS anchor rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYH-3, OYH-1, OYM-1, OYJ-6, OYJ-5

Heat treatment lot OYH is from heat of steel ID A113149 (Batch# H210)
Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)
Heat treatment lot OYJ is from heat of steel ID A113151 (Batch# H207)

Attachments:
Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112054	660110-SA-017 CO 022	9200 MM	6 pc	10/17/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9200mm OAL PWS anchor rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYP-5, OYN-11, OYO-9, OYO-4, OYO-5, OYO-3

Heat treatment lot OYP is from heat of steel ID A113151 **(Batch# H222)**
Heat treatment lot OYN is from heat of steel ID A113151 **(Batch# H215)**
Heat treatment lot OYO is from heat of steel ID A113151 **(Batch# H217)**

Attachments:

Mill Test Reports
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112055	660110-SA-017 CO 022	9300 MM	6 pcs	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYJ-7, OYJ-9, OYM-7, OYM-10, OYJ-10, OYH-10

Heat treatment lot OYJ is from heat of steel ID A113151 (Batch# H207)
Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)
Heat treatment lot OYH is from heat of steel ID A113149 (Batch# H210)

Attachments:

Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112055	660110-SA-017 CO 022	9300 MM	7 pcs	10/17/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYN-10, OYN-8, OYN-9, OYP-3, OYO-6, OYP-4, OYO-7

Heat treatment lot OYN is from heat of steel ID A113151 **(Batch # H215)**
Heat treatment lot OYP is from heat of steel ID A113151 **(Batch# H222)**
Heat treatment lot OYO is from heat of steel ID A113151 **(Batch# H217)**

Attachments:

Mill Test Reports
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112056	660110-SA-017 CO 022	9400 MM	3 pc	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9400mm (30'-10.08") OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2".4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.: OYI-4, OYM-4, OYM-5

Heat treatment lot OYI is from heat of steel ID A113149 (Batch# H222)
Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)

Attachments:
Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112056	660110-SA-017 CO 022	9400 MM	1 pc	10/17/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9400mm (30'-10.08") OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2".4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.: OYG-5

Heat treatment lot OYG is from heat of steel ID A113149 **(Batch# H208)**

Attachments:

Mill Test Report
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003762
Date Inspected: 22-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 700
OSM Departure Time: 1530
Location: Glasgow, MO

Quality Control Contact: Ryan Monnig
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☐ N/A
Sampled Items: ☐ Yes ☐ No ☐ N/A
Stock Transfer: ☐ Yes ☐ No ☐ N/A
OK to Cut: ☐ Yes ☐ No ☐ N/A
Rebar Test Witness: ☐ Yes ☐ No ☐ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☐ N/A
Other: N/A
Bridge No: 34-0006
Component: PWS Anchor Rods
Bid Item: 68
Lot No: N/A

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to monitor, at random intervals, the galvanizing of Parallel Wire Strand (PWS) High Strength Rods from Dyson Corporation for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA met with Monnig Industries General Manager Ryan Monnig and was informed of the following status regarding the galvanizing of the PWS Anchor Rods:

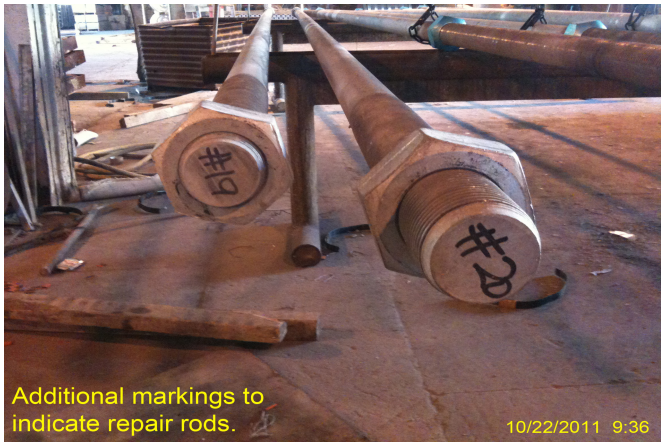
The following rods were listed for the next shipment and at the current time with in various stages of the galvanizing process.
Rods in repair:
OQY-18C, OQY-13C, OQY-15C, OQY-23C, OQY-20C, OQY-22C, OQY-3C, OQY-31, OQY-28, OQY-29, OPY4-24, OPY4-22, OPY4-21, OQY-23B, OPY4-20, OPY4-19, OTD-1H, OOH-2F, OTD-2E, OTD-23D, OTD-1D, OTD-2D, OQY-27, OQY-21C, OQY-25, OQY-26, OQX4-30, and OOH-3F.

This QA performed a visual verification at random intervals of Parallel Wire Strand (PWS) High Strength Rods during and after completion of the glvanizing process. This QA Inspector observed the galvanizing process was performed within 4 hours of the blasting and appeared to comply with the contract requirements.

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.

SOURCE INSPECTION REPORT

(Continued Page 2 of 2)



Summary of Conversations:

This QA Inspector had general conversations with Monnig General Manager Ryan Monnig and other Monnig personnel. Unless noted above there were no other notable conversations.

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:	Clifford,William	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003763
Date Inspected: 24-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 700
OSM Departure Time: 1530
Location: Glasgow, MO

Quality Control Contact: Ryan Monnig
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☐ N/A
Sampled Items: ☐ Yes ☐ No ☐ N/A
Stock Transfer: ☐ Yes ☐ No ☐ N/A
OK to Cut: ☐ Yes ☐ No ☐ N/A
Rebar Test Witness: ☐ Yes ☐ No ☐ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☐ N/A
Other: N/A
Bridge No: 34-0006
Component: PWS Anchor Rods
Bid Item: 68
Lot No: N/A

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to monitor, at random intervals, the galvanizing of Parallel Wire Strand (PWS) High Strength Rods from Dyson Corporation for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA met with Monnig Industries General Manager Ryan Monnig and was informed of the following status regarding the galvanizing of the PWS Anchor Rods:

The following rods were listed for the next shipment and at the current time with in various stages of the galvanizing process.
OYJ-4, OYI-3, OYI-4, OYM-9, OYJ-9, OYH-7, OYJ-6, OYJ-11, OYM-8, and OYH-9.
Rods in repair:
OQY-22C/#29, OQY-23/#25, OOH-2F/#32, OQY-21/#30, OQX4-30/#18, OPY4-20/#26, OTD-1H/#35, OOH-3F/#9, OPY4-21/#24, OPY4-19/#36, OQY-19C/#21, OPY4-22/#23, OQY-20C/#28, OQY-25/#12, OQY-3C/#40, and OQY-26/#17.

This QA performed a visual verification of rods after completion of the galvanizing and cleaning process, see photo below for random images of galvanizing process. This QA Inspector observed the galvanizing process was performed within 4 hours of the blasting and appeared to comply with the contract requirements.

This QA was informd that Dyson was coordinating shipping with Monnig and that 1 trucks would arrive

tomorrow (10/25/11) to transport the material to the job site and that a shipper was in the process of being created.

Attached to this report are photographs representative of various stages of the galvanizing process and/or loading and tagged of completed rods.

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.

Summary of Conversations:

This QA Inspector had general conversations with Monnig General Manager Ryan Monnig and other Monnig personnel. Unless noted above there were no other notable conversations.

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:	Clifford,William	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003764
Date Inspected: 25-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 700
OSM Departure Time: 1530
Location: Glasgow, MO

Quality Control Contact: Ryan Monnig
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☐ N/A
Sampled Items: ☐ Yes ☐ No ☐ N/A
Stock Transfer: ☐ Yes ☐ No ☐ N/A
OK to Cut: ☐ Yes ☐ No ☐ N/A
Rebar Test Witness: ☐ Yes ☐ No ☐ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☐ N/A
Other: N/A
Bridge No: 34-0006
Component: PWS Anchor Rods
Bid Item: 68
Lot No: N/A

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to monitor, at random intervals, the galvanizing of Parallel Wire Strand (PWS) High Strength Rods from Dyson Corporation for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA met with Monnig Industries General Manager Ryan Monnig and was informed of the following status regarding the galvanizing of the PWS Anchor Rods:

This QA Inspector observed the following PWS Rods were part of load - #7:
Of the 26 rods in this shipment twenty-six (26) were Blue Tagged for delicery to the job site.

The SMR authorization S54-024-11 has been included in this report.
MSD 0785: OYJ-4, OYI-3, OYI-4, OYM-9, OYJ-9, OYH-7, OYJ-6, OYJ-11, OYM-8, and OYH-9.
MSD 0786: OQY-22C/#29, OQY-23/#25, OOH-2F/#32, OQY-21/#30, OQX4-30/#18, OPY4-20/#26, OTD-1H/#35, OOH-3F/#9, OPY4-21/#24, OPY4-19/#36, OQY-19C/#21, OPY4-22/#23, OQY-20C/#28, OQY-25/#12, OQY-3C/#40, and OQY-26/#17.

1. This QA Inspector observed a dimensional report from Dyson Corporation accepting the rods was submitted for the heat treatment lots.
2. This QA Inspector observed a Certificate Of Compliance (COC), Material Test Report (MTR), Magnetic Particle Testing reports per material heat and shipper were submitted from Dyson Corporation.

3. This QA Inspector observed a COC and QC reports for blasting and galvanizing were submitted from Monnig Industries.

These documents submitted appeared to comply with the contract requirements.

This QA Inspector observed a spherical nut and regular nut were threaded full length and shipped as such.

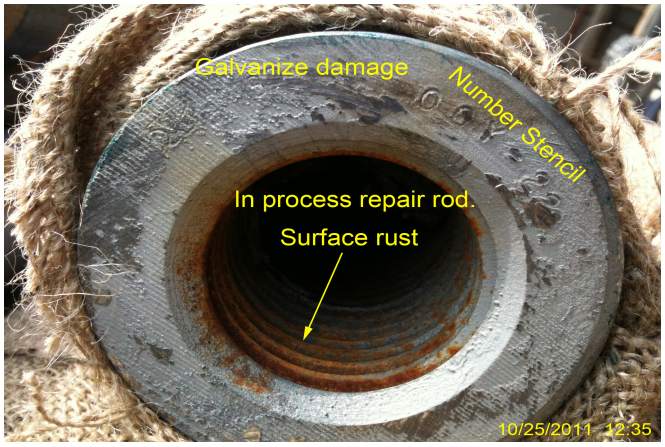
The following rods were listed for the next shipment and at the current time with in various stages of the galvanizing process.
OOH-1E, OTD-2E, OQY-32, OOH-4F, OQY-27, OQY-23C, OQY-28, OTD-1D, OTD-23D, OTD-2D, OQY-15C, OQY-13C, OPY4-24, OQY-31, OQY-18C, OQY-14C, OQY-29, OYN-3, OYN-4, OYN-5, OYO-6, OYL-5, OYN-11, OYN-10, OYL-6, OYL-9, and OYO-4.

This QA performed a visual verification at random intervals of Parallel Wire Strand (PWS) High Strength Rods during and after completion of the glvanizing process. This QA Inspector observed the galvanizing process was performed within 4 hours of the blasting and appeared to comply with the contract requirements.

This QA Inspector spoke with Monnig Industries representative Andrew Monnig and was informed by Mr. Monnig that the truck that is to transport load #8 has been scheduled to arrive at the Monnig facility some time after (2pm) on (10-27-11).

Attached to this report are photographs representative of various stages of the galvanizing process and/or loading and tagged of completed rods.

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.



Summary of Conversations:
This QA Inspector had general conversations with Monnig General Manager Ryan Monnig and other Monnig personnel. Except as described above there were no other notable conversations.
Comments

SOURCE INSPECTION REPORT

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:	Clifford,William	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.25A

MATERIAL SUITABILITY REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: MSR-000057
Report Date: 25-Oct-2011
SMR Authorization #:

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

Date of NCR:
Location: Glasgow, MO

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
B211-003-11	68	26	ea	PWS High Strength Anchor Rods - load - #7

Identification:
One Blue Tag attached to load.

Description of Non-Conformance (NCRs):

Summary of Items Observed:

The SMR authorization S54-024-11 has been included in this report.

This QA Inspector observed the following PWS Rods were part of load - #7:
MSD 0786:
OYJ-4, OYI-3, OYI-4, OYM-9, OYJ-9, OYH-7, OYJ-6, OYJ-11, OYM-8, and OYH-9.
MSD 0785:
OQY-22C/#29, OQY-23/#25, OOH-2F/#32, OQY-21/#30, OQX4-30/#18, OPY4-20/#26, OTD-1H/#35, OOH-3F/#9, OPY4-21/#24, OPY4-19/#36, OQY-19C/#21, OPY4-22/#23, OQY-20C/#28, OQY-25/#12, OQY-3C/#40, and OQY-26/#17.

This QA Inspector observed a spherical nut and regular nut were threaded full length and shipped as such.

This QA Inspector observed a dimensional report from Dyson Corporation accepting the rods was submitted for the heat treatment lots.

This QA Inspector observed a COC and QC reports for blasting and galvanizing were submitted from Monnig Industries.

The documents submitted appeared to comply with the contract requirements.

MATERIAL SUITABILITY REPORT

(Continued Page 2 of 2)

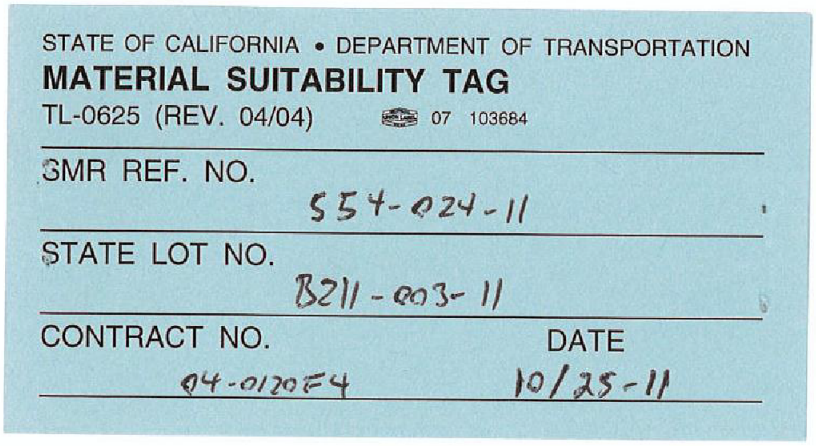
Summary of Conversations:

This QA Inspector had general conversations with Monnig Industries personnel and the SMR. Except as described above there were no other notable conversations.

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:	Clifford,William	Quality Assurance Inspector
Reviewed By:	Levell,Bill	QA Reviewer


STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
MATERIAL SUITABILITY TAG
TL-0625 (REV. 04/04) 07 103684
SMR REF. NO. 554-024-11
STATE LOT NO. B211-003-11
CONTRACT NO. 04-0120F4
DATE 10/25-11

Monnig Industries, Inc.

HOT DIP & MECHANICAL GALVANIZING
P.O. BOX 98
GLASGOW, MO 65254
PH. 660-338-2242 FAX: 660-338-5199

AUGUST 30, 2011

DYSON CORPORATION
50 FREEDOM ROAD
PAINESVILLE, OH 44077

RE: GALVANIZING CERTIFICATE-CALTRAN

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE ATTACHED SPREADSHEET MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS.

55 PWS ANCHOR RODS

ROD ID/MIL THICKNESS MEASUREMENTS

OQY-25 / 6.0	OQY-26 / 5.5	OQY-27 / 5.5	OQY-28 / 6.0	OQY-29 / 5.5
OQX4-30 / 5.0	OQY-31 / 4.5	OQY-32 / 5.5	OQY-1C / 5.5	OQY-2C / 6.0
OQY-3C / 5.0	OQY-4C / 5.0	OQX2-5 / 5.5	OQY-6C / 5.5	OQY-7C / 6.0
OQX2-8 / 6.0	OQY-9C / 5.5	OQY-10C / 6.0	OQY-11C / 6.0	OQY-12C / 6.5
OQY-13C / 6.0	OQY-14C / 5.0	OQY-15C / 5.5	OQY-16C / 6.0	OQY-17C / 5.5
OQY-18C / 6.0	OQY-19C / 5.5	OQY-20C / 5.0	OQY-21C / 6.0	OQY-22C / 5.5
OQY-23C / 5.0	OQY-24C / 6.5	OPY4-19 / 5.5	OPY4-20 / 6.0	OPY4-21 / 5.5
OPY4-22 / 6.5	OQY-23B / 6.0	OPY4-24 / 6.0	OTD-1H / 5.5	OOH-1F / 5.5
OOH-2F / 6.0	OOH-3F / 5.5	OOH-4F / 5.5	OOH-5F / 6.0	OOH-1E / 6.0
OTD-2E / 5.0	OTD-1D / 6.5	OTD-2D / 6.0	OTD-3D / 6.0	OQX6-1 / 5.5
OQX6-2 / 6.0	OQX6-3 / 5.0	OQW2-4 / 5.5	OQW2-5 / 6.0	OQW2-6 / 6.5

PATRICIA S. WESTHUES
NOTARY PUBLIC STATE OF MISSOURI
HOWARD COUNTY
MY COMMISSION EXP. APR. 18, 2012

John Monnig
JOHN MONNIG, PRESIDENT

Patricia S Westhues
PATRICIA S. WESTHUES,
NOTARY PUBLIC

Phoenix Manufacturing, Inc.
P.O. BOX 330
26666 Von Holten Rd.
Cole Camp, MO. 65325
660-668-2611
660-668-3160 (fax)

SSPC-SP10 Near White Metal Blast

Near-White Blast Cleaning - Removal of nearly all mill scale, rust, rust scale, paint, or foreign matter by the use of abrasives propelled through nozzles or by centrifugal wheels to the degree hereafter specified. A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides, or light, tight residues of paint or coating that may remain. At least 95 percent of each square inch of surface area shall be free of all visible residues, and the remainder shall be limited to the light discoloration mentioned above.

55 PWS ANCHOR RODS

ROD ID/MIL THICKNESS MEASUREMENTS

OQY-25	OQY-26	OQY-27	OQY-28	OQY-29
OQX4-30	OQY-31	OQY-32	OQY-1C	OQY-2C
OQY-3C	OQY-4C	OQX2-5	OQY-6C	OQY-7C
OQX2-8	OQY-9C	OQY-10C	OQY-11C	OQY-12C
OQY-13C	OQY-14C	OQY-15C	OQY-16C	OQY-17C
OQY-18C	OQY-19C	OQY-20C	OQY-21C	OQY-22C
OQY-23C	OQY-24C	OPY4-19	OPY4-20	OPY4-21
OPY4-22	OQY-23B	OPY4-24	OTD-1H	OOH-1F
OOH-2F	OOH-3F	OOH-4F	OOH-5F	OOH-1E
OTD-2E	OTD-1D	OTD-2D	OTD-3D	OQX6-1
OQX6-2	OQX6-3	OQW2-4	OQW2-5	OQW2-6

Gene Eddy

Monnig Industries, Inc.

HOT DIP & MECHANICAL GALVANIZING
P.O. BOX 98
GLASGOW, MO 65254
PH. 660-338-2242 FAX: 660-338-5199

OCTOBER 24, 2011

DYSON CORPORATION
50 FREEDOM ROAD
PAINESVILLE, OH 44077

RE: GALVANIZING CERTIFICATE-CALTRAN

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE LIST BELOW MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS.

10 PWS ANCHOR RODS

ROD ID/MIL THICKNESS MEASUREMENTS

OYJ-4/8.08	OYI-4/9.64	OYJ-9/9.22	OYJ-6/8.04	OYM-8/9.29
OYI-3/7.61	OYM-9/8.10	OYH-7/9.32	OYJ-11/8.87	OYH-9/7.93

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE LIST BELOW MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS. ALL REPAIRS WERE DONE TO ASTM-780-01 SPECIFICATIONS.

16 PWS ANCHOR RODS

ROD ID/REPAIR ID/MIL THICKNESS MEASUREMENTS

OQY-22C/#29/7.14	OQX4-30/#18/5.37	OOH-3F/#9/6.19	OQY-19C/#21/6.57	OQY-25/#12/5.94
OQY-23B/#25/9.14	OPY4-20/#26/11.15	OPY4-21/#24/11.33	OPY4-22/#23/11.02	OQY-3C/#40/6.59
OOH-2F/#32/7.33	OTD-1H/#35/7.36	OPY4-19/#36/9.75	OQY-20C/#28/6.25	OQY-26/#17/5.33
OQY-21C/#30/5.66				

PATRICIA S. WESTHUES
NOTARY PUBLIC STATE OF MISSOURI
HOWARD COUNTY
MY COMMISSION EXP. APR. 18, 2012

John Monnig
JOHN MONNIG, PRESIDENT

Patricia S. Westhues
PATRICIA S. WESTHUES,
NOTARY PUBLIC

Phoenix Manufacturing, Inc.
P.O. BOX 330
26666 Von Holten Rd.
Cole Camp, MO. 65325
660-668-2611
660-668-3160 (fax)

SSPC-SP10 Near White Metal Blast

Near-White Blast Cleaning - Removal of nearly all mill scale, rust, rust scale, paint, or foreign matter by the use of abrasives propelled through nozzles or by centrifugal wheels, to the degree hereafter specified. A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides, or light, tight residues of paint or coating that may remain. At least 95 percent of each square inch of surface area shall be free of all visible residues, and the remainder shall be limited to the light discoloration mentioned above.

OYJ-4	OYI-4	OYJ-9	OYJ-6	OYM-8
OYI-3	OYM-9	OYH-7	OYJ-11	OYH-9

Ruby Nan

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112047	660110-SA-017 CO 022	8500 MM	24 pcs	8/31/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. Material per ASTM-A354, gr BD; Hot Dipped Galvanized per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OQY-1C, OQY-2C, OQY-3C, OQY-4C, OQX2-5, OQY-6C, OQY-7C, OQX2-8, OQY-9C, OQY-10C, OQY-11C, OQY-12C, OQY-13C, OQY-14C, OQY-15C, OQY-16C, OQY-17C, OQY-18C, OQY-19C, OQY-20C, OQY-21C, OQY-22C, OQY-23C, OQY-24C

Heat treatment lot OQX is from heat of steel ID 4M76367-2

Heat treatment lot OQY is from heat of steel ID 4M76367-1

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
8/29/11

PWS ANCHOR RODS and EXTENSION ROD THREAD MAPPING

AUGUST 31, 2(

Date	BAR				COUPLER END			TAPPED END							
Measured	I.D	LENGTH	LENGTH	DYSON	No-Go	Pitch Diameter [In.]		No-Go	Pitch Diameter Readings (+/- 1 Pitch) [Inches]						
	CODE / BAR	MM	FT./IN	S.O. #	Pass/Fail	0.75"	12.75"	Pass/Fail	0.75"	2.25"	12.75"	24.75"	36.75"	48.75"	60.75"
8/8/11	OQY-1C	8500	27'-10.65"	112047	Pass	3.323	3.332	Pass	3.323	3.332	3.332	3.332	3.331	3.332	3.331
8/8/11	OQY-2C	8500	27'-10.65"	112047	Pass	3.323	3.332	Pass	3.323	3.331	3.331	3.331	3.331	3.331	3.330
8/8/11	OQY-3C	8500	27'-10.65"	112047	Pass	3.323	3.331	Pass	3.329	3.329	3.330	3.330	3.330	3.331	3.330
8/8/11	OQY-4C	8500	27'-10.65"	112047	Pass	3.324	3.331	Pass	3.331	3.330	3.330	3.330	3.329	3.329	3.330
8/8/11	OQX2-5	8500	27'-10.65"	112047	Pass	3.323	3.331	Pass	3.330	3.330	3.329	3.329	3.329	3.329	3.330
8/8/11	OQY-6C	8500	27'-10.65"	112047	Pass	3.323	3.331	Pass	3.331	3.331	3.331	3.330	3.330	3.330	3.330
8/8/11	OQY-7C	8500	27'-10.65"	112047	Pass	3.323	3.330	Pass	3.331	3.330	3.330	3.330	3.330	3.329	3.329
8/8/11	OQX2-8	8500	27'-10.65"	112047	Pass	3.328	3.332	Pass	3.333	3.333	3.331	3.332	3.332	3.332	3.332
8/8/11	OQY-9C	8500	27'-10.65"	112047	Pass	3.323	3.331	Pass	3.330	3.331	3.330	3.330	3.330	3.330	3.330
8/8/11	OQY-10C	8500	27'-10.65"	112047	Pass	3.323	3.330	Pass	3.332	3.332	3.330	3.331	3.330	3.331	3.330
8/8/11	OQY-11C	8500	27'-10.65"	112047	Pass	3.324	3.332	Pass	3.331	3.332	3.330	3.331	3.331	3.331	3.331
8/8/11	OQY-12C	8500	27'-10.65"	112047	Pass	3.325	3.331	Pass	3.331	3.331	3.332	3.330	3.330	3.330	3.330
8/8/11	OQY-13C	8500	27'-10.65"	112047	Pass	3.331	3.331	Pass	3.332	3.332	3.331	3.331	3.332	3.332	3.332
8/8/11	OQY-14C	8500	27'-10.65"	112047	Pass	3.324	3.331	Pass	3.331	3.332	3.331	3.331	3.332	3.331	3.332
8/8/11	OQY-15C	8500	27'-10.65"	112047	Pass	3.326	3.331	Pass	3.332	3.332	3.331	3.330	3.330	3.330	3.330
8/8/11	OQY-16C	8500	27'-10.65"	112047	Pass	3.323	3.332	Pass	3.333	3.333	3.332	3.332	3.332	3.332	3.332
8/8/11	OQY-17C	8500	27'-10.65"	112047	Pass	3.324	3.331	Pass	3.333	3.333	3.333	3.333	3.332	3.332	3.333
8/8/11	OQY-18C	8500	27'-10.65"	112047	Pass	3.324	3.333	Pass	3.333	3.333	3.332	3.331	3.332	3.333	3.332
8/8/11	OQY-19C	8500	27'-10.65"	112047	Pass	3.323	3.332	Pass	3.333	3.332	3.331	3.331	3.331	3.331	3.331
8/8/11	OQY-20C	8500	27'-10.65"	112047	Pass	3.323	3.330	Pass	3.333	3.332	3.331	3.330	3.330	3.330	3.330
8/8/11	OQY-21C	8500	27'-10.65"	112047	Pass	3.324	3.331	Pass	3.332	3.332	3.332	3.331	3.331	3.331	3.331
8/8/11	OQY-22C	8500	27'-10.65"	112047	Pass	3.324	3.332	Pass	3.331	3.333	3.331	3.330	3.330	3.331	3.331
8/8/11	OQY-23C	8500	27'-10.65"	112047	Pass	3.324	3.333	Pass	3.332	3.331	3.332	3.331	3.332	3.331	3.331
8/8/11	OQY-24C	8500	27'-10.65"	112047	Pass	3.324	3.331	Pass	3.331	3.332	3.330	3.330	3.330	3.330	3.330

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112047	660110-SA-017 CO 022	8500 MM	12 pcs	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. Material per ASTM-A354, gr BD; Hot Dipped Galvanized per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OQY-3C, OQY-13C, OQY-14C, OQY-15C, OQY-18C, OQY-19C, OQY-20C, OQY-21C, OQY-22C, OQY-23C, OQY-27, OQY-32

Heat treatment lot OQY is from heat of steel ID 4M7636-1

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112049	660110-SA-017 CO 022	8700 MM	6 pcs	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8700mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & Tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OQY-25, OQY-26, OQY-28, OQY-29, OQY-31, OQX4-30

Heat treatment lot OQY is from heat of steel ID 4M76367-1
Heat treatment lot OQX is from heat of steel ID 4M76367-2

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112051	660110-SA-017 CO 022	8900 MM	6 ~~7~~ pcs	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8900mm OAL PWS anchor rod w/1850mm of useable thread one end and 280mm (13.78") on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end, HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OPY4-19, OPY4-20, OPY4-21, OPY4-22, OPY4-24, OQY-23B, ~~OOH-TF~~ PL 9/30/11

Heat treatment lot OPY is from heat of steel ID 3M75738-2
Heat treatment lot OQY is from heat of steel ID 4M76367-1
Heat treatment lot OOH is from heat of steel ID 4M76368-3

Attachments:

Mill Test Reports
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

CERTIFICATE OF COMPLIANCE

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 112051	660110-SA-017 CO 022	8900 MM	5 pcs	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8900mm OAL PWS anchor rod w/1850mm of useable thread one end and 280mm (13.78") on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end, HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYM-3, OYM-6, OYJ-4, OYI-3, OYH-~~3~~2 10/14/11

Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)
Heat treatment lot OYJ is from heat of steel ID A113151 (Batch# H207)
Heat treatment lot OYI is from heat of steel ID A113149 (Batch# H222)
Heat treatment lot OYH is from heat of steel ID A113149 (Batch# H210)

Attachments:
Mill Test Reports
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112054	660110-SA-017 CO 022	9200 MM	6 pc	8/31/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9200mm OAL PWS anchor rod w/1850mm of usenble thread one end & 280mm on opposite end. Drill & tap 3"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OTD-16, OTD-17, OTD-18, OTD-5, OTD-4, OTD-1H
Heat treatment lot OTD is from heat of steel ID 4M76368-1

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
8/29/11

PWS ANCHOR RODS and EXTENSION ROD THREAD MAPPING

AUGUST 31, 201

Date	BAR				COUPLER END			TAPPED END							
Measured	I.D	LENGTH	LENGTH	DYSON	No-Go	Pitch Diameter [In.]		No-Go	Pitch Diameter Readings (+/- 1 Pitch) [Inches]						
	CODE / BAR	MM	FT./IN	S.O. #	Pass/Fail	0.75"	12.75"	Pass/Fail	0.75"	2.25"	12.75"	24.75"	36.75"	48.75"	60.75"
6/27/11	OTD-16 (OID-2)	9200	30'-2.25"	112054 (A)	Pass	3.325	3.330	Pass	3.324	3.328	3.334	3.336	3.323	3.328	3.328
6/27/11	OTD-17 (OID-3	9200	30'-2.25"	112054 (A)	Pass	3.329	3.334	Pass	3.323	3.330	3.332	3.336	3.337	3.340	3.343
6/27/11	OTD-18 (OID-4)	9200	30'-2.25"	112054 (A)	Pass	3.330	3.331	Pass	3.334	3.337	3.332	3.326	3.332	3.328	3.324
6/27/11	OTD-5	9200	30'-2.25"	112054 (A)	Pass	3.325	3.334	Pass	3.324	3.329	3.332	3.333	3.335	3.337	3.329
6/26/11	OTD-4	9200	30'-2.25"	112054 (A)	Pass	3.323	3.329	Pass	3.327	3.328	3.326	3.325	3.327	3.325	3.324
8/10/11	OTD-1H	9200	30'-2.20"	112054	Pass	3.333	3.332	Pass	3.333	3.333	3.333	3.333	3.333	3.333	3.333

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112054	660110-SA-017 CO 022	9200 MM	2 pc	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9200mm OAL PWS anchor rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OTD-1H, OOH-4F

Heat treatment lot OTD is from heat of steel ID 4M76368-1
Heat treatment lot OOH is from heat of steel ID 4M76368-3

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112054	660110-SA-017 CO 022	9200 MM	5 pc	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9200mm OAL PWS anchor rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYH-3, OYH-1, OYM-1, OYJ-6, OYJ-5

Heat treatment lot OYH is from heat of steel ID A113149 (Batch# H210)
Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)
Heat treatment lot OYJ is from heat of steel ID A113151 (Batch# H207)

Attachments:
Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112055	660110-SA-017 CO 022	9300 MM	7 pcs	8/31/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/shim metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: ~~OOH2-6~~, ~~OOH2-22~~, ~~OOH-1F~~, ~~OOH-2F~~, ~~OOH-3F~~, ~~OOH-4F~~, ~~OOH-5F~~

Heat treatment lot OOH is from heat of steel ID

attached

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
8/29/11

PWS ANCHOR RODS and EXTENSION ROD THREAD MAPPING

AUGUST 31, 2011

Date	BAR				COUPLER END			TAPPED END							
Measured	I.D	LENGTH	LENGTH	DYSON	No-Go	Pitch Diameter [In.]		No-Go	Pitch Diameter Readings (+/- 1 Pitch) [Inches]						
	CODE / BAR	MM	FT./IN	S.O. #	Pass/Fail	0.75"	12.75"	Pass/Fail	0.75"	2.25"	12.75"	24.75"	36.75"	48.75"	60.75"
6/27/11	OOH2-6	9300	30'-6.25"	112055	Pass	3.330	3.334	Pass	3.328	3.334	3.335	3.340	3.343	3.345	3.349
6/26/11	OOH2-22	9300	30'-6.25"	112055	Pass	3.324	3.328	Pass	3.326	3.326	3.323	3.328	3.337	3.330	3.337
8/10/11	OOH-1F	9300	30'-6.14"	112055	Pass	3.324	3.333	Pass	3.330	3.330	3.331	3.330	3.329	3.330	3.330
8/10/11	OOH-2F	9300	30'-6.14"	112055	Pass	3.326	3.333	Pass	3.330	3.327	3.332	3.329	3.332	3.329	3.329
8/10/11	OOH-3F	9300	30'-6.14"	112055	Pass	3.332	3.333	Pass	3.333	3.333	3.333	3.333	3.332	3.333	3.333
8/10/11	OOH-4F	9300	30'-6.14"	112055	Pass	3.328	3.333	Pass	3.333	3.333	3.333	3.333	3.333	3.332	3.332
8/10/11	OOH-5F	9300	30'-6.14"	112055	Pass	3.333	3.334	Pass	3.334	3.334	3.334	3.334	3.334	3.334	3.334

CERTIFICATE OF COMPLIANCE

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 112055	660110-SA-017 CO 022	9300 MM	3 pcs	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OOH-2F, OOH-3F, OOH-1E

Heat treatment lot OOH is from heat of steel ID 3M76368-3

Attachments:
Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112055	660110-SA-017 CO 022	9300 MM	6 pcs	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYJ-7, OYJ-9, OYM-7, OYM-10, OYJ-10, OYH-10

Heat treatment lot OYJ is from heat of steel ID A113151 (Batch# H207)
Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)
Heat treatment lot OYH is from heat of steel ID A113149 (Batch# H210)

Attachments:

Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112056	660110-SA-017 CO 022	9400 MM	3 pc	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9400mm (30'-10.08") OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2".4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.: OYI-4, OYM-4, OYM-5

Heat treatment lot OYI is from heat of steel ID A113149 (Batch# H222)
Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)

Attachments:
Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112057	660110-SA-017 CO 022	9500 MM	3 pcs	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9500mm OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYJ-8, OYM-9, OYH-7

Heat treatment lot OYJ is from heat of steel ID A113151 (Batch# H207)
Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)
Heat treatment lot OYH is from heat of steel ID A113149 (Batch# H210)

Attachments:

Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112058	660110-SA-017 CO 022	9600 MM	4 pcs	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9600mm OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYH-9, OYI-5, OYJ-11, OYH-5

Heat treatment lot OYH is from heat of steel ID A113149 (Batch# H210)
Heat treatment lot OYI is from heat of steel ID A113149 (Batch# H222)
Heat treatment lot OYJ is from heat of steel ID A113151 (Batch# H207)

Attachments:

Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112059	660110-SA-017 CO 022	9700 MM	1 pc	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9700mmOAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYM-8

Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)

Attachments:

Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

Date Received: 6/3/2011

Test Report No.: DYS006-11-06-26885-1 *REVISED

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

P.O. No.: 78333 / 78375

TEST REPORT
ITAR-CONTROLLED DATA

Sample Description: MT On-Site Wet Fluorescent Cal Trans Witness of Anchor Rods Representing 3.50"-4UNC 2A x Random Lengths*, 6/6/2011, Heat#/Heat Codes: 4M76368/OOF and 4M76368/OOH *

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM F788-06 (Acceptance Criteria)
Procedure:	SOP 42.03 /ASTM E1444 (Method) per ASTM A 490/ Caltran Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05

METHOD

☐ Dry	☒ Wet

PARTICLES

Magnaflux Particles:	*Part Preparation:	Wet Particle Carrier:
☐ 8A Red ☐ 14A ☐ 3A Black ☒ 14AM ☐ 1 Gray ☐ Other Batch No. 09D02K	☐ None Required ☐ Solvent Clean ☐ Grinding ☒ Other: Precleaned by Customer	☐ Magnaflux Carrier II ☒ Pre Mixed ☐ Concentration MI Batch No.

CURRENT

☐ AC	☐ FWDC
☐ Central Conductor (AMPS)	☐ Head Shot (AMPS)
☐ Coil (AMPS)	☐ Prods (AMPS/Spacing)

Field Verified by: ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe

EQUIPMENT

☐ Magnaflux H-720 S/N: Cal Due Date:

☒ Yoke ☐ AC ☒ DC S/N: 3005 Spacing: 4" – 6" Cal Due Date: 12/1/11

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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 Baumiller
Customer Services Manager

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

Date Received: 6/3/2011

Test Report No.: DYS006-11-06-26885-1 *REVISED

P.O. No.: 78333 / 78375

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
ITAR-CONTROLLED DATA

INSPECTION RESULTS	
Quantity*	**Results***
4 PCS OOH Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
4 PCS OOF Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
Comments: "ID of tube only"- Magnetic Flux Field cannot be verified for sensitivity; thus only a cursory examination was performed for informational purposes only.* Marking Requirements: Demag and post cleaning requirements:	
Inspected by: Matthew Novak	Certification: ASNT-SNT-TC-1A Level ☐ II ☒ III

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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This document contains technical data whose export and re-export/re-transfer is subject to control by the U.S. Department of State under the Arms Export Control Act and the International Traffic in Arms Regulations. The Department of State's prior written approval is required for the export or re-export/re-transfer of such technical data to any foreign person, foreign entity or foreign organization whether in the United States or abroad.

*REVISED: Corrected quantity/sample descriptions (6/13/11).
Corrected part preparation and standard/ procedure (6/14/11).
Added Heat Number, Code, Lengths, Comments and expanded Results (8/01/11).

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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 Baumiller
Customer Services Manager

STORK
Materials Technology

Stork Herron Testing Laboratories

6/17/2011

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

Date Received: 6/15/2011

Test Report No.: DYS006-11-06-27669-1
REVISED

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

P.O. No.: 78540

TEST REPORT
ITAR-CONTROLLED DATA

Sample Description: MT On-site Wet Fluorescent Exam of Anchor Rods Representing 3.50"-4UNC 2A x Random Lengths*, 6/16/11, ASTM E 1444 SOP 42.03, ASTM F788, Heat#/Heat Code: 4M76368/OTD*

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM F788-06 (Acceptance Criteria)	
Procedure:	SOP 42.03 /ASTM E1444 (Method) per ASTM A490 Caltran Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05	
METHOD		
☐ Dry	☒ Wet	
PARTICLES		
Magnaflux Particles: ☐ 8A Red ☐ 14A ☐ 3A Black ☒ 14AM ☐ 1 Gray ☐ Other Batch No. 09D02K	**Part Preparation:** ☐ None Required ☐ Solvent Clean ☐ Grinding ☒ Other Precleaned by Customer	**Wet Particle Carrier:** ☐ Magnaflux Carrier II ☒ Pre Mixed ☐ Concentration MI Batch No.
CURRENT		
☐ AC	☐ FWDC	
☐ Central Conductor (AMPS)	☐ Head Shot (AMPS)	
☐ Coil (AMPS)	☐ Prods (AMPS/Spacing)	
Field Verified by: ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe		
EQUIPMENT		
☐ Magnaflux H-720 S/N: Cal Due Date:		
☒ Yoke ☐ AC ☒ DC S/N: 3005 Spacing: 4" – 6" Cal Due Date: 12/1/11		

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Michael R. Gaydos
General Manager, COO

STORK
Materials Technology

Stork Herron Testing Laboratories

6/17/2011

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

Date Received: 6/15/2011

Test Report No.: DYS006-11-06-27669-1
REVISED

P.O. No.: 78540

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
ITAR-CONTROLLED DATA

INSPECTION RESULTS	
Quantity	**Results**
3 PCS **OTD, Heat# 4M76368*** **3.50"-4UNC-2A X Random Lengths* PWS Anchor Rod**	**O.D. only was inspected and found to be acceptable***
Comments: "ID of tube only"- Magnetic Flu Field cannot be verified for sensitivity; thus only a cursory examination was performed for informational purposes only.* Marking Requirements: Demag and post cleaning requirements:	
Inspected by: Matthew Novak	Certification: ASNT-SNT-TC-1A Level ☐ II ☒ III

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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This document contains technical data whose export and re-export/re-transfer is subject to control by the U.S. Department of State under the Arms Export Control Act and the International Traffic in Arms Regulations. The Department of State's prior written approval is required for the export or re-export/re-transfer of such technical data to any foreign person, foreign entity or foreign organization whether in the United States or abroad.

*REVISED (08/01/11): Added Heat Number, Length, Comments and expanded Results.

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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.

Michael R. Gaydos
General Manager, COO

STORK
Materials Technology

Stork Herron Testing Laboratories

8/5/2011

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

Date Received: 8/3/2011

Test Report No.: DYS006-11-08-31132-1

P.O. No.: 79319

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
ITAR-CONTROLLED DATA

Sample Description: One (1) Lot (4 Pcs.) MT Exam of Anchor Rods, Representing 3.50"- 4UNC 2A Random Length Rods, Material Per ASTM-A354, gr BD, ASTM E1444 Per ASTM A490 with Acceptance Per ASTM F788, MIL-I-45208A, AM#1 Applies, Cust PO # 660110-SA-017 CO 022, Heat #/Code 4M76367/OQY

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM F788-06 (Acceptance Criteria)		
Procedure:	SOP 42.03 / ASTM E1444(Method) per ASTM A490 / Caltrans Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05		
METHOD			
☐ Dry		☒ Wet	
PARTICLES			
Magnaflux Particles: ☐ 8A Red ☐ 14A ☐ 3A Black ☒ 14AM ☐ 1 Gray ☐ Other Batch No. 09D02K.	**Part Preparation:** ☐ None Required ☐ Solvent Clean ☐ Ultrasonic Cleaner / Water ☒ Other Precleaned by Customer	**Wet Particle Carrier:** ☐ Ardrox Base Oil ☒ Pre Mixed ☐ Concentration Ml Lot No.	
CURRENT			
☐ AC		☐ FWDC ☐ HWDC	
☐ Central Conductor (AMPS)		☐ Head Shot (AMPS)	
☐ Coil (AMPS)		☐ Prods (AMPS/Spacing)	
Field Verified by: ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe			
EQUIPMENT			
☐ MagWerks MVS-2445 S/N: 000404		Cal Due Date: 9/22/2011	
☐ Magnaflux H-720 S/N: 81417		Cal Due Date: 9/22/2011	
☒ Yoke ☐ AC ☒ DC S/N: 3005 Spacing: 4"-6" Cal Due Date: 12/1/11			

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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.

Michael R. Gaydos
General Manager, COO

STORK
Materials Technology

Stork Herron Testing Laboratories

8/5/2011

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

Date Received: 8/3/2011

Test Report No.: DYS006-11-08-31132-1

P.O. No.: 79319

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
ITAR-CONTROLLED DATA

INSPECTION RESULTS	WO# 006-110831132 (PO# 79319)
Quantity	**Results**
4 PCS of 9 PCS Completes P.O. 79319 OQY Heat # 4M76367 3.50"-4UNC-2A X Random Lengths PWS Anchor Rods OQY-4, OQY-3, OQY-2, OQY-1 For balance of order see Work Order DYS006-110830874, Dated 8/1/11, P.O. 79319	**O.D. only was inspected and found to be acceptable**

Comments: Examined per customer request "ID of tube only" –Magnetic Flux Field cannot be verified for sensitivity; thus only a cursory examination was performed for informational purposes only, and no indications were noted at the time of inspection.

Marking Requirements:

Demag and post cleaning requirements: N/A

☐ Post Preservation: Ardrox 3968 Lot#: 05030711 Expiration Date: 4-13-2013

Inspected by:	Certification: Level ☐ II ☒ III	Inspection Date:
Matthew Novak	Recertification Date:6/25/13	8/4/11

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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Michael R. Gaydos
General Manager, COO

STORK
Materials Technology

Stork Herron Testing Laboratories

10/13/2011

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

Date Received: 10/11/2011

Test Report No.: DYS006-11-10-35829-1

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.: 80417

ITAR-CONTROLLED DATA

Sample Description: Eight (8) Anchor Rods Representing 3.50"-4UNC 2A Random Length Rods, Material ASTM-A354, Gr. BD, Spec.: ASTM A490 Section 10, On-Site Wet Fluorescent Magnetic Particle Exam 10/13/11, (2) Code OYH-8 & OYH-9 / Batch # H210, Heat# A113149, (2) Code OYI-4 & OYI-5 / Batch # H222 (Ref. Code OYP), Heat# A113149, (2) Code OYJ-8 & OYJ-11 / Batch # H207, Heat# A113151, (2) Code OYM-5 & OYM-9 / Batch # H214, Heat# A113151

NDT MAGNETIC PARTICLE INSPECTION REPORT

SPECIFICATIONS	
Procedure	ASTM E 1444 (Method) per ASTM A490 / Caltrans Special Provisions 10-1.59, 10-1.60, 10-1.61, and Caltrans Standard Specifications 75-1.05
Acceptance	ASTM F788-06 (Acceptance Criteria)

EQUIPMENT / MATERIAL DATA		
☐ MagWerks MVS-2445 S/N: 000404 Cal. Due Date: 3/22/2012		
☐ Magnaflux H-720 S/N: 81471 Cal. Due Date: 3/22/2012		
☒ Yoke ☐ AC ☒ DC S/N: 6512 Spacing: 4-6" Cal. Due Date: 2/11/2012		
Magnaflux Particles: ☐ 8A Red ☐ 14A ☐ 3A Black ☐ 14AM ☐ 1 Gray ☒ Ardrox 8800A Lot No.65121410	**Part Preparation:** ☐ None Required ☐ Solvent Clean ☐ Ultrasonic Cleaner / Water ☒ Other: Pre-cleaned by Customer	**Wet Particle Carrier :** ☐ Ardrox Base Oil ☒ Pre Mixed ☐ Concentration MI Lot No.

INSPECTION PARAMETERS		
☐ Dry (Visible)		☒ Wet (Fluorescent)
☐ AC	☐ FWDC	☐ HWDC
☐ Central Conductor (AMPS)		☐ Head Shot (AMPS)
☐ Coil (AMPS)		☐ Prods (AMPS/Spacing)
Field Verified by ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe		

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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.

Michael R. Gaydos
General Manager, COO

STORK Materials Technology

Stork Herron Testing Laboratories

10/13/2011

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

Date Received: 10/11/2011

Test Report No.: DYS006-11-10-35829-1

P.O. No.: 80417

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
ITAR-CONTROLLED DATA

INSPECTION PIECE(S) DATA			
Work Order No.	DYS006-111035829	Purchase Order No.	80417
Material	ASTM A354 Gr. BD	Heat No.	A113149 / A113151
Part Cleaning ☐ Ultrasonic Cleaner, Ardrox 6333A 20%bv, Lot No. 05031011, Exp. Date 5/6/2013			
☐ Drawing Attached		☐ Picture Attached	

INSPECTION RESULTS		
Nomenclature	**Quantity**	**Results**
Code OYH-8 & OYH-9 / Batch # H210, Heat# A113149	2 Rods	☒ Acceptable
Code OYI-4 & OYI-5 / Batch # H222 (Ref. Code OYP), Heat# A113149	2 Rods	☒ Acceptable
Code OYJ-8 & OYJ-11 / Batch # H207, Heat# A113151	2 Rods	☒ Acceptable
Code OYM-5 & OYM-9 / Batch # H214, Heat# A113151	2 Rods	☒ Acceptable
Comments: O.D. only was inspected and found to be acceptable Marking Requirements: Demag and post cleaning requirements: N/A ☐ Post Preservation: Ardrox 3968, Lot No. 05030711, Expiration Date 4/13/2013		
Inspected by: Matthew Novak	Certification Level ☐ II ☒ III Recertification: 6/25/13	Inspection Date 10/13/11

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)

This document contains technical data whose export and re-export/re-transfer is subject to control by the U.S. Department of State under the Arms Export Control Act and the International Traffic in Arms Regulations. The Department of State's prior written approval is required for the export or re-export/re-transfer of such technical data to any foreign person, foreign entity or foreign organization whether in the United States or abroad.

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or International test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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.

Michael R. Gaydos
General Manager, COO

State of California
Department of Transportation

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

TEST REPORT

ACCREDITED
CERTIFICATE NO. 2364.01

Remarks ref: ASTM A354 BD TM03. Heats #A113149 & A113151, Code #OYG & OYK

Sample No: SM-11-1038
Date Sampled: 10/12/11 **Date Rec'd:** 10/17/11 **Date Reported:** 10/25/11
Lot No: B30502811 **TL-101 / SIC No:** C711635
Contract/Permit No: 04-0120F4
Material: 3.5" A354 BD Main Cable Anchor Rods
Manufacturer: Dyson / Steel Dynamics
Sampler: Fred Edmondson 10-25

Results: SAMPLES SUBMITTED ARE SATISFACTORY FOR USE

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

SM-11-1038
10-17

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
SAMPLE IDENTIFICATION CARD CARD NUMBER C711635
TL-0101 (REV. 10/97)

☐ PRELIMINARY TESTS
☐ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

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

FIELD NO.
DIST. LAB NO.
LOT NO. B30502811
SHIPMENT NO.
P.O. OR REQ. NO.
AUTHORIZATION NO.

SAMPLE OF 3.5 inch main cable anchor
FOR USE IN Rods - A354, Gr. BD Rt
PWLS Anchorage
SAMPLE FROM Dyson
Painesville OH
DEPTH Heat treatment lot OYG/OYK
LOCATION OF SOURCE Ht. Nos A113149 and A113151
THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) 1 pallet AND IS ONE OF A GROUP OF 4 SAMPLES REPRESENTING (TONS, GALS, BBLS, STA, ETC.) LOT
OWNER OR MANUFACTURER
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☐ NORMAL ☐ PRIORITY
DATE NEEDED
REMARKS 1 - Tower ex. 12.00 mm threaded
2 - spare, 300mm round
stock.
COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 10-12-11
BY Fred Edmondson TITLE DA Inspector
DIST, CO, RTE, PM CC 80 BR
LIMITS Special Provisions
CONT. NO. 04-0120F4
FED. NO.
RES. ENGR. OR SUPT. Peter Siegenthaler
ADDRESS Berman Rd, Oakland, CA.
CONTRACTOR ABF

ENCLOSE WITH SAMPLE

Lab Manager Quality Manager

Print

.500 SAMPLES

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

SM Number = 11-1038

Temperature 71°

Sample	Heat Number	Diameter (in)	Area (in^2)	Stress at Offset (psi)	Tensile Strength (psi)	Elongation in 4 x d (%)	Tested By
OYG-A	OYG	0.497	0.194	120906	145310	15.5	FSaylor
OYG-B	OYG	0.492	0.1901	141300 OK	166050 OK	15.7 OK	FSaylor
OYK-A	OYK	0.498	0.1948	136931	158050	17.2	FSaylor
OYK-B	OYK	0.499	0.1956	132447 OK	155510 OK	17.3 OK	FSaylor

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

TRANSPORTATION LABORATORY
REPORT OF TESTS

TL - 619 (REV. 5/95)

S. M. NO. 11-1038	DATE RECEIVED 10/17/11
T 101 NO. C711635	CONT. . W.O.. OR P.O. NO. 04-0120F4
LOT NO. B305028 11	F.A.P. NO.

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

SAMPLE NO.	SAMPLE TYPE	HEAT NO.	SIZE	AREA BEFORE	AREA AFTER	YIELD ~~MPa~~ ACTUAL	YIELD PSI	ULTIMATE PSI ACTUAL	ULTIMATE ~~MPa~~	ELONG. ~~IN~~ %	RED. AREA %	COLD BEND	CHEMICAL ANALYSIS C	MN	P	S	SI	A OR E
OYG-A		OYG	.497	2.005	2.315		120904		145310	15.5								
OYG-B		"	.492	2.005	2.319		141300		166050	15.7								
OYK-A		OYK	.498	2.005	2.349		136931		158050	17.2								
OYK-A		"	.499	2.005	2.351		132447		155510	17.3								

SPECIFICATIONS

REMARKS A354 Grade BD

DATE TESTED 10/25/11	TESTED BY [signature]	APPROVED BY

FM 3018 M 95

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TM-3 (REV. 07/11)

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Agile B Marty

FASTENER ASSEMBLY WORKSHEET

SM Number	11-1038, 1039	Lot Number	B30502811 B30503011	Date Received	
Contract Number	04-0120 F4	TL-0101 Number	C711635 C711637	Date Tested	10/21/11
Lab Technician	FLBD	Test Temperature	70°	Page _____ of _____	

BOLTS: A354 Grade BD

Sample No.	1A	1B	~~2~~		OK		
Heat / Mfg. Lot No.	04G		~~04I~~	6W			
Product Markings	—		—		We got only a Slug		
Size	3.5"		~~3.5"~~				
Pitch Diameter	3.32951	3.32951	~~3.32951~~	~~3.32951~~			
Bolt Length							
Ring Gage Go/No-Go	—						
Zinc Coating Thick.	—						
Hardness: Rc / Rb	—						
Spacing	—						
.500 ~~Wedge~~ Tensile							

NUTS:

Sample No.							
Mfg. Lot No.							
Product Markings							
Size							
Plug Gage Go/No-Go							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							
Nut Proof Load							

WASHER:

Sample No.							
Mfg. Lot No.							
Product Markings							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652 (REV. 3/05)

TEST SPECIMEN PREPARATION AND RECORD

APPROVED FOR USE BY SMTL
QUALITY MANAGER: B Berger

SM No.	Contract No.	Requesting Lab Technician	Date Needed
11-1038	04-0120F4	Glen	ASAP ~~Routine~~
TL-0101 No.	**E.A./Spec. Desg./Object**	**Date Received**	**Date Tested/Provided**
C711635	0400000018 3	10-17-11	

[X] Machine Shop

Work Requested

[X] standard round tension test specimen, circle one: 0.500"

[] standard rectangular tension test specimen, circle one: 18" long, 8" gage
8" long, 2" gage length

[] Charpy, circle one: 10mm x 10mm
10mm x 7.5mm

[] hardness measurement sample (fasteners)

[] weld nugget

[] chemistry slug

[] other: _____

[] see instructions →

2 505's per each
Slug. OYG & OYK

[] Chemistry Lab

type of material:

Work Requested

[] neoprene verification

[] oil swell

[] zinc coating weight

[] steel chemistry analysis

[] other: _____

← [] see instructions

[] Other (explain)

Comments or further instructions

The received service is acceptable

Frank Baylor
Receiving Lab Technician

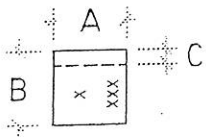
10/24/11
Date

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652a (REV. 10/10)

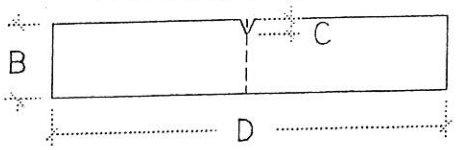
Specimen Preparation Information

SM # 11-1038
EA #
HEAT # OYK
PREPARED BY MA
DATE 10-25-11

Charpy Impact Specimens



45° V NOTCH WITH
A 0.010 RAD $^{+.001}_{-.001}$



MATERIAL SURFACE

SPEC # x
HEAT # xxx

NOTCH ORIENTATION

	OK
1	
2	
3	

SPC #	A	B	C	D
	NOTE #2	0.394 $^{+.001}_{-.001}$	0.079 $^{+.001}_{-.001}$	2.165 $^{+.000}_{-.100}$
1				
2				
3				

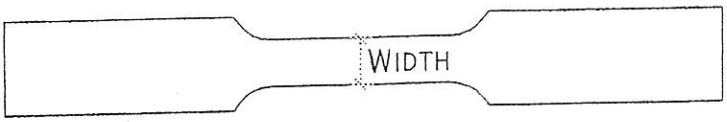
NOTE:
1. ALL MEASUREMENTS IN INCHES
2. MEASUREMENT "A" 0.394, 0.295, 0.197, 0.098
   TOLERANCE $^{+.001}_{-.001}$
3. SPECIMENS ARE TO BE SURFACE GROUND

Reduced Tensile Round Specimens

SPC #	DIA
A	.498
B	.499

NOTE: SPECIMEN DIA
1. 0.500 $^{+.010}_{-.010}$
2. 0.350 $^{+.007}_{-.007}$

Reduced Tensile Flat Specimens



SPC #	WIDTH
A	
B	

NOTE: SPECIMEN WIDTH
1. 0.500 $^{+.010}_{-.010}$

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Agile B Martz

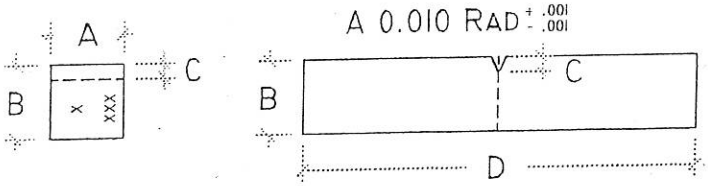
STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652a (REV. 10/10)

Specimen Preparation Information

SM #11-1038
EA #
HEAT #046
PREPARED BY MA
DATE 10-25-11

Charpy Impact Specimens

45° V NOTCH WITH
A 0.010 RAD $^{+.001}_{-.001}$



MATERIAL SURFACE

SPEC # x
HEAT # xxx

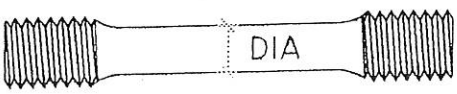
NOTCH ORIENTATION

	OK
1	
2	
3	

SPC #	A	B	C	D
	NOTE #2	0.394 $^{+.001}_{-.001}$	0.079 $^{+.001}_{-.001}$	2.165 $^{+.000}_{-.100}$
1				
2				
3				

NOTE:
1. ALL MEASUREMENTS IN INCHES
2. MEASUREMENT "A" 0.394, 0.295, 0.197, 0.098
   TOLERANCE $^{+.001}_{-.001}$
3. SPECIMENS ARE TO BE SURFACE GROUND

Reduced Tensile Round Specimens



SPC #	DIA
A	.497
B	.492

NOTE: SPECIMEN DIA
1. 0.500 $^{+.010}_{-.010}$
2. 0.350 $^{+.007}_{-.007}$

Reduced Tensile Flat Specimens

SPC #	WIDTH
A	
B	

NOTE: SPECIMEN WIDTH
1. 0.500 $^{+.010}_{-.010}$

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Agile B Martz

SM-11-1038

Steel Dynamics, Inc.
Engineered Bar Products Division

CODE OYG

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

Certified Material Test Report

Cert # : 117655	Mill Order : 1109058	Heat # : A113149	Issued : 8/30/2011 09:38:57
Work Order : 115418	Sales Order : 95886-1	Customer : Turret Steel Industries	PO # : 33033-1
Load # : 141557	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"
Grain Practice : Al Fine Grain (5-8) per ASTM A29		Reduction Ratio : 12.9 to 1	Disposition : 1

Ladle Chemistry Analysis (ASTM A29)

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	B	Ca	W	Ti	DI
0.41	0.95	0.009	0.006	0.27	0.025	0.18	0.16	0.99	0.22	0.011	0.0069	0.004	0.002	0.0001	0.0013	0.000	0.002	6.31

Pb	Co	As	Sb	Zr	Bi	H	O	Ceq	J-Factor
0.001	0.008	0.005	0.003	0.001	0.001	1.6		0.84	

Product Check Analysis (ASTM A29)

	C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	Ti	B	Ca	O
Front																		
Back																		

Jominy (ASTM A255)

	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J12	J14	J16	J18	J20	J24	J28	J32
Calc'd	57	57	57	57	57	57	57	57	57	57	55	52	50	50	49	48	47	43
Front																		
Back																		

Microcleanliness (ASTM E45)

Method A								Method C		Method E	
AT	AH	BT	BH	CT	CH	DT	DH	S	O	SAM "B"	SAM "D"

Microcleanliness (DIN 50602)

K			M
S	O	Tot	Tot

Decarb

Depth	% of Diameter

Grainsize

Austenitic	Ferritic
7	

Macrostructure (ASTM E381)

S	R	C

Magnetic Particle Inspection

Frequency	Severity

Mechanical Properties (ASTM A370)

Tensile Properties					Hardness	
Tensile Strength	0.2% Yield Strength	% Elong (2")	% ROA	0.35% EUL Yield Strength	(MR)	(Surf)

Steel Dynamics - Engineered Bar Products has a quality system in place which has been certified ISO 9001:2008 compliant, including PED certification.

Comments/Specs

ASTM A322-07 ----- Quench & Temper, Straighten, Stress Relieve ----- Contact Ultrasonic Inspected to 1/8" FBH ----- ASTM A354 Grade BD

Q.A. REVIEWED
DATE 8/31/11
DYSON

Batch # H208

Condition : Quench, Temper, Temper, Straighten, Straighten, Stress Relieve, Contact UT

UT: Passed Ultrasonic Inspection

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Dylan Kale - Rolling Mill Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results. No weld repair has been performed on this material. This material is not radioactive and has not been exposed to radioactivity while under the control of Steel Dynamics. This material has not been exposed to mercury while under the control of Steel Dynamics. Unless otherwise noted, this material was melted, continually cast, and rolled in the USA; w/ all testing performed by Steel Dynamics.

Steel Dynamics, Inc.
Engineered Bar Products Division • Pittsboro, Indiana

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE OYG

Certified Material Test Report

Heat Treatment Addendum

Cert # : 117655	Mill Order : 1109058	Heat # : A113149	Issued : 8/29/2011
Work Order : 115418	Sales Order : 95886	Customer : Turret Steel Industries	PO # : 33033 / 1
Load # :	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"

Normalize		Austentize		Quench Media			Temper		Stress Relieve	
Time	Temp	Time	Temp	Type	Time	Temp	Time	Temp	Time	Temp
hrs	°F	2.5 hrs	1650 °F	Water	15 min	95-99 °F	6.3 hrs	1025 °F	5.0 hrs	900 °F

* Furnaces are calibrated to API 6A Annex P, and use atmospheric thermocouples

** QTC is 12" prolongation from longitudinal orientation machined to a 0.505" buttonhead for tensile.

Hardness (ASTM A370)

Bundle #	Batch #	Location	HB	Rb	Rc
1138928	H208	Mid-Rad Q1			35
1138926	H210	Mid-Rad Q1			35
1138927	H210	Mid-Rad Q1			35
1138929	H222	Mid-Rad Q1			36

Tensile (ASTM A370)

Bundle #	Batch #	Orientation	Location	Tensile	0.2% Yield	%E (2")	%ROA
1138928	H208	Longitudinal	Mid-Rad Q1	153,800 psi	132,400 psi	16	52
1138926	H210	Longitudinal	Mid-Rad Q1	155,700 psi	134,500 psi	15	51
1138927	H210	Longitudinal	Mid-Rad Q1	155,700 psi	134,500 psi	15	51
1138929	H222	Longitudinal	Mid-Rad Q1	155,500 psi	134,500 psi	15	52

Q.A. REVIEWED
DATE 8/31/11
DYSON

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Garrett Bouyett - Bar Finishing Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results.

Steel Dynamics, Inc.
Engineered Bar Products Division

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE OYK

Certified Material Test Report

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/30/2011 09:38:57
Work Order : 115418	Sales Order : 95886-1	Customer : Turret Steel Industries	PO # : 33033-1
Load # : 141557	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"
Grain Practice : Al Fine Grain (5-8) per ASTM A29		Reduction Ratio : 12.9 to 1	Disposition : 1

Ladle Chemistry Analysis (ASTM A29)

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	B	Ca	W	Ti	Dl
0.40	0.96	0.009	0.005	0.25	0.024	0.20	0.07	0.98	0.22	0.011	0.0081	0.004	0.002	0.0001	0.0009	0.000	0.001	6.09

Pb	Co	As	Sb	Zr	Bi	H	O	Ceq	J-Factor
0.001	0.008	0.005	0.003	0.001	0.000	1.4		0.82	

Product Check Analysis (ASTM A29)

	C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	Ti	B	Ca	O
Front																		
Back																		

Jominy (ASTM A255)

	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J12	J14	J16	J18	J20	J24	J28	J32
Calc'd	56	56	56	56	56	56	56	56	56	54	50	51	48	48	47	46	45	41
Front																		
Back																		

Microcleanliness (ASTM E45)

Method A								Method C		Method E	
AT	AH	BT	BH	CT	CH	DT	DH	S	O	SAM "B"	SAM "D"

Microcleanliness (DIN 50602)

K			M
S	O	Tot	Tot

Decarb

Depth	% of Diameter

Grainsize

Austenitic	Ferritic
7	

Macrostructure (ASTM E381)

S	R	C

Magnetic Particle Inspection

Frequency	Severity

Mechanical Properties (ASTM A370)

Tensile Properties					Hardness	
Tensile Strength	0.2% Yield Strength	% Elong (2")	% ROA	0.35% EUL Yield Strength	(MR)	(Surf)

Steel Dynamics - Engineered Bar Products has a quality system in place which has been certified ISO 9001:2008 compliant, including PED certification.

Comments/Specs

ASTM A322-07 ----- Quench & Temper, Straighten, Stress Relieve ----- Contact Ultrasonic Inspected to 1/8" FBH ----- ASTM A354 Grade BD

Q.A. REVIEWED
DATE 8/31/11
DYSON

Batch #H208

Condition : Quench, Temper, Temper, Straighten, Stress Relieve, Contact UT

UT: Passed Ultrasonic Inspection

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Dylan Kale - Rolling Mill Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results. No weld repair has been performed on this material. This material is not radioactive and has not been exposed to radioactivity while under the control of Steel Dynamics. This material has not been exposed to mercury while under the control of Steel Dynamics. Unless otherwise noted, this material was melted, continually cast, and rolled in the USA; w/ all testing performed by Steel Dynamics.

Steel Dynamics, Inc.
Engineered Bar Products Division • Pittsboro, Indiana

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE OYK

Certified Material Test Report

Heat Treatment Addendum

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/29/2011
Work Order : 115418	Sales Order : 95886	Customer : Turret Steel Industries	PO # : 33033 / 1
Load # :	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"

Normalize		Austentize		Quench Media			Temper		Stress Relieve	
Time	Temp	Time	Temp	Type	Time	Temp	Time	Temp	Time	Temp
hrs	°F	2.5 hrs	1650 °F	Water	15 min	95-99 °F	6.3 hrs	1025 °F	5.0 hrs	900 °F

* Furnaces are calibrated to API 6A Annex P, and use atmospheric thermocouples

** QTC is 12" prolongation from longitudinal orientation machined to a 0.505" buttonhead for tensile.

Hardness (ASTM A370)

Bundle #	Batch #	Location		HB	Rb	Rc
1138941	H207	Mid-Rad	Q1			36
1138943	H207	Mid-Rad	Q1			36
1138939	H208	Mid-Rad	Q1			36
1138933	H211	Mid-Rad	Q1			36
1138934	H211	Mid-Rad	Q1			36
1138932	H214	Mid-Rad	Q1			36
1138931	H214	Mid-Rad	Q1			36
1138944	H215	Mid-Rad	Q1			36
1138936	H215	Mid-Rad	Q1			36
1138942	H217	Mid-Rad	Q1			36
1138949	H217	Mid-Rad	Q1			36
1138948	H222	Mid-Rad	Q1			36

Tensile (ASTM A370)

Bundle #	Batch #	Orientation	Location		Tensile	0.2% Yield	%E (2")	%ROA
1138941	H207	Longitudinal	Mid-Rad	Q1	147,600 psi	124,200 psi	16	54
1138943	H207	Longitudinal	Mid-Rad	Q1	147,600 psi	124,200 psi	16	54
1138939	H208	Longitudinal	Mid-Rad	Q1	151,700 psi	129,700 psi	16	54
1138933	H211	Longitudinal	Mid-Rad	Q1	147,100 psi	123,200 psi	16	54
1138934	H211	Longitudinal	Mid-Rad	Q1	147,100 psi	123,200 psi	16	54
1138932	H214	Longitudinal	Mid-Rad	Q1	151,600 psi	128,900 psi	16	53
1138931	H214	Longitudinal	Mid-Rad	Q1	151,600 psi	128,900 psi	16	53
1138944	H215	Longitudinal	Mid-Rad	Q1	156,500 psi	135,300 psi	16	53
1138936	H215	Longitudinal	Mid-Rad	Q1	156,500 psi	135,300 psi	16	53
1138942	H217	Longitudinal	Mid-Rad	Q1	152,000 psi	130,000 psi	15	52
1138949	H217	Longitudinal	Mid-Rad	Q1	152,000 psi	130,000 psi	15	52
1138948	H222	Longitudinal	Mid-Rad	Q1	148,200 psi	125,300 psi	16	55

Q.A. REVIEWED
DATE 8/31/11
DYSON

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Garrett Bouyett - Bar Finishing Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results.

State of California
Department of Transportation

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

TEST REPORT

ACCREDITED
CERTIFICATE NO. 2364.01

Remarks ref: ASTM A354 BD, TM03. Heats #A113149 & Code #OYI, #A11315 & Code #OYP.

Sample No: SM-11-1039
Date Sampled: 10/12/11 **Date Rec'd:** 10/17/11 **Date Reported:** 10/25/11
Lot No: B30503011 **TL-101 / SIC No:** C711637
Contract/Permit No: 04-0120F4
Material: 3.5" A354 BD Main Cable Anchor Rods
Manufacturer: Dyson / Steel Dynamics
Sampler: Fred Edmondson 10-25

Results: SAMPLES SUBMITTED ARE SATISFACTORY FOR USE

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

10-17 SM-11-1039

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
SAMPLE IDENTIFICATION CARD CARD NUMBER C711637
TL-0101 (REV. 10/97)

☐ PRELIMINARY TESTS ☐ PROCESS TESTS ☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS ☐ DIST. LAB ☐ TRANS. LAB ☐ SPECIAL TESTS

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

FIELD NO. ✓
DIST. LAB NO.
LOT NO. B305-030-11
SHIPMENT NO. P.O. OR REQ. NO.
AUTHORIZATION NO.

SAMPLE OF 3.5 inch main cable anchor rods
FOR USE IN PWS Anchorage
A354, Gr. BD Rt 7
SAMPLE FROM Dyson
Painesville, OH
DEPTH Heat treatment Lot. OYI/OYP
LOCATION OF SOURCE Heat Nos A113149 and A11315
THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) 1 pallet AND IS ONE OF A GROUP OF 4 SAMPLES REPRESENTING (TONS, GALS, BBLS, STA, ETC.) Lot
OWNER OR MANUFACTURER
TOTAL QUANTITY AVAILABLE TEST RESULTS DESIRED ☐ NORMAL ☐ PRIORITY DATE NEEDED
REMARKS 1 - 9000 ex. 1200mm threaded
2 - 6000 ex 300mm round stock
COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 10-12-11
BY Fred Edmondson TITLE QA Inspector
DIST, CO, RTE, PM 04-ORA-0 F4
LIMITS Special Provisions
CONT. NO.
FED. NO.
RES. ENGR. OR SUPT. Kato Siamthaleu
ADDRESS Buena Park, Oakland, CA
CONTRACTOR ARIF

ENCLOSE WITH SAMPLE

Lab Manager GW Quality Manager

Print

.500 SAMPLES

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

SM Number = 11-1039

Temperature 71°

Sample	Heat Number	Diameter (in)	Area (in²)	Stress at Offset (psi)	Tensile Strength (psi)	Elongation in 4 x d (%)	Tested By
OYP-A	OYP	0.493	0.1909	147984	165140	16.2	FSaylor
OYP-B	OYP	0.49	0.1886	148008 OK	164460 OK	16.3 OK	FSaylor
OYI-A	OYI	0.503	0.1987	136395	154630	17.5	FSaylor
OYI-B	OYI	0.493	0.1909	139287 OK	158260 OK	16.8 OK	FSaylor

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

TRANSPORTATION LABORATORY
REPORT OF TESTS

TL - 619 (REV. 5/95)

S. M. NO. 11-1039	DATE RECEIVED ~~11-1039~~ 10/17/11
T 101 NO. ~~B~~ C711637	CONT. . W.O.. OR P.O. NO. 04-0120F4
LOT NO. B30503011	F.A.P. NO.

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

SAMPLE NO.	SAMPLE TYPE	HEAT NO.	SIZE	AREA BEFORE	AREA AFTER	YIELD ~~MPa~~ ACTUAL	YIELD PSI	ULTIMATE PSI ACTUAL	ULTIMATE ~~MPa~~	ELONG. ~~IN~~ %	RED. AREA %	COLD BEND	CHEMICAL ANALYSIS C	MN	P	S	SI	A OR E
OYP-A		OYP	.493	2.003	2.3275		147984		165140	16.2								
OYP-B		"	.490	2.003	2.330		148008		164460	16.3								
OYI-A		OYI	.503	.2003	2.353		136395		154630	17.5								
OYI-B		OYI	.493	.2003	2.340		139287		158260	16.8								

SPECIFICATIONS

REMARKS A354 Grade BD

DATE TESTED 10/25/11	TESTED BY [signature]	APPROVED BY

FM 3018 M 95

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TM-3 (REV. 07/11)

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Agila B Martz

FASTENER ASSEMBLY WORKSHEET

SM Number	11-1038, 1039	Lot Number	B30502811 B30503011	Date Received	
Contract Number	04-0120 F4	TL-0101 Number	C711635 C711637	Date Tested	10/21/11
Lab Technician	FRED	Test Temperature	70°	Page _____ of _____	

BOLTS: A354 Grade BD

Sample No.	~~1A~~	~~1B~~	2		04P		
Heat / Mfg. Lot No.	~~04G~~	~~6W~~	04I		We got only a Slug		
Product Markings	—		—				
Size	~~3.5"~~		3.5"				
Pitch Diameter	~~3.32951~~	~~3.32951~~	3.32951	3.32951			
Bolt Length							
Ring Gage Go/No-Go	—						
Zinc Coating Thick.	—						
Hardness: Rc / Rb	—						
Spacing	—						
.500 ~~Wedge~~ Tensile							

NUTS:

Sample No.							
Mfg. Lot No.							
Product Markings							
Size							
Plug Gage Go/No-Go							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							
Nut Proof Load							

WASHER:

Sample No.							
Mfg. Lot No.							
Product Markings							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							

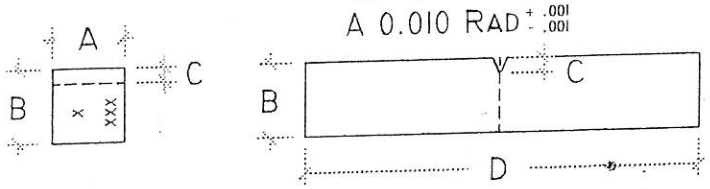
STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652a (REV. 10/10)

Specimen Preparation Information

SM # 11-1039
EA #
HEAT # 04P
PREPARED BY ma
DATE 10-25-11

Charpy Impact Specimens

45° V NOTCH WITH
A 0.010 RAD $^{+.001}_{-.001}$



MATERIAL SURFACE

SPEC # x
HEAT # xxx

NOTCH ORIENTATION

	OK
1	
2	
3	

SPC #	A	B	C	D
	NOTE #2	0.394 $^{+.001}_{-.001}$	0.079 $^{+.001}_{-.001}$	2.165 $^{+.000}_{-.100}$
1				
2				
3				

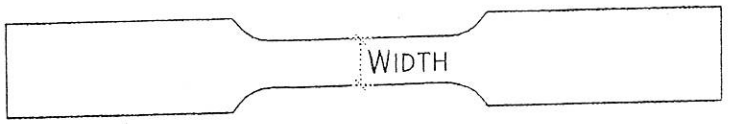
NOTE:
1. ALL MEASUREMENTS IN INCHES
2. MEASUREMENT "A" 0.394, 0.295, 0.197, 0.098
   TOLERANCE $^{+.001}_{-.001}$
3. SPECIMENS ARE TO BE SURFACE GROUND

Reduced Tensile Round Specimens

SPC #	DIA
A	.494
B	.490

NOTE: SPECIMEN DIA
1. 0.500 $^{+.010}_{-.010}$
2. 0.350 $^{+.007}_{-.007}$

Reduced Tensile Flat Specimens



SPC #	WIDTH
A	
B	

NOTE: SPECIMEN WIDTH
1. 0.500 $^{+.010}_{-.010}$

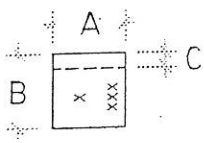
APPROVED FOR USE BY SMTL
QUALITY MANAGER
Gyle B Martz

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652a (REV. 10/10)

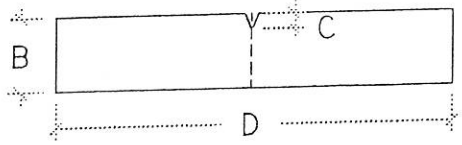
Specimen Preparation Information

SM #11-1039
EA #
HEAT #041
PREPARED BY ms
DATE 10-25-11

Charpy Impact Specimens



45° V NOTCH WITH
A 0.010 RAD $^{+.001}_{-.001}$



MATERIAL SURFACE

SPEC # x
HEAT # xxx

NOTCH ORIENTATION

	OK
1	
2	
3	

SPC #	A	B	C	D
	NOTE #2	0.394 $^{+.001}_{-.001}$	0.079 $^{+.001}_{-.001}$	2.165 $^{+.000}_{-.100}$
1				
2				
3				

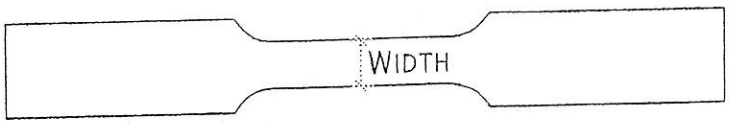
NOTE:
1. ALL MEASUREMENTS IN INCHES
2. MEASUREMENT "A" 0.394, 0.295, 0.197, 0.098
   TOLERANCE $^{+.001}_{-.001}$
3. SPECIMENS ARE TO BE SURFACE GROUND

Reduced Tensile Round Specimens

SPC #	DIA
A	.503
B	.494

NOTE: SPECIMEN DIA
1. 0.500 $^{+.010}_{-.010}$
2. 0.350 $^{+.007}_{-.007}$

Reduced Tensile Flat Specimens



SPC #	WIDTH
A	
B	

NOTE: SPECIMEN WIDTH
1. 0.500 $^{+.010}_{-.010}$

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Angela G Martz

DM-11-10 39

Steel Dynamics, Inc.
Engineered Bar Products Division

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE OY I

Certified Material Test Report

Cert # : 117655	Mill Order : 1109058	Heat # : A113149	Issued : 8/30/2011 09:38:57
Work Order : 115418	Sales Order : 95886-1	Customer : Turret Steel Industries	PO # : 33033-1
Load # : 141557	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"
Grain Practice : Al Fine Grain (5-8) per ASTM A29		Reduction Ratio : 12.9 to 1	Disposition : 1

Ladle Chemistry Analysis (ASTM A29)

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	B	Ca	W	Ti	DI
0.41	0.95	0.009	0.006	0.27	0.025	0.18	0.16	0.99	0.22	0.011	0.0069	0.004	0.002	0.0001	0.0013	0.000	0.002	6.31

Pb	Co	As	Sb	Zr	Bi	H	O	Ceq	J-Factor
0.001	0.008	0.005	0.003	0.001	0.001	1.6		0.84	

Product Check Analysis (ASTM A29)

	C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	Ti	B	Ca	O
Front																		
Back																		

Jominy (ASTM A255)

	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J12	J14	J16	J18	J20	J24	J28	J32
Calc'd	57	57	57	57	57	57	57	57	57	57	55	52	50	50	49	48	47	43
Front																		
Back																		

Microcleanliness (ASTM E45)

Method A								Method C		Method E	
AT	AH	BT	BH	CT	CH	DT	DH	S	O	SAM "B"	SAM "D"

Microcleanliness (DIN 50602)

K			M
S	O	Tot	Tot

Decarb

Depth	% of Diameter

Grainsize

Austenitic	Ferritic
7	

Macrostructure (ASTM E381)

S	R	C

Magnetic Particle Inspection

Frequency	Severity

Mechanical Properties (ASTM A370)

Tensile Properties					Hardness	
Tensile Strength	0.2% Yield Strength	% Elong (2")	% ROA	0.35% EUL Yield Strength	(MR)	(Surf)

Steel Dynamics - Engineered Bar Products has a quality system in place which has been certified ISO 9001:2008 compliant, including PED certification.

Comments/Specs

ASTM A322-07 ----- Quench & Temper, Straighten, Stress Relieve ----- Contact Ultrasonic Inspected to 1/8" FBH ----- ASTM A354 Grade BD

Q.A. REVIEWED
DATE 8/31/11
DYSON

Batch # H222

Condition : Quench, Temper, Temper, Straighten, Straighten, Stress Relieve, Contact UT

UT: Passed Ultrasonic Inspection

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Dylan Kale - Rolling Mill Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results. No weld repair has been performed on this material. This material is not radioactive and has not been exposed to radioactivity while under the control of Steel Dynamics. This material has not been exposed to mercury while under the control of Steel Dynamics. Unless otherwise noted, this material was melted, continually cast, and rolled in the USA; w/ all testing performed by Steel Dynamics.

Steel Dynamics, Inc.
Engineered Bar Products Division • Pittsboro, Indiana

CODE OYI

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

Certified Material Test Report

Heat Treatment Addendum

Cert # : 117655	Mill Order : 1109058	Heat # : A113149	Issued : 8/29/2011
Work Order : 115418	Sales Order : 95886	Customer : Turrel Steel Industries	PO # : 33033 / 1
Load # :	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"

Normalize		Austentize		Quench Media			Temper		Stress Relieve	
Time	Temp	Time	Temp	Type	Time	Temp	Time	Temp	Time	Temp
hrs	°F	2.5 hrs	1650 °F	Water	15 min	95-99 °F	6.3 hrs	1025 °F	5.0 hrs	900 °F

* Furnaces are calibrated to API 6A Annex P, and use atmospheric thermocouples

** QTC is 12" prolongation from longitudinal orientation machined to a 0.505" buttonhead for tensile.

Hardness (ASTM A370)

Bundle #	Batch #	Location	HB	Rb	Rc
1138928	H208	Mid-Rad Q1			35
1138926	H210	Mid-Rad Q1			35
1138927	H210	Mid-Rad Q1			35
1138929	H222	Mid-Rad Q1			36

Tensile (ASTM A370)

Bundle #	Batch #	Orientation	Location	Tensile	0.2% Yield	%E (2")	%ROA
1138928	H208	Longitudinal	Mid-Rad Q1	153,800 psi	132,400 psi	16	52
1138926	H210	Longitudinal	Mid-Rad Q1	155,700 psi	134,500 psi	15	51
1138927	H210	Longitudinal	Mid-Rad Q1	155,700 psi	134,500 psi	15	51
1138929	H222	Longitudinal	Mid-Rad Q1	155,500 psi	134,500 psi	15	52

Q.A. REVIEWED
DATE 8/31/11
BYSON

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Garrett Bouyett - Bar Finishing Metallurgist

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Steel Dynamics, Inc.
Engineered Bar Products Division

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE OYP

Certified Material Test Report

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/30/2011 09:38:57
Work Order : 115418	Sales Order : 95886-1	Customer : Turret Steel Industries	PO # : 33033-1
Load # : 141557	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"
Grain Practice : Al Fine Grain (5-8) per ASTM A29		Reduction Ratio : 12.9 to 1	Disposition : 1

Ladle Chemistry Analysis (ASTM A29)

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	B	Ca	W	Ti	DI
0.40	0.96	0.009	0.005	0.25	0.024	0.20	0.07	0.98	0.22	0.011	0.0081	0.004	0.002	0.0001	0.0009	0.000	0.001	6.09

Pb	Co	As	Sb	Zr	Bi	H	O	Ceq	J-Factor
0.001	0.008	0.005	0.003	0.001	0.000	1.4		0.82	

Product Check Analysis (ASTM A29)

	C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	Ti	B	Ca	O
Front																		
Back																		

Jominy (ASTM A255)

	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J12	J14	J16	J18	J20	J24	J28	J32
Calc'd	56	56	56	56	56	56	56	56	56	54	50	51	48	48	47	46	45	41
Front																		
Back																		

Microcleanliness (ASTM E45)

Method A								Method C		Method E	
AT	AH	BT	BH	CT	CH	DT	DH	S	O	SAM "B"	SAM "D"

Microcleanliness (DIN 50602)

K			M
S	O	Tot	Tot

Decarb

Depth	% of Diameter

Grainsize

Austenitic	Ferritic
7	

Macrostructure (ASTM E381)

S	R	C

Magnetic Particle Inspection

Frequency	Severity

Mechanical Properties (ASTM A370)

Tensile Properties					Hardness	
Tensile Strength	0.2% Yield Strength	% Elong (2")	% ROA	0.35% EUL Yield Strength	(MR)	(Surf)

Steel Dynamics - Engineered Bar Products has a quality system in place which has been certified ISO 9001:2008 compliant, including PED certification.

Comments/Specs

ASTM A322-07 ----- Quench & Temper, Straighten, Stress Relieve ----- Contact Ultrasonic Inspected to 1/8" FBH ----- ASTM A354 Grade BD

Q.A. REVIEWED
DATE 8/31/11
DYSON

Batch # H222

Condition : Quench, Temper, Temper, Straighten, Stress Relieve, Contact UT

UT: Passed Ultrasonic Inspection

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Dylan Kale - Rolling Mill Metallurgist

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Steel Dynamics, Inc.
Engineered Bar Products Division • Pittsboro, Indiana

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE 04P

Certified Material Test Report

Heat Treatment Addendum

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/29/2011
Work Order : 115418	Sales Order : 95886	Customer : Turret Steel Industries	PO # : 33033 / 1
Load # :	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"

Normalize		Austentize		Quench Media			Temper		Stress Relieve	
Time	Temp	Time	Temp	Type	Time	Temp	Time	Temp	Time	Temp
hrs	°F	2.5 hrs	1650 °F	Water	15 min	95-99 °F	6.3 hrs	1025 °F	5.0 hrs	900 °F

* Furnaces are calibrated to API 6A Annex P, and use atmospheric thermocouples

** QTC is 12" prolongation from longitudinal orientation machined to a 0.505" buttonhead for tensile.

Hardness (ASTM A370)

Bundle #	Batch #	Location		HB	Rb	Rc
1138941	H207	Mid-Rad	Q1			36
1138943	H207	Mid-Rad	Q1			36
1138939	H208	Mid-Rad	Q1			36
1138933	H211	Mid-Rad	Q1			36
1138934	H211	Mid-Rad	Q1			36
1138932	H214	Mid-Rad	Q1			36
1138931	H214	Mid-Rad	Q1			36
1138944	H215	Mid-Rad	Q1			36
1138936	H215	Mid-Rad	Q1			36
1138942	H217	Mid-Rad	Q1			36
1138949	H217	Mid-Rad	Q1			36
1138948	H222	Mid-Rad	Q1			36

Tensile (ASTM A370)

Bundle #	Batch #	Orientation	Location		Tensile	0.2% Yield	%E (2")	%ROA
1138941	H207	Longitudinal	Mid-Rad	Q1	147,600 psi	124,200 psi	16	54
1138943	H207	Longitudinal	Mid-Rad	Q1	147,600 psi	124,200 psi	16	54
1138939	H208	Longitudinal	Mid-Rad	Q1	151,700 psi	129,700 psi	16	54
1138933	H211	Longitudinal	Mid-Rad	Q1	147,100 psi	123,200 psi	16	54
1138934	H211	Longitudinal	Mid-Rad	Q1	147,100 psi	123,200 psi	16	54
1138932	H214	Longitudinal	Mid-Rad	Q1	151,600 psi	128,900 psi	16	53
1138931	H214	Longitudinal	Mid-Rad	Q1	151,600 psi	128,900 psi	16	53
1138944	H215	Longitudinal	Mid-Rad	Q1	156,500 psi	135,300 psi	16	53
1138936	H215	Longitudinal	Mid-Rad	Q1	156,500 psi	135,300 psi	16	53
1138942	H217	Longitudinal	Mid-Rad	Q1	152,000 psi	130,000 psi	15	52
1138949	H217	Longitudinal	Mid-Rad	Q1	152,000 psi	130,000 psi	15	52
1138948	H222	Longitudinal	Mid-Rad	Q1	148,200 psi	125,300 psi	16	55

Q.A. REVIEWED
DATE 8/31/11
BYSON

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Garrett Bouyett - Bar Finishing Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results.

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652 (REV. 3/05)

TEST SPECIMEN PREPARATION AND RECORD

APPROVED FOR USE BY SMTL
QUALITY MANAGER: B Berger

SM No.	Contract No.	Requesting Lab Technician	Date Needed
11-1039	04-0120F4	Glen	ASAP
TL-0101 No.	**E.A./Spec. Desg./Object**	**Date Received**	**Date Tested/Provided**
C711637	0400000018 3	10-17-11	

[X] Machine Shop

Work Requested

[X] standard ~~round~~ tension test specimen, circle one: 0.500"

[] standard rectangular tension test specimen, circle one: 18" long, 8" gage
8" long, 2" gage length

[] Charpy, circle one: 10mm x 10mm
10mm x 7.5mm

[] hardness measurement sample (fasteners)

[] weld nugget

[] chemistry slug

[] other: _____

[] see instructions →

2 505's per each Slug, OYI & OYP

[] Chemistry Lab

type of material:

Work Requested

[] neoprene verification

[] oil swell

[] zinc coating weight

[] steel chemistry analysis

[] other: _____

← [] see instructions

[] Other (explain)

Comments or further instructions

The received service is acceptable

Receiving Lab Technician

10/25/11
Date

State of California
Department of Transportation

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

TEST REPORT

ACCREDITED
CERTIFICATE NO. 2364.01

Remarks ref: ASTM A354 BD, TM03. Heat #A113151 & Code #OYL

Sample No: SM-11-1040
Date Sampled: 10/12/11 **Date Rec'd:** 10/17/11 **Date Reported:** 10/26/11
Lot No: B30503211 **TL-101 / SIC No:** C711639
Contract/Permit No: 04-0120F4
Material: 3.5" A354 BD Main Cable Anchor Rods
Manufacturer: Dyson / Steel Dynamics
Sampler: Fred Edmondson

10-26

Results: SAMPLES SUBMITTED ARE SATISFACTORY FOR USE

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

10-17 SM-11-1040

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
SAMPLE IDENTIFICATION CARD
TL-0101 (REV. 10/97)
CARD NUMBER C711639

☐ PRELIMINARY TESTS
☐ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

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

FIELD NO.
DIST. LAB NO.
LOT NO. B305-032-11
SHIPMENT NO.
P.O. OR REQ. NO.
AUTHORIZATION NO.

SAMPLE OF 3.5 inch main cable anchor
FOR USE IN Rods A354 GR BD Q+T
SAMPLE FROM Dyson
Painesville, OH
DEPTH Heat treatment lot OYL
LOCATION OF SOURCE Ht. No. A113151
THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) 1
AND IS ONE OF A GROUP OF 4
SAMPLES REPRESENTING (TONS, GALS, BBLS, STA, ETC.) Lot
OWNER OR MANUFACTURER
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☐ NORMAL ☐ PRIORITY
DATE NEEDED
REMARKS 1-upper ex. 120mm threaded
2-upper ex. 360mm threaded
5 ft. lg.
COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 10-12-11
BY Fred Edmondson TITLE QA Inspector
DIST, CO, RTE, PM 04 - 012 - 04
LIMITS Special Provision
CONT. NO.
FED. NO.
RES. ENGR. OR SUPT. Pete Sigenthaler
ADDRESS Burma Road, Oakland CA
CONTRACTOR ABF

ENCLOSE WITH SAMPLE

Lab Manager

Quality Manager

Print

Steel Dynamics, Inc.
Engineered Bar Products Division • Pittsboro, Indiana

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE OYL

Certified Material Test Report

Heat Treatment Addendum

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/29/2011
Work Order : 115418	Sales Order : 95886	Customer : Turret Steel Industries	PO # : 33033 / 1
Load # :	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"

Normalize		Austentize		Quench Media			Temper		Stress Relieve	
Time	Temp	Time	Temp	Type	Time	Temp	Time	Temp	Time	Temp
hrs	°F	2.5 hrs	1650 °F	Water	15 min	95-99 °F	6.3 hrs	1025 °F	5.0 hrs	900 °F

* Furnaces are calibrated to API 6A Annex P, and use atmospheric thermocouples

** QTC is 12" prolongation from longitudinal orientation machined to a 0.505" buttonhead for tensile.

Hardness (ASTM A370)

Bundle #	Batch #	Location		HB	Rb	Rc
1138941	H207	Mid-Rad	Q1			36
1138943	H207	Mid-Rad	Q1			36
1138939	H208	Mid-Rad	Q1			36
1138933	H211	Mid-Rad	Q1			36
1138934	H211	Mid-Rad	Q1			36
1138932	H214	Mid-Rad	Q1			36
1138931	H214	Mid-Rad	Q1			36
1138944	H215	Mid-Rad	Q1			36
1138936	H215	Mid-Rad	Q1			36
1138942	H217	Mid-Rad	Q1			36
1138949	H217	Mid-Rad	Q1			36
1138948	H222	Mid-Rad	Q1			36

Tensile (ASTM A370)

Bundle #	Batch #	Orientation	Location		Tensile	0.2% Yield	%E (2")	%ROA
1138941	H207	Longitudinal	Mid-Rad	Q1	147,600 psi	124,200 psi	16	54
1138943	H207	Longitudinal	Mid-Rad	Q1	147,600 psi	124,200 psi	16	54
1138939	H208	Longitudinal	Mid-Rad	Q1	151,700 psi	129,700 psi	16	54
1138933	H211	Longitudinal	Mid-Rad	Q1	147,100 psi	123,200 psi	16	54
1138934	H211	Longitudinal	Mid-Rad	Q1	147,100 psi	123,200 psi	16	54
1138932	H214	Longitudinal	Mid-Rad	Q1	151,600 psi	128,900 psi	16	53
1138931	H214	Longitudinal	Mid-Rad	Q1	151,600 psi	128,900 psi	16	53
1138944	H215	Longitudinal	Mid-Rad	Q1	156,500 psi	135,300 psi	16	53
1138936	H215	Longitudinal	Mid-Rad	Q1	156,500 psi	135,300 psi	16	53
1138942	H217	Longitudinal	Mid-Rad	Q1	152,000 psi	130,000 psi	15	52
1138949	H217	Longitudinal	Mid-Rad	Q1	152,000 psi	130,000 psi	15	52
1138948	H222	Longitudinal	Mid-Rad	Q1	148,200 psi	125,300 psi	16	55

Q.A. REVIEWED
DATE 8/31/11
DYSON

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Garrett Bouyett - Bar Finishing Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results.

SM-11-1040

Steel Dynamics, Inc.
Engineered Bar Products Division

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE OYL

Certified Material Test Report

Cert # : 116463
Work Order : 115418
Load # : 141557
Size : 3-3/4"
Grain Practice : Al Fine Grain (5-8) per ASTM A29

Mill Order : 1109059
Sales Order : 95886-1
Reference # :
Shape : Round

Heat # : A113151
Customer : Turret Steel Industries
Reference Desc :
Grade : 4140
Reduction Ratio : 12.9 to 1

Issued : 8/30/2011 09:38:57
PO # : 33033-1
End Use :
Length : 32'00"
Disposition : 1

Ladle Chemistry Analysis (ASTM A29)

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	B	Ca	W	Ti	Dl
0.40	0.96	0.009	0.005	0.25	0.024	0.20	0.07	0.98	0.22	0.011	0.0081	0.004	0.002	0.0001	0.0009	0.000	0.001	6.09

Pb	Co	As	Sb	Zr	Bi	H	O	Ceq	J-Factor
0.001	0.008	0.005	0.003	0.001	0.000	1.4		0.82	

Product Check Analysis (ASTM A29)

	C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	Ti	B	Ca	O
Front																		
Back																		

Jominy (ASTM A255)

	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J12	J14	J16	J18	J20	J24	J28	J32
Calc'd	56	56	56	56	56	56	56	56	56	54	50	51	48	48	47	46	45	41
Front																		
Back																		

Microcleanliness (ASTM E45)

Method A								Method C		Method E	
AT	AH	BT	BH	CT	CH	DT	DH	S	O	SAM "B"	SAM "D"

Microcleanliness (DIN 50602)

K			M
S	O	Tot	Tot

Decarb

Depth	% of Diameter

Grainsize

Austenitic	Ferritic
7	

Macrostructure (ASTM E381)

S	R	C

Magnetic Particle Inspection

Frequency	Severity

Mechanical Properties (ASTM A370)

Tensile Properties					Hardness	
Tensile Strength	0.2% Yield Strength	% Elong (2")	% ROA	0.35% EUL Yield Strength	(MR)	(Surf)

Steel Dynamics - Engineered Bar Products has a quality system in place which has been certified ISO 9001:2008 compliant, including PED certification.

Comments/Specs

ASTM A322-07 ----- Quench & Temper, Straighten, Stress Relieve ----- Contact Ultrasonic Inspected to 1/8" FBH ----- ASTM A354 Grade BD

Q.A. REVIEWED
DATE 8/31/11
DYSON

Batch # H211

Condition : Quench, Temper, Temper, Straighten, Stress Relieve, Contact UT

UT: Passed Ultrasonic Inspection

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Dylan Kale - Rolling Mill Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results. No weld repair has been performed on this material. This material is not radioactive and has not been exposed to radioactivity while under the control of Steel Dynamics. This material has not been exposed to mercury while under the control of Steel Dynamics. Unless otherwise noted, this material was melted, continually cast, and rolled in the USA; w/ all testing performed by Steel Dynamics.

.500 SAMPLES

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

SM Number = 11-1040

Temperature 71°

Sample	Heat Number	Diameter	Area	Stress at Offset	Tensile Strength	Elongation in 4 x d	Tested By
		(in)	*(in²)*	*(psi)*	*(psi)*	*(%)*	
OYL-A	OYL	0.503	0.1987	140080	159090	17	FSaylor
OYL-B	OYL	0.503	0.1987	130782	150440	16.6	FSaylor
				OK	OK	OK	

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

TRANSPORTATION LABORATORY
REPORT OF TESTS

TL - 619 (REV. 5/95)

S. M. NO. 11-1040	DATE RECEIVED 10/17/11
T 101 NO. C711639	CONT. . W.O.. OR P.O. NO. 04-0120F4
LOT NO. B 305-03211	F.A.P. NO.

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

SAMPLE NO.	SAMPLE TYPE	HEAT NO.	SIZE	AREA BEFORE	AREA AFTER	YIELD ~~MPa~~ ACTUAL	YIELD PSI	ULTIMATE PSI ACTUAL	ULTIMATE ~~MPa~~	ELONG. ~~IN~~ %	RED. AREA %	COLD BEND	CHEMICAL ANALYSIS C	MN	P	S	SI	A OR E
04L-A		04L	.503	2.003	2.3435		140080		159090	17.0								
04L-B		"	.503	2.003	2.335		130782		150440	16.6								

SPECIFICATIONS

REMARKS A354 Grade BD

DATE TESTED 10/25/11 | TESTED BY [signature] | APPROVED BY

FM 3018 M 95

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TM-3 (REV. 07/11)

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Agile A Martz

FASTENER ASSEMBLY WORKSHEET

SM Number	11-1040	Lot Number		Date Received	
Contract Number		TL-0101 Number		Date Tested	
Lab Technician		Test Temperature		Page _____ of _____	

BOLTS:

Sample No.	1						
Heat / Mfg. Lot No.	04L						
Product Markings	—						
Size	3.5"						
Pitch Diameter	3.329	3.327	✓				
Bolt Length							
Ring Gage Go/No-Go	—						
Zinc Coating Thick.	—						
Hardness: Rc / Rb	—						
Spacing	—						
1500 ~~Wedge~~ Tensile							

NUTS:

Sample No.							
Mfg. Lot No.							
Product Markings							
Size							
Plug Gage Go/No-Go							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							
Nut Proof Load							

WASHER:

Sample No.							
Mfg. Lot No.							
Product Markings							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652 (REV. 3/05)

TEST SPECIMEN PREPARATION AND RECORD

APPROVED FOR USE BY SMTL
QUALITY MANAGER: B Berger

SM No.	Contract No.	Requesting Lab Technician	Date Needed
11-1040	04-0120F4	Glen	Routine
TL-0101 No.	**E.A./Spec. Desg./Object**	**Date Received**	**Date Tested/Provided**
C711639	0400000018 3	10-17-11	

[X] Machine Shop
Work Requested
[X] standard round tension test specimen, circle one: 0.500"
[] standard rectangular tension test specimen, circle one: 18" long, 8" gage
8" long, 2" gage length
[] Charpy, circle one: 10mm x 10mm
10mm x 7.5mm
[] hardness measurement sample (fasteners)
[] weld nugget
[] chemistry slug
[] other: _____
[] see instructions →

2 505's per each Slug. OYL

[] Chemistry Lab
type of material:
Work Requested
[] neoprene verification
[] oil swell
[] zinc coating weight
[] steel chemistry analysis
[] other: _____
← [] see instructions

[] Other (explain)

Comments or further instructions

The received service is acceptable

Receiving Lab Technician

10/25/11
Date

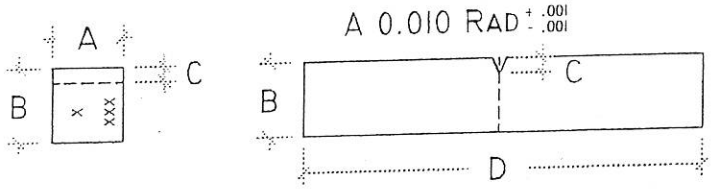
STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652a (REV. 10/10)

Specimen Preparation Information

SM #11-1040
EA #
HEAT # 04L
PREPARED BY ma
DATE 10-25-11

Charpy Impact Specimens

45° V NOTCH WITH
A 0.010 RAD $^{+.001}_{-.001}$



MATERIAL SURFACE

SPEC # x
HEAT # xxx

NOTCH ORIENTATION

	OK
1	
2	
3	

SPC #	A	B	C	D
	NOTE #2	0.394 $^{+.001}_{-.001}$	0.079 $^{+.001}_{-.001}$	2.165 $^{+.000}_{-.100}$
1				
2				
3				

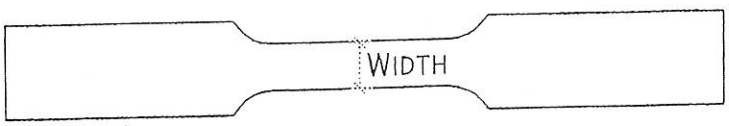
NOTE:
1. ALL MEASUREMENTS IN INCHES
2. MEASUREMENT "A" 0.394, 0.295, 0.197, 0.098
   TOLERANCE $^{+.001}_{-.001}$
3. SPECIMENS ARE TO BE SURFACE GROUND

Reduced Tensile Round Specimens

SPC #	DIA
A	.504
B	.504

NOTE: SPECIMEN DIA
1. 0.500 $^{+.010}_{-.010}$
2. 0.350 $^{+.007}_{-.007}$

Reduced Tensile Flat Specimens



SPC #	WIDTH
A	
B	

NOTE: SPECIMEN WIDTH
1. 0.500 $^{+.010}_{-.010}$

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Angela G Martz

State of California
Department of Transportation

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

TEST REPORT

ACCREDITED
CERTIFICATE NO. 2364.01

Remarks ref: ASTM A354 BD, TM03. Heat #A113151 & Code #OYO

Sample No: SM-11-1041
Date Sampled: 10/12/11 **Date Rec'd:** 10/17/11 **Date Reported:** 10/26/11
Lot No: B30503511 **TL-101 / SIC No:** C711642
Contract/Permit No: 04-0120F4
Material: 3.5" A354 BD Main Cable Anchor Rods
Manufacturer: Dyson / Dynamic Steel
Sampler: Fred Edmondson

10-26

Results: SAMPLES SUBMITTED ARE SATISFACTORY FOR USE

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

10-17 SM-11-1041

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
SAMPLE IDENTIFICATION CARD
TL-0101 (REV. 10/97)
CARD NUMBER C711642

☐ PRELIMINARY TESTS
☐ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

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

FIELD NO.
DIST. LAB NO.
LOT NO. B305-035-11
SHIPMENT NO.
P.O. OR REQ. NO.
AUTHORIZATION NO.

SAMPLE OF 3.5 inch main cable anchor
FOR USE IN rods A354 Gr BD OXT
PWS Anchorage
SAMPLE FROM Dyson
Painesville, OH
DEPTH Heat treatment lot OYO
LOCATION OF SOURCE HT. NO. A113151
THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) 1 pallet
AND IS ONE OF A GROUP OF 4
SAMPLES REPRESENTING (TONS, GALS, BBLS, STA., ETC.) Lots
OWNER OR MANUFACTURER
TOTAL QUANTITY AVAILABLE 8
TEST RESULTS DESIRED ☐ NORMAL ☐ PRIORITY
DATE NEEDED
REMARKS 1 - approx. 1200 mm threaded
2 - approx. 300 mm round
stock
COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 10-12-11
BY Fred Edmondson
TITLE DA Inspector
DIST., CO., RTE., PM SF08B
LIMITS Special Provisions
CONT. NO. 04-0120F4
FED. NO.
RES. ENGR. OR SUPT. Pete Siegenthaler
ADDRESS Buena Park, California
CONTRACTOR ABF

ENCLOSE WITH SAMPLE

Lab Manager Quality Manager

Print

.500 SAMPLES

Caltrans

SM Number = 11-1041

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

Temperature 71°

Sample	Heat Number	Diameter	Area	Stress at Offset	Tensile Strength	Elongation in 4 x d	Tested By
		(in)	*(in²)*	*(psi)*	*(psi)*	*(%)*	
OYO-A	OYO	0.503	0.1987	129623	149080	17.6	FSaylor
OYO-B	OYO	0.504	0.1995	137048	156750	16.2	FSaylor
				OK	OK	OK	

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

TRANSPORTATION LABORATORY
REPORT OF TESTS

TL - 619 (REV. 5/95)

S. M. NO. 11-1041	DATE RECEIVED 10/17/11
T 101 NO. C711642	CONT. . W.O.. OR P.O. NO. 04-0120F4
LOT NO. B305035 11	F.A.P. NO.

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

SAMPLE NO.	SAMPLE TYPE	HEAT NO.	SIZE	AREA BEFORE	AREA AFTER	YIELD ~~MPa~~ ACTUAL	YIELD PSI	ULTIMATE PSI ACTUAL	ULTIMATE ~~MPa~~	ELONG. ~~IN~~ %	RED. AREA %	COLD BEND	CHEMICAL ANALYSIS C	MN	P	S	SI	A OR E
040-A		040	.503	2.003	2.3565		129623		149080	17.6								
040-B		"	.504	2.003	2.328		137048		156750	16.2								

SPECIFICATIONS

REMARKS A354 Grade BD

DATE TESTED 10/25/11	TESTED BY [signature]	APPROVED BY

FM 3018 M 95

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TM-3 (REV. 07/11)

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Angela B Martz

FASTENER ASSEMBLY WORKSHEET

SM Number	11-1041	Lot Number		Date Received	
Contract Number		TL-0101 Number		Date Tested	
Lab Technician		Test Temperature		Page _____ of _____	

BOLTS:

Sample No.	1						
Heat / Mfg. Lot No.	040						
Product Markings	—						
Size	3.5						
Pitch Diameter	3.328	3.328	✓				
Bolt Length							
Ring Gage Go/No-Go	—						
Zinc Coating Thick.	—						
Hardness: Rc / Rb	—						
Spacing	—						
.500 ~~Wedge~~ Tensile							

NUTS:

Sample No.							
Mfg. Lot No.							
Product Markings							
Size							
Plug Gage Go/No-Go							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							
Nut Proof Load							

WASHER:

Sample No.							
Mfg. Lot No.							
Product Markings							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652 (REV. 3/05)

TEST SPECIMEN PREPARATION AND RECORD

APPROVED FOR USE BY SMTL
QUALITY MANAGER: B Berger

SM No.	Contract No.	Requesting Lab Technician	Date Needed
11-1041	04-0120F4	Glen	
TL-0101 No.	**E.A./Spec. Desg./Object**	**Date Received**	**Date Tested/Provided**
C711642	0400000018 3	10-17-11	

[X] Machine Shop

Work Requested

[X] standard round tension test specimen, circle one: 0.500"

[] standard rectangular tension test specimen, circle one: 18" long, 8" gage
8" long, 2" gage length

[] Charpy, circle one: 10mm x 10mm
10mm x 7.5mm

[] hardness measurement sample (fasteners)

[] weld nugget

[] chemistry slug

[] other: _____

[] see instructions →

2 505's per each Slug. OYO

[] Chemistry Lab

type of material:

Work Requested

[] neoprene verification

[] oil swell

[] zinc coating weight

[] steel chemistry analysis

[] other: _____

← [] see instructions

[] Other (explain)

Comments or further instructions

The received service is acceptable

Receiving Lab Technician

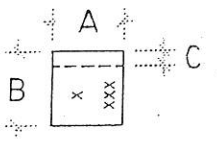
10/25/11
Date

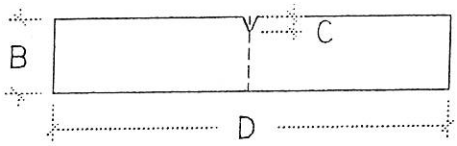
STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652a (REV. 10/10)

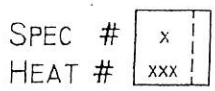
Specimen Preparation Information

SM # 11-1041
EA #
HEAT # 040
PREPARED BY ns
DATE 10-25-11

Charpy Impact Specimens







	OK
1	
2	
3	

SPC #	A	B	C	D
	NOTE #2	0.394 +.001 -.001	0.079 +.001 -.001	2.165 +.000 -.100
1				
2				
3				

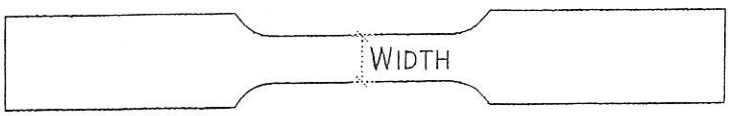
NOTE:
1. ALL MEASUREMENTS IN INCHES
2. MEASUREMENT "A" 0.394, 0.295, 0.197, 0.098
   TOLERANCE +.001 -.001
3. SPECIMENS ARE TO BE SURFACE GROUND

Reduced Tensile Round Specimens

SPC #	DIA
A	.503
B	.504

NOTE: SPECIMEN DIA
1. 0.500 +.010 -.010
2. 0.350 +.007 -.007

Reduced Tensile Flat Specimens



SPC #	WIDTH
A	
B	

NOTE: SPECIMEN WIDTH
1. 0.500 +.010 -.010

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Gyle H Martz

SM-11-1041

Steel Dynamics, Inc.
Engineered Bar Products Division

CODE 0410

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

Certified Material Test Report

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/30/2011 09:38:57
Work Order : 115418	Sales Order : 95886-1	Customer : Turret Steel Industries	PO # : 33033-1
Load # : 141557	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"
Grain Practice : Al Fine Grain (5-8) per ASTM A29		Reduction Ratio : 12.9 to 1	Disposition : 1

Ladle Chemistry Analysis (ASTM A29)

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	B	Ca	W	Ti	Dl
0.40	0.96	0.009	0.005	0.25	0.024	0.20	0.07	0.98	0.22	0.011	0.0081	0.004	0.002	0.0001	0.0009	0.000	0.001	6.09

Pb	Co	As	Sb	Zr	Bi	H	O	Ceq	J-Factor
0.001	0.008	0.005	0.003	0.001	0.000	1.4		0.82	

Product Check Analysis (ASTM A29)

	C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	Ti	B	Ca	O
Front																		
Back																		

Jominy (ASTM A255)

	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J12	J14	J16	J18	J20	J24	J28	J32
Calc'd	56	56	56	56	56	56	56	56	56	54	50	51	48	48	47	46	45	41
Front																		
Back																		

Microcleanliness (ASTM E45)

Method A								Method C		Method E	
AT	AH	BT	BH	CT	CH	DT	DH	S	O	SAM "B"	SAM "D"

Microcleanliness (DIN 50602)

K			M
S	O	Tot	Tot

Decarb

Depth	% of Diameter

Grainsize

Austenitic	Ferritic
7	

Macrostructure (ASTM E381)

S	R	C

Magnetic Particle Inspection

Frequency	Severity

Mechanical Properties (ASTM A370)

Tensile Properties					Hardness	
Tensile Strength	0.2% Yield Strength	% Elong (2")	% ROA	0.35% EUL Yield Strength	(MR)	(Surf)

Steel Dynamics - Engineered Bar Products has a quality system in place which has been certified ISO 9001:2008 compliant, including PED certification.

Comments/Specs

ASTM A322-07 ----- Quench & Temper, Straighten, Stress Relieve ----- Contact Ultrasonic Inspected to 1/8" FBH ----- ASTM A354 Grade BD

QA REVIEWED
DATE 8/31/11
BY SON

Batch # H217

Condition : Quench, Temper, Temper, Straighten, Stress Relieve, Contact UT

UT: Passed Ultrasonic Inspection

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Dylan Kale - Rolling Mill Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results. No weld repair has been performed on this material. This material is not radioactive and has not been exposed to radioactivity while under the control of Steel Dynamics. This material has not been exposed to mercury while under the control of Steel Dynamics. Unless otherwise noted, this material was melted, continually cast, and rolled in the USA; w/ all testing performed by Steel Dynamics.

Steel Dynamics, Inc.
Engineered Bar Products Division • Pittsboro, Indiana

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE OXO

Certified Material Test Report

Heat Treatment Addendum

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/29/2011
Work Order : 115418	Sales Order : 95886	Customer : Turret Steel Industries	PO # : 33033 / 1
Load # :	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"

Normalize		Austentize		Quench Media			Temper		Stress Relieve	
Time	Temp	Time	Temp	Type	Time	Temp	Time	Temp	Time	Temp
hrs	°F	2.5 hrs	1650 °F	Water	15 min	95-99 °F	6.3 hrs	1025 °F	5.0 hrs	900 °F

* Furnaces are calibrated to API 6A Annex P, and use atmospheric thermocouples

** QTC is 12" prolongation from longitudinal orientation machined to a 0.505" buttonhead for tensile.

Hardness (ASTM A370)

Bundle #	Batch #	Location	HB	Rb	Rc
1138941	H207	Mid-Rad Q1			36
1138943	H207	Mid-Rad Q1			36
1138939	H208	Mid-Rad Q1			36
1138933	H211	Mid-Rad Q1			36
1138934	H211	Mid-Rad Q1			36
1138932	H214	Mid-Rad Q1			36
1138931	H214	Mid-Rad Q1			36
1138944	H215	Mid-Rad Q1			36
1138936	H215	Mid-Rad Q1			36
1138942	H217	Mid-Rad Q1			36
1138949	H217	Mid-Rad Q1			36
1138948	H222	Mid-Rad Q1			36

Tensile (ASTM A370)

Bundle #	Batch #	Orientation	Location	Tensile	0.2% Yield	%E (2")	%ROA
1138941	H207	Longitudinal	Mid-Rad Q1	147,600 psi	124,200 psi	16	54
1138943	H207	Longitudinal	Mid-Rad Q1	147,600 psi	124,200 psi	16	54
1138939	H208	Longitudinal	Mid-Rad Q1	151,700 psi	129,700 psi	16	54
1138933	H211	Longitudinal	Mid-Rad Q1	147,100 psi	123,200 psi	16	54
1138934	H211	Longitudinal	Mid-Rad Q1	147,100 psi	123,200 psi	16	54
1138932	H214	Longitudinal	Mid-Rad Q1	151,600 psi	128,900 psi	16	53
1138931	H214	Longitudinal	Mid-Rad Q1	151,600 psi	128,900 psi	16	53
1138944	H215	Longitudinal	Mid-Rad Q1	156,500 psi	135,300 psi	16	53
1138936	H215	Longitudinal	Mid-Rad Q1	156,500 psi	135,300 psi	16	53
1138942	H217	Longitudinal	Mid-Rad Q1	152,000 psi	130,000 psi	15	52
1138949	H217	Longitudinal	Mid-Rad Q1	152,000 psi	130,000 psi	15	52
1138948	H222	Longitudinal	Mid-Rad Q1	148,200 psi	125,300 psi	16	55

Q.A. REVIEWED
DATE 8/31/11
DYSON

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Garrett Bouyell - Bar Finishing Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results.

State of California
Department of Transportation

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

TEST REPORT

ACCREDITED
CERTIFICATE NO. 2364.01

Remarks ref: ASTM A354 BD, TM03. Heat #A113151, Lot #OYM

Sample No: SM-11-1076
Date Sampled: 10/12/11 **Date Rec'd:** 10/17/11 **Date Reported:** 10/26/11
Lot No: B30503311 **TL-101 / SIC No:** C711640
Contract/Permit No: 04-0120F4
Material: 3.5" A354 BD Main Cable Anchor Rods
Manufacturer: Dyson / Steel Dynamics
Sampler: Fred Edmondson

10-26

Results: SAMPLES SUBMITTED ARE SATISFACTORY FOR USE

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

10-17 SM 11-1076

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
SAMPLE IDENTIFICATION CARD CARD NUMBER C711640
TL-0101 (REV. 10/97)

☐ PRELIMINARY TESTS ☐ PROCESS TESTS ☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS ☐ DIST. LAB ☐ TRANS. LAB
☐ SPECIAL TESTS

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

FIELD NO.
DIST. LAB NO.
LOT NO. B305-033-11
SHIPMENT NO.
P.O. OR REQ. NO.
AUTHORIZATION NO.

SAMPLE OF 3.5 inch main cable anchor Rods
FOR USE IN A354, Gr. BD QFT
PWL's Anchorage
SAMPLE FROM Dyson
Painesville OH
DEPTH
LOCATION OF SOURCE HT. Treatment Lot OYM
THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) 1 pallet
AND IS ONE OF A GROUP OF 4 pallets
SAMPLES REPRESENTING (TONS, GALS, BBLS, STA, ETC.) Lots
OWNER OR MANUFACTURER
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☐ NORMAL ☐ PRIORITY
DATE NEEDED
REMARKS 1-approx. 120mm threaded
2-approx. 300mm round
stock
COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 10-12-11
BY Fred Edmondson TITLE QA Inspector
DIST, CO, RTE, PM SCOPE
LIMITS Special Provisions
CONT. NO. 04-0120F4
FED. NO.
RES. ENGR. OR SUPT. Pete Sigrathaler
ADDRESS Barma Rd., Oakland, CA
CONTRACTOR ABF

ENCLOSE WITH SAMPLE

Lab Manager GH Quality Manager

Print

.500 SAMPLES

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

SM Number = 11-1076

Temperature 71°

Sample	Heat Number	Diameter	Area	Stress at Offset	Tensile Strength	Elongation in 4 x d	Tested By
		(in)	*(in²)*	*(psi)*	*(psi)*	*(%)*	
OYM-A	OYM	0.502	0.1979	135447	158440	17.6	FSaylor
OYM-B	OYM	0.498	0.1948	133984	154970	16.7	FSaylor
				OK	OK	OK	

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

TRANSPORTATION LABORATORY
REPORT OF TESTS

TL - 619 (REV. 5/95)

S. M. NO. 11-1076	DATE RECEIVED 10/17/11
T 101 NO. C711640	CONT. . W.O.. OR P.O. NO. 04-0120F4
LOT NO. B30503311	F.A.P. NO.

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

SAMPLE NO.	SAMPLE TYPE	HEAT NO.	SIZE	AREA BEFORE	AREA AFTER	YIELD ~~MPa~~ ACTUAL	YIELD PSI	ULTIMATE PSI ACTUAL	ULTIMATE ~~MPa~~	ELONG. ~~IN~~ %	RED. AREA %	COLD BEND	CHEMICAL ANALYSIS C	MN	P	S	SI	A OR E
04m-A		04m	.502	2.003	2.3565		135447		158440	17.6								
04m-B		"	.498	2.003	2.337		133984		154970	16.7								

SPECIFICATIONS

REMARKS A354 Grade BD

DATE TESTED 10/25/11	TESTED BY [signature]	APPROVED BY

FM 3018 M 95

SM-11-1076

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TM-3 (REV. 07/11)

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Agila B Martz

FASTENER ASSEMBLY WORKSHEET

SM Number		Lot Number	B30503311	Date Received	10-17
Contract Number	04-0120F4	TL-0101 Number	C711640	Date Tested	
Lab Technician		Test Temperature		Page 1 of 1	

BOLTS:

Sample No.							
Heat / Mfg. Lot No.	04M						
Product Markings							
Size	3.5"						
Pitch Diameter	3.328	3.324	✓				
Bolt Length							
Ring Gage Go/No-Go							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							
Wedge Tensile							

NUTS:

Sample No.							
Mfg. Lot No.							
Product Markings							
Size							
Plug Gage Go/No-Go							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							
Nut Proof Load							

WASHER:

Sample No.							
Mfg. Lot No.							
Product Markings							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652 (REV. 3/05)

TEST SPECIMEN PREPARATION AND RECORD

APPROVED FOR USE BY SMTL
QUALITY MANAGER: B Berger

SM No.	Contract No.	Requesting Lab Technician	Date Needed
11-1076	04-0120F4	FRAEL	ASAP
TL-0101 No.	**E.A./Spec. Desg./Object**	**Date Received**	**Date Tested/Provided**
C711640	04000000018-3	10/17	

[X] Machine Shop
Work Requested

[X] standard round tension test specimen, circle one: 0.500"

[] standard rectangular tension test specimen, circle one: 18" long, 8" gage
8" long, 2" gage length

[] Charpy, circle one: 10mm x 10mm
10mm x 7.5mm

[] hardness measurement sample (fasteners)

[] weld nugget

[] chemistry slug

[] other: _____

[] see instructions →

Slug 0YM

[] Chemistry Lab
type of material:
Work Requested

[] neoprene verification

[] oil swell

[] zinc coating weight

[] steel chemistry analysis

[] other: _____

← [] see instructions

[] Other (explain)

Comments or further instructions

The received service is acceptable

Fred Daugher
Receiving Lab Technician

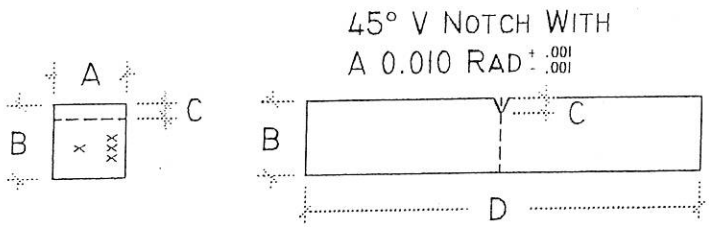
10/25/11
Date

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652a (REV. 10/10)

Specimen Preparation Information

SM # 11-1076
EA #
HEAT # 04m
PREPARED BY MA
DATE 10-25-11

Charpy Impact Specimens



MATERIAL SURFACE
SPEC # x
HEAT # xxx
NOTCH ORIENTATION

	OK
1	
2	
3	

SPC #	A	B	C	D
	NOTE #2	0.394 +.001 -.001	0.079 +.001 -.001	2.165 +.000 -.100
1				
2				
3				

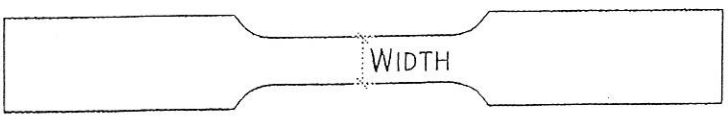
NOTE:
1. ALL MEASUREMENTS IN INCHES
2. MEASUREMENT "A" 0.394, 0.295, 0.197, 0.098
   TOLERANCE +.001 -.001
3. SPECIMENS ARE TO BE SURFACE GROUND

Reduced Tensile Round Specimens

SPC #	DIA
A	.502
B	.498

NOTE: SPECIMEN DIA
1. 0.500 +.010 -.010
2. 0.350 +.007 -.007

Reduced Tensile Flat Specimens



SPC #	WIDTH
A	
B	

NOTE: SPECIMEN WIDTH
1. 0.500 +.010 -.010

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Agile G Martz

SM 11-1076

Steel Dynamics, Inc.
Engineered Bar Products Division

CODE OYM

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

Certified Material Test Report

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/30/2011 09:38:57
Work Order : 115418	Sales Order : 95886-1	Customer : Turret Steel Industries	PO # : 33033-1
Load # : 141557	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"
Grain Practice : Al Fine Grain (5-8) per ASTM A29		Reduction Ratio : 12.9 to 1	Disposition : 1

Ladle Chemistry Analysis (ASTM A29)

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	B	Ca	W	Ti	DI
0.40	0.96	0.009	0.005	0.25	0.024	0.20	0.07	0.98	0.22	0.011	0.0081	0.004	0.002	0.0001	0.0009	0.000	0.001	6.09

Pb	Co	As	Sb	Zr	Bi	H	O	Ceq	J-Factor
0.001	0.008	0.005	0.003	0.001	0.000	1.4		0.82	

Product Check Analysis (ASTM A29)

	C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	Ti	B	Ca	O
Front																		
Back																		

Jominy (ASTM A255)

	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J12	J14	J16	J18	J20	J24	J28	J32
Calc'd	56	56	56	56	56	56	56	56	56	54	50	51	48	48	47	46	45	41
Front																		
Back																		

Microcleanliness (ASTM E45)

Method A								Method C		Method E	
AT	AH	BT	BH	CT	CH	DT	DH	S	O	SAM "B"	SAM "D"

Microcleanliness (DIN 50602)

K			M
S	O	Tot	Tot

Decarb

Depth	% of Diameter

Grainsize

Austenitic	Ferritic
7	

Macrostructure (ASTM E381)

S	R	C

Magnetic Particle Inspection

Frequency	Severity

Mechanical Properties (ASTM A370)

Tensile Properties					Hardness	
Tensile Strength	0.2% Yield Strength	% Elong (2")	% ROA	0.35% EUL Yield Strength	(MR)	(Surf)

Steel Dynamics - Engineered Bar Products has a quality system in place which has been certified ISO 9001:2008 compliant, including PED certification.

Comments/Specs

ASTM A322-07 ----- Quench & Temper, Straighten, Stress Relieve ----- Contact Ultrasonic Inspected to 1/8" FBH ----- ASTM A354 Grade BD

QA REVIEWED
DATE 8/31/11
DIVISION

Batch #H214

Condition : Quench, Temper, Temper, Straighten, Stress Relieve, Contact UT

UT: Passed Ultrasonic Inspection

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Dylan Kale - Rolling Mill Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results. No weld repair has been performed on this material. This material is not radioactive and has not been exposed to radioactivity while under the control of Steel Dynamics. This material has not been exposed to mercury while under the control of Steel Dynamics. Unless otherwise noted, this material was melted, continually cast, and rolled in the USA; w/ all testing performed by Steel Dynamics.

Steel Dynamics Rev Level 1 [115] - 275

Retrieved on : 8/30/2011 09:37:27

State of California
Department of Transportation

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

TEST REPORT

ACCREDITED
CERTIFICATE NO. 2364.01

Remarks ref: ASTM A354 BD, TM03. Heat #A113151, Lot #OYN

Sample No: SM-11-1077
Date Sampled: 10/12/11 **Date Rec'd:** 10/17/11 **Date Reported:** 10/26/11
Lot No: B30503411 **TL-101 / SIC No:** C711641
Contract/Permit No: 04-0120F4
Material: 3.5" A354 BD Main Cable Anchor Rods
Manufacturer: Dyson / Steel Dynamics
Sampler: Fred Edmondson 10-26

Results: SAMPLES SUBMITTED ARE SATISFACTORY FOR USE

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

10-17 SM 11-1077

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
SAMPLE IDENTIFICATION CARD CARD NUMBER C711641
TL-0101 (REV. 10/97)

☐ PRELIMINARY TESTS ☐ PROCESS TESTS ☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS ☐ DIST. LAB ☐ TRANS. LAB ☐ SPECIAL TESTS

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

FIELD NO. / DIST. LAB NO. / LOT NO. B305-03 -11 / SHIPMENT NO. / P.O. OR REQ. NO. B305-034-11 / AUTHORIZATION NO.

SAMPLE OF 3.5 inch maincable anchor
FOR USE IN rods A354, Gr. BD & T
SAMPLE FROM DYSON PWS Anchorage
DEPTH Pennsville, OH.
LOCATION OF SOURCE Heat treatment Lot OYN
THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) 1 pallet AND IS ONE OF A GROUP OF 4 SAMPLES REPRESENTING (TONS, GALS, BBLS, STA, ETC.) Lots
OWNER OR MANUFACTURER
TOTAL QUANTITY AVAILABLE 8' TEST RESULTS DESIRED ☐ NORMAL ☐ PRIORITY DATE NEEDED
REMARKS 1- approx. 12 mm threaded
2- approx 200 mm round
stock
COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 10-12-11
BY Fred Edmondson TITLE DA Inspector
DIST., CO., RTE., PM SFOBB
LIMITS Special Provisions
CONT. NO. 04-0120F4
FED. NO.
RES. ENGR. OR SUPT. Pete Sigenthaler
ADDRESS Burma Road, Oakland
CONTRACTOR ARE

ENCLOSE WITH SAMPLE

Lab Manager Quality Manager

Print

.500 SAMPLES

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

SM Number = 11-1077

Temperature 71°

Sample	Heat Number	Diameter	Area	Stress at Offset	Tensile Strength	Elongation in 4 x d	Tested By
		(in)	*(in²)*	*(psi)*	*(psi)*	*(%)*	
OYN-A	OYN	0.498	0.1948	145956	162660	16.7	FSaylor
OYN-B	OYN	0.503	0.1987	143423	161100	16.8	FSaylor
				OK	OK	OK	

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

TRANSPORTATION LABORATORY
REPORT OF TESTS

TL - 619 (REV. 5/95)

S. M. NO. 11-1077	DATE RECEIVED 10/17/11
T 101 NO. C711641	CONT. . W.O.. OR P.O. NO. 04-0120F4
LOT NO. B30503411	F.A.P. NO.

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

SAMPLE NO.	SAMPLE TYPE	HEAT NO.	SIZE	AREA BEFORE	AREA AFTER	YIELD ~~MPa~~ ACTUAL	YIELD PSI	ULTIMATE PSI ACTUAL	ULTIMATE ~~MPa~~	ELONG. ~~IN~~ %	RED. AREA %	COLD BEND	CHEMICAL ANALYSIS C	MN	P	S	SI	A OR E
DYN-A		DYN	.498	2.003	2.337		145856		162660	16.7								
DYN-B		"	.503	2.003	2.339		143423		161100	16.8								

SPECIFICATIONS

REMARKS A354 Grade BD

DATE TESTED 10/25/11	TESTED BY [signature]	APPROVED BY

FM 3018 M 95

SMH-1074

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TM-3 (REV. 07/11)

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Agila B Marty

FASTENER ASSEMBLY WORKSHEET

SM Number		Lot Number	B305034 11	Date Received	10-17
Contract Number	04-0120F4	TL-0101 Number	C711641	Date Tested	
Lab Technician		Test Temperature		Page 1 of 1	

BOLTS: A354 3½"

Sample No.							
Heat / Mfg. Lot No.	04N						
Product Markings							
Size	3.5						
Pitch Diameter	3.331	3.329	✓				
Bolt Length							
Ring Gage Go/No-Go	—						
Zinc Coating Thick.	—						
Hardness: Rc / Rb	—						
Spacing	—						
1500 ~~Wedge~~ Tensile							

NUTS:

Sample No.							
Mfg. Lot No.							
Product Markings							
Size							
Plug Gage Go/No-Go							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							
Nut Proof Load							

WASHER:

Sample No.							
Mfg. Lot No.							
Product Markings							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652 (REV. 3/05)

TEST SPECIMEN PREPARATION AND RECORD

APPROVED FOR USE BY SMTL
QUALITY MANAGER: B Berger

SM No.	Contract No.	Requesting Lab Technician	Date Needed
11-1077	04-0120F4	FRED	ASAP
TL-0101 No.	**E.A./Spec. Desg./Object**	**Date Received**	**Date Tested/Provided**
C711641	04000000018-3	10/17/11	

[X] Machine Shop

Work Requested

[X] standard round tension test specimen, circle one: 0.500"

[] standard rectangular tension test specimen, circle one: 18" long, 8" gage
8" long, 2" gage length

[] Charpy, circle one: 10mm x 10mm
10mm x 7.5mm

[] hardness measurement sample (fasteners)

[] weld nugget

[] chemistry slug

[] other: _____

[] see instructions →

Slug OYN

[] Chemistry Lab

type of material:

Work Requested

[] neoprene verification

[] oil swell

[] zinc coating weight

[] steel chemistry analysis

[] other: _____

← [] see instructions

[] Other (explain)

Comments or further instructions

The received service is acceptable

Fred Smith
Receiving Lab Technician

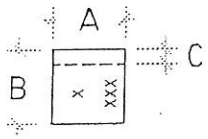
10/25/11
Date

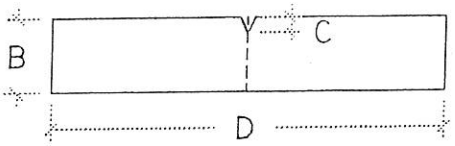
STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652a (REV. 10/10)

Specimen Preparation Information

SM # 11-1077
EA #
HEAT # OYN
PREPARED BY MA
DATE 10-25-11

Charpy Impact Specimens





MATERIAL SURFACE

SPEC # x
HEAT # xxx

NOTCH ORIENTATION

	OK
1	
2	
3	

SPC #	A	B	C	D
	NOTE #2	0.394 +.001 -.001	0.079 +.001 -.001	2.165 +.000 -.100
1				
2				
3				

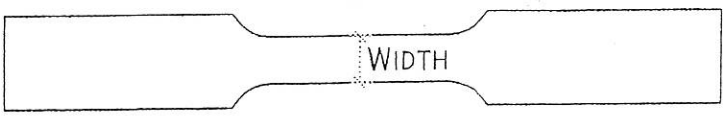
NOTE:
1. ALL MEASUREMENTS IN INCHES
2. MEASUREMENT "A" 0.394, 0.295, 0.197, 0.098
   TOLERANCE +.001 -.001
3. SPECIMENS ARE TO BE SURFACE GROUND

Reduced Tensile Round Specimens

SPC #	DIA
A	.498
B	.503

NOTE: SPECIMEN DIA
1. 0.500 +.010 -.010
2. 0.350 +.007 -.007

Reduced Tensile Flat Specimens



SPC #	WIDTH
A	
B	

NOTE: SPECIMEN WIDTH
1. 0.500 +.010 -.010

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Angela B Martz

SM-11-1074

Steel Dynamics, Inc.
Engineered Bar Products Division

CODE OYN

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

Certified Material Test Report

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/30/2011 09:38:57
Work Order : 115418	Sales Order : 95886-1	Customer : Turret Steel Industries	PO # : 33033-1
Load # : 141557	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"
Grain Practice : Al Fine Grain (5-8) per ASTM A29		Reduction Ratio : 12.9 to 1	Disposition : 1

Ladle Chemistry Analysis (ASTM A29)

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	B	Ca	W	Ti	DI
0.40	0.96	0.009	0.005	0.25	0.024	0.20	0.07	0.98	0.22	0.011	0.0081	0.004	0.002	0.0001	0.0009	0.000	0.001	6.09

Pb	Co	As	Sb	Zr	Bi	H	O	Ceq	J-Factor
0.001	0.008	0.005	0.003	0.001	0.000	1.4		0.82	

Product Check Analysis (ASTM A29)

	C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	Ti	B	Ca	O
Front																		
Back																		

Jominy (ASTM A255)

	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J12	J14	J16	J18	J20	J24	J28	J32
Calc'd	56	56	56	56	56	56	56	56	56	54	50	51	48	48	47	46	45	41
Front																		
Back																		

Microcleanliness (ASTM E45)

Method A								Method C		Method E	
AT	AH	BT	BH	CT	CH	DT	DH	S	O	SAM "B"	SAM "D"

Microcleanliness (DIN 50602)

K			M
S	O	Tot	Tot

Decarb

Depth	% of Diameter

Grainsize

Austenitic	Ferritic
7	

Macrostructure (ASTM E381)

S	R	C

Magnetic Particle Inspection

Frequency	Severity

Mechanical Properties (ASTM A370)

Tensile Properties					Hardness	
Tensile Strength	0.2% Yield Strength	% Elong (2")	% ROA	0.35% EUL Yield Strength	(MR)	(Surf)

Steel Dynamics - Engineered Bar Products has a quality system in place which has been certified ISO 9001:2008 compliant, including PED certification.

Comments/Specs

ASTM A322-07 ----- Quench & Temper, Straighten, Stress Relieve ----- Contact Ultrasonic Inspected to 1/8" FBH ----- ASTM A354 Grade BD

Q.A. REVIEWED
DATE 8/31/11
DYSON

Batch #H215

Condition : Quench, Temper, Temper, Straighten, Stress Relieve, Contact UT

UT: Passed Ultrasonic Inspection

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Dylan Kale - Rolling Mill Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results. No weld repair has been performed on this material. This material is not radioactive and has not been exposed to radioactivity while under the control of Steel Dynamics. This material has not been exposed to mercury while under the control of Steel Dynamics. Unless otherwise noted, this material was melted, continually cast, and rolled in the USA; w/ all testing performed by Steel Dynamics.

Steel Dynamics, Inc.
Engineered Bar Products Division • Pittsboro, Indiana

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE OYN

Certified Material Test Report

Heat Treatment Addendum

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/29/2011
Work Order : 115418	Sales Order : 95886	Customer : Turret Steel Industries	PO # : 33033 / 1
Load # :	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"

Normalize		Austentize		Quench Media			Temper		Stress Relieve	
Time	Temp	Time	Temp	Type	Time	Temp	Time	Temp	Time	Temp
hrs	°F	2.5 hrs	1650 °F	Water	15 min	95-99 °F	6.3 hrs	1025 °F	5.0 hrs	900 °F

* Furnaces are calibrated to API 6A Annex P, and use atmospheric thermocouples

** QTC is 12" prolongation from longitudinal orientation machined to a 0.505" buttonhead for tensile.

Hardness (ASTM A370)

Bundle #	Batch #	Location	HB	Rb	Rc
1138941	H207	Mid-Rad Q1			36
1138943	H207	Mid-Rad Q1			36
1138939	H208	Mid-Rad Q1			36
1138933	H211	Mid-Rad Q1			36
1138934	H211	Mid-Rad Q1			36
1138932	H214	Mid-Rad Q1			36
1138931	H214	Mid-Rad Q1			36
1138944	H215	Mid-Rad Q1			36
1138936	H215	Mid-Rad Q1			36
1138942	H217	Mid-Rad Q1			36
1138949	H217	Mid-Rad Q1			36
1138948	H222	Mid-Rad Q1			36

Tensile (ASTM A370)

Bundle #	Batch #	Orientation	Location	Tensile	0.2% Yield	%E (2")	%ROA
1138941	H207	Longitudinal	Mid-Rad Q1	147,600 psi	124,200 psi	16	54
1138943	H207	Longitudinal	Mid-Rad Q1	147,600 psi	124,200 psi	16	54
1138939	H208	Longitudinal	Mid-Rad Q1	151,700 psi	129,700 psi	16	54
1138933	H211	Longitudinal	Mid-Rad Q1	147,100 psi	123,200 psi	16	54
1138934	H211	Longitudinal	Mid-Rad Q1	147,100 psi	123,200 psi	16	54
1138932	H214	Longitudinal	Mid-Rad Q1	151,600 psi	128,900 psi	16	53
1138931	H214	Longitudinal	Mid-Rad Q1	151,600 psi	128,900 psi	16	53
1138944	H215	Longitudinal	Mid-Rad Q1	156,500 psi	135,300 psi	16	53
1138936	H215	Longitudinal	Mid-Rad Q1	156,500 psi	135,300 psi	16	53
1138942	H217	Longitudinal	Mid-Rad Q1	152,000 psi	130,000 psi	15	52
1138949	H217	Longitudinal	Mid-Rad Q1	152,000 psi	130,000 psi	15	52
1138948	H222	Longitudinal	Mid-Rad Q1	148,200 psi	125,300 psi	16	55

Q.A. FINAL INSP.
DATE 8/31/11
BY SJM

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Garrett Bouyett - Bar Finishing Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results.

State of California
Department of Transportation

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

TEST REPORT

ACCREDITED
CERTIFICATE NO. 2364.01

Remarks ref: ASTM A354 BD, TM03. Heat #A113149, Lot #OYH

Sample No: SM-11-1078
Date Sampled: 10/12/11 **Date Rec'd:** 10/17/11 **Date Reported:** 10/26/11
Lot No: B30502911 **TL-101 / SIC No:** C711636
Contract/Permit No: 04-0120F4
Material: 3.5" A354 BD Main Cable Anchor Rods
Manufacturer: Dyson / Steel Dynamics
Sampler: Fred Edmondson 10-26

Results: SAMPLES SUBMITTED ARE SATISFACTORY FOR USE

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

10-17 SM-11-1078

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
SAMPLE IDENTIFICATION CARD CARD NUMBER C711636
TL-0101 (REV. 10/97)

☐ PRELIMINARY TESTS
☐ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

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

FIELD NO.
DIST. ~~LAB NO.~~
LOT NO. B30502-0291-11
SHIPMENT NO.
P.O. OR REQ. NO.
AUTHORIZATION NO.

SAMPLE OF 3.5 inch main cable anchor rods
FOR USE IN A354, Gr. BD 0.4T
PWS Anchorage
SAMPLE FROM Dyson
Painesville, OH.
DEPTH Heat treatment Lot OYH
LOCATION OF SOURCE Heat No. A113149
THIS SAMPLE IS SHIPPED IN Pallet AND IS ONE OF A GROUP OF 4 SAMPLES REPRESENTING (TONS, GALS, BBLS, STA., ETC.) Lot
(NO. CONTAINERS)
OWNER OR MANUFACTURER
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☐ NORMAL ☐ PRIORITY
DATE NEEDED
REMARKS 1 - approx. 12 00 mm threaded
2 - approx. 300 mm round
stock

COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 10-12-11
BY Fred Edmondson TITLE QA Inspector
DIST, CO, RTE, PM SEORE
LIMITS Special Provisions
CONT. NO. 04-0120F4
FED. NO.
RES. ENGR. OR SUPT. Pete Sigenthaler
ADDRESS Burma Rd. Oakland, CA
CONTRACTOR ABLE

ENCLOSE WITH SAMPLE

Lab Manager Quality Manager

Print

.500 SAMPLES

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

SM Number = 11-1078

Temperature 71°

Sample	Heat Number	Diameter	Area	Stress at Offset	Tensile Strength	Elongation in 4 x d	Tested By
		(in)	*(in²)*	*(psi)*	*(psi)*	*(%)*	
OYH-A	OYH	0.489	0.1878	147436	165610	16.8	FSaylor
OYH-B	OYH	0.49	0.1886	142968	161680	17.3	FSaylor
				OK	OK	OK	

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

TRANSPORTATION LABORATORY
REPORT OF TESTS

TL - 619 (REV. 5/95)

S. M. NO. 11-1078	DATE RECEIVED 10/17/11
T 101 NO. C711636	CONT. . W.O.. OR P.O. NO. 04-0120F4
LOT NO. B305029 11	F.A.P. NO.

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

SAMPLE NO.	SAMPLE TYPE	HEAT NO.	SIZE	AREA BEFORE	AREA AFTER	YIELD ~~MPa~~ ACTUAL	YIELD PSI	ULTIMATE ACTUAL	ULTIMATE PSI ~~MPa~~	ELONG. ~~IN~~ %	RED. AREA %	COLD BEND	CHEMICAL ANALYSIS C	MN	P	S	SI	A OR E
04H-A		04H	.489	2.003	2.3395		147436		165610	16.8								
04H-B		"	.490	2.003	2.3495		142968		161680	17.3								

SPECIFICATIONS

REMARKS A354 Grade BD

DATE TESTED 10/26/11	TESTED BY [signature]	APPROVED BY

FM 3018 M 95

SM-11-1078

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TM-3 (REV. 07/11)

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Agila B Martz

FASTENER ASSEMBLY WORKSHEET

SM Number		Lot Number	B30502911	Date Received	10-17
Contract Number	04-0120F4	TL-0101 Number	C711636	Date Tested	
Lab Technician		Test Temperature		Page 1 of 1	

BOLTS:

Sample No.							
Heat / Mfg. Lot No.	04H						
Product Markings							
Size	3.5						
Pitch Diameter	3.327	3.327	✓				
Bolt Length							
Ring Gage Go/No-Go	—						
Zinc Coating Thick.	—						
Hardness: Rc / Rb	—						
Spacing	—						
1,500 ~~Wedge~~ Tensile							

NUTS:

Sample No.							
Mfg. Lot No.							
Product Markings							
Size							
Plug Gage Go/No-Go							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							
Nut Proof Load							

WASHER:

Sample No.							
Mfg. Lot No.							
Product Markings							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652 (REV. 3/05)

TEST SPECIMEN PREPARATION AND RECORD

APPROVED FOR USE BY SMTL
QUALITY MANAGER: B Berger

SM No.	Contract No.	Requesting Lab Technician	Date Needed
11-1078	04-020F4	Fred	ASAP
TL-0101 No.	**E.A./Spec. Desg./Object**	**Date Received**	**Date Tested/Provided**
C711636	04 000000018-3	10/17/11	

[X] Machine Shop
Work Requested

[X] standard round tension test specimen, circle one: 0.500"

[] standard rectangular tension test specimen, circle one: 18" long, 8" gage
8" long, 2" gage length

[] Charpy, circle one: 10mm x 10mm
10mm x 7.5mm

[] hardness measurement sample (fasteners)

[] weld nugget

[] chemistry slug

[] other: _____

[] see instructions →

Slug 04 H

[] Chemistry Lab
type of material:
Work Requested

[] neoprene verification

[] oil swell

[] zinc coating weight

[] steel chemistry analysis

[] other: _____

← [] see instructions

[] Other (explain)

Comments or further instructions

The received service is acceptable

Fred [signature]
Receiving Lab Technician

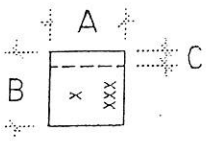
10/26/11
Date

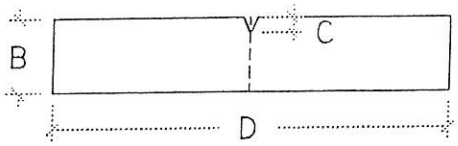
STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652a (REV. 10/10)

Specimen Preparation Information

SM #11-1078
EA #
HEAT #07H
PREPARED BY ma
DATE 10-25-11

Charpy Impact Specimens





MATERIAL SURFACE

SPEC # x
HEAT # xxx

NOTCH ORIENTATION

	OK
1	
2	
3	

SPC #	A	B	C	D
	NOTE #2	0.394 +.001 -.001	0.079 +.001 -.001	2.165 +.000 -.100
1				
2				
3				

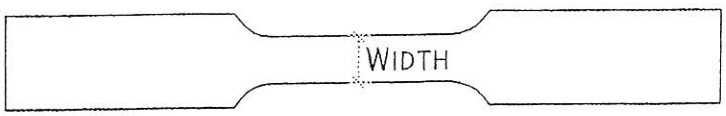
NOTE:
1. ALL MEASUREMENTS IN INCHES
2. MEASUREMENT "A" 0.394, 0.295, 0.197, 0.098
   TOLERANCE +.001 -.001
3. SPECIMENS ARE TO BE SURFACE GROUND

Reduced Tensile Round Specimens

SPC #	DIA
A	.490
B	.490

NOTE: SPECIMEN DIA
1. 0.500 +.010 -.010
2. 0.350 +.007 -.007

Reduced Tensile Flat Specimens



SPC #	WIDTH
A	
B	

NOTE: SPECIMEN WIDTH
1. 0.500 +.010 -.010

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Gyle H Marty

CODE OYH

Steel Dynamics, Inc.
Engineered Bar Products Division

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

Certified Material Test Report

Cert # : 117655	Mill Order : 1109058	Heat # : A113149	Issued : 8/30/2011 09:38:57
Work Order : 115418	Sales Order : 95886-1	Customer : Turret Steel Industries	PO # : 33033-1
Load # : 141557	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"
Grain Practice : Al Fine Grain (5-8) per ASTM A29		Reduction Ratio : 12.9 to 1	Disposition : 1

Ladle Chemistry Analysis (ASTM A29)

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	B	Ca	W	Ti	Dl
0.41	0.95	0.009	0.006	0.27	0.025	0.18	0.16	0.99	0.22	0.011	0.0069	0.004	0.002	0.0001	0.0013	0.000	0.002	6.31

Pb	Co	As	Sb	Zr	Bi	H	O	Ceq	J-Factor
0.001	0.008	0.005	0.003	0.001	0.001	1.6		0.84	

Product Check Analysis (ASTM A29)

	C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	Ti	B	Ca	O
Front																		
Back																		

Jominy (ASTM A255)

	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J12	J14	J16	J18	J20	J24	J28	J32
Calc'd	57	57	57	57	57	57	57	57	57	57	55	52	50	50	49	48	47	43
Front																		
Back																		

Microcleanliness (ASTM E45)

Method A								Method C		Method E	
AT	AH	BT	BH	CT	CH	DT	DH	S	O	SAM "B"	SAM "D"

Microcleanliness (DIN 50602)

K			M
S	O	Tot	Tot

Decarb

Depth	% of Diameter

Grainsize

Austenitic	Ferritic
7	

Macrostructure (ASTM E381)

S	R	C

Magnetic Particle Inspection

Frequency	Severity

Mechanical Properties (ASTM A370)

Tensile Properties					Hardness	
Tensile Strength	0.2% Yield Strength	% Elong (2")	% ROA	0.35% EUL Yield Strength	(MR)	(Surf)

Steel Dynamics - Engineered Bar Products has a quality system in place which has been certified ISO 9001:2008 compliant, including PED certification.

Comments/Specs

ASTM A322-07 ----- Quench & Temper, Straighten, Stress Relieve ----- Contact Ultrasonic Inspected to 1/8" FBH ----- ASTM A354 Grade BD

Q.A. REVIEWED
DATE 8/31/11
DYSON

Batch #H210

Condition : Quench, Temper, Temper, Straighten, Straighten, Stress Relieve, Contact UT

UT: Passed Ultrasonic Inspection

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Dylan Kale - Rolling Mill Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results. No weld repair has been performed on this material. This material is not radioactive and has not been exposed to radioactivity while under the control of Steel Dynamics. This material has not been exposed to mercury while under the control of Steel Dynamics. Unless otherwise noted, this material was melted, continually cast, and rolled in the USA; w/ all testing performed by Steel Dynamics.

Steel Dynamics, Inc.
Engineered Bar Products Division • Pittsboro, Indiana

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE OYH

Certified Material Test Report

Heat Treatment Addendum

Cert # : 117655	Mill Order : 1109058	Heat # : A113149	Issued : 8/29/2011
Work Order : 115418	Sales Order : 95886	Customer : Turret Steel Industries	PO # : 33033 / 1
Load # :	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"

Normalize		Austentize		Quench Media			Temper		Stress Relieve	
Time	Temp	Time	Temp	Type	Time	Temp	Time	Temp	Time	Temp
hrs	°F	2.5 hrs	1650 °F	Water	15 min	95-99 °F	6.3 hrs	1025 °F	5.0 hrs	900 °F

* Furnaces are calibrated to API 6A Annex P, and use atmospheric thermocouples

** QTC is 12" prolongation from longitudinal orientation machined to a 0.505" buttonhead for tensile.

Hardness (ASTM A370)

Bundle #	Batch #	Location	HB	Rb	Rc
1138928	H208	Mid-Rad Q1			35
1138926	H210	Mid-Rad Q1			35
1138927	H210	Mid-Rad Q1			35
1138929	H222	Mid-Rad Q1			36

Tensile (ASTM A370)

Bundle #	Batch #	Orientation	Location	Tensile	0.2% Yield	%E (2")	%ROA
1138928	H208	Longitudinal	Mid-Rad Q1	153,800 psi	132,400 psi	16	52
1138926	H210	Longitudinal	Mid-Rad Q1	155,700 psi	134,500 psi	15	51
1138927	H210	Longitudinal	Mid-Rad Q1	155,700 psi	134,500 psi	15	51
1138929	H222	Longitudinal	Mid-Rad Q1	155,500 psi	134,500 psi	15	52

Q.A. REVIEWED
DATE 8/31/11
DYSON

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Garrett Bouyett - Bar Finishing Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results.

State of California
Department of Transportation

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

TEST REPORT

ACCREDITED
CERTIFICATE NO. 2364.01

Remarks ref: ASTM A354 BD, TM03. Heat #A113151, Lot #OYJ

Sample No: SM-11-1079
Date Sampled: 10/12/11 **Date Rec'd:** 10/17/11 **Date Reported:** 10/26/11
Lot No: B30503111 **TL-101 / SIC No:** C711638
Contract/Permit No: 04-0120F4
Material: 3.5" A354 BD Main Cable Anchor Rods
Manufacturer: Dyson / Steel Dynamics
Sampler: Fred Edmondson

10-26

Results: SAMPLES SUBMITTED ARE SATISFACTORY FOR USE

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

10-17 SM 11-1079

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
SAMPLE IDENTIFICATION CARD CARD NUMBER C711638
TL-0101 (REV. 10/97)

☐ PRELIMINARY TESTS
☑ PROCESS TESTS
☐ ACCEPTANCE TESTS
INDEPENDENT ASSURANCE TESTS
☐ DIST. LAB
☐ TRANS. LAB
☐ SPECIAL TESTS

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

FIELD NO.
DIST. LAB NO.
LOT NO. B305-031-11
SHIPMENT NO.
P.O. OR REQ. NO.
AUTHORIZATION NO.

SAMPLE OF 3.5 inch Main cable anchor rods
FOR USE IN A354 GR. BD BOLT
PWS Anchorage
SAMPLE FROM Dyson
Painesville, OH
DEPTH Heat treatment Lot OYJ
LOCATION OF SOURCE HT. No. A113151
THIS SAMPLE IS SHIPPED IN (NO. CONTAINERS) 1
AND IS ONE OF A GROUP OF 4
SAMPLES REPRESENTING (TONS, GALS, BBLS, STA, ETC.) Lot
OWNER OR MANUFACTURER
TOTAL QUANTITY AVAILABLE
TEST RESULTS DESIRED ☐ NORMAL ☐ PRIORITY
DATE NEEDED
REMARKS 1 - approx. 1200mm - threaded
2 - approx. 700mm - round
Ister K
COVER ADDITIONAL INFORMATION WITH LETTER
DATE SAMPLED 10-12-11
BY Fred Edmondson TITLE QA Inspector
DIST, CO, RTE, PM Special Provisions
LIMITS
CONT. NO. 04-0120 F4
FED. NO.
RES. ENGR. OR SUPT. Pete Sigenthaler
ADDRESS Burma Rd, Oakland, CA
CONTRACTOR ABF

ENCLOSE WITH SAMPLE

Lab Manager GW Quality Manager

Print

.500 SAMPLES

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

SM Number = 11-1079

Temperature 71°

Sample	Heat Number	Diameter	Area	Stress at Offset	Tensile Strength	Elongation in 4 x d	Tested By
		(in)	*(in²)*	*(psi)*	*(psi)*	*(%)*	
OYJ-A	OYJ	0.489	0.1878	135813	153110	17.2	FSaylor
OYJ-B	OYJ	0.489	0.1878	136646	159040	15.9	FSaylor
				OK	OK	OK	

STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION

TRANSPORTATION LABORATORY
REPORT OF TESTS

TL - 619 (REV. 5/95)

S. M. NO. 11-1079	DATE RECEIVED 10/17/11
T 101 NO. C711638	CONT. . W.O.. OR P.O. NO. 04-0120F4
LOT NO. B305031 11	F.A.P. NO.

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

SAMPLE NO.	SAMPLE TYPE	HEAT NO.	SIZE	AREA BEFORE	AREA AFTER	YIELD ~~MPa~~ ACTUAL	YIELD PSI	ULTIMATE PSI ACTUAL	ULTIMATE ~~MPa~~	ELONG. ~~IN~~ %	RED. AREA %	COLD BEND	CHEMICAL ANALYSIS C	MN	P	S	SI	A OR E
OYJ-A		OYJ	.489	2.003	2.348		135813		153110	17.2								
OYJ-B		11	.489	2.003	2.3215		136646		159040	15.9								

SPECIFICATIONS

REMARKS A354 Grade BD

DATE TESTED 10/26/11 | TESTED BY [signature] | APPROVED BY

FM 3018 M 95

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TM-3 (REV. 07/11)

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Angela B Martz

FASTENER ASSEMBLY WORKSHEET

SM Number		Lot Number	B30503111	Date Received	10-17
Contract Number	04-0120F4	TL-0101 Number	C711638	Date Tested	
Lab Technician		Test Temperature		Page 1 of 1	

BOLTS:

Sample No.							
Heat / Mfg. Lot No.	04J						
Product Markings	—						
Size	3.5						
Pitch Diameter	3.323	3.323	✓				
Bolt Length							
Ring Gage Go/No-Go	—						
Zinc Coating Thick.	—						
Hardness: Rc / Rb	—						
Spacing	—						
, 500 ~~Wedge~~ Tensile							

NUTS:

Sample No.							
Mfg. Lot No.							
Product Markings							
Size							
Plug Gage Go/No-Go							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							
Nut Proof Load							

WASHER:

Sample No.							
Mfg. Lot No.							
Product Markings							
Zinc Coating Thick.							
Hardness: Rc / Rb							
Spacing							

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652 (REV. 3/05)

TEST SPECIMEN PREPARATION AND RECORD

APPROVED FOR USE BY SMTL
QUALITY MANAGER: B Berger

SM No.	Contract No.	Requesting Lab Technician	Date Needed
11-1079	04-0120F4	FRRD	ASAP
TL-0101 No.	**E.A./Spec. Desg./Object**	**Date Received**	**Date Tested/Provided**
	04 0000 00 18-3	10/12/11	

[X] Machine Shop

Work Requested

[X] standard round tension test specimen, circle one: 0.500"

[] standard rectangular tension test specimen, circle one: 18" long, 8" gage
8" long, 2" gage length

[] Charpy, circle one: 10mm x 10mm
10mm x 7.5mm

[] hardness measurement sample (fasteners)

[] weld nugget

[] chemistry slug

[] other: _____

[] see instructions →

Slug 04J

[] Chemistry Lab

type of material:

Work Requested

[] neoprene verification

[] oil swell

[] zinc coating weight

[] steel chemistry analysis

[] other: _____

← [] see instructions

[] Other (explain)

Comments or further instructions

The received service is acceptable

Fred Sayler
Receiving Lab Technician

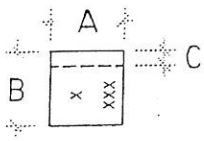
10/26/11
Date

STRUCTURAL MATERIALS TESTING LABORATORY
FORM TL-652a (REV. 10/10)

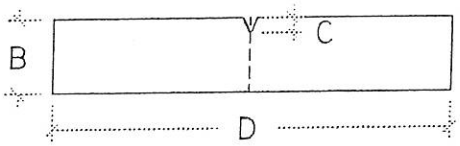
Specimen Preparation Information

SM # 11-1079
EA #
HEAT # 04J
PREPARED BY ma
DATE 10-25-11

Charpy Impact Specimens



45° V NOTCH WITH
A 0.010 RAD $^{+.001}_{-.001}$



MATERIAL SURFACE

SPEC # x
HEAT # xxx

NOTCH ORIENTATION

	OK
1	
2	
3	

SPC #	A	B	C	D
	NOTE #2	0.394 $^{+.001}_{-.001}$	0.079 $^{+.001}_{-.001}$	2.165 $^{+.000}_{-.100}$
1				
2				
3				

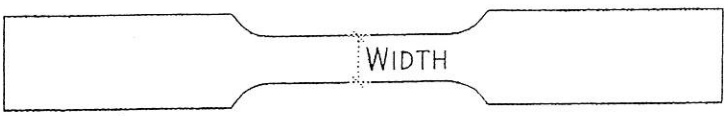
NOTE:
1. ALL MEASUREMENTS IN INCHES
2. MEASUREMENT "A" 0.394, 0.295, 0.197, 0.098
   TOLERANCE $^{+.001}_{-.001}$
3. SPECIMENS ARE TO BE SURFACE GROUND

Reduced Tensile Round Specimens

SPC #	DIA
A	.490
B	.490

NOTE: SPECIMEN DIA
1. 0.500 $^{+.010}_{-.010}$
2. 0.350 $^{+.007}_{-.007}$

Reduced Tensile Flat Specimens



SPC #	WIDTH
A	
B	

NOTE: SPECIMEN WIDTH
1. 0.500 $^{+.010}_{-.010}$

APPROVED FOR USE BY SMTL
QUALITY MANAGER
Gayle G Martz

SMI - 11 - 1049

Steel Dynamics, Inc.
Engineered Bar Products Division

CODE OYJ

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

Certified Material Test Report

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/30/2011 09:38:57
Work Order : 115418	Sales Order : 95886-1	Customer : Turret Steel Industries	PO # : 33033-1
Load # : 141557	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"
Grain Practice : Al Fine Grain (5-8) per ASTM A29		Reduction Ratio : 12.9 to 1	Disposition : 1

Ladle Chemistry Analysis (ASTM A29)

C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	B	Ca	W	Ti	DI
0.40	0.96	0.009	0.005	0.25	0.024	0.20	0.07	0.98	0.22	0.011	0.0081	0.004	0.002	0.0001	0.0009	0.000	0.001	6.09

Pb	Co	As	Sb	Zr	Bi	H	O	Ceq	J-Factor
0.001	0.008	0.005	0.003	0.001	0.000	1.4		0.82	

Product Check Analysis (ASTM A29)

	C	Mn	P	S	Si	Al	Cu	Ni	Cr	Mo	Sn	N	V	Cb	Ti	B	Ca	O
Front																		
Back																		

Jominy (ASTM A255)

	J1	J2	J3	J4	J5	J6	J7	J8	J9	J10	J12	J14	J16	J18	J20	J24	J28	J32
Calc'd	56	56	56	56	56	56	56	56	56	54	50	51	48	48	47	46	45	41
Front																		
Back																		

Microcleanliness (ASTM E45)

Method A								Method C		Method E	
AT	AH	BT	BH	CT	CH	DT	DH	S	O	SAM "B"	SAM "D"

Microcleanliness (DIN 50602)

K			M
S	O	Tot	Tot

Decarb		Grainsize		Macrostructure (ASTM E381)			Magnetic Particle Inspection	
Depth	% of Diameter	Austenitic	Ferritic	S	R	C	Frequency	Severity
		7						

Mechanical Properties (ASTM A370)

Tensile Properties					Hardness	
Tensile Strength	0.2% Yield Strength	% Elong (2")	% ROA	0.35% EUL Yield Strength	(MR)	(Surf)

Steel Dynamics - Engineered Bar Products has a quality system in place which has been certified ISO 9001:2008 compliant, including PED certification.

Comments/Specs

ASTM A322-07 ----- Quench & Temper, Straighten, Stress Relieve ----- Contact Ultrasonic Inspected to 1/8" FBH ----- ASTM A354 Grade BD

Q.A. REVIEWED
DATE 8/31/11
DYSON

Batch# H 207

Condition : Quench, Temper, Temper, Straighten, Stress Relieve, Contact UT

UT: Passed Ultrasonic Inspection

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Dylan Kale - Rolling Mill Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results. No weld repair has been performed on this material. This material is not radioactive and has not been exposed to radioactivity while under the control of Steel Dynamics. This material has not been exposed to mercury while under the control of Steel Dynamics. Unless otherwise noted, this material was melted, continually cast, and rolled in the USA; w/ all testing performed by Steel Dynamics.

Steel Dynamics, Inc.
Engineered Bar Products Division • Pittsboro, Indiana

8000 N. County Road 225 East
Pittsboro, IN 46167
Phone: (317) 892-7000
Fax: (317) 892-7285

CODE OYJ

Certified Material Test Report

Heat Treatment Addendum

Cert # : 116463	Mill Order : 1109059	Heat # : A113151	Issued : 8/29/2011
Work Order : 115418	Sales Order : 95886	Customer : Turret Steel Industries	PO # : 33033 / 1
Load # :	Reference # :	Reference Desc :	End Use :
Size : 3-3/4"	Shape : Round	Grade : 4140	Length : 32'00"

Normalize		Austentize		Quench Media			Temper		Stress Relieve	
Time	Temp	Time	Temp	Type	Time	Temp	Time	Temp	Time	Temp
hrs	°F	2.5 hrs	1650 °F	Water	15 min	95-99 °F	6.3 hrs	1025 °F	5.0 hrs	900 °F

* Furnaces are calibrated to API 6A Annex P, and use atmospheric thermocouples

** QTC is 12" prolongation from longitudinal orientation machined to a 0.505" buttonhead for tensile.

Hardness (ASTM A370)

Bundle #	Batch #	Location		HB	Rb	Rc
1138941	H207	Mid-Rad	Q1			36
1138943	H207	Mid-Rad	Q1			36
1138939	H208	Mid-Rad	Q1			36
1138933	H211	Mid-Rad	Q1			36
1138934	H211	Mid-Rad	Q1			36
1138932	H214	Mid-Rad	Q1			36
1138931	H214	Mid-Rad	Q1			36
1138944	H215	Mid-Rad	Q1			36
1138936	H215	Mid-Rad	Q1			36
1138942	H217	Mid-Rad	Q1			36
1138949	H217	Mid-Rad	Q1			36
1138948	H222	Mid-Rad	Q1			36

Tensile (ASTM A370)

Bundle #	Batch #	Orientation	Location		Tensile	0.2% Yield	%E (2")	%ROA
1138941	H207	Longitudinal	Mid-Rad	Q1	147,600 psi	124,200 psi	16	54
1138943	H207	Longitudinal	Mid-Rad	Q1	147,600 psi	124,200 psi	16	54
1138939	H208	Longitudinal	Mid Rad	Q1	151,700 psi	129,700 psi	16	54
1138933	H211	Longitudinal	Mid-Rad	Q1	147,100 psi	123,200 psi	16	54
1138934	H211	Longitudinal	Mid-Rad	Q1	147,100 psi	123,200 psi	16	54
1138932	H214	Longitudinal	Mid-Rad	Q1	151,600 psi	128,900 psi	16	53
1138931	H214	Longitudinal	Mid-Rad	Q1	151,600 psi	128,900 psi	16	53
1138944	H215	Longitudinal	Mid-Rad	Q1	156,500 psi	135,300 psi	16	53
1138936	H215	Longitudinal	Mid-Rad	Q1	156,500 psi	135,300 psi	16	53
1138942	H217	Longitudinal	Mid-Rad	Q1	152,000 psi	130,000 psi	15	52
1138949	H217	Longitudinal	Mid-Rad	Q1	152,000 psi	130,000 psi	15	52
1138948	H222	Longitudinal	Mid-Rad	Q1	148,200 psi	125,300 psi	16	55

Q.A. REVIEWED
DATE 8/31/11
DYSON

I hereby certify that the content of this report is correct and accurate, and that all tests and operations performed on this material were in compliance with applicable material specifications and purchaser designated requirements.

Garrett Bouyett - Bar Finishing Metallurgist

Any alteration to this report voids Steel Dynamic's warranting of results.

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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003765
Date Inspected: 26-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 700
OSM Departure Time: 1530
Location: Glasgow, MO

Quality Control Contact: Ryan Monnig
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☐ N/A
Sampled Items: ☐ Yes ☐ No ☐ N/A
Stock Transfer: ☐ Yes ☐ No ☐ N/A
OK to Cut: ☐ Yes ☐ No ☐ N/A
Rebar Test Witness: ☐ Yes ☐ No ☐ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☐ N/A
Other: N/A
Bridge No: 34-0006
Component: PWS Anchor Rods
Bid Item: 68
Lot No: N/A

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to monitor, at random intervals, the galvanizing of Parallel Wire Strand (PWS) High Strength Rods from Dyson Corporation for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA met with Monnig Industries General Manager Ryan Monnig and was informed of the following status regarding the galvanizing of the PWS Anchor Rods:

The following rods were listed for the next shipment and at the current time with in various stages of the galvanizing process.
OOH-1E, OTD-2E, OQY-32, OOH-4F, OQY-27, OQY-23C, OQY-28, OTD-1D, OTD-23D, OTD-2D, OQY-15C, OQY-13C, OPY4-24, OQY-31, OQY-18C, OQY-14C, OQY-29, OYN-3, OYN-4, OYN-5, OYO-6, OYL-5, OYN-11, OYN-10, OYL-6, OYL-9, and OYO-4

This QA performed a visual verification at random intervals of Parallel Wire Strand (PWS) High Strength Rods during and after completion of the glvanizing process. This QA Inspector observed the galvanizing process was performed within 4 hours of the blasting and appeared to comply with the contract requirements.

This QA Inspector spoke with Monnig Industries representative Andrew Monnig and was informed by Mr. Monnig that the truck that is to transport load #9 has been scheduled to arrive at the Monnig facility some time after (2pm) tommorow (10-27-11).

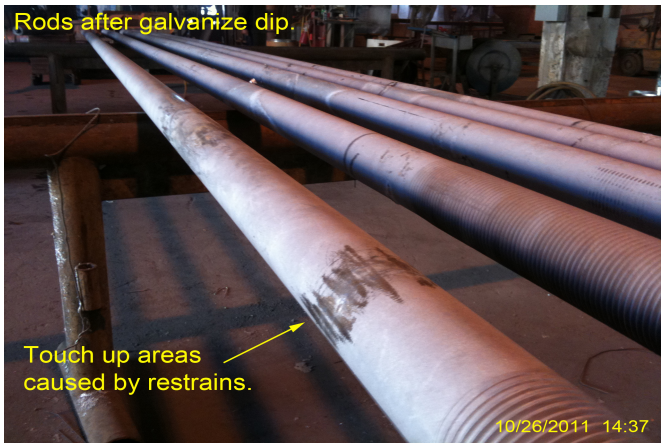
SOURCE INSPECTION REPORT

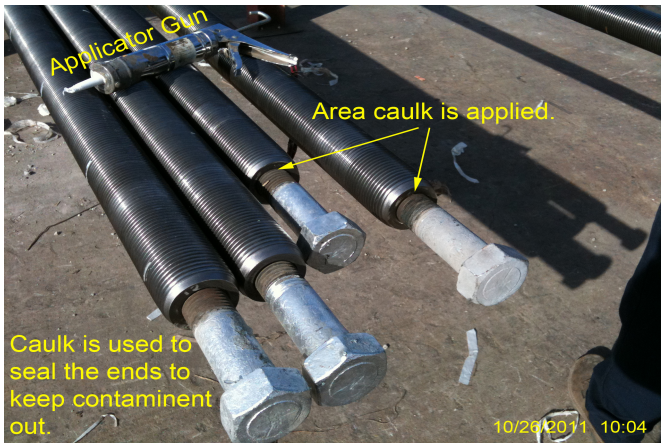
(Continued Page 2 of 2)

Attached to this report are photographs representative of various stages of the galvanizing process and/or loading and tagged of completed rods.

Note: This QA Inspector was informed by SMR Kit Guest that a shipment of nuts to be used at Monning Industries was instead sent to the job site. These nuts were to be shipped to the Monnig facility and would be part of the final Parallel Wire Strand (PWS) High Strength Rod shipment.

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.





Summary of Conversations:

This QA Inspector had general conversations with Monnig General Manager Ryan Monnig and other Monnig personnel. Unless noted above there were no other notable conversations.

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:	Clifford,William	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003766
Date Inspected: 27-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 700
OSM Departure Time: 1530
Location: Glasgow, MO

Quality Control Contact: Ryan Monnig
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☐ N/A
Sampled Items: ☐ Yes ☐ No ☐ N/A
Stock Transfer: ☐ Yes ☐ No ☐ N/A
OK to Cut: ☐ Yes ☐ No ☐ N/A
Rebar Test Witness: ☐ Yes ☐ No ☐ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☐ N/A
Other: N/A
Bridge No: 34-0006
Component: PWS Anchor Rods
Bid Item: 68
Lot No: N/A

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to monitor, at random intervals, the galvanizing of Parallel Wire Strand (PWS) High Strength Rods from Dyson Corporation for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA Inspector met with Monnig Industries General Manager Ryan Monnig and was informed of the following status regarding the galvanizing of the PWS Anchor Rods:

This QA Inspector observed the following PWS Rods were part of load - #8:
Of the 27 rods in this shipment twenty-seven (27) were Blue Tagged for delivery to the job site.

The SMR authorization S54-025-11 has been included in this report.
MSD 0785:
OOH-1E, OTD-2E, OQY-32, OOH-4F, OQY-27, OQY-23C, OQY-28, OTD-1D, OTD-23D, OTD-2D, OQY-15C, OQY-13C, OPY4-24, OQY-31, OQY-18C, OQY-14C, OQY-29
MSD 0786:
OYN-3, OYN-4, OYN-5, OYO-6, OYL-5, OYN-11, OYN-10, OYL-6, OYL-9, OYO-4.

1. This QA Inspector observed a dimensional report from Dyson Corporation accepting the rods was submitted for the heat treatment lots.
2. This QA Inspector observed a Certificate Of Compliance (COC), Material Test Report (MTR), Magnetic

Particle Testing reports per material heat and shipper were submitted from Dyson Corporation.
3. This QA Inspector observed a COC and QC reports for blasting and galvanizing were submitted from Monnig Industries.

These documents submitted appeared to comply with the contract requirements.

This QA Inspector observed a spherical nut and regular nut were threaded full length and shipped as such.

The following rods were listed for the next shipment and at the current time with in various stages of the galvanizing process.
OYH-8, OYG-1, OYK-5, R1011OTD, OYO-9, OYN-6, OYN-8, OOH2-20, OYM-5, OPY3-8, OYK-4, OYN-9, OOH2-23, OYG-2, OOF2-4, OYO-8, OYP-4, OYI-5, OYL-4, OOH2-2, OYN-7, OYO-7, OYJ-8, and OYO-5

This QA performed a visual verification at random intervals of Parallel Wire Strand (PWS) High Strength Rods during and after completion of the glvanizing process. This QA Inspector observed the galvanizing process was performed within 4 hours of the blasting and appeared to comply with the contract requirements.

This QA Inspector spoke with Monnig Industries representative Andrew Monnig and was informed by Mr. Monnig that the truck that is to transport load #9 has been scheduled to arrive at the Monnig facility some time after noon (12pm) tommorow (10-28-11).

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.

Summary of Conversations:

This QA Inspector had general conversations with Monnig General Manager Ryan Monnig and other Monnig personnel. Unless noted above there were no other notable conversations.

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:	Clifford,William	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.25A

MATERIAL SUITABILITY REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: MSR-000060
Report Date: 27-Oct-2011
SMR Authorization #:

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

Date of NCR:
Location: Glasgow, MO

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
B211-004-11	68	27	ea	PWS High Strength Anchor Rods - load - #8

Identification:
One Blue Tag attached to load.
Description of Non-Conformance (NCRs):

Summary of Items Observed:
The SMR authorization S54-025-11 has been included in this report.

This QA Inspector observed the following PWS Rods were part of load - #8:
MSD 0785:
OOH-1E, OTD-2E, OQY-32, OOH-4F, OQY-27, OQY-23C, OQY-28, OTD-1D, OTD-23D, OTD-2D, OQY-15C, OQY-13C, OPY4-24, OQY-31, OQY-18C, OQY-14C, OQY-29
MSD 0786:
OYN-3, OYN-4, OYN-5, OYO-6, OYL-5, OYN-11, OYN-10, OYL-6, OYL-9, OYO-4.

BTL item: Heat treatment lots OOF, OOH, OTD and OPY contained some rods with thread sizes outside the specified range. Per RFI 2502 it was determined that oversized threads would be fit for purposes provided the nut is able to thread freely down the bar/rod and an acceptable dimensional report is submitted.?

This QA Inspector observed a spherical nut and regular nut were threaded full length and shipped as such.

This QA Inspector observed a dimensional report from Dyson Corporation accepting the rods was submitted for the heat treatment lots.

This QA Inspector observed a Certificate Of Compliance (COC), Material Test Report (MTR), Magnetic Particle

MATERIAL SUITABILITY REPORT

(Continued Page 2 of 2)

Testing reports per material heat and shipper were submitted from Dyson Corporation.

This QA Inspector observed a COC and QC reports for blasting and galvanizing were submitted from Monnig Industries.

The documents submitted appeared to comply with the contract requirements.

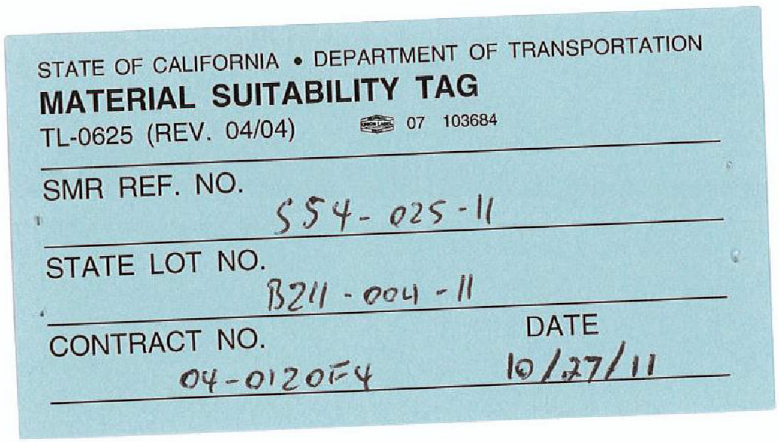
Summary of Conversations:

This QA Inspector had general conversations with Monnig Industries personnel and the SMR. Except as described above there were no other notable conversations.

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:	Clifford,William	Quality Assurance Inspector
Reviewed By:	Levell,Bill	QA Reviewer


STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
MATERIAL SUITABILITY TAG
TL-0625 (REV. 04/04) 07 103684
SMR REF. NO. S54-025-11
STATE LOT NO. B211-004-11
CONTRACT NO. 04-0120F4
DATE 10/27/11

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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.25A

MATERIAL SUITABILITY REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: MSR-000061
Report Date: 28-Oct-2011
SMR Authorization #:

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

Date of NCR:
Location: Glasgow, MO

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
B211-005-11	68	2	ea	PWS High Strength Anchor Rods - load - #9

Identification:
One Blue Tag attached to load.
Description of Non-Conformance (NCRs):

Summary of Items Observed:
The SMR authorization S54-026-11 has been included in this report.

This QA Inspector observed the following PWS Rods were part of load - #9:
MSD 0784:
OOH2-20 and OOH2-2

BTL item: Heat treatment lots OOF, OOH, OTD and OPY contained some rods with thread sizes outside the specified range. Per RFI 2502 it was determined that oversized threads would be fit for purposes provided the nut is able to thread freely down the bar/rod and an acceptable dimensional report is submitted.?

This QA Inspector observed a spherical nut and regular nut were threaded full length and shipped as such.

This QA Inspector observed a dimensional report from Dyson Corporation accepting the rods was submitted for the heat treatment lots.

This QA Inspector observed a Certificate Of Compliance (COC), Material Test Report (MTR), Magnetic Particle Testing reports per material heat and shipper were submitted from Dyson Corporation.

This QA Inspector observed a COC and QC reports for blasting and galvanizing were submitted from Monnig

Industries.

The documents submitted appeared to comply with the contract requirements.

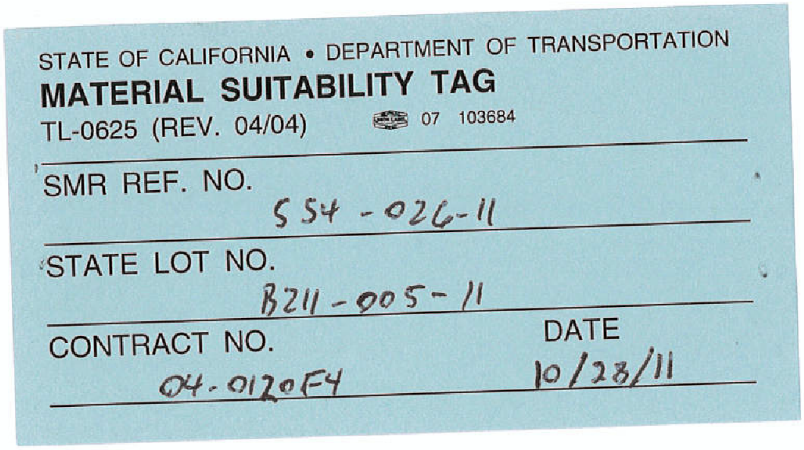
Summary of Conversations:

This QA Inspector had general conversations with Monnig Industries personnel and the SMR. Except as described above there were no other notable conversations.

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:	Clifford,William	Quality Assurance Inspector
Reviewed By:	Levell,Bill	QA Reviewer


STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
MATERIAL SUITABILITY TAG
TL-0625 (REV. 04/04) 07 103684
SMR REF. NO.
S 54 - 026-11
STATE LOT NO.
B211-005-11
CONTRACT NO.
04-0120F4
DATE
10/28/11

Monnig Industries, Inc.

HOT DIP & MECHANICAL GALVANIZING
P.O. BOX 98
GLASGOW, MO 65254
PH. 660-338-2242 FAX: 660-338-5199

AUGUST 30, 2011

DYSON CORPORATION
50 FREEDOM ROAD
PAINESVILLE, OH 44077

RE: GALVANIZING CERTIFICATE-CALTRAN

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE ATTACHED SPREADSHEET MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS.

55 PWS ANCHOR RODS

ROD ID/MIL THICKNESS MEASUREMENTS

OQY-25 / 6.0	OQY-26 / 5.5	OQY-27 / 5.5	OQY-28 / 6.0	OQY-29 / 5.5
OQX4-30 / 5.0	OQY-31 / 4.5	OQY-32 / 5.5	OQY-1C / 5.5	OQY-2C / 6.0
OQY-3C / 5.0	OQY-4C / 5.0	OQX2-5 / 5.5	OQY-6C / 5.5	OQY-7C / 6.0
OQX2-8 / 6.0	OQY-9C / 5.5	OQY-10C / 6.0	OQY-11C / 6.0	OQY-12C / 6.5
OQY-13C / 6.0	OQY-14C / 5.0	OQY-15C / 5.5	OQY-16C / 6.0	OQY-17C / 5.5
OQY-18C / 6.0	OQY-19C / 5.5	OQY-20C / 5.0	OQY-21C / 6.0	OQY-22C / 5.5
OQY-23C / 5.0	OQY-24C / 6.5	OPY4-19 / 5.5	OPY4-20 / 6.0	OPY4-21 / 5.5
OPY4-22 / 6.5	OQY-23B / 6.0	OPY4-24 / 6.0	OTD-1H / 5.5	OOH-1F / 5.5
OOH-2F / 6.0	OOH-3F / 5.5	OOH-4F / 5.5	OOH-5F / 6.0	OOH-1E / 6.0
OTD-2E / 5.0	OTD-1D / 6.5	OTD-2D / 6.0	OTD-3D / 6.0	OQX6-1 / 5.5
OQX6-2 / 6.0	OQX6-3 / 5.0	OQW2-4 / 5.5	OQW2-5 / 6.0	OQW2-6 / 6.5

PATRICIA S. WESTHUES
NOTARY PUBLIC STATE OF MISSOURI
HOWARD COUNTY
MY COMMISSION EXP. APR. 18, 2012

John Monnig
JOHN MONNIG, PRESIDENT

Patricia S Westhues
PATRICIA S. WESTHUES,
NOTARY PUBLIC

Phoenix Manufacturing, Inc.
P.O. BOX 330
26666 Von Holten Rd.
Cole Camp, MO. 65325
660-668-2611
660-668-3160 (fax)

SSPC-SP10 Near White Metal Blast

Near-White Blast Cleaning - Removal of nearly all mill scale, rust, rust scale, paint, or foreign matter by the use of abrasives propelled through nozzles or by centrifugal wheels to the degree hereafter specified. A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides, or light, tight residues of paint or coating that may remain. At least 95 percent of each square inch of surface area shall be free of all visible residues, and the remainder shall be limited to the light discoloration mentioned above.

55 PWS ANCHOR RODS

ROD ID/MIL THICKNESS MEASUREMENTS

OQY-25	OQY-26	OQY-27	OQY-28	OQY-29
OQX4-30	OQY-31	OQY-32	OQY-1C	OQY-2C
OQY-3C	OQY-4C	OQX2-5	OQY-6C	OQY-7C
OQX2-8	OQY-9C	OQY-10C	OQY-11C	OQY-12C
OQY-13C	OQY-14C	OQY-15C	OQY-16C	OQY-17C
OQY-18C	OQY-19C	OQY-20C	OQY-21C	OQY-22C
OQY-23C	OQY-24C	OPY4-19	OPY4-20	OPY4-21
OPY4-22	OQY-23B	OPY4-24	OTD-1H	OOH-1F
OOH-2F	OOH-3F	OOH-4F	OOH-5F	OOH-1E
OTD-2E	OTD-1D	OTD-2D	OTD-3D	OQX6-1
OQX6-2	OQX6-3	OQW2-4	OQW2-5	OQW2-6

Gene Eddy

Monnig Industries, Inc.

HOT DIP & MECHANICAL GALVANIZING
P.O. BOX 98
GLASGOW, MO 65254
PH. 660-338-2242 FAX: 660-338-5199

OCTOBER 27, 2011

DYSON CORPORATION
50 FREEDOM ROAD
PAINESVILLE, OH 44077

RE: GALVANIZING CERTIFICATE-CALTRAN

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE LIST BELOW MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS.

10 PWS ANCHOR RODS

ROD ID/MIL THICKNESS MEASUREMENTS

OYN-3/10.48	OYN-4/8.96	OYN-5/7.95	OYO-6/8.07	OYL-5/7.99
OYN-11/7.92	OYN-10/7.62	OYL-6/6.87	OYL-9/7.76	OYO-4/7.64

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE LIST BELOW MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS. ALL REPAIRS WERE DONE TO ASTM-780-01 SPECIFICATIONS.

17 PWS ANCHOR RODS

ROD ID/REPAIR ROD ID/MIL THICKNESS MEASUREMENTS

OOH-1E/NO#/7.57	OTD-2E/#20/7.37	OQY-32/#46/5.28	OOH-4F/NO#/6.62	OQY-27/#16/6.05
OQY-23C/#27/8.75	OQY-28/#15/7.87	OTD-1D/#48/7.91	OTD-23D/#47/7.87	OTD-2D/#49/7.30
OQY-15C/#22/5.77	OQY-13C/#14/4.61	OPY4-24/#2/8.17	OQY-31/#11/5.47	OQY-18C/#4/6.28
OQY-14C/#13/10.12	OQY-29/#19/8.33			

PATRICIA S. WESTHUES
NOTARY PUBLIC STATE OF MISSOURI
HOWARD COUNTY
MY COMMISSION EXP. APR. 18, 2012

John Monnig
JOHN MONNIG, PRESIDENT

Patricia S Westhues
PATRICIA S. WESTHUES,
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Phoenix Manufacturing, Inc.
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SSPC-SP10 Near White Metal Blast

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OYN-3	OYN-4	OYN-5	OYO-6	OYL-5
OYN-11	OYN-10	OYL-6	OYL-9	OYO-4

Ruby Nan

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112047	660110-SA-017 CO 022	8500 MM	24 pcs	8/31/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. Material per ASTM-A354, gr BD; Hot Dipped Galvanized per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OQY-1C, OQY-2C, OQY-3C, OQY-4C, OQX2-5, OQY-6C, OQY-7C, OQX2-8, OQY-9C, OQY-10C, OQY-11C, OQY-12C, OQY-13C, OQY-14C, OQY-15C, OQY-16C, OQY-17C, OQY-18C, OQY-19C, OQY-20C, OQY-21C, OQY-22C, OQY-23C, OQY-24C

Heat treatment lot OQX is from heat of steel ID 4M76367-2

Heat treatment lot OQY is from heat of steel ID 4M76367-1

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
8/29/11

PWS ANCHOR RODS and EXTENSION ROD THREAD MAPPING

AUGUST 31, 2(

Date	BAR				COUPLER END			TAPPED END							
Measured	I.D	LENGTH	LENGTH	DYSON	No-Go	Pitch Diameter [In.]		No-Go	Pitch Diameter Readings (+/- 1 Pitch) [Inches]						
	CODE / BAR	MM	FT./IN	S.O. #	Pass/Fail	0.75"	12.75"	Pass/Fail	0.75"	2.25"	12.75"	24.75"	36.75"	48.75"	60.75"
8/8/11	OQY-1C	8500	27'-10.65"	112047	Pass	3.323	3.332	Pass	3.323	3.332	3.332	3.332	3.331	3.332	3.331
8/8/11	OQY-2C	8500	27'-10.65"	112047	Pass	3.323	3.332	Pass	3.323	3.331	3.331	3.331	3.331	3.331	3.330
8/8/11	OQY-3C	8500	27'-10.65"	112047	Pass	3.323	3.331	Pass	3.329	3.329	3.330	3.330	3.330	3.331	3.330
8/8/11	OQY-4C	8500	27'-10.65"	112047	Pass	3.324	3.331	Pass	3.331	3.330	3.330	3.330	3.329	3.329	3.330
8/8/11	OQX2-5	8500	27'-10.65"	112047	Pass	3.323	3.331	Pass	3.330	3.330	3.329	3.329	3.329	3.329	3.330
8/8/11	OQY-6C	8500	27'-10.65"	112047	Pass	3.323	3.331	Pass	3.331	3.331	3.331	3.330	3.330	3.330	3.330
8/8/11	OQY-7C	8500	27'-10.65"	112047	Pass	3.323	3.330	Pass	3.331	3.330	3.330	3.330	3.330	3.329	3.329
8/8/11	OQX2-8	8500	27'-10.65"	112047	Pass	3.328	3.332	Pass	3.333	3.333	3.331	3.332	3.332	3.332	3.332
8/8/11	OQY-9C	8500	27'-10.65"	112047	Pass	3.323	3.331	Pass	3.330	3.331	3.330	3.330	3.330	3.330	3.330
8/8/11	OQY-10C	8500	27'-10.65"	112047	Pass	3.323	3.330	Pass	3.332	3.332	3.330	3.331	3.330	3.331	3.330
8/8/11	OQY-11C	8500	27'-10.65"	112047	Pass	3.324	3.332	Pass	3.331	3.332	3.330	3.331	3.331	3.331	3.331
8/8/11	OQY-12C	8500	27'-10.65"	112047	Pass	3.325	3.331	Pass	3.331	3.331	3.332	3.330	3.330	3.330	3.330
8/8/11	OQY-13C	8500	27'-10.65"	112047	Pass	3.331	3.331	Pass	3.332	3.332	3.331	3.331	3.332	3.332	3.332
8/8/11	OQY-14C	8500	27'-10.65"	112047	Pass	3.324	3.331	Pass	3.331	3.332	3.331	3.331	3.332	3.331	3.332
8/8/11	OQY-15C	8500	27'-10.65"	112047	Pass	3.326	3.331	Pass	3.332	3.332	3.331	3.330	3.330	3.330	3.330
8/8/11	OQY-16C	8500	27'-10.65"	112047	Pass	3.323	3.332	Pass	3.333	3.333	3.332	3.332	3.332	3.332	3.332
8/8/11	OQY-17C	8500	27'-10.65"	112047	Pass	3.324	3.331	Pass	3.333	3.333	3.333	3.333	3.332	3.332	3.333
8/8/11	OQY-18C	8500	27'-10.65"	112047	Pass	3.324	3.333	Pass	3.333	3.333	3.332	3.331	3.332	3.333	3.332
8/8/11	OQY-19C	8500	27'-10.65"	112047	Pass	3.323	3.332	Pass	3.333	3.332	3.331	3.331	3.331	3.331	3.331
8/8/11	OQY-20C	8500	27'-10.65"	112047	Pass	3.323	3.330	Pass	3.333	3.332	3.331	3.330	3.330	3.330	3.330
8/8/11	OQY-21C	8500	27'-10.65"	112047	Pass	3.324	3.331	Pass	3.332	3.332	3.332	3.331	3.331	3.331	3.331
8/8/11	OQY-22C	8500	27'-10.65"	112047	Pass	3.324	3.332	Pass	3.331	3.333	3.331	3.330	3.330	3.331	3.331
8/8/11	OQY-23C	8500	27'-10.65"	112047	Pass	3.324	3.333	Pass	3.332	3.331	3.332	3.331	3.332	3.331	3.331
8/8/11	OQY-24C	8500	27'-10.65"	112047	Pass	3.324	3.331	Pass	3.331	3.332	3.330	3.330	3.330	3.330	3.330

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112047	660110-SA-017 CO 022	8500 MM	12 pcs	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. Material per ASTM-A354, gr BD; Hot Dipped Galvanized per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OQY-3C, OQY-13C, OQY-14C, OQY-15C, OQY-18C, OQY-19C, OQY-20C, OQY-21C, OQY-22C, OQY-23C, OQY-27, OQY-32

Heat treatment lot OQY is from heat of steel ID 4M7636-1

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

CERTIFICATE OF COMPLIANCE

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 112049	660110-SA-017 CO 022	8700 MM	31 pcs	8/31/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8700mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & Tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

double w/ date 8/30/11

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

Bar I.D.'s: OQX4-5, OQX4-6, OQX4-7, OQX4-9, OQX4-10, OQX4-11, OQX4-12, OQX4-13, OQY-1, OQY-2, OQY-3, OQY-4, OQY-14, OQY-15, OQY-16, OQX4-17, OQX4-18, OQY-19, OQX4-20, OQX4-21, OQX4-22, OQX4-23, OQX4-24, OQY-25, OQY-26, OQY-27, OQY-28, OQY-29, OQX4-30, OQY-31, OQY-32

Heat treatment lot OQX is from heat of steel ID 4M76367-2

Heat treatment lot OQY is from heat of steel ID 4M76367-1

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
8/29/11

PWS ANCHOR RODS and EXTENSION ROD THREAD MAPPING

AUGUST 31, 2011

Date	BAR				COUPLER END			TAPPED END							
Measured	I.D	LENGTH	LENGTH	DYSON	No-Go	Pitch Diameter [In.]		No-Go	Pitch Diameter Readings (+/- 1 Pitch) [inches]						
	CODE / BAR	MM	FT./IN	S.O. #	Pass/Fail	0.75"	12.75"	Pass/Fail	0.75"	2.25"	12.75"	24.75"	36.75"	48.75"	60.75"
8/3/11	OQX4-5	8700	28'-6.52"	112049	Pass	3.323	3.331	Pass	3.331	3.333	3.334	3.334	3.334	3.334	3.334
8/3/11	OQX4-6	8700	28'-6.52"	112049	Pass	3.323	3.328	Pass	3.334	3.333	3.333	3.333	3.333	3.333	3.333
8/3/11	OQX4-7	8700	28'-6.52"	112049	Pass	3.323	3.332	Pass	3.334	3.331	3.332	3.332	3.332	3.332	3.332
8/3/11	OQX4-9	8700	28'-6.52"	112049	Pass	3.327	3.329	Pass	3.333	3.333	3.332	3.332	3.332	3.332	3.332
8/3/11	OQX4-10	8700	28'-6.52"	112049	Pass	3.327	3.332	Pass	3.332	3.332	3.332	3.331	3.331	3.331	3.331
8/3/11	OQX4-11	8700	28'-6.52"	112049	Pass	3.329	3.334	Pass	3.332	3.330	3.330	3.331	3.331	3.331	3.331
8/3/11	OQX4-12	8700	28'-6.52"	112049	Pass	3.332	3.334	Pass	3.334	3.334	3.334	3.334	3.334	3.334	3.334
8/3/11	OQX4-13	8700	28'-6.52"	112049	Pass	3.323	3.334	Pass	3.333	3.331	3.332	3.331	3.332	3.331	3.331
8/5/11	OQY-1	8700	28'-6.52"	112049	Pass	3.324	3.332	Pass	3.334	3.333	3.333	3.333	3.333	3.333	3.333
8/5/11	OQY-2	8700	28'-6.52"	112049	Pass	3.323	3.332	Pass	3.333	3.332	3.331	3.331	3.331	3.331	3.331
8/5/11	OQY-3	8700	28'-6.52"	112049	Pass	3.328	3.330	Pass	3.330	3.330	3.329	3.330	3.329	3.330	3.330
8/5/11	OQY-4	8700	28'-6.52"	112049	Pass	3.333	3.332	Pass	3.330	3.328	3.328	3.327	3.332	3.331	3.331
8/5/11	OQY-14	8700	28'-6.52"	112049	Pass	3.332	3.332	Pass	3.331	3.331	3.331	3.331	3.329	3.331	3.331
8/5/11	OQY-15	8700	28'-6.52"	112049	Pass	3.325	3.333	Pass	3.326	3.332	3.333	3.333	3.333	3.333	3.333
8/5/11	OQY-16	8700	28'-6.52"	112049	Pass	3.332	3.332	Pass	3.331	3.331	3.331	3.331	3.331	3.331	3.331
8/5/11	OQX4-17	8700	28'-6.52"	112049	Pass	3.334	3.333	Pass	3.334	3.334	3.334	3.334	3.334	3.334	3.334
8/5/11	OQX4-18	8700	28'-6.52"	112049	Pass	3.323	3.331	Pass	3.333	3.333	3.333	3.333	3.334	3.332	3.333
8/5/11	OQY-19	8700	28'-6.52"	112049	Pass	3.324	3.332	Pass	3.333	3.333	3.332	3.331	3.331	3.332	3.332
8/5/11	OQX4-20	8700	28'-6.52"	112049	Pass	3.325	3.332	Pass	3.333	3.333	3.333	3.332	3.332	3.332	3.332
8/5/11	OQX4-21	8700	28'-6.52"	112049	Pass	3.323	3.332	Pass	3.334	3.331	3.332	3.332	3.332	3.332	3.332
8/5/11	OQX4-22	8700	28'-6.52"	112049	Pass	3.327	3.333	Pass	3.332	3.333	3.333	3.334	3.333	3.333	3.334
8/5/11	OQX4-23	8700	28'-6.52"	112049	Pass	3.331	3.334	Pass	3.331	3.330	3.329	3.329	3.330	3.330	3.330
8/5/11	OQX4-24	8700	28'-6.52"	112049	Pass	3.323	3.331	Pass	3.331	3.331	3.331	3.332	3.332	3.332	3.332
8/5/11	OQY-25	8700	28'-6.52"	112049	Pass	3.323	3.331	Pass	3.331	3.331	3.331	3.332	3.332	3.332	3.332
8/5/11	OQY-26	8700	28'-6.52"	112049	Pass	3.328	3.333	Pass	3.333	3.333	3.333	3.333	3.332	3.332	3.332
8/5/11	OQY-27	8700	28'-6.52"	112049	Pass	3.327	3.333	Pass	3.334	3.334	3.334	3.334	3.334	3.334	3.334
8/5/11	OQY-28	8700	28'-6.52"	112049	Pass	3.327	3.333	Pass	3.334	3.334	3.334	3.334	3.334	3.334	3.334
8/5/11	OQY-29	8700	28'-6.52"	112049	Pass	3.330	3.334	Pass	3.332	3.332	3.332	3.331	3.331	3.331	3.331
8/5/11	OQX4-30	8700	28'-6.52"	112049	Pass	3.323	3.329	Pass	3.334	3.333	3.333	3.334	3.334	3.334	3.334
8/5/11	OQY-31	8700	28'-6.52"	112049	Pass	3.323	3.333	Pass	3.333	3.333	3.332	3.330	3.328	3.326	3.326
8/5/11	OQY-32	8700	28'-6.52"	112049	Pass	3.323	3.326	Pass	3.334	3.334	3.334	3.334	3.334	3.334	3.334

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112049	660110-SA-017 CO 022	8700 MM	6 pcs	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8700mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & Tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OQY-25, OQY-26, OQY-28, OQY-29, OQY-31, OQX4-30

Heat treatment lot OQY is from heat of steel ID 4M76367-1
Heat treatment lot OQX is from heat of steel ID 4M76367-2

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112051	660110-SA-017 CO 022	8900 MM	6 ~~7~~ pcs	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8900mm OAL PWS anchor rod w/1850mm of useable thread one end and 280mm (13.78") on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end, HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OPY4-19, OPY4-20, OPY4-21, OPY4-22, OPY4-24, OQY-23B, ~~OOH-TF~~ PL 9/30/11

Heat treatment lot OPY is from heat of steel ID 3M75738-2
Heat treatment lot OQY is from heat of steel ID 4M76367-1
Heat treatment lot OOH is from heat of steel ID 4M76368-3

Attachments:

Mill Test Reports
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

CERTIFICATE OF COMPLIANCE

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 112051	660110-SA-017 CO 022	8900 MM	14 pcs	10/17/11

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

PRODUCT DESCRIPTION
3.50"-4UNC 2A x 8900mm OAL PWS anchor rod w/1850mm of usable thread one end and 280mm (13.78") on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end, HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

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

DRAWING

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.

Bar I.D.'s: OYL-7, OYK-4, OYL-6, OYL-9, OYN-6, OYN-4, OYN-5, OYN-3, OYN-2, OYG-4, OYO-8, OYN-7, OYL-5, OYG-1

Heat treatment lot OYL is from heat of steel ID A113151 **(Batch# H211)**
Heat treatment lot OYK is from heat of steel ID A113151 **(Batch# H208)**
Heat treatment lot OYN is from heat of steel ID A113151 **(Batch# H215)**
Heat treatment lot OYG is from heat of steel ID A113149 **(Batch# H208)**
Heat treatment lot OYO is from heat of steel ID A113151 **(Batch# H217)**

Attachments:
Mill Test Reports
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112054	660110-SA-017 CO 022	9200 MM	2 pc	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9200mm OAL PWS anchor rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OTD-1H, OOH-4F

Heat treatment lot OTD is from heat of steel ID 4M76368-1
Heat treatment lot OOH is from heat of steel ID 4M76368-3

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112054	660110-SA-017 CO 022	9200 MM	6 pc	10/17/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9200mm OAL PWS anchor rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYP-5, OYN-11, OYO-9, OYO-4, OYO-5, OYO-3

Heat treatment lot OYP is from heat of steel ID A113151 **(Batch# H222)**
Heat treatment lot OYN is from heat of steel ID A113151 **(Batch# H215)**
Heat treatment lot OYO is from heat of steel ID A113151 **(Batch# H217)**

Attachments:

Mill Test Reports
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

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 112055	660110-SA-017 CO 022	9300 MM	3 pcs	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OOH-2F, OOH-3F, OOH-1E

Heat treatment lot OOH is from heat of steel ID 3M76368-3

Attachments:
Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112055	660110-SA-017 CO 022	9300 MM	7 pcs	10/17/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYN-10, OYN-8, OYN-9, OYP-3, OYO-6, OYP-4, OYO-7

Heat treatment lot OYN is from heat of steel ID A113151 **(Batch # H215)**
Heat treatment lot OYP is from heat of steel ID A113151 **(Batch# H222)**
Heat treatment lot OYO is from heat of steel ID A113151 **(Batch# H217)**

Attachments:

Mill Test Reports
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112056	660110-SA-017 CO 022	9400 MM	3 pcs	8/31/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9400mm (30'-10.08") OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2".4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.: OOF2-1, OOH-1E, OTD-2E
Heat treatment lot OOF is from heat of steel ID 4M76368-2
Heat treatment lot OOH is from heat of steel ID 4M76368-3
Heat treatment lot OTD is from heat of steel ID 4M76368-1

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
8/29/11

PWS ANCHOR RODS and EXTENSION ROD THREAD MAPPING

AUGUST 31, 2011

Date	BAR				COUPLER END			TAPPED END							
Measured	I.D	LENGTH	LENGTH	DYSON	No-Go	Pitch Diameter [In.]		No-Go	Pitch Diameter Readings (+/- 1 Pitch) [Inches]						
	CODE / BAR	MM	FT./IN	S.O. #	Pass/Fail	0.75"	12.75"	Pass/Fail	0.75"	2.25"	12.75"	24.75"	36.75"	48.75"	60.75"
6/28/11	OOF2-1	9400	30'-10"	112056	Pass	3.343	3.347	Pass	3.324	3.329	3.330	3.333	3.332	3.334	3.339
8/10/11	OOH-1E	9400	30'-10.08"	112056	Pass	3.323	3.329	Pass	3.333	3.333	3.333	3.333	3.333	3.333	3.333
8/10/11	OTD-2E	9400	30'-10.08"	112056	Pass	3.323	3.330	Pass	3.323	3.331	3.332	3.333	3.333	3.333	3.333

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112056	660110-SA-017 CO 022	9400 MM	1 pcs	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9400mm (30'-10.08") OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2".4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.: OTD-2E

Heat treatment lot OTD is from heat of steel ID 4M76368-1

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112057	660110-SA-017 CO 022	9500 MM	4 pcs	8/31/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9500mm OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OOF3-4, OTD-1D, OTD-2D, OTD-3D
Heat treatment lot OOF is from heat of steel ID 4M76368-2
Heat treatment lot OTD is from heat of steel ID 4M76368-1

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
8/29/11

PWS ANCHOR RODS and EXTENSION ROD THREAD MAPPING

AUGUST 31, 2011

Date	BAR				COUPLER END			TAPPED END							
Measured	I.D	LENGTH	LENGTH	DYSON	No-Go	Pitch Diameter [In.]		No-Go	Pitch Diameter Readings (+/- 1 Pitch) [Inches]						
	CODE / BAR	MM	FT./IN	S.O. #	Pass/Fail	0.75"	12.75"	Pass/Fail	0.75"	2.25"	12.75"	24.75"	36.75"	48.75"	60.75"
6/25/11	OOF3-4	9500	31'-2"	112057	Pass	3.324	3.326	Pass	3.323	3.330	3.330	3.332	3.332	3.333	3.334
8/10/11	OTD-1D	9500	31'-2.02"	112057	Pass	3.324	3.330	Pass	3.333	3.333	3.331	3.331	3.331	3.331	3.331
8/10/11	OTD-2D	9500	31'-2.02"	112057	Pass	3.326	3.333	Pass	3.333	3.333	3.333	3.333	3.333	3.333	3.333
8/10/11	OTD-3D	9500	31'-2.02"	112057	Pass	3.324	3.333	Pass	3.333	3.333	3.333	3.333	3.333	3.333	3.333

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112057	660110-SA-017 CO 022	9500 MM	3 pcs	9/29/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9500mm OAL PWS Anchor Rod w/1850mm (72.83") of usable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A153 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OTD-1D, OTD-2D, OTD-23D

Heat treatment lot OTD is from heat of steel ID 4M76368-1

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification
Pitch Diameter Record

Deborah A. Smith
Q.A. Admin. Assistant
9/29/11

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

Date Received: 6/3/2011

Test Report No.: DYS006-11-06-26885-1 *REVISED

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

P.O. No.: 78333 / 78375

TEST REPORT
ITAR-CONTROLLED DATA

Sample Description: MT On-Site Wet Fluorescent Cal Trans Witness of Anchor Rods Representing 3.50"-4UNC 2A x Random Lengths*, 6/6/2011, Heat#/Heat Codes: 4M76368/OOF and 4M76368/OOH *

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM F788-06 (Acceptance Criteria)
Procedure:	SOP 42.03 /ASTM E1444 (Method) per ASTM A 490/ Caltran Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05

METHOD

☐ Dry	☒ Wet

PARTICLES

Magnaflux Particles:	*Part Preparation:	Wet Particle Carrier:
☐ 8A Red ☐ 14A ☐ 3A Black ☒ 14AM ☐ 1 Gray ☐ Other Batch No. 09D02K	☐ None Required ☐ Solvent Clean ☐ Grinding ☒ Other: Precleaned by Customer	☐ Magnaflux Carrier II ☒ Pre Mixed ☐ Concentration MI Batch No.

CURRENT

☐ AC	☐ FWDC
☐ Central Conductor (AMPS)	☐ Head Shot (AMPS)
☐ Coil (AMPS)	☐ Prods (AMPS/Spacing)

Field Verified by: ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe

EQUIPMENT

☐ Magnaflux H-720 S/N: Cal Due Date:

☒ Yoke ☐ AC ☒ DC S/N: 3005 Spacing: 4" – 6" Cal Due Date: 12/1/11

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Karen Baumiller
Customer Services Manager

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

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TEST REPORT
ITAR-CONTROLLED DATA

INSPECTION RESULTS	
Quantity*	**Results***
4 PCS OOH Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
4 PCS OOF Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
Comments: "ID of tube only"- Magnetic Flux Field cannot be verified for sensitivity; thus only a cursory examination was performed for informational purposes only.* Marking Requirements: Demag and post cleaning requirements:	
Inspected by: Matthew Novak	Certification: ASNT-SNT-TC-1A Level ☐ II ☒ III

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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*REVISED: Corrected quantity/sample descriptions (6/13/11).
Corrected part preparation and standard/ procedure (6/14/11).
Added Heat Number, Code, Lengths, Comments and expanded Results (8/01/11).

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Karen Baumiller
Customer Services Manager

STORK
Materials Technology

Stork Herron Testing Laboratories

6/17/2011

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

Date Received: 6/15/2011

Test Report No.: DYS006-11-06-27669-1
REVISED

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

P.O. No.: 78540

TEST REPORT
ITAR-CONTROLLED DATA

Sample Description: MT On-site Wet Fluorescent Exam of Anchor Rods Representing 3.50"-4UNC 2A x Random Lengths*, 6/16/11, ASTM E 1444 SOP 42.03, ASTM F788, Heat#/Heat Code: 4M76368/OTD*

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM F788-06 (Acceptance Criteria)	
Procedure:	SOP 42.03 /ASTM E1444 (Method) per ASTM A490 Caltran Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05	
METHOD		
☐ Dry	☒ Wet	
PARTICLES		
Magnaflux Particles: ☐ 8A Red ☐ 14A ☐ 3A Black ☒ 14AM ☐ 1 Gray ☐ Other Batch No. 09D02K	**Part Preparation:** ☐ None Required ☐ Solvent Clean ☐ Grinding ☒ Other Precleaned by Customer	**Wet Particle Carrier:** ☐ Magnaflux Carrier II ☒ Pre Mixed ☐ Concentration MI Batch No.
CURRENT		
☐ AC	☐ FWDC	
☐ Central Conductor (AMPS)	☐ Head Shot (AMPS)	
☐ Coil (AMPS)	☐ Prods (AMPS/Spacing)	
Field Verified by: ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe		
EQUIPMENT		
☐ Magnaflux H-720 S/N: Cal Due Date:		
☒ Yoke ☐ AC ☒ DC S/N: 3005 Spacing: 4" – 6" Cal Due Date: 12/1/11		

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Michael R. Gaydos
General Manager, COO

STORK
Materials Technology

Stork Herron Testing Laboratories

6/17/2011

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

Date Received: 6/15/2011

Test Report No.: DYS006-11-06-27669-1
REVISED

P.O. No.: 78540

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Cleveland, OH 44131
USA

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

TEST REPORT
ITAR-CONTROLLED DATA

INSPECTION RESULTS	
Quantity	**Results**
3 PCS **OTD, Heat# 4M76368*** **3.50"-4UNC-2A X Random Lengths* PWS Anchor Rod**	**O.D. only was inspected and found to be acceptable***
Comments: "ID of tube only"- Magnetic Flu Field cannot be verified for sensitivity; thus only a cursory examination was performed for informational purposes only.* Marking Requirements: Demag and post cleaning requirements:	
Inspected by: Matthew Novak	Certification: ASNT-SNT-TC-1A Level ☐ II ☒ III

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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*REVISED (08/01/11): Added Heat Number, Length, Comments and expanded Results.

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Michael R. Gaydos
General Manager, COO

STORK
Materials Technology

Stork Herron Testing Laboratories

8/5/2011

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

Date Received: 8/3/2011

Test Report No.: DYS006-11-08-31132-1

P.O. No.: 79319

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
ITAR-CONTROLLED DATA

Sample Description: One (1) Lot (4 Pcs.) MT Exam of Anchor Rods, Representing 3.50"- 4UNC 2A Random Length Rods, Material Per ASTM-A354, gr BD, ASTM E1444 Per ASTM A490 with Acceptance Per ASTM F788, MIL-I-45208A, AM#1 Applies, Cust PO # 660110-SA-017 CO 022, Heat #/Code 4M76367/OQY

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM F788-06 (Acceptance Criteria)		
Procedure:	SOP 42.03 / ASTM E1444(Method) per ASTM A490 / Caltrans Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05		
METHOD			
☐ Dry		☒ Wet	
PARTICLES			
Magnaflux Particles: ☐ 8A Red ☐ 14A ☐ 3A Black ☒ 14AM ☐ 1 Gray ☐ Other Batch No. 09D02K.	**Part Preparation:** ☐ None Required ☐ Solvent Clean ☐ Ultrasonic Cleaner / Water ☒ Other Precleaned by Customer	**Wet Particle Carrier:** ☐ Ardrox Base Oil ☒ Pre Mixed ☐ Concentration Ml Lot No.	
CURRENT			
☐ AC		☐ FWDC ☐ HWDC	
☐ Central Conductor (AMPS)		☐ Head Shot (AMPS)	
☐ Coil (AMPS)		☐ Prods (AMPS/Spacing)	
Field Verified by: ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe			
EQUIPMENT			
☐ MagWerks MVS-2445 S/N: 000404		Cal Due Date: 9/22/2011	
☐ Magnaflux H-720 S/N: 81417		Cal Due Date: 9/22/2011	
☒ Yoke ☐ AC ☒ DC S/N: 3005 Spacing: 4"-6" Cal Due Date: 12/1/11			

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Michael R. Gaydos
General Manager, COO

STORK
Materials Technology

Stork Herron Testing Laboratories

8/5/2011

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

Date Received: 8/3/2011

Test Report No.: DYS006-11-08-31132-1

P.O. No.: 79319

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
ITAR-CONTROLLED DATA

INSPECTION RESULTS	WO# 006-110831132 (PO# 79319)
Quantity	**Results**
4 PCS of 9 PCS Completes P.O. 79319 OQY Heat # 4M76367 3.50"-4UNC-2A X Random Lengths PWS Anchor Rods OQY-4, OQY-3, OQY-2, OQY-1 For balance of order see Work Order DYS006-110830874, Dated 8/1/11, P.O. 79319	**O.D. only was inspected and found to be acceptable**

Comments: Examined per customer request "ID of tube only" –Magnetic Flux Field cannot be verified for sensitivity; thus only a cursory examination was performed for informational purposes only, and no indications were noted at the time of inspection.

Marking Requirements:

Demag and post cleaning requirements: N/A

☐ Post Preservation: Ardrox 3968 Lot#: 05030711 Expiration Date: 4-13-2013

Inspected by:	Certification: Level ☐ II ☒ III	Inspection Date:
Matthew Novak	Recertification Date:6/25/13	8/4/11

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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Michael R. Gaydos
General Manager, COO

STORK Materials Technology

Stork Herron Testing Laboratories

10/14/2011

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

Date Received: 10/11/2011

Test Report No.: DYS006-11-10-35831-1

P.O. No.: 80419

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
ITAR-CONTROLLED DATA

Sample Description: Eight (8) Anchor Rods Representing 3.50"-4UNC 2A Random Length Rods, Material ASTM-A354, Gr. BD, Spec.: ASTM A490 Section 10, On-Site Wet Fluorescent Magnetic Particle Exam 10/14/11, Heat# A113151, (2) Code OYK-4 & OYK-5 / Batch # H208 (Ref. Code OYG), (2) Code OYL-4 & OYL-6 / Batch # H211, (2) Code OYN-10 & OYN-11 / Batch # H215, (2) Code OYO-4 & OYO-5 / Batch # H217

NDT MAGNETIC PARTICLE INSPECTION REPORT

SPECIFICATIONS	
Procedure	ASTM E1444 (Method) per ASTM A490 / Caltrans Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05
Acceptance	ASTM F788-06 (Acceptance Criteria)

EQUIPMENT / MATERIAL DATA		
☐ MagWerks MVS-2445 S/N: 000404 Cal. Due Date: 3/22/2012		
☐ Magnaflux H-720 S/N: 81471 Cal. Due Date: 3/22/2012		
☒ Yoke ☐ AC ☒ DC S/N: 6512 Spacing: 4-6" Cal. Due Date: 2/11/12		
Magnaflux Particles: ☐ 8A Red ☐ 14A ☐ 3A Black ☐ 14AM ☐ 1 Gray ☒ Ardrox 8800A Lot No. 65121410	**Part Preparation:** ☐ None Required ☐ Solvent Clean ☐ Ultrasonic Cleaner / Water ☒ Other: Precleaned by Customer	**Wet Particle Carrier:** ☐ Ardrox Base Oil ☒ Pre Mixed ☐ Concentration Ml Lot No.

INSPECTION PARAMETERS		
☐ Dry (Visible)	☒ Wet (Fluorescent)	
☐ AC	☐ FWDC	☐ HWDC
☐ Central Conductor (AMPS)	☐ Head Shot (AMPS)	
☐ Coil (AMPS)	☐ Prods (AMPS/Spacing)	
Field Verified by ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe		

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Michael R. Gaydos
General Manager, COO

STORK Materials Technology

Stork Herron Testing Laboratories

10/14/2011

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

Date Received: 10/11/2011

Test Report No.: DYS006-11-10-35831-1

P.O. No.: 80419

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Cleveland, OH 44131
USA

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

TEST REPORT
ITAR-CONTROLLED DATA

INSPECTION PIECE(S) DATA			
Work Order No.	DYS006-111035831	Purchase Order No.	80419
Material	ASTM A354 Gr. BD	Heat No.	A113151
Part Cleaning ☐ Ultrasonic Cleaner, Ardrox 6333A 20%bv, Lot No. 05031011, Exp. Date 5/6/2013			
☐ Drawing Attached		☐ Picture Attached	

INSPECTION RESULTS			
Nomenclature	**Quantity**	**Results**	
Code OYK-4 & OYK-5 / Batch # H208 (Ref. Code OYG)	2 Rods	☒ Acceptable	☐ Rejectable
Code OYL-4 & OYL-6 / Batch # H211	2 Rods	☒ Acceptable	☐ Rejectable
Code OYN-10 & OYN-11 / Batch # H215	2 Rods	☒ Acceptable	☐ Rejectable
Code OYO-4 & OYO-5 / Batch # H217	2 Rods	☒ Acceptable	☐ Rejectable
Comments: O.D. only was inspected and found to be acceptable Marking Requirements: Demag and post cleaning requirements: N/A ☐ Post Preservation: Ardrox 3968, Lot No. 05030711, Expiration Date 4/13/2013			
Inspected by: Matthew Novak	Certification Level ☐ II ☒ III Recertification: 6/25/13		Inspection Date 6/14/11

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Michael R. Gaydos
General Manager, COO

Monnig Industries, Inc.

HOT DIP & MECHANICAL GALVANIZING
P.O. BOX 98
GLASGOW, MO 65254
PH. 660-338-2242 FAX: 660-338-5199

OCTOBER 27, 2011

DYSON CORPORATION
50 FREEDOM ROAD
PAINESVILLE, OH 44077

RE: GALVANIZING CERTIFICATE-CALTRAN

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE LIST BELOW MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS.

24 PWS ANCHOR RODS

ROD ID/MIL THICKNESS MEASUREMENTS

OYH-8/8.86	OYN-6/7.82	OYK-4/7.17	OYO-8/6.66	OYN-7/8.80
OYG-1/9.93	OYN-8/10.40	OYN-9/9.33	OYP-4/8.52	OYO-7/7.70
OYK-5/9.29	OOH2-20/6.33	OOH2-23/6.34	OYI-5/7.96	OYJ-8/8.59
R1011OTD/8.27	OYM-5/10.95	OYG-2/7.68	OYL-4/9.28	OYO-5/6.38
OYO-9/7.95	OPY3-8/6.98	OOF2-4/9.30	OOH2-2/5.90	

PATRICIA S. WESTHUES
NOTARY PUBLIC STATE OF MISSOURI
HOWARD COUNTY
MY COMMISSION EXP. APR. 18, 2012

John Monnig
JOHN MONNIG, PRESIDENT

Patricia S. Westhues
PATRICIA S. WESTHUES,
NOTARY PUBLIC

Phoenix Manufacturing, Inc.
P.O. BOX 330
26666 Von Holten Rd.
Cole Camp, MO. 65325
660-668-2611
660-668-3160 (fax)

SSPC-SP10 Near White Metal Blast

Near-White Blast Cleaning - Removal of nearly all mill scale, rust, rust scale, paint, or foreign matter by the use of abrasives propelled through nozzles or by centrifugal wheels, to the degree hereafter specified. A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides, or light, tight residues of paint or coating that may remain. At least 95 percent of each square inch of surface area shall be free of all visible residues, and the remainder shall be limited to the light discoloration mentioned above.

OYH-8	OYN-6	OYK-4	OYO-8	OYN-7
OYG-1	OYN-8	OYN-9	OYP-4	OYO-7
OYK-5	OOH2-20	OOH2-23	OYI-5	OYJ-8
R1011OTD	OYM-5	OYG-2	OYL-4	OYO-5
OYO-9	OPY3-8	OOF2-4	OOH2-2	

CERTIFICATE OF COMPLIANCE

DYSON CORP.

D|N 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 112047	660110-SA-017 CO 022	8500 MM	8 pcs	10/19/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"-4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 -

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OPY2-6, OPY3-8, OOH2-23, OOH2-2, OOF2-4, OPY2-13, OPY2-3

Heat treatment lot OPY is from heat of steel ID 3M75738-2
Heat treatment lot OOH is from heat of steel ID 4M76368-3
Heat treatment lot OOF is from heat of steel ID 4M76368-2

Attachments:

Mill Test Reports
Mag Particle Certifications
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/19/11

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

Date Received: 6/3/2011

Test Report No.: DYS006-11-06-26885-1 *REVISED

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

P.O. No.: 78333 / 78375

TEST REPORT
ITAR-CONTROLLED DATA

Sample Description: MT On-Site Wet Fluorescent Cal Trans Witness of Anchor Rods Representing 3.50"-4UNC 2A x Random Lengths*, 6/6/2011, Heat#/Heat Codes: 4M76368/OOF and 4M76368/OOH *

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM F788-06 (Acceptance Criteria)
Procedure:	SOP 42.03 /ASTM E1444 (Method) per ASTM A 490/ Caltran Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05

METHOD

☐ Dry	☒ Wet

PARTICLES

Magnaflux Particles:	*Part Preparation:	Wet Particle Carrier:
☐ 8A Red ☐ 14A ☐ 3A Black ☒ 14AM ☐ 1 Gray ☐ Other Batch No. 09D02K	☐ None Required ☐ Solvent Clean ☐ Grinding ☒ Other: Precleaned by Customer	☐ Magnaflux Carrier II ☒ Pre Mixed ☐ Concentration MI Batch No.

CURRENT

☐ AC	☐ FWDC
☐ Central Conductor (AMPS)	☐ Head Shot (AMPS)
☐ Coil (AMPS)	☐ Prods (AMPS/Spacing)

Field Verified by: ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe

EQUIPMENT

☐ Magnaflux H-720 S/N: Cal Due Date:

☒ Yoke ☐ AC ☒ DC S/N: 3005 Spacing: 4" – 6" Cal Due Date: 12/1/11

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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 Baumiller
Customer Services Manager

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

Date Received: 6/3/2011

Test Report No.: DYS006-11-06-26885-1 *REVISED

P.O. No.: 78333 / 78375

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
ITAR-CONTROLLED DATA

INSPECTION RESULTS	
Quantity*	**Results***
4 PCS OOH Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
4 PCS OOF Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
Comments: "ID of tube only"- Magnetic Flux Field cannot be verified for sensitivity; thus only a cursory examination was performed for informational purposes only.* Marking Requirements: Demag and post cleaning requirements:	
Inspected by: Matthew Novak	Certification: ASNT-SNT-TC-1A Level ☐ II ☒ III

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)
This document contains technical data whose export and re-export/re-transfer is subject to control by the U.S. Department of State under the Arms Export Control Act and the International Traffic in Arms Regulations. The Department of State's prior written approval is required for the export or re-export/re-transfer of such technical data to any foreign person, foreign entity or foreign organization whether in the United States or abroad.

*REVISED: Corrected quantity/sample descriptions (6/13/11).
Corrected part preparation and standard/ procedure (6/14/11).
Added Heat Number, Code, Lengths, Comments and expanded Results (8/01/11).

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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 Baumiller
Customer Services Manager

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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003770
Date Inspected: 28-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 700
OSM Departure Time: 1530
Location: Glasgow, MO

Quality Control Contact: Ryan Monnig
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☐ N/A
Sampled Items: ☐ Yes ☐ No ☐ N/A
Stock Transfer: ☐ Yes ☐ No ☐ N/A
OK to Cut: ☐ Yes ☐ No ☐ N/A
Rebar Test Witness: ☐ Yes ☐ No ☐ N/A
Delayed/Cancelled: ☐ Yes ☐ No ☐ N/A
Other: N/A
Bridge No: 34-0006
Component: PWS Anchor Rods
Bid Item: 68
Lot No: N/A

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to monitor, at random intervals, the galvanizing of Parallel Wire Strand (PWS) High Strength Rods from Dyson Corporation for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA met with Monnig Industries General Manager Ryan Monnig and was informed of the following status regarding the galvanizing of the PWS Anchor Rods:

This QA Inspector observed the following PWS Rods were part of load - #9:
Of the 24 rods in this shipment twenty-two (22) were Orange Tagged...
OYH-8, OYG-1, OYK-5, R1011OTD, OYO-9, OYN-6, OYN-8, OYM-5, OPY3-8, OYK-4, OYN-9, OOH2-23, OYG-2, OOF2-4, OYO-8, OYP-4, OYI-5, OYL-4, OYN-7, OYO-7, OYJ-8, and OYO-5.

And two (2) were Blue Tagged.
The SMR authorization S54-025-11 has been included in this report.
MSD 784: OOH2-2 and OOH2-20.

1. This QA Inspector observed a dimensional report from Dyson Corporation accepting the rods was submitted for the heat treatment lots.
2. This QA Inspector observed a Certificate Of Compliance (COC), Material Test Report (MTR), Magnetic Particle Testing reports per material heat and shipper were submitted from Dyson Corporation.

SOURCE INSPECTION REPORT

(Continued Page 2 of 2)

3. This QA Inspector observed a COC and QC reports for blasting and galvanizing were submitted from Monnig Industries.

These documents submitted appeared to comply with the contract requirements.

This QA Inspector observed a spherical nut and regular nut were threaded full length and shipped as such.

This QA performed a visual verification of rods after completion of the galvanizing and cleaning process.

This QA Inspector observed the galvanizing process was performed within 4 hours of the blasting and appeared to comply with the contract requirements.

Note: Two (2) Parallel Wire Strand (PWS) High Strength Rods were rejected as being suitable for use at this time. It was observed that a nut could not be run for the entire length of the threaded area. See attached photo for a visual representation. (OPY2-3 and OPY2-13)

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.

Summary of Conversations:

Comments

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

Inspected By:	Clifford,William	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 1.9

REPORT OF INSPECTION OF MATERIAL

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: RIM-000108
Date Inspected: 28-Oct-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Monnig Industries

OSM Arrival Time: 700
OSM Departure Time: 1330
Location: Glasgow, MO

The following material has been inspected in accordance with Section 6 of the Standard Specifications and found to substantially comply* with contract plans and specifications.

Item	Lot #	Bid Item#	Quantity	Material Description
1	B211-005-11	68	22	PWS Anchor Rods - load #9

Identification: One Tag Attached to Load
Shipped to: Job Site

Summary of Items Observed:

This Quality Assurance (QA) Inspector, William Clifford, was present at Monnig Industries Inc. in Glasgow, MO as requested to release the Parallel Wire Strand (PWS) High Strength Anchor Rods for use on the San Francisco / Oakland / Bay Bridge (SFOBB), Self Anchored Suspension (SAS) project.

This QA Inspector met with Monnig Industries General Manager Ryan Monnig and was informed all PWS Anchor Rods had been galvanized, passed QC inspections, spherical and regular nuts had been threaded on all rods and that all rods had been packaged for shipment.

This QA Inspector observed the following PWS Rods were part of load:
OYH-8, OYG-1, OYK-5, R1011OTD, OYO-9, OYN-6, OYN-8, OYM-5, OPY3-8, OYK-4, OYN-9, OOH2-23, OYG-2, OOF2-4, OYO-8, OYP-4, OYI-5, OYL-4, OYN-7, OYO-7, OYJ-8, and OYO-5.

This QA Inspector was provided a Certificate of Compliance (COC), Material Test Reports (MTR's), Magnetic Particle Testing (MT) inspection reports per material heat, Thread Dimension reports and a shipper from Dyson Corporation for the PWS Anchor Rods in load package.

This QA Inspector was provided a COC, Quality Control (QC)Blasting report and QC inspection report for galvanizing thicknesses from Monnig Industries for the PWS Anchor Rods in load package.

This QA Inspector had previously confirmed with Structural Material Representative (SMR) Kittric Guest that all material check samples had been accepted.

The documents provided appeared to comply with the contract requirements therefore an Orange Tag was placed in a plastic pouch and attached to the load.

REPORT OF INSPECTION OF MATERIAL

This QA Inspector randomly observed as the material listed above was loaded onto each truck. See photos of documentation package and overall truck loaded shipment below.

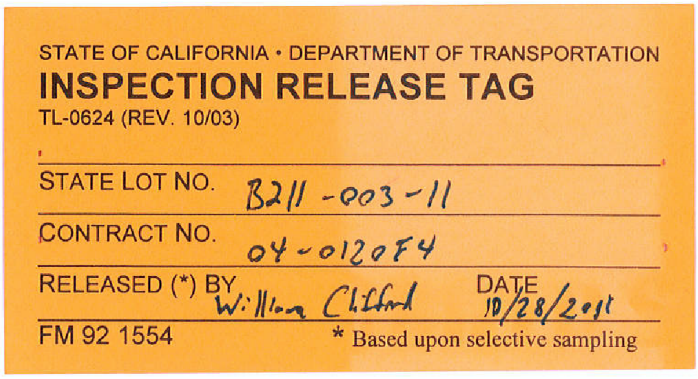
Summary of Conversations:

General conversation as noted above.

Comments

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

Inspected By:	Clifford, William	Quality Assurance Inspector
Reviewed By:	Levell, Bill	QA Reviewer


STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
INSPECTION RELEASE TAG
TL-0624 (REV. 10/03)
STATE LOT NO. B211-003-11
CONTRACT NO. 04-0120F4
RELEASED (*) BY William Clifford DATE 10/28/2011
FM 92 1554 * Based upon selective sampling

Monnig Industries, Inc.

HOT DIP & MECHANICAL GALVANIZING
P.O. BOX 98
GLASGOW, MO 65254
PH. 660-338-2242 FAX: 660-338-5199

OCTOBER 27, 2011

DYSON CORPORATION
50 FREEDOM ROAD
PAINESVILLE, OH 44077

RE: GALVANIZING CERTIFICATE-CALTRAN

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE LIST BELOW MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS.

24 PWS ANCHOR RODS

ROD ID/MIL THICKNESS MEASUREMENTS

OYH-8/8.86	OYN-6/7.82	OYK-4/7.17	OYO-8/6.66	OYN-7/8.80
OYG-1/9.93	OYN-8/10.40	OYN-9/9.33	OYP-4/8.52	OYO-7/7.70
OYK-5/9.29	OOH2-20/6.33	OOH2-23/6.34	OYI-5/7.96	OYJ-8/8.59
R1011OTD/8.27	OYM-5/10.95	OYG-2/7.68	OYL-4/9.28	OYO-5/6.38
OYO-9/7.95	OPY3-8/6.98	OOF2-4/9.30	OOH2-2/5.90	

PATRICIA S. WESTHUES
NOTARY PUBLIC STATE OF MISSOURI
HOWARD COUNTY
MY COMMISSION EXP. APR. 18, 2012

John Monnig
JOHN MONNIG, PRESIDENT

Patricia S. Westhues
PATRICIA S. WESTHUES,
NOTARY PUBLIC

Phoenix Manufacturing, Inc.
P.O. BOX 330
26666 Von Holten Rd.
Cole Camp, MO. 65325
660-668-2611
660-668-3160 (fax)

SSPC-SP10 Near White Metal Blast

Near-White Blast Cleaning - Removal of nearly all mill scale, rust, rust scale, paint, or foreign matter by the use of abrasives propelled through nozzles or by centrifugal wheels, to the degree hereafter specified. A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides, or light, tight residues of paint or coating that may remain. At least 95 percent of each square inch of surface area shall be free of all visible residues, and the remainder shall be limited to the light discoloration mentioned above.

OYH-8	OYN-6	OYK-4	OYO-8	OYN-7
OYG-1	OYN-8	OYN-9	OYP-4	OYO-7
OYK-5	OOH2-20	OOH2-23	OYI-5	OYJ-8
R1011OTD	OYM-5	OYG-2	OYL-4	OYO-5
OYO-9	OPY3-8	OOF2-4	OOH2-2	

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112047	660110-SA-017 CO 022	8500 MM	15 pcs	10/7/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. HDG per ASTM-A153 w/white metal blast prior to galvanize. BID ITEM 66 -

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OPY2-2, OPY2-6, OPY3-8, OTD-13, OOH2-23, OOH2-16, OOH2-20, OOH2-2, OOH2-4, OOF2-4, OOF4-4, OPY2-13, OPY2-15, OPY2-3, OPY2-7

Heat treatment lot OPY is from heat of steel ID 3M75738-2
Heat treatment lot OTD is from heat of steel ID 4M76368-1
Heat treatment lot OOH is from heat of steel ID 4M76368-3
Heat treatment lot OOF is from heat of steel ID 4M76368-2

Attachments:
Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/6/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112047	660110-SA-017 CO 022	8500 MM	2 pcs	10/17/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 -

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYG-2, OYG-3

Heat treatment lot OYG is from heat of steel ID A113149 **(Batch # H208)**

STATE OF CALIFORNIA
STOCK MATERIAL

LOT NO. B305-040-11
INSPECTOR'S NAME Edmondson DATE 10-17-11

Attachments:

Mill Test Reports
Mag Particle Certifications

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

D|N 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 112047	660110-SA-017 CO 022	8500 MM	8 pcs	10/19/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"-4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 -

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OPY2-6, OPY3-8, OOH2-23, OOH2-2, OOF2-4, OPY2-13, OPY2-3

Heat treatment lot OPY is from heat of steel ID 3M75738-2
Heat treatment lot OOH is from heat of steel ID 4M76368-3
Heat treatment lot OOF is from heat of steel ID 4M76368-2

Attachments:

Mill Test Reports
Mag Particle Certifications
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/19/11

CERTIFICATE OF COMPLIANCE

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 112051	660110-SA-017 CO 022	8900 MM	14 pcs	10/17/11

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

PRODUCT DESCRIPTION
3.50"-4UNC 2A x 8900mm OAL PWS anchor rod w/1850mm of usable thread one end and 280mm (13.78") on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end, HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

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

DRAWING

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.

Bar I.D.'s: OYL-7, OYK-4, OYL-6, OYL-9, OYN-6, OYN-4, OYN-5, OYN-3, OYN-2, OYG-4, OYO-8, OYN-7, OYL-5, OYG-1

Heat treatment lot OYL is from heat of steel ID A113151 **(Batch# H211)**
Heat treatment lot OYK is from heat of steel ID A113151 **(Batch# H208)**
Heat treatment lot OYN is from heat of steel ID A113151 **(Batch# H215)**
Heat treatment lot OYG is from heat of steel ID A113149 **(Batch# H208)**
Heat treatment lot OYO is from heat of steel ID A113151 **(Batch# H217)**

Attachments:
Mill Test Reports
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112052	660110-SA-017 CO 022	9000 MM	2 pcs	10/17/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9000mm (29'-6.33") OAL FWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC-2A x 60mm (2.36") Deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 -

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYL-4, OYK-5

Heat treatment lot OYL is from heat of steel ID A113151 **(Batch# H211)**
Heat treatment lot OYK is from heat of steel ID A113151 **(Batch# H208)**

Attachments:
Mill Test Report
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112054	660110-SA-017 CO 022	9200 MM	2 pc	10/7/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9200mm OAL PWS anchor rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OTD-12, R1011-OTD

Heat treatment lot OTD is from heat of steel ID 4M76368

Attachments:

Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/6/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112054	660110-SA-017 CO 022	9200 MM	6 pc	10/17/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9200mm OAL PWS anchor rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYP-5, OYN-11, OYO-9, OYO-4, OYO-5, OYO-3

Heat treatment lot OYP is from heat of steel ID A113151 **(Batch# H222)**
Heat treatment lot OYN is from heat of steel ID A113151 **(Batch# H215)**
Heat treatment lot OYO is from heat of steel ID A113151 **(Batch# H217)**

Attachments:

Mill Test Reports
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112055	660110-SA-017 CO 022	9300 MM	7 pcs	10/17/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 9300mm OAL PWS Anchor Rod w/1850mm of useable thread one end and 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYN-10, OYN-8, OYN-9, OYP-3, OYO-6, OYP-4, OYO-7

Heat treatment lot OYN is from heat of steel ID A113151 **(Batch # H215)**
Heat treatment lot OYP is from heat of steel ID A113151 **(Batch# H222)**
Heat treatment lot OYO is from heat of steel ID A113151 **(Batch# H217)**

Attachments:

Mill Test Reports
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/17/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112056	660110-SA-017 CO 022	9400 MM	3 pc	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9400mm (30'-10.08") OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2".4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.: OYI-4, OYM-4, OYM-5

Heat treatment lot OYI is from heat of steel ID A113149 (Batch# H222)
Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)

Attachments:
Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112057	660110-SA-017 CO 022	9500 MM	3 pcs	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9500mm OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end & 280mm on opposite end. Drill & tap 2"-4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYJ-8, OYM-9, OYH-7

Heat treatment lot OYJ is from heat of steel ID A113151 (Batch# H207)
Heat treatment lot OYM is from heat of steel ID A113151 (Batch# H214)
Heat treatment lot OYH is from heat of steel ID A113149 (Batch# H210)

Attachments:

Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112058	660110-SA-017 CO 022	9600 MM	4 pcs	10/14/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9600mm OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanize BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYH-9, OYI-5, OYJ-11, OYH-5

Heat treatment lot OYH is from heat of steel ID A113149 (Batch# H210)
Heat treatment lot OYI is from heat of steel ID A113149 (Batch# H222)
Heat treatment lot OYJ is from heat of steel ID A113151 (Batch# H207)

Attachments:

Mill Test Report
Mag Particle Certification

Steve Marsh
Q.A. Manager
10/14/11

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112058	660110-SA-017 CO 022	9600 MM	2 pcs	10/28/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC-2A x 9600mm OAL PWS Anchor Rod w/1850mm of useable thread one end & 280mm on opposite end. Drill & tap 2"4.5UNC-2A x 60mm deep on 1850mm threaded end. HDG per ASTM-A123 w/white metal blast prior to galvanizing. BID ITEM 66 - FURNISH PWS CABLE SYSTEM

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYI-5, OYH-8

Heat treatment lot OYI is from heat of steel ID A113149 (Batch# H222)
Heat treatment lot OYH is from heat of steel ID A113149 (Batch# H210)

Note:
OYI-5 also in this shipment.
It is highlighted on a later sheet.
- Bob Brignano, CT

Attachments:
Mill Test Report
Mag Particle Certification
Galvanizing Certification

Deborah A. Smith
Q.A. Admin. Assistant
10/28/11

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

Date Received: 6/3/2011

Test Report No.: DYS006-11-06-26885-1 *REVISED

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

P.O. No.: 78333 / 78375

TEST REPORT
ITAR-CONTROLLED DATA

Sample Description: MT On-Site Wet Fluorescent Cal Trans Witness of Anchor Rods Representing 3.50"-4UNC 2A x Random Lengths*, 6/6/2011, Heat#/Heat Codes: 4M76368/OOF and 4M76368/OOH *

MAGNETIC PARTICLE INSPECTION REPORT

Standard:	ASTM F788-06 (Acceptance Criteria)
Procedure:	SOP 42.03 /ASTM E1444 (Method) per ASTM A 490/ Caltran Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05

METHOD

☐ Dry	☒ Wet

PARTICLES

Magnaflux Particles:	*Part Preparation:	Wet Particle Carrier:
☐ 8A Red ☐ 14A ☐ 3A Black ☒ 14AM ☐ 1 Gray ☐ Other Batch No. 09D02K	☐ None Required ☐ Solvent Clean ☐ Grinding ☒ Other: Precleaned by Customer	☐ Magnaflux Carrier II ☒ Pre Mixed ☐ Concentration MI Batch No.

CURRENT

☐ AC	☐ FWDC
☐ Central Conductor (AMPS)	☐ Head Shot (AMPS)
☐ Coil (AMPS)	☐ Prods (AMPS/Spacing)

Field Verified by: ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe

EQUIPMENT

☐ Magnaflux H-720 S/N: Cal Due Date:

☒ Yoke ☐ AC ☒ DC S/N: 3005 Spacing: 4" – 6" Cal Due Date: 12/1/11

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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 Baumiller
Customer Services Manager

STORK
Materials Technology

Stork Herron Testing Laboratories

6/13/2011

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

Date Received: 6/3/2011

Test Report No.: DYS006-11-06-26885-1 *REVISED

P.O. No.: 78333 / 78375

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
ITAR-CONTROLLED DATA

INSPECTION RESULTS	
Quantity*	**Results***
4 PCS OOH Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
4 PCS OOF Heat# 4M76368 3.50"-4UNC-2A X Random Length Rods*	**O.D. only was inspected and found to be acceptable**
Comments: "ID of tube only"- Magnetic Flux Field cannot be verified for sensitivity; thus only a cursory examination was performed for informational purposes only.* Marking Requirements: Demag and post cleaning requirements:	
Inspected by: Matthew Novak	Certification: ASNT-SNT-TC-1A Level ☐ II ☒ III

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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*REVISED: Corrected quantity/sample descriptions (6/13/11).
Corrected part preparation and standard/ procedure (6/14/11).
Added Heat Number, Code, Lengths, Comments and expanded Results (8/01/11).

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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 Baumiller
Customer Services Manager

STORK
Materials Technology

Stork Herron Testing Laboratories

10/13/2011

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

Date Received: 10/11/2011

Test Report No.: DYS006-11-10-35829-1

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.: 80417

ITAR-CONTROLLED DATA

Sample Description: Eight (8) Anchor Rods Representing 3.50"-4UNC 2A Random Length Rods, Material ASTM-A354, Gr. BD, Spec.: ASTM A490 Section 10, On-Site Wet Fluorescent Magnetic Particle Exam 10/13/11, (2) Code OYH-8 & OYH-9 / Batch # H210, Heat# A113149, (2) Code OYI-4 & OYI-5 / Batch # H222 (Ref. Code OYP), Heat# A113149, (2) Code OYJ-8 & OYJ-11 / Batch # H207, Heat# A113151, (2) Code OYM-5 & OYM-9 / Batch # H214, Heat# A113151

NDT MAGNETIC PARTICLE INSPECTION REPORT

SPECIFICATIONS	
Procedure	ASTM E 1444 (Method) per ASTM A490 / Caltrans Special Provisions 10-1.59, 10-1.60, 10-1.61, and Caltrans Standard Specifications 75-1.05
Acceptance	ASTM F788-06 (Acceptance Criteria)

EQUIPMENT / MATERIAL DATA		
☐ MagWerks MVS-2445 S/N: 000404 Cal. Due Date: 3/22/2012		
☐ Magnaflux H-720 S/N: 81471 Cal. Due Date: 3/22/2012		
☒ Yoke ☐ AC ☒ DC S/N: 6512 Spacing: 4-6" Cal. Due Date: 2/11/2012		
Magnaflux Particles: ☐ 8A Red ☐ 14A ☐ 3A Black ☐ 14AM ☐ 1 Gray ☒ Ardrox 8800A Lot No.65121410	**Part Preparation:** ☐ None Required ☐ Solvent Clean ☐ Ultrasonic Cleaner / Water ☒ Other: Pre-cleaned by Customer	**Wet Particle Carrier :** ☐ Ardrox Base Oil ☒ Pre Mixed ☐ Concentration MI Lot No.

INSPECTION PARAMETERS		
☐ Dry (Visible)		☒ Wet (Fluorescent)
☐ AC	☐ FWDC	☐ HWDC
☐ Central Conductor (AMPS)		☐ Head Shot (AMPS)
☐ Coil (AMPS)		☐ Prods (AMPS/Spacing)
Field Verified by ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe		

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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.

Michael R. Gaydos
General Manager, COO

STORK Materials Technology

Stork Herron Testing Laboratories

10/13/2011

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

Date Received: 10/11/2011

Test Report No.: DYS006-11-10-35829-1

P.O. No.: 80417

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
ITAR-CONTROLLED DATA

INSPECTION PIECE(S) DATA			
Work Order No.	DYS006-111035829	Purchase Order No.	80417
Material	ASTM A354 Gr. BD	Heat No.	A113149 / A113151
Part Cleaning ☐ Ultrasonic Cleaner, Ardrox 6333A 20%bv, Lot No. 05031011, Exp. Date 5/6/2013			
☐ Drawing Attached		☐ Picture Attached	

INSPECTION RESULTS		
Nomenclature	**Quantity**	**Results**
Code OYH-8 & OYH-9 / Batch # H210, Heat# A113149	2 Rods	☒ Acceptable
Code OYI-4 & OYI-5 / Batch # H222 (Ref. Code OYP), Heat# A113149	2 Rods	☒ Acceptable
Code OYJ-8 & OYJ-11 / Batch # H207, Heat# A113151	2 Rods	☒ Acceptable
Code OYM-5 & OYM-9 / Batch # H214, Heat# A113151	2 Rods	☒ Acceptable
Comments: O.D. only was inspected and found to be acceptable Marking Requirements: Demag and post cleaning requirements: N/A ☐ Post Preservation: Ardrox 3968, Lot No. 05030711, Expiration Date 4/13/2013		
Inspected by: Matthew Novak	Certification Level ☐ II ☒ III Recertification: 6/25/13	Inspection Date 10/13/11

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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The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or International test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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.

Michael R. Gaydos
General Manager, COO

STORK Materials Technology

Stork Herron Testing Laboratories

10/14/2011

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

Date Received: 10/11/2011

Test Report No.: DYS006-11-10-35831-1

P.O. No.: 80419

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
ITAR-CONTROLLED DATA

Sample Description: Eight (8) Anchor Rods Representing 3.50"-4UNC 2A Random Length Rods, Material ASTM-A354, Gr. BD, Spec.: ASTM A490 Section 10, On-Site Wet Fluorescent Magnetic Particle Exam 10/14/11, Heat# A113151, (2) Code OYK-4 & OYK-5 / Batch # H208 (Ref. Code OYG), (2) Code OYL-4 & OYL-6 / Batch # H211, (2) Code OYN-10 & OYN-11 / Batch # H215, (2) Code OYO-4 & OYO-5 / Batch # H217

NDT MAGNETIC PARTICLE INSPECTION REPORT

SPECIFICATIONS	
Procedure	ASTM E1444 (Method) per ASTM A490 / Caltrans Special Provisions 10-1.59, 10-1.60, 10-1.61 and Caltrans Standard Specifications 75-1.05
Acceptance	ASTM F788-06 (Acceptance Criteria)

EQUIPMENT / MATERIAL DATA		
☐ MagWerks MVS-2445 S/N: 000404 Cal. Due Date: 3/22/2012		
☐ Magnaflux H-720 S/N: 81471 Cal. Due Date: 3/22/2012		
☒ Yoke ☐ AC ☒ DC S/N: 6512 Spacing: 4-6" Cal. Due Date: 2/11/12		
Magnaflux Particles: ☐ 8A Red ☐ 14A ☐ 3A Black ☐ 14AM ☐ 1 Gray ☒ Ardrox 8800A Lot No. 65121410	**Part Preparation:** ☐ None Required ☐ Solvent Clean ☐ Ultrasonic Cleaner / Water ☒ Other: Precleaned by Customer	**Wet Particle Carrier:** ☐ Ardrox Base Oil ☒ Pre Mixed ☐ Concentration Ml Lot No.

INSPECTION PARAMETERS		
☐ Dry (Visible)	☒ Wet (Fluorescent)	
☐ AC	☐ FWDC	☐ HWDC
☐ Central Conductor (AMPS)	☐ Head Shot (AMPS)	
☐ Coil (AMPS)	☐ Prods (AMPS/Spacing)	
Field Verified by ☒ Pie Gage ☐ QQI ☐ Hall Effect Probe		

The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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.

Michael R. Gaydos
General Manager, COO

STORK Materials Technology

Stork Herron Testing Laboratories

10/14/2011

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

Date Received: 10/11/2011

Test Report No.: DYS006-11-10-35831-1

P.O. No.: 80419

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
ITAR-CONTROLLED DATA

INSPECTION PIECE(S) DATA			
Work Order No.	DYS006-111035831	Purchase Order No.	80419
Material	ASTM A354 Gr. BD	Heat No.	A113151
Part Cleaning ☐ Ultrasonic Cleaner, Ardrox 6333A 20%bv, Lot No. 05031011, Exp. Date 5/6/2013			
☐ Drawing Attached		☐ Picture Attached	

INSPECTION RESULTS			
Nomenclature	**Quantity**	**Results**	
Code OYK-4 & OYK-5 / Batch # H208 (Ref. Code OYG)	2 Rods	☒ Acceptable	☐ Rejectable
Code OYL-4 & OYL-6 / Batch # H211	2 Rods	☒ Acceptable	☐ Rejectable
Code OYN-10 & OYN-11 / Batch # H215	2 Rods	☒ Acceptable	☐ Rejectable
Code OYO-4 & OYO-5 / Batch # H217	2 Rods	☒ Acceptable	☐ Rejectable
Comments: O.D. only was inspected and found to be acceptable Marking Requirements: Demag and post cleaning requirements: N/A ☐ Post Preservation: Ardrox 3968, Lot No. 05030711, Expiration Date 4/13/2013			
Inspected by: Matthew Novak	Certification Level ☐ II ☒ III Recertification: 6/25/13		Inspection Date 6/14/11

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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The above testing was performed in accordance with the latest revision of the applicable commercial, military and/or international test method unless otherwise noted. The above services were performed in accordance with Herron Testing Laboratories' Quality Assurance Program Edition 1, Revision 3 dated 6/30/09. 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 6 months 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.

Michael R. Gaydos
General Manager, COO

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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.8

COMPONENT MATERIAL INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: CMI-000391
Date Inspected: 07-Nov-2011

Contractor: Dyson Corp. & Subs
Location: 53 freedom Rd, Painsville, OH 44077
Bridge No.: 34-0006

OSM Arrival Time: 1000
OSM Departure Time: 1200
Component:#

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: Monnig Industries, Inc. 400 industrial drive, Glasgow, MO 65254

Lot #	Bid Item #	Quantity		Material Description
B306-005-11	66	2	ea	PWS A354 gr BD Anchor Rods

Identification: 3.5" PWS Anchor Rods

Summary of Items Observed:

On this date, Quality Assurance Inspector (QAI) Kenneth Riley traveled to Dyson Corporation in Painesville, Ohio as requested, to green tag release two (2) PWS Anchor Rods.

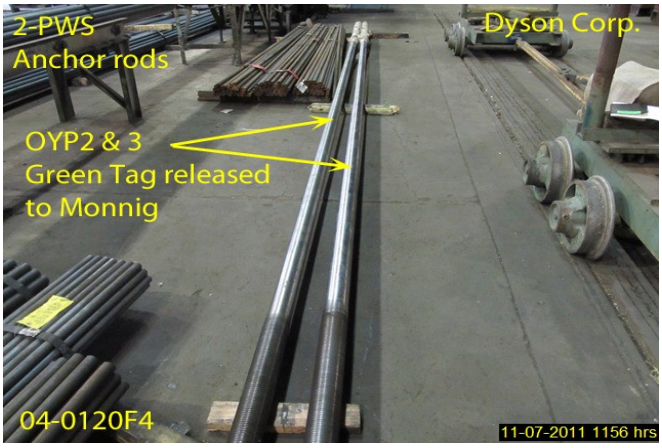
This (QA) Inspector met with QC manager Russ Welsh who accompanied this QA inspector through the facility. This QAI observed the following material;
OYP2- 3.5” diameter PWS Anchor Rod
OYP3- 3.5” diameter PWS Anchor Rod

This QAI reviewed Material Test Reports (MTR’s), Certificate Of Compliance (COC) and Magnetic particle Test Reports for the 2 ea. 3.5” A354 Gr BD Anchor rods. The Anchor rods are being shipped to Monnig Industries Inc. 400 Industrial Drive, Glasgow, MO for Galvanizing.

This QAI along with Dyson QC Cody Reznak performed a random visual inspection of the 2 anchor rods which appeared at the time of inspection to generally comply with the contract documents.

COMPONENT MATERIAL INSPECTION REPORT

(Continued Page 2 of 2)



Summary of Conversations:

Basic conservation, fundamental to completion of the tasks at hand, occurred between this QAI and Dyson Corp. QC, personnel .

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:	Riley, Ken	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.15

SOURCE INSPECTION REPORT

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: SIR-003813
Date Inspected: 10-Nov-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 800
OSM Departure Time: 1630
Location: Glasgow, MO

Quality Control Contact: Ryan Monnig
Quality Control Present: ☑ Yes ☐ No
Material transfer: ☐ Yes ☐ No ☑ N/A
Sampled Items: ☐ Yes ☐ No ☑ N/A
Stock Transfer: ☐ Yes ☐ No ☑ N/A
OK to Cut: ☐ Yes ☐ No ☑ N/A
Rebar Test Witness: ☐ Yes ☐ No ☑ N/A
Delayed/Cancelled: ☐ Yes ☑ No ☐ N/A
Other:
Bridge No: 34-0006
Component: 3.5" Main Cable Anchor Rods
Bid Item: 66
Lot No:

Summary of Items Observed:

On this date, Quality Assurance Inspector (QAI) Fred Edmondson was present at Monnig Industries, 400 Industrial Drive, Glasgow, MO as requested to release 2 ea - 3.5” diameter A354 grade BD, Q&T Main Cable Anchor Rods (anchor rods) for the San Francisco Oakland Bay Bridge (SFOBB) project.

This QAI met with Monnig General Manager Ryan Monnig and was informed that blasting and hot-dip galvanizing (HDG) was in-process at this time.

This QAI observed Material Testing Reports (MTR’s), Certificates of Conformance (COC’s), Magnetic Particle Testing Reports and thread mapping reports for 2 ea anchor rods (OYL-3 and OYP-2) had been submitted with the shipper from the Dyson Corporation.

This QAI observed the galvanizing process was completed within 4 hours of the blasting process and appeared to comply with the contract documents. The anchor rods were cooling at the time of this QAI’s departure from Monnig.

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.

Summary of Conversations:

Conversation, fundamental for completion the tasks at hand, occurred between this QAI and Monnig personnel.

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:	Edmondson,Fred	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 #: 04-0120F4
Cty: SF/ALA Rte: 80 PM: 13.2/13.9
File #: 76.9

REPORT OF INSPECTION OF MATERIAL

Resident Engineer: Casey, William
Address: 333 Burma Road
City: Oakland, CA 94607

Report No: RIM-000109
Date Inspected: 11-Nov-2011

Project Name: SAS Superstructure
Prime Contractor: American Bridge/Fluor Enterprises, a JV
Contractor: Dyson Corp. & Subs

OSM Arrival Time: 800
OSM Departure Time: 1030
Location: Glasgow, MO

The following material has been inspected in accordance with Section 6 of the Standard Specifications and found to substantially comply* with contract plans and specifications.

Item	Lot #	Bid Item#	Quantity	Material Description
1	B305-042-11	66	2	3.5” diameter A354 grade BD, Q&T, Main Cable Anchor Rods

Identification: Orange tag attached to Load
Shipped to: Job Site

Summary of Items Observed:

On this date, Quality Assurance Inspector (QAI) Fred Edmondson was present at Monnig Industries, 400 Industrial Drive, Glasgow, MO, as requested, to release 2 ea - 3.5” diameter A354 grade BD, Q&T Main Cable Anchor Rods(anchor rods) for the San Francisco Oakland Bay Bridge (SFOBB) project and met with Monnig General Manager Ryan Monnig,

This QAI observed General Manager Ryan performing a random thickness testing of the galvanized coating on each of the anchor rods and that the anchor rods hab been bundled and readied for shipment to the job site (Reference photos).

This QAI performed a random visual inspection of the galvanized coating on the anchor rods.

This QAI observed that jam nuts and spherical nuts had been run-up the full length of the threaded area on each anchor rod.

This QAI was provided a Certificate of Conformance (COC) blasting report (SSPC-SP10 Near-White Blast Cleaning) and a COC report for galvanized coating thicknesses for the anchor rods.

This QAI placed an orange tag, with anchor rod COC's, into a clear plastic pouch and attached the pouch to the bundle of 2 ea anchor rods. This QAI assigned Lot number B305-042-11 to these anchor rods for traceability perpose. The anchor rods, identified as OYL-3 and OYP-2 are 8500 mm in length.

Unless otherwise noted, all work observed on this date appeared to generally comply with applicable contract documents.

REPORT OF INSPECTION OF MATERIAL

(Continued Page 2 of 2)

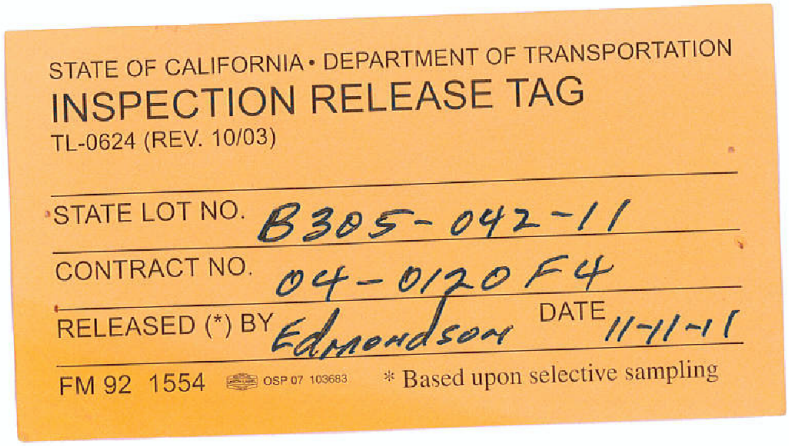
Summary of Conversations:

Fundamental conversation, necessary to complete the tasks at hand, occurred between this QAI and Monnig personnel.

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:	Edmondson, Fred	Quality Assurance Inspector
Reviewed By:	Levell, Bill	QA Reviewer


STATE OF CALIFORNIA • DEPARTMENT OF TRANSPORTATION
INSPECTION RELEASE TAG
TL-0624 (REV. 10/03)
STATE LOT NO. B305-042-11
CONTRACT NO. 04-0120F4
RELEASED (*) BY Edmondson DATE 11-11-11
FM 92 1554 OSP 07 103683 * Based upon selective sampling

Monnig Industries, Inc.

HOT DIP & MECHANICAL GALVANIZING
P.O. BOX 98
GLASGOW, MO 65254
PH. 660-338-2242 FAX: 660-338-5199

NOVEMBER 10, 2011

DYSON CORPORATION
50 FREEDOM ROAD
PAINESVILLE, OH 44077

RE: GALVANIZING CERTIFICATE-CALTRAN

THIS WILL CERTIFY THAT THE RODS GALVANIZED ON THE LIST BELOW MEETS OR EXCEEDS THE MINIMUM REQUIREMENTS OF ASTM A-123 & F2329 SPECIFICATIONS.

2 PWS ANCHOR RODS

ROD ID/AVG MIL THICKNESS MEASUREMENTS

OYL-3/	9.5	9.8	8.1	9.8
OYP-2/	9.5	9.4	8	8.5

PATRICIA S. WESTHUES
NOTARY PUBLIC STATE OF MISSOURI
HOWARD COUNTY
MY COMMISSION EXP. APR. 18, 2012

John Monnig
JOHN MONNIG, PRESIDENT

Patricia S. Westhues
PATRICIA S. WESTHUES,
NOTARY PUBLIC

Phoenix Manufacturing, Inc.
P.O. BOX 330
26666 Von Holten Rd.
Cole Camp, MO. 65325
660-668-2611
660-668-3160 (fax)

SSPC-SP10 Near White Metal Blast

Near-White Blast Cleaning - Removal of nearly all mill scale, rust, rust scale, paint, or foreign matter by the use of abrasives propelled through nozzles or by centrifugal wheels, to the degree hereafter specified A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides, or light, tight residues of paint or coating that may remain. At least 95 percent of each square inch of surface area shall be free of all visible residues, and the remainder shall be limited to the light discoloration mentioned above

2 PWS ACHOR RODS

ROD IDs

OYL-3

OYP-2

Kirby Nor

CERTIFICATE OF COMPLIANCE

DYSON CORP.

DN 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 112047	660110-SA-017 CO 022	8500 MM	2 pcs	11/7/11

CUSTOMER

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

PRODUCT DESCRIPTION

3.50"-4UNC 2A x 8500mm (27'-10.65") OAL PWS Anchor Rod w/1850mm (72.83") of useable thread one end and 280mm (13.78") on opposite end. Drill & Tap 2"- 4-1/2 UNC 2A x 60mm (2.36") Deep on 1850mm threaded end. HDG per ASTM-A153 w/white metal blast prior to galvanize. BID ITEM 66 -

SPECIFICATIONS

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

DRAWING

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.

Bar I.D.'s: OYL-3, OYP-2

Heat treatment lot OYL is from heat of steel ID A113151 (Batch# H211)
Heat treatment lot OYP is from heat of steel ID A113151 (Batch# H222)

STATE OF CALIFORNIA
STOCK MATERIAL
LOT NO. B300 005-11
INSPECTOR'S
NAME Riley DATE 11-7-11

Attachments:

Mill Test Report
Mag Particle Certification

Deborah A. Smith
Q.A. Admin. Assistant
11/7/11

Designation: A123/A123M – 12

Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products[1]

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.**

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

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

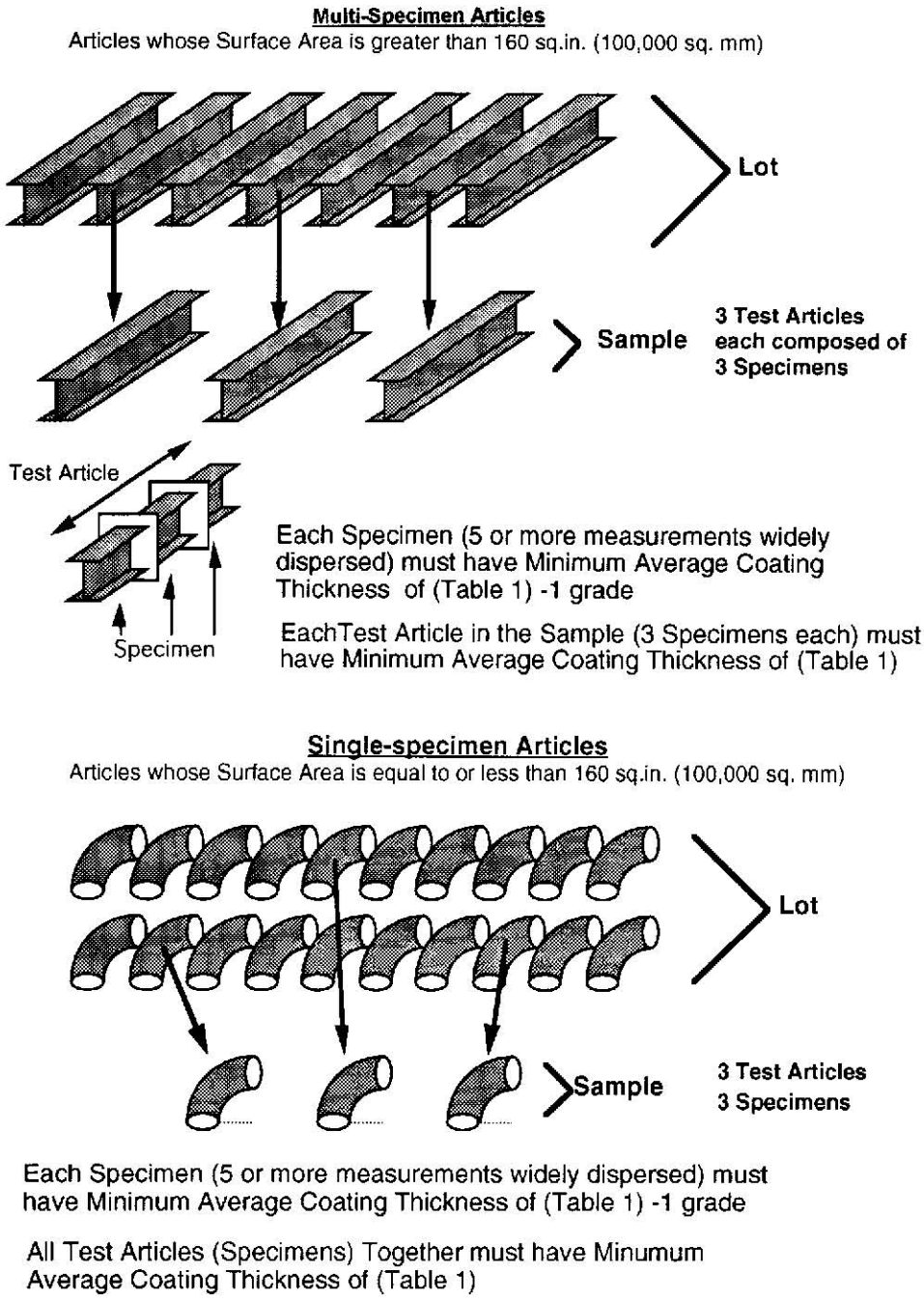

FIG. 1 Single- and Multi-Specimen Articles

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TABLE 1 Minimum Average Coating Thickness Grade by Material Category

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

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

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

3.2.6 *multi-specimen article*, *n*—a unit of product whose surface area is greater than 160 in.^{2}[100 000 mm^2]. 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 mm^2] 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 mm^2], 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

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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.

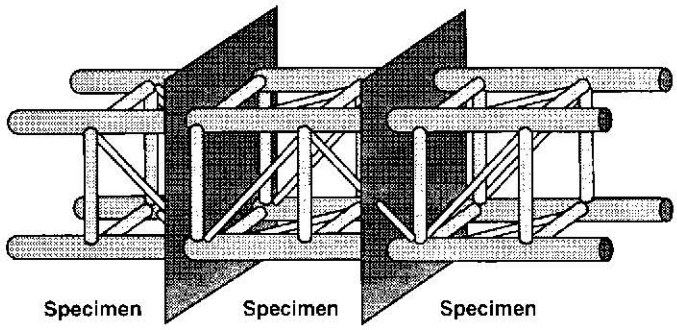
5.4 *Zinc*—The zinc used in the galvanizing bath shall conform to Specification B6, or Specification B960, or both. If a zinc alloy is used as the primary feed to the galvanizing bath, then the base material used to make that alloy shall conform to Specification B6, or Specification B960, or both.

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



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

6.1.1 For articles whose surface area is greater than 160 in.^{2} [100 000 mm^2] (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 mm^2] (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/ft^2 = µm × 0.02316; g/m^2 = µm × 7.067.

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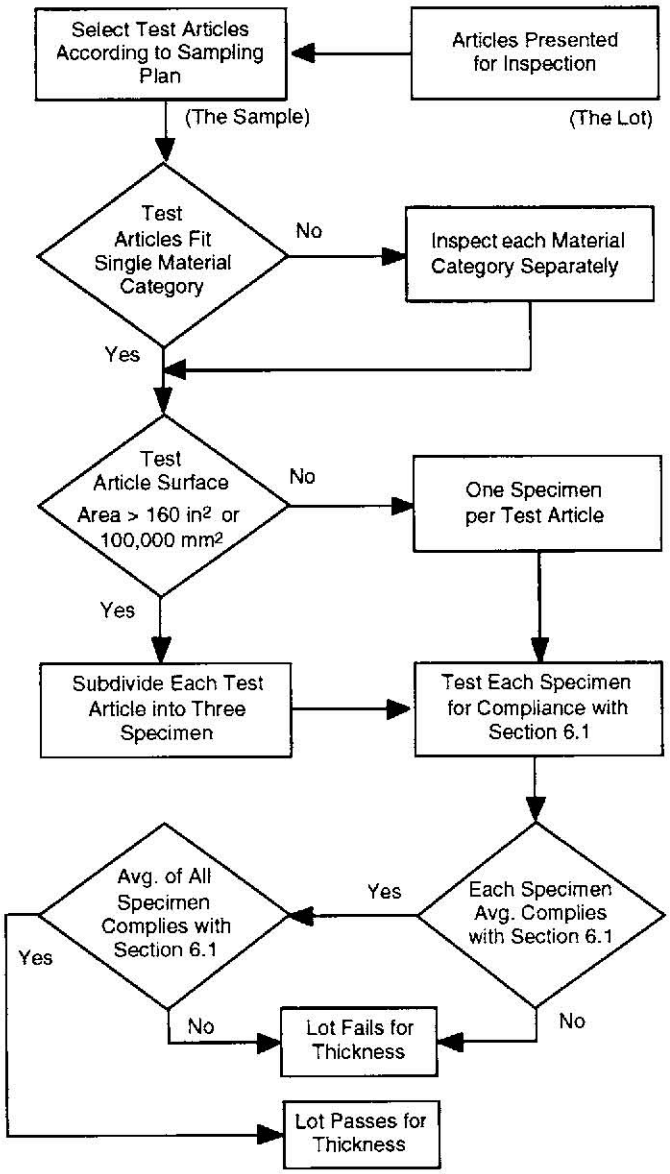

FIG. 3 Coating Thickness Inspection Steps

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 cm^2 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 dross inclusions. Lumps, projections, globules, or heavy deposits of zinc which will interfere with the intended use of the material will not be

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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 mm^2] (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 mm^2] (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

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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.

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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)

(*1*) Revised Table 1.

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Designation: A 143/A 143M – 07

Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement[1]

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]

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.

[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.

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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 5⁄16 to 11⁄16 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 1⁄16 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.

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

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

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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, l, in. [mm] (see Fig. 1)	Length Between Supports, L_1, in. [mm]	Minimum Length, L_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.

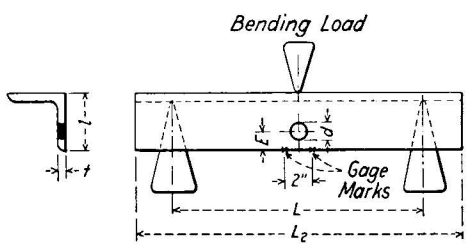
9.4.2.4 The test shall be made upon galvanized specimens having a temperature not below 60°F [16°C] and not over 90°F [32°C] when tested.

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



NOTE 1—2 in. = 51 mm.

FIG. 1 Specimen for Elongation after Fracture

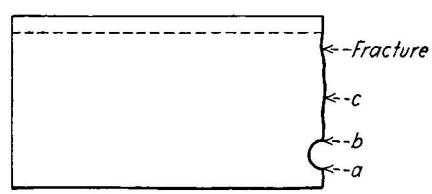


FIG. 2 Measurement of Reduction of Thickness after Fracture

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Designation: A 153/A 153M – 09

American Association State Highway and Transportation Officials Standard AASHTO No. M232

Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware[1]

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.**

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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 overtapping 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
Class A—Castings—Malleable Iron, Steel	2.00 [610]	1.80 [550]	3.4 [86]	3.1 [79]
Class B—Rolled, pressed, and forged articles (except those which would be included under Classes C and D):				
B-1—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 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]
Class C—Fasteners over 3/8 in. [9.52 mm] in diameter and similar articles. Washers 3/16 in. and 1/4 in. [4.76 and 6.35 mm] in thickness	1.25 [381]	1.00 [305]	2.1 [53]	1.7 [43]
Class D—Fasteners 3/8 in. [9.52 mm] and under in diameter, rivets, nails and similar articles. Washers under 3/16 in. [4.76 mm] in thickness	1.00 [305]	0.85 [259]	1.7 [43]	1.4 [36]

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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

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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

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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)

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

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Designation: A354 – 11

Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners[1]

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

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

1. Scope*

1.1 This specification[2] 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 pretentioned 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:

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

[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.

[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.**

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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 temperating 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.

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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 1 ½ in.	0.30-0.48	0.28-0.50
For sizes larger than 1 ½ 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]

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

TABLE 2 Hardness Requirements for Full-Size Fasteners

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

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

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

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

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

7. Dimensions

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

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

7.3 *Threads*:

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

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

7.3.3 Unless otherwise specified, bolts and studs to be used with nuts or tapped holes that have been tapped oversize, in accordance with Specification A563, shall have Class 2A threads before hot dip or mechanically deposited zinc coating. After zinc coating, the maximum limit of pitch and major diameter may exceed the Class 2A limit by the following amount:

Diameter, in.	Oversize Limit, in. (mm)[A]
¼	0.016
5/16 , ⅜	0.017
7/16 , ½	0.018
9/16 to ¾ , incl	0.020
⅞	0.022
1.0 to 1¼ , incl	0.024
1⅜ , 1½	0.027
1¾ to 4.0, incl	0.050

[A] These values are the same as the overtapping 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,

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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
⅜	16	0.0775	9 700	8 150	8 450	11 650	9 300	10 075
⅜	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
⅝	11	0.226	28 250	23 750	24 650	33 900	27 100	29 400
⅝	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
⅞	9	0.462	57 750	48 500	50 350	69 300	55 450	60 100
⅞	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
1⅛	7	0.763	95 400	80 100	83 150	114 450	91 550	99 200
1⅛	8	0.790	98 750	82 950	86 200	118 500	94 800	102 700
1⅛	12	0.856	107 000	89 800	93 300	128 400	102 700	111 250
1¼	7	0.969	121 150	101 750	105 600	145 350	116 300	126 000
1¼	8	1.000	125 000	105 000	109 000	150 000	120 000	130 000
1¼	12	1.073	134 100	112 600	116 950	161 000	128 800	139 450
1⅜	6	1.155	144 400	121 300	125 900	173 250	138 600	150 200
1⅜	8	1.233	154 150	129 450	134 400	185 000	148 000	160 300
1⅜	12	1.315	164 400	138 100	143 300	197 200	157 800	170 950
1½	6	1.405	175 650	147 550	153 150	210 750	168 600	182 500
1½	8	1.492	186 500	156 650	162 250	233 800	175 050	194 000
1½	12	1.581	197 600	166 000	172 300	237 200	189 700	205 500
1¾	5	1.90	237 500	199 500	207 100	285 000	228 000	247 000
1¾	8	2.08	260 000	218 400	226 700	312 000	249 600	270 000
2	4½	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
2¼	4½	3.25	406 250	341 250	354 250	487 000	390 000	422 500
2¼	8	3.56	445 000	373 800	388 050	534 000	422 200	462 800
2½	4	4.00	500 000	420 000	436 000	600 000	480 000	520 000
2½	8	4.44	550 000	466 200	483 950	666 000	532 800	577 200
2¾	4	4.93	566 950	468 350	488 050	690 200	517 650	566 950
2¾	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
3¼	4	7.10	816 500	674 500	702 900	994 000	745 500	816 500
3¼	8	7.69	884 350	730 550	761 300	1 076 600	807 650	884 350
3½	4	8.33	957 950	791 350	824 650	1 166 200	874 650	957 950
3½	8	8.96	1 030 400	851 200	887 050	1 254 400	940 800	1 030 400
3¾	4	9.66	1 110 900	917 700	956 350	1 352 400	1 014 300	1 110 900
3¾	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}= $0.7854\ [D - 0.9743/n]^2$ where D = nominal diameter, in., and n = threads/in.
[B] Based on 125 000 psi for sizes ¼ to 2½ in., inclusive, and on 115 000 psi for sizes over 2½ to 4 in., inclusive.
[C] Based on 105 000 psi for sizes ¼ to 2½ in., inclusive, and on 95 000 psi for sizes over 2½ to 4 in., inclusive.
[D] Based on 109 000 psi for sizes ¼ to 2½ in., inclusive, and on 99 000 psi for sizes over 2½ to 4 in., inclusive.
[E] Based on 150 000 psi for sizes ¼ to 2½ in., inclusive, and on 140 000 psi for sizes over 2½ to 4 in., inclusive.
[F] Based on 120 000 psi for sizes ¼ to 2½ in., inclusive, and on 105 000 psi for sizes over 2½ to 4 in., inclusive.
[G] Based on 130 000 psi for sizes ¼ to 2½ in., inclusive, and on 115 000 psi for sizes over 2½ to 4 in., inclusive.

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TABLE 4 Mechanical Requirements for Machined Specimens

Grade	Size, in.	Tensile Strength min, psi	Yield Strength (0.2 % offset), min, psi	Elongation in 2 in. min, %	Reduction 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
Proof Load
Coating Weight/Thickness
Workmanship (Surface Discontinuities Section 8)

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.

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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.)

(*1*) *Revised*—Table 1.

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American Association State Highway and Transportation Officials Standard
AASHTO No.: M 253

Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength[1]

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 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

[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.

Current edition approved April 1, 2012. Published April 2012. Originally approved in 1964. Last previous edition approved in 2011 as A490 – 11. DOI: 10.1520/A0490-12.

[2] Available from American Institute of Steel Construction (AISC), One E. Wacker Dr., Suite 700, Chicago, IL 60601-2001, http://www.aisc.org.

[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.**

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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.

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TABLE 1 Chemical Requirements for Type 1 Bolts

Alloy Steel		
Element	Heat Analysis, %	Product Analysis, %
Carbon		
For sizes through 1⅜ 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 1⅜ 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]

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

TABLE 2 Chemical Requirements for Type 3 Bolts

Element	Heat Analysis, %	Product Analysis, %
Carbon		
Sizes 0.75 in. and smaller	0.20–0.53	0.19–0.55
Sizes larger than 0.75 in.	0.30–0.53	0.28–0.55
Manganese, min	0.40	0.37
Phosphorus, max	0.035	0.040
Sulfur, max	0.040	0.045
Copper	0.20–0.60	0.17–0.63
Chromium, min	0.45	0.42
Nickel, min	0.20	0.17
or		
Molybdenum, min	0.15	0.14

5.3 Product analyses made on finished bolts representing each lot shall conform to the product analysis requirements specified in Tables 1 and 2, as applicable.

5.4 Heats of steel to which bismuth, selenium, tellurium, or lead has been intentionally added shall not be used for bolts furnished to this specification. Compliance with this requirement shall be based on certification that steels having these elements intentionally added were not used.

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

6. Mechanical Properties

6.1 *Hardness*—The bolts shall conform to the hardness specified in Table 3.

6.2 *Tensile Properties*:

6.2.1 Except as permitted in 6.2.1.1 for long bolts and 6.2.1.2 for short bolts, sizes 1.00 in. and smaller having a nominal length of 2¼ *D* and longer and sizes larger than 1.00 in. having a nominal length of 3*D* 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 2¼ *D* down to 2*D*, 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 2*D* 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 2*D*	311	352	33	38
	2*D* and longer	. . .	352	. . .	38
Over 1 to 1½ , incl.	Less than 3*D*	311	352	33	38
	3*D* and longer	. . .	352	. . .	38

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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
⅞-9 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

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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/F788M
Magnetic particle inspection	Specification F788/F788M
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.

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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 identifications 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$^{\varepsilon 1}$) 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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Designation: A788/A788M – 11

An American National Standard

Standard Specification for Steel Forgings, General Requirements[1]

This standard is issued under the fixed designation A788/A788M; 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[2] covers a group of common requirements that, unless otherwise specified in the individual product specification, shall apply to steel forgings under any of the following specifications issued by ASTM:

ASTM Designation	Title
A266/A266M	Carbon Steel Forgings for Pressure Vessel Components
A288	Carbon and Alloy Steel Forgings for Magnetic Retaining Rings for Turbine Generators
A289/A289M	Alloy Steel Forgings for Nonmagnetic Retaining Rings for Generators
A290/A290M	Carbon and Alloy Steel Forgings for Rings for Reduction Gears
A291/A291M	Steel Forgings, Carbon and Alloy, for Pinions, Gears, and Shafts for Reduction Gears
A336/A336M	Alloy Steel Forgings for Pressure and High-Temperature Parts
A372/A372M	Carbon and Alloy Steel Forgings for Thin-Walled Pressure Vessels
A427/A427M	Wrought Alloy Steel Rolls for Cold and Hot Reduction
A469/A469M	Vacuum-Treated Steel Forgings for Generator Rotors
A470/A470M	Vacuum-Treated Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts
A471/A471M	Vacuum-Treated Alloy Steel Forgings for Turbine Rotor Disks and Wheels
A504/A504M	Wrought Carbon Steel Wheels
A508/A508M	Quenched and Tempered Vacuum-Treated Carbon and Alloy Steel Forgings for Pressure Vessels
A521/A521M	Steel, Closed-Impression Die Forgings for General Industrial Use
A541/A541M	Quenched and Tempered Carbon and Alloy Steel Forgings for Pressure Vessel Components
A579/A579M	Superstrength Alloy Steel Forgings
A592/A592M	High-Strength Quenched and Tempered Low-Alloy Steel Forged Fittings and Parts for Pressure Vessels
A646/A646M	Premium Quality Alloy Steel Blooms and Billets for Aircraft and Aerospace Forgings
A649/A649M	Forged Steel Rolls Used for Corrugating Paper Machinery
A668/A668M	Steel Forgings, Carbon and Alloy, for General Industrial Use
A711/A711M	Steel Forging Stock
A723/A723M	Alloy Steel Forgings for High-Strength Pressure Component Application
A729/A729M	Alloy Steel Axles, Heat Treated, for Mass Transit and Electric Railway Service
A765/A765M	Carbon Steel and Low-Alloy Steel Pressure-Vessel-Component Forgings with Mandatory Toughness Requirements
A768/A768M	Vacuum-Treated 12 % Chromium Alloy Steel Forgings for Turbine Rotors and Shafts
A837/A837M	Steel Forgings, Alloy, for Carburizing Applications
A859/A859M	Age-Hardening Alloy Steel Forgings for Pressure Vessel Components
A891/A891M	Precipitation Hardening Iron Base Superalloy Forgings for Turbine Rotor Disks and Wheels
A909/A909M	Steel Forgings, Microalloy, for General Industrial Use
A940/A940M	Vacuum Treated Steel Forgings, Alloy, Differentially Heat Treated, for Turbine Rotors
A965/A965M	Steel Forgings, Austenitic, for Pressure and High Temperature Parts
A982/A982M	Steel Forgings, Stainless, for Compressor and Turbine Airfoils
A983/A983M	Specification for Continous Grain Flow Forged Carbon and Alloy Steel Crankshafts for Medium Speed Diesel Engines
A986/A986M	Magnetic Particle Examination of Continuous Grain Flow Crankshaft Forgings
A1021/A1021M	Martensitic Stainless Steel Forgings and Forging Stock for High-Temperature Service
A1048/A1048M	Pressure Vessel Forgings, Alloy Steel, Higher Strength Chromium-Molybdenum-Tungsten for Elevated Temperature Service
A1049/A1049M	Stainless Steel Forgings, Ferritic/Austenitic (Duplex), for Pressure Vessels and Related Components

1.2 In case of conflict in requirements, the requirements of the individual product specifications shall prevail over those of this specification.

1.3 The purchaser may specify additional requirements (see 4.2.3) that do not negate any of the provisions of either this specification or of the individual product specifications. The acceptance of any such additional requirements shall be dependent on negotiations with the supplier and must be included in the order.

1.4 If, by agreement, forgings are to be supplied in a partially completed condition, that is, all of the provisions of

[1] This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.06 on Steel Forgings and Billets.

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[2] For ASME Boiler and Pressure Vessel Code applications, see related Specification SA–788 in Section II of that code.

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

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the product specification have not been filled, then the material marking (see Section 17) and certification (see Section 16) shall reflect the extent to which the product specification requirements have been met.

1.5 As noted in the Certification Section (16), the number and year date of this specification, as well as that of the product specification, are required to be included in the product certification.

1.6 When the SI version of a product specification is required by the purchase order, Specification A788/A788M shall be used in conjunction with Test Methods A1058 instead of Test Methods and Definitions A370.

1.7 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.8 *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:*[3]

A266/A266M Specification for Carbon Steel Forgings for Pressure Vessel Components

A275/A275M Practice for Magnetic Particle Examination of Steel Forgings

A288 Specification for Carbon and Alloy Steel Forgings for Magnetic Retaining Rings for Turbine Generators

A289/A289M Specification for Alloy Steel Forgings for Nonmagnetic Retaining Rings for Generators

A290/A290M Specification for Carbon and Alloy Steel Forgings for Rings for Reduction Gears

A291/A291M Specification for Steel Forgings, Carbon and Alloy, for Pinions, Gears and Shafts for Reduction Gears

A336/A336M Specification for Alloy Steel Forgings for Pressure and High-Temperature Parts

A370 Test Methods and Definitions for Mechanical Testing of Steel Products

A372/A372M Specification for Carbon and Alloy Steel Forgings for Thin-Walled Pressure Vessels

A388/A388M Practice for Ultrasonic Examination of Steel Forgings

A427/A427M Specification for Wrought Alloy Steel Rolls for Cold and Hot Reduction

A469/A469M Specification for Vacuum-Treated Steel Forgings for Generator Rotors

A470/A470M Specification for Vacuum-Treated Carbon and Alloy Steel Forgings for Turbine Rotors and Shafts

A471/A471M Specification for Vacuum-Treated Alloy Steel Forgings for Turbine Rotor Disks and Wheels

A504/A504M Specification for Wrought Carbon Steel Wheels

A508/A508M Specification for Quenched and Tempered Vacuum-Treated Carbon and Alloy Steel Forgings for Pressure Vessels

A521/A521M Specification for Steel, Closed-Impression Die Forgings for General Industrial Use

A541/A541M Specification for Quenched and Tempered Carbon and Alloy Steel Forgings for Pressure Vessel Components

A551/A551M Specification for Carbon Steel Tires for Railway and Rapid Transit Applications

A579/A579M Specification for Superstrength Alloy Steel Forgings

A592/A592M Specification for High-Strength Quenched and Tempered Low-Alloy Steel Forged Parts for Pressure Vessels

A646/A646M Specification for Premium Quality Alloy Steel Blooms and Billets for Aircraft and Aerospace Forgings

A649/A649M Specification for Forged Steel Rolls Used for Corrugating Paper Machinery

A668/A668M Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use

A711/A711M Specification for Steel Forging Stock

A723/A723M Specification for Alloy Steel Forgings for High-Strength Pressure Component Application

A729/A729M Specification for Alloy Steel Axles, Heat-Treated, for Mass Transit and Electric Railway Service

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

A765/A765M Specification for Carbon Steel and Low-Alloy Steel Pressure-Vessel-Component Forgings with Mandatory Toughness Requirements

A768/A768M Specification for Vacuum-Treated 12 % Chromium Alloy Steel Forgings for Turbine Rotors and Shafts

A833 Practice for Indentation Hardness of Metallic Materials by Comparison Hardness Testers

A837/A837M Specification for Steel Forgings, Alloy, for Carburizing Applications

A859/A859M Specification for Age-Hardening Alloy Steel Forgings for Pressure Vessel Components

A891/A891M Specification for Precipitation Hardening Iron Base Superalloy Forgings for Turbine Rotor Disks and Wheels

A909/A909M Specification for Steel Forgings, Microalloy, for General Industrial Use

A939 Practice for Ultrasonic Examination from Bored Surfaces of Cylindrical Forgings

A940/A940M Specification for Vacuum Treated Steel Forgings, Alloy, Differentially Heat Treated, for Turbine Rotors

A941 Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys

A965/A965M Specification for Steel Forgings, Austenitic, for Pressure and High Temperature Parts

A966/A966M Practice for Magnetic Particle Examination of Steel Forgings Using Alternating Current

[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.

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A982/A982M Specification for Steel Forgings, Stainless, for Compressor and Turbine Airfoils
A983/A983M Specification for Continuous Grain Flow Forged Carbon and Alloy Steel Crankshafts for Medium Speed Diesel Engines
A986/A986M Specification for Magnetic Particle Examination of Continuous Grain Flow Crankshaft Forgings
A991/A991M Test Method for Conducting Temperature Uniformity Surveys of Furnaces Used to Heat Treat Steel Products
A1021/A1021M Specification for Martensitic Stainless Steel Forgings and Forging Stock for High-Temperature Service
A1048/A1048M Specification for Pressure Vessel Forgings, Alloy Steel, Higher Strength Chromium-Molybdenum-Tungsten for Elevated Temperature Service
A1049/A1049M Specification for Stainless Steel Forgings, Ferritic/Austenitic (Duplex), for Pressure Vessels and Related Components
A1058 Test Methods for Mechanical Testing of Steel Products—Metric
E23 Test Methods for Notched Bar Impact Testing of Metallic Materials
E112 Test Methods for Determining Average Grain Size
E165 Practice for Liquid Penetrant Examination for General Industry
E380 Practice for Use of the International System of Units (SI) (The Modernized Metric System)[4]
E399 Test Method for Linear-Elastic Plane-Strain Fracture Toughness K_{Ic} of Metallic Materials
E428 Practice for Fabrication and Control of Metal, Other than Aluminum, Reference Blocks Used in Ultrasonic Testing
E1290 Test Method for Crack-Tip Opening Displacement (CTOD) Fracture Toughness Measurement
E1820 Test Method for Measurement of Fracture Toughness
E1916 Guide for Identification of Mixed Lots of Metals

2.2 *Other Standards:*

ANSI/ASME B46.1 Surface Texture (Surface Roughness, Waviness and Lay)[5]

3. Terminology

3.1 Terminology A941 is applicable to this specification. Additional terms and wording more applicable to forgings are as noted in this section.

3.2 *Forging Definitions:*

3.2.1 *steel forging*, *n*—the product of a substantially compressive plastic working operation that consolidates the material and produces the desired shape. The plastic working may be performed by a hammer, press, forging machine, or ring rolling machine, and must deform the material to produce an essentially wrought structure.

3.2.1.1 *Discussion*—Hot rolling operations may be used to produce blooms or billets for reforging.

3.3 *Forging Geometries:*

3.3.1 *bar forging*, *n*—forging that has no bore and having an axial length greater than its maximum cross sectional dimension.

3.3.1.1 *Discussion*—More than one cross sectional shape or size may be included. Sometimes referred to as a solid forging.

3.3.2 *hollow forging*, *n*—forging (also known as a shell forging or a mandrel forging) in which *(a)* the axial length is equal to or greater than the diameter, and *(b)* the forging length and wall thickness are produced by hot working over a mandrel (usually water cooled) such that the bore diameter remains essentially the same as that of the mandrel.

3.3.2.1 *Discussion*—Unless a hollow ingot has been used, the starting slug is hot trepanned or punched after upsetting and the bore diameter adjusted to suit the forging mandrel. The outside diameter may be contoured if required. The workpiece is forged between the upper die and lower dies while the mandrel is supported by cranes or manipulators to facilitate rotation.

3.3.3 *ring forging*, *n*—type of hollow forging in which *(a)* the axial length is less than the diameter, *(b)* the wall thickness is reduced, and *(c)* the outside diameter is increased by hot working between the top die and a mandrel supported on temporary saddles.

3.3.3.1 *Discussion*—Forging between the top die and the mandrel enables the ring diameter to be increased while reducing the wall thickness, without increasing the axial length.

3.3.4 *ring rolling*, *n*—involves the use of specialized equipment whereby a hot punched, trepanned, or bored disk is *(a)* hot worked between a powered outer roller and an idling inner roller, such that the wall thickness is reduced and the outside diameter is increased, and *(b)* the axial length of the ring is not intended to increase and may be contained by a radially oriented tapered roller.

3.3.5 *disk forging*, *n*—forging, sometimes referred to as a pancake forging, that has *(a)* an axial length appreciably less than its diameter, *(b)* may be dished on one or both faces, and *(c)* final forging includes upsetting operations to reduce the height of the stock and increase its diameter.

3.3.5.1 *Discussion*—Since much of the hot working is done in axially compressing the stock, the central area may not receive sufficient consolidation. To counter this effect, consideration is usually given to the initial saddening (see 3.3.7) of the ingot or billet.

3.3.6 *slab forging*, *n*—forging, sometimes referred to as a forged plate, that is usually square or rectangular in shape, with a thickness appreciably smaller than the other dimension. The hot working may include upsetting.

3.3.7 *saddening*, *n*—term used in the open die forging industry to describe the initial hot working of an ingot for surface compaction and flute working surface prior to full working of the ingot cross section.

3.3.7.1 *Discussion*—The term is also extended to initial hot working intended to give consolidation of ingot central areas

[4] Withdrawn. The last approved version of this historical standard is referenced on www.astm.org.

[5] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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prior to upsetting when making products such as turbine and generator rotors and tube sheets.

3.4 *billets and blooms, n*—interchangeable terms representing hot-worked semi-finished product intended as a starting stock for making forgings.

3.4.1 *Discussion*—No size limitations are assumed for either term. Cast shapes produced by a continuous casting process, without subsequent work, are considered to be ingots for the purposes of this specification, and if supplied as billets or blooms must carry the descriptor *Cast* Billet or *Cast* Bloom.

3.5 *Definitions of Terms Specific to This Standard:*

3.5.1 *bottom pouring, n*—steel from a single heat, or from a multiple heat tapped into a common ladle (see 8.1.1 and 8.1.2), introduced into ingot mold(s) such that they are filled from the bottom up. One or more molds can be set up on an individual plate, and more than one plate may be poured in sequence from a heat.

3.5.2 *ingot, n*—the product obtained when molten steel, upon being cast into a mold, is subsequently capable of being wrought in conformance with 3.1. Open-ended molds, which are usually cooled and used, for example, in the continuous casting of steel, are considered to be included in this definition.

3.5.3 *intercritical heat treatment, n*—use of a multi-stage heat treatment procedure in which the material is first austenitized at a temperature above the upper critical temperature (Ac3) followed by cooling below the lower critical temperature (Ac1). The material is then reheated to a temperature in the intercrtical range between the Ac1 and the Ac3 and again cooled below the Ac1, followed by subcritical tempering in the range specified in the material specification.

3.5.3.1 *Discussion*—This procedure is generally applicable to low hardenability carbon and low alloy steels that would usually have a microstructure of ferrite and pearlite in the heat treated section size of the component being heat treated.

3.5.4 *vacuum carbon deoxidation (VCD), n*—steelmaking process in which primary deoxidation occurs during vacuum treatment as a result of the carbon-oxygen reaction. In order for primary deoxidation to occur during vacuum treatment, deoxidizing agents such as aluminum or silicon are not to be added to the melt in any significant amount prior to the vacuum treatment operation.

3.5.5 *precipitation deoxidation, n*—steelmaking process in which primary deoxidation is achieved by the addition of strong deoxidizing agents, such as aluminum, early in the process, and holding the steel in the molten state for sufficient time for the products of deoxidation to separate from the melt to the slag.

3.5.6 *sequential or continuous strand casting, n*—steel from several heats poured consecutively into a cooled open-ended mold to form a continuous cast product with a change from heat to heat along its length (see 8.1.5).

3.5.7 *strand casting, n*—steel from one heat poured into a cooled open-ended mold to form a continuous strand or strands.

4. Ordering Information

4.1 It shall be the responsibility of the purchaser to specify all requirements that are necessary for forgings under the applicable product specification. Such requirements to be considered include, but are not restricted to, the following:

4.1.1 Quantity,

4.1.2 Dimensions, including tolerances and surface finishes.

4.1.3 Specification number with type, class, and grade as applicable (including year date), and should include:

4.1.4 Number of copies of the material test report.

4.1.5 Choice of testing track from the options listed in Test Methods A1058 when forgings are ordered to a suffix M product standard. If the choice of test track is not made in the ordering information then the default ASTM track shall be used as noted in Test Methods A1058.

4.2 Additional information including the following may be added by agreement with the supplier:

4.2.1 Type of heat treatment when alternative methods are allowed by the product specification,

4.2.2 Supplementary requirements, if any, and

4.2.3 Additional requirements (see 1.4, 16.1.5, and 16.1.6).

4.2.4 Repair welding NOT permitted.

4.3 For dual format specifications, unless otherwise specified, the inch-pound units shall be used.

5. Melting Process

5.1 Unless otherwise specified in the product specification, the steel shall be produced by any of the following primary processes: electric-furnace, basic oxygen, vacuum-induction (VIM), or open-hearth. The primary melting may incorporate separate degassing or refining and may be followed by secondary melting, using electro slag remelting (ESR) or vacuum arc remelting (VAR).

5.1.1 The steel shall be fully killed.

5.2 The molten steel may be vacuum-treated prior to or during pouring of the ingot.

5.2.1 When vacuum treatment of the molten steel is required by the product specification the following conditions shall apply:

5.2.1.1 When the vacuum stream degassing process is used, the vacuum system must be of sufficient capacity to effect a blank-off pressure low enough (usually less than 1000 µm) to break up the normal tight, rope-like stream of molten metal into a wide-angled conical stream of relatively small droplets. The capacity of the system must also be sufficiently high to reduce the initial surge pressure at the start of the pour to a low level within 2 min.

5.2.1.2 When the vacuum-lift process is utilized, the molten metal shall be repeatedly drawn into the evacuated vessel to give a recirculation factor (see Annex A1) of at least 2.5 to ensure thorough degassing and mixing of the entire heat. The evacuation system shall be capable of reducing the pressure surges, which occur each time a new portion of steel is admitted to the vessel to increasingly lower levels, until a blank-off pressure (usually less than 1000 µm) is achieved signifying the end of the degassing treatment.

5.2.1.3 When the ladle degassing process is used, the evacuation system shall be capable of reducing the system vacuum pressure to a low level (usually less than 1000 µm). The molten metal shall be adequately stirred for a sufficient length of time to maximize exposure to the evacuated atmosphere.

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5.2.1.4 Other methods of vacuum treatment may be used if the supplier can demonstrate adequate degassing and acceptable properties in the finished forging to the satisfaction of the purchaser.

6. Forging

6.1 Forgings shall be made in accordance with 3.2.1.

6.2 Because of differences in manufacture, hot-rolled, or hot-rolled and cold-finished bars (semi-finished or finished), billets, or blooms are not considered to be forgings.

6.3 Cold worked forgings shall be made from material previously hot worked by forging or rolling; however, a hot-cold worked forging may be produced in one continuous operation wherein the material is first hot worked and then cold worked by control of the finishing temperature.

7. Cooling Prior to Heat Treatment

7.1 After forging and before reheating for heat treatment, the forgings shall be allowed to cool in such a manner as to prevent injury and, in the case of ferritic forgings, to permit substantially complete transformation of austenite.

8. Chemical Composition

8.1 *Heat Analysis*:

8.1.1 An analysis of each heat of steel shall be made by the steel producer to determine the percentages of those elements specified in the product specification. This analysis shall be made from a test sample preferably taken during the pouring of the heat and shall conform to the requirements of the product specification.

8.1.2 When multiple heats are tapped into a common ladle, the ladle chemistry shall apply. The chemical composition thus determined shall conform to the requirements of the product specification.

8.1.3 For multiple-heat ingots, either individual heat analyses or a weighted average (see Annex A2) may be taken. The results of the method used shall conform to the requirements of the product specification.

8.1.4 With the exception of the product from multiple heats sequentially cast in strand casting machines (see 8.1.5), if the test sample taken for a heat analysis is lost or declared inadequate for chemical determinations, the steel producer may take alternative samples from appropriate locations near the surface of the ingot or forging as necessary to establish the analysis of the heat in question.

8.1.5 For multiple heats sequentially cast in strand casting machines, the heat analysis shall be determined for each individual heat in accordance with 8.1.1 or 8.1.2 if applicable.

8.1.5.1 If, for multiple heats sequentially strand cast, the test sample is lost or declared inadequate for chemical analysis determination, alternative samples, remote from the transition zones, may be taken by the steel producer from the cast material or product of that heat, as defined in 8.2 or 8.3 as appropriate.

8.1.6 *Heat Analysis for Remelted Ingots*:

8.1.6.1 When consumable remelting processes are used, a chemical analysis shall be taken from a remelted ingot (or the product of a remelted ingot) for the remelt heat analysis.

8.1.6.2 When more than one electrode is prepared from a master or parent heat for remelting in the same facility by the same process, then the heat analysis obtained from one remelted ingot, or the product from that ingot, shall be taken as the heat analysis for all of the remelted ingots from that master heat. For analysis from each remelted ingot, see S27.

8.1.6.3 When electrodes from different master heats are remelted sequentially, an analysis shall be made in each zone of the remelted ingot corresponding to at least one electrode from each master heat. The resultant chemical analysis of each zone shall conform to the requirements of the product specification. The heat analysis of the remelted ingot shall be represented by a weighted average (see Annex A2) of the individual chemical analyses for each zone.

8.1.6.4 Limits on aluminum content in remelt ingots shall be set as required in the product specification.

8.2 *Heat Number Assignment for Sequentially Strand Cast Material*—When heats of the same chemical composition are sequentially strand cast, the heat number assigned to the cast product may remain unchanged until all of the steel in the product is from the following heat, except when Supplementary Requirement S3 is invoked.

8.3 *Identification of Material of Different Chemical Composition Ranges, Sequentially Strand Cast*—Because of intermixing in the tun dish, separation and identification of the resultant transition material is required when steels of different chemical composition ranges are sequentially strand cast. The steel producer shall remove the transition material by any established procedure that positively separates the grades.

8.4 *Product Analysis*:

8.4.1 An analysis may be made by the purchaser from a forging representing each heat or multiple heat (see 8.1). Samples for analysis may be taken from the forging or from a full-size prolongation at any point from the midradius to the outer surface of disk or other solid forgings or midway between the inner and outer surfaces of hollow or bored forgings. The analysis may also be taken from a mechanical test specimen or the mechanical test location as defined in the product specification.

8.4.2 The chemical composition thus determined shall conform to the heat analysis requirements of the forging specification subject to the permissible variations specified in Table 1, for those elements listed in the product specification. Limitations on the application of the allowances in Table 1 may be made in the product specification for specified elements.

8.5 *Residual and Unspecified Elements*—Provisions for the limitation of certain residual and unspecified elements have been made in Supplementary Requirements S1 and S2, respectively.

8.6 Grade substitution is not permitted.

8.7 *Method of Analysis*—Methods included in Test Methods, Practices, and Terminology A751 shall be used for referee purposes.

9. Heat Treatment

9.1 Heat treatment shall be performed as specified in the product specification. Supplementary Requirement S4 concerns a specialized heat treat process (see 3.5.3) whose application will be controlled in the product specification.

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TABLE 1 Permissible Variations in Product Analysis for Killed Steel

NOTE 1—This table covers permissible variations in product analysis for most of the elements commonly found in killed steels under the jurisdiction of A01.06. This table is applicable only for those elements for which product analysis variations are permitted by the material specification. The listed variation value is subtracted from the minimum specified limit, or added to the maximum specified limit for the heat analysis in the product specification.

NOTE 2— Product cross-sectional area (taken at right angles to the axis of the original ingot or billet) is defined as either: (*1*) maximum cross-sectional area of rough machined forging (excluding boring), (*2*) maximum cross-sectional area of the unmachined forging, or (*3*) maximum cross-sectional area of the billet bloom or slab.

		Permissible Variation Over the Specified Maximum Limit or Under the Specified Minimum Limit					
Element	Maximum or Specified Range—I	Up to and incl 100 in.^{2} [650 cm^2][A]	Over 100[A] to 200 in.^{2} incl [650 to 1300 cm^2]	Over 200 in.^{2} to 400 in.^{2} incl [1300 to 2600 cm^2]	Over 400 in.^{2} to 800 in.^{2} incl [2600 to 5200 cm^2]	Over 800 in.^{2} to 1600 in.^{2} incl [5200 to 10300 cm^2]	Over 1600 in.^{2} [over 10300 cm^2]
Carbon	Up to and incl 0.05	0.005	0.005	0.005	0.01	0.01	0.01
	0.06 to 0.10, incl	0.01	0.01	0.01	0.01	0.01	0.01
	0.11 to 0.25, incl	0.02	0.03	0.03	0.04	0.05	0.05
	0.26 to 0.55, incl	0.03	0.04	0.04	0.05	0.06	0.06
	0.56 and over	0.04	0.05	0.05	0.06	0.07	0.07
Manganese	Up to and incl 0.90	0.03	0.04	0.05	0.06	0.07	0.08
	0.91 and over	0.06	0.06	0.07	0.08	0.08	0.09
Phosphorus	Up to and incl 0.05	0.008	0.008	0.010	0.010	0.015	0.015
Sulfur	Up to and incl 0.030	0.005	0.005	0.005	0.005	0.006	0.006
	0.031 to 0.060 incl	0.008	0.010	0.010	0.010	0.015	0.015
Silicon	Up to and incl 0.35	0.02	0.03	0.04	0.04	0.05	0.06
	0.36 and over	0.05	0.06	0.06	0.07	0.07	0.08
Nickel	Up to and incl 1.00	0.03	0.03	0.03	0.03	0.03	0.03
	1.01 to 2.00, incl	0.05	0.05	0.05	0.05	0.05	0.05
	2.01 to 5.30, incl	0.07	0.07	0.07	0.07	0.07	0.07
	5.31 to 10.00, incl	0.10	0.10	0.10	0.10	0.10	0.10
	10.01 and over	0.15	0.15	0.15	0.15	0.15	0.15
Chromium	Up to and incl 0.90	0.03	0.04	0.04	0.05	0.05	0.06
	0.91 to 2.10, incl	0.05	0.06	0.06	0.07	0.07	0.08
	2.11 to 10.00, incl	0.10	0.10	0.12	0.14	0.15	0.16
	10.01 to 15.00, incl	0.15	0.15	0.15	0.17	0.17	0.19
	15.01 to 20.00, incl	0.20	0.20	0.20	0.22	0.24	0.24
	20.01 and over	0.25	0.25	0.25	0.27	0.27	0.29
Molybdenum	Up to and incl 0.20	0.01	0.02	0.02	0.02	0.03	0.03
	0.21 to 0.40, incl	0.02	0.03	0.03	0.03	0.04	0.04
	0.41 to 1.15, incl	0.03	0.04	0.05	0.06	0.07	0.08
	1.16 to 5.50, incl	0.05	0.06	0.08	0.10	0.12	0.12
Vanadium	Up to and incl 0.10	0.01	0.01	0.01	0.01	0.01	0.01
	0.11 to 0.25, incl	0.02	0.02	0.02	0.02	0.02	0.02
	0.26 to 0.50, incl	0.03	0.03	0.03	0.03	0.03	0.03
	0.51 to 1.25, incl	0.04	0.04	0.04	0.04	0.04	0.04
Columbium (Niobium)	Up to and incl 0.14	0.02	0.02	0.02	0.02	0.03	0.03
	0.15 to 0.50, incl	0.06	0.06	0.06	0.06	0.07	0.08
Titanium	Up to and incl 0.85	0.05	0.05	0.05	0.05	0.05	0.05
Cobalt	Up to and incl 0.25	0.01	0.01	0.01	0.01	0.01	0.01
	0.25 to 5.00, incl	0.07	0.07	0.07	0.08	0.08	0.09
	5.01 to 10.00, incl	0.14	0.14	0.14	0.16	0.16	0.18
Tungsten	Up to and incl 1.00	0.05	0.05	0.05	0.06	0.06	0.07
	1.01 to 4.00, incl	0.09	0.09	0.10	0.12	0.12	0.14
Copper	Up to and incl 1.0	0.03	0.03	0.03	0.03	0.03	0.03
	1.01 to 2.00, incl	0.05	0.05	0.05	0.05	0.05	0.05
	2.01 to 5.00, incl	0.07	0.07	0.07	0.07	0.07	0.07
Aluminum	Up to and incl 0.03	0.01	0.01	0.01	0.01	0.01	0.01
	Over 0.03 to 0.05, incl	0.01	0.01	0.02	0.02	0.03	0.03
	0.06 to 0.15, incl	0.02	0.02	0.02	0.03	0.03	0.03
	0.16 to 0.50, incl	0.05	0.05	0.06	0.07	0.07	0.08
	0.50 to 2.00, incl	0.10	0.10	0.10	0.12	0.12	0.14
Zirconium	Up to and incl 0.15	0.01	0.01	0.01	0.01	0.01	0.01
Nitrogen	Up to 0.02 incl	0.005	0.005	0.005	0.005	0.005	0.005
	Over 0.02 to 0.19, incl	0.01	0.01	0.01	0.01	0.01	0.01
	Over 0.19 to 0.25, incl	0.02	0.02	0.02	0.02	0.02	0.02
	Over 0.25 to 0.35, incl	0.03	0.03	0.03	0.03	0.03	0.03
	Over 0.35 to 0.45, incl	0.04	0.04	0.04	0.04	0.04	0.04

[A] When the product size range up to 100 in.^{2} [650 cm^2] is deleted, then the 100 to 200-in.^{2} [650 to 1300 cm^2] column shall be changed to read up to and including 200 in.^{2} [1300 cm^2].

Unless otherwise specified during a heat treating hold cycle, the recorded furnace temperature shall be within ±25°F [±15°C] of the controlling set point temperature. Material shall be heat treated in the working zone of a furnace that has been surveyed in accordance with Test Method A991/A991M

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provided that the working zone was established using a variation of ±25°F [±15°C] or less from the furnace set point.

10. Mechanical Testing

10.1 *Test Methods*—Except as specified in 4.1.5 or 10.2.1 and 10.2.2, all tests shall be conducted in accordance with Test Methods and Definitions A370. When forgings are ordered to SI requirements (M suffix standard) Test Methods A1058 shall be used (see 4.1.5).

10.1.1 In addition to the hardness testing provisions of Test Methods and Definitions A370 or, when required, Test Methods A1058, comparison hardness testing in accordance with Practice A833 may be used in determining the hardness of forgings.

10.2 *Fracture Appearance Transition Temperature ($FATT_n$)*—For a product specification (including M suffix SI specifications) that requires the determination of the fracture appearance transition temperature ($FATT_n$) where n is the required minimum percentage of shear fracture as measured on the fracture surface of a Charpy V-notch sample by one of the methods described in Test Methods and Definitions A370, the Charpy test specimen location and orientation shall be as specified in the product standard.

10.2.1 When the actual fracture appearance transition temperature is required, break at least four specimens that have been taken from a comparable location. Test each specimen at a different temperature such that the percentage of shear fracture will be both above and below the value of n, but within a range of ±0.60 times that of the specified value of n. It is desirable that two of the specimens will have values of cleavage fracture above the value of n, and two will have values below this level. Plot the percentage shear fracture against test temperature and determine the transition temperature by interpolation (extrapolation is not permitted).

10.2.2 When rather than calling for an actual $FATT_n$ as described in 10.2.1, the product specification requires a minimum $FATT_n$ at a given temperature then, unless otherwise specified, a single test run at the required temperature satisfies the requirement provided that the fracture appearance value is at least n. For example, a single test run at 100°F [38°C] with a fracture appearance of 55 % shear fracture satisfies a requirement of $FATT_{50}$ at 100°F [38°C].

10.3 *Retests*—If the results of the tests do not conform to the requirements specified, retests are permitted as outlined in Test Methods and Definitions A370 or as follows:

10.3.1 If the percentage of elongation or reduction of area of any tension test specimen is less than specified because a flaw becomes evident in the test specimen during testing, a retest shall be allowed provided that the defect was not attributable to ruptures, cracks, or flakes in the steel.

10.3.2 If the average impact energy value meets the specification requirements, but the energy value for one specimen is below the specified minimum value for individual specimens prescribed in the material specification, a retest is permitted. This shall consist of two impact specimens from a location adjacent to and on either side of the specimen that failed. Each of the retested specimens must exhibit an energy value equal to or greater than the minimum average value required by the product specification.

11. Reheat Treatment

11.1 If the results of the initial mechanical tests do not conform to the specified requirements, the forgings may be heat treated (if initially tested in the as-forged condition) or reheat treated (if heat treated prior to initial testing).

12. Repair Welding

12.1 Repair welding of forgings is not permitted unless specifically allowed by the product specification (see also 4.2.4).

13. Dimensions and Finish

13.1 The forgings shall conform to the dimensions, tolerances, and finishes required by the ordering information (4.1.2). Supplementary Requirements S5 or S6, concerning straightening of forgings, may be used.

13.2 When surface finish, roughness, or texture is specified in a steel forging product standard, unless otherwise required by the purchaser, the roughness average (Ra), as defined in ANSI/ASME B46.1, shall be used (see 4.1.2).

14. Inspection

14.1 All tests and inspections other than 8.4 shall be made at the place of manufacture, unless otherwise agreed upon.

14.2 The manufacturer shall afford the purchaser's inspector all reasonable facilities necessary to satisfy him that the material is being produced and furnished in accordance with the material specification.

14.3 Mill inspection by the purchaser shall not interfere unnecessarily with the manufacturer's operations.

15. Rejection

15.1 Any rejection based on the presence of an injurious defect found subsequent to acceptance at the manufacturer's works or based on the results of a product analysis made in accordance with 8.4 shall be reported to the manufacturer.

15.2 Disposition of forgings rejected by the purchaser under 15.1 shall be as agreed upon between manufacturer and the purchaser.

16. Certification

16.1 The manufacturer shall furnish to the purchaser the number of copies of the material test report specified in the ordering information (4.1.4). The following items shall be reported:

16.1.1 Purchase order number,

16.1.2 Forging identification number,

16.1.3 The product specification number, including the year date and revision letter if any, as well as the appropriate class, type, and grade,

16.1.3.1 Reference to Specification A788/A788M including the year date together with the applicable revision letter, if any, of the revision used shall be a part of the certification.

16.1.4 Heat number and analysis,

16.1.5 Results of the required acceptance tests for mechanical properties,

16.1.6 Results of any required nondestructive examinations,

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16.1.7 Final heat treatment cycle including austenitizing and tempering temperatures and holding times and cooling methods if required by the product specification or 4.2.3,

16.1.8 Extent to which the forging is incomplete with respect to the product specification (see 1.4 and 16.1.7), and

16.1.9 Results of any supplementary and additional test requirements that were specified.

16.1.10 The material test report may be sent to the purchaser in electronic form from an electronic data interchange (EDI) transmission, and this shall be regarded as having the same validity as a counterpart printed in the certifier's facility. The content of the EDI transmitted document shall meet the requirements of the invoked ASTM standard(s) and conform to any existing EDI agreement between the purchaser and the supplier. Notwithstanding the absence of a signature, the organization submitting the EDI transmission is responsible for the content of the report.

17. Packaging and Package Marking

17.1 Each forging shall be legibly identified as required by the product specification and instructions from the purchaser. When not otherwise defined, each forging shall be identified by the manufacturer as follows:

17.1.1 Manufacturer's name or symbol.

17.1.2 Manufacturer's identification or heat number.

17.1.3 Product specification number.

17.1.4 The class, grade, and type identification as appropriate.

17.1.5 Purchaser's identification (4.2.3).

17.1.6 Location of stamping (4.2.3).

17.1.7 Incomplete forging (1.4). The marking shall include the suffix Y immediately following the ASTM number, and preceding any other suffix. This suffix shall not be removed until the material specification requirements have been completed and the material test report supplemented.

17.2 Marking shall be done by impression stamping or other acceptable means specified in the product specification or order. Bar coding is an acceptable supplemental identification method. The purchaser may specify in the order a specific bar coding system to be used. The bar coding system, if applied at the discretion of the supplier, should be consistent with one of published industry standards for bar coding.

17.3 The specification year date, and revision letter are not required to be marked on the forgings.

18. Keywords

18.1 general delivery requirements; steel forgings—alloy; steel forgings—carbon

SUPPLEMENTARY REQUIREMENTS

(GENERAL)

The following supplementary general requirements are common to the forging specifications listed in this specification. These and other limitations or tests may be performed by agreement between the supplier and purchaser. The additional requirements shall be specified in the order, and shall be completed by the supplier before the shipment of the forgings.

S1. Residual Elements

S1.1 Small quantities of certain unspecified elements may be present in carbon and low alloy steel forgings. These elements are considered as incidental and may be present to the following maximum amounts:

Copper	0.35 %
Nickel	0.30 %
Chromium	0.25 %
Molybdenum	0.10 %
Vanadium[A]	0.03 %

[A] Unless Supplementary Requirement S2 is required.

S2. Unspecified Elements

S2.1 Vanadium used for grain refinement or deoxidation shall not exceed 0.08 %.

S3. Sequential or Continuous Strand Casting

S3.1 When multiple heats of the same chemical composition range are sequentially strand cast, the heats shall be separated by an established procedure such that intermix material will not be supplied.

S4. Intercritical Heat Treatment

S4.1 The austenitizing stage in the heat treatment of ferritic forgings is intended to be done at suitable temperatures above the upper critical temperature (Ac_3) for the heat of steel involved, that is, full austenitization. However, when multiple austenitizing stages are used the temperature for the last may be set between the upper (Ac_3) and lower (Ac_1) critical temperature for partial austenitizing. Such cycles shall be followed by tempering within the temperature limits required by the material specification.

S5. Straightening of Forgings

S5.1 Unless otherwise specified by Supplementary Requirement S6, straightening of forgings after heat treatment for properties shall be performed at a temperature which is not more than 100°F [55°C] below the final tempering temperature. Following straightening, forgings shall be stress relieved at a temperature of 50 to 100°F [30 to 55°C] below the final tempering temperature and shall be reported on the material

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test report. Any straightening performed before heat treatment for properties does not require an intermediate stress-relief heat treatment.

S6. Post-Heat Treatment Straightening of Forgings

S6.1 Straightening after heat treatment for specified properties is not permitted without prior approval by the purchaser.

S7. Fracture Toughness Test

S7.1 The purchaser shall specify one or more of the following test methods for fracture toughness determination. Required information including test temperature, conditioning, environment, and acceptance criteria shall be provided as necessary.

S7.2 Determination of the plane strain fracture toughness in accordance with Test Method E399.

S7.3 Fracture toughness determination in accordance with Test Method E1820.

S7.4 Crack-tip opening displacement determination in accordance with Test Method E1290.

S8. Vacuum Degassing

S8.1 The vacuum degassing requirements of 5.2 shall apply.

S9. Vacuum Carbon Deoxidation

S9.1 The molten steel shall be vacuum carbon deoxidized (VCD) during processing, in which case the silicon content shall be 0.10 % maximum.

S10. Restricted Phosphorus and Sulfur, Levels A or B

S10.1 For level A, the phosphorus and sulfur levels shall be limited as follows:

		Heat	Product
Level A	P	0.015 % maximum	0.018 % maximum
	S	0.018 % maximum	0.021 % maximum

S10.2 For level B, the phosphorus and sulfur levels shall be limited to the following:

		Heat	Product
Level B	P	0.012 % maximum	0.015% maximum
	S	0.015% maximum	0.018 % maximum

S11. Restricted Copper, Levels A or B

S11.1 For level A, the heat and product analyses limits for copper shall be 0.15 % maximum.

S11.2 For level B, the heat and product analyses limits for copper shall be 0.10 % maximum.

S12. Tension Specimens for Hubbed Flanges and Tube Sheets

S12.1 For hubbed tube sheets and flanges to be used in ASME Boiler and Pressure Vessel Code construction, an axial tension specimen shall be taken as close as possible to the hub and either inboard or outboard of it, using a sub size specimen if necessary. The longitudinal axis of the specimen shall be parallel to the length of the hub, as shown in Fig. S1.

S12.2 By agreement with the purchaser, this test orientation may replace a specified tension test specimen, provided that other location criteria are met.

S13. Charpy Impact Tests

S13.1 Charpy impact tests shall be made. The number, orientation and location of the tests shall be specified along with the test temperature and the applicable acceptance criteria for absorbed energy, fracture appearance, lateral expansion, or both.

S13.2 The specimens shall be machined and tested in accordance with Test Methods and Definitions A370 or Test Methods A1058 in accordance with the purchase order.

S14. Charpy V Notch Impact Transition Curve

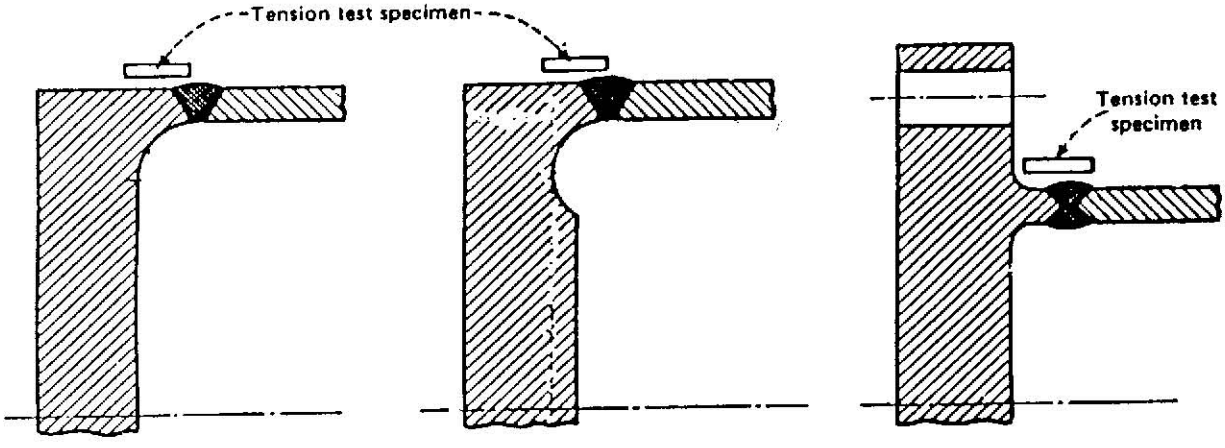
S14.1 Sufficient impact tests shall be made from the forging material to establish a transition temperature curve based upon one or several of the following criteria:

S14.1.1 Absorbed energy (ft·lbf [J]) (See Test Methods E23 or, if required by the purchase order, Test Methods A1058),

S14.1.2 Fracture appearance (see Supplement 5 of Test Methods and Definitions A370), or

S14.1.3 Lateral expansion.

S14.1.4 The test temperature range shall be wide enough to establish the upper and lower shelf energies, with sufficient testing at intermediate temperatures to permit a smooth curve



NOTE—Tension test specimens also may be located inboard of the hub.

FIG. S1 Tension Test Specimens

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to be plotted. A minimum test temperature may be set by agreement instead of establishing the lower shelf temperature. The upper shelf energy level is defined as having at least 95 % fibrous fracture and the lower shelf level is defined as showing 5 % or less fibrous fracture.

S14.2 The purchaser shall furnish the manufacturer with details of sample location, number of specimens, heat treatments, and information to be derived from the test.

S15. Grain Size

S15.1 When a grain size range is required, it shall be specified in the ordering information as heat treated or austenitic, and shall be determined by an agreed-upon method from Test Methods E112.

S15.2 Samples for grain size estimation from heat treated products shall be taken from the tension test specimen location.

S16. Rough Machining and Boring

S16.1 The position of the rough machining and boring in the manufacturing sequence shall be specified by the purchaser, particularly with regard to heat treatment for mechanical properties.

S17. Simulated Post-Weld Heat Treatment of Mechanical Test Samples

S17.1 All test coupons shall be subjected to single or multiple heat treatments at subcritical temperatures prior to testing. Such treatments are intended to simulate post-weld or other treatments to which the forgings will be subjected during subsequent fabrication. The purchaser shall furnish the manufacturer with details of the desired heat treatment for the test coupons, including temperatures, times, and cooling rates.

S18. Magnetic Particle Examination

S18.1 All accessible surfaces of the finished forging shall be subject to magnetic particle examination in accordance with Test Method A275/A275M.

S18.2 Unless otherwise agreed upon between the manufacturer and the purchaser the wet continuous method shall be used.

S18.2.1 The following conditions are subject to rejection or removal:

S18.2.1.1 Indications with major dimension exceeding 3/16 in. [5 mm].

S18.2.1.2 Four or more indications exceeding 1/16 in. [1.5 mm] in major dimensions that are aligned and separated by 1/16 in. [1.5 mm] or less end to end.

S18.2.1.3 Ten or more indications exceeding 1/16 in. [1.5 mm] in major dimensions contained in any 6 in.^{2} [40 cm^2] of surface, with the major dimension of this area not to exceed 6 in. [150 mm]. The area shall be taken in the most unfavorable location relative to the indications being evaluated.

S19. Liquid Penetrant Examination

S19.1 All accessible surfaces of the finished forging shall be subject to liquid penetrant examination in accordance with Test Method E165. The penetrant system to be used shall be agreed upon between the manufacturer and purchaser.

S19.2 The following conditions are subject to rejection or removal:

S19.2.1 Indications with major dimensions exceeding 3/16 in. [5 mm].

S19.2.2 Four or more indications exceeding 1/16 in. [1.5 mm] in major dimensions that are aligned and separated by 1/16 in. [1.5 mm] or less end to end.

S19.2.3 Ten or more indications exceeding 1/16 in. [1.5 mm] in major dimensions contained in any 6 in.^{2} [40 cm^2] of surface, with the major dimension in this area not to exceed 6 in. [150 mm]. The area shall be taken in the most unfavorable location relative to the indications being evaluated.

S20. Ultrasonic Examination

S20.1 Ultrasonic examination of forgings shall be carried out in accordance with Practice A388/A388M.

S20.2 Unless otherwise agreed upon between the manufacturer and the purchaser, acceptance levels BR or DA shall be specified for the longitudinal wave examination and level S for shear wave examination.

Level BR—Longitudinal Wave

S20.2.1 The back reflection method of tuning shall be used in accordance with Practice A388/A388M.

S20.2.2 In addition to the reportable conditions of the Recording Section of Practice A388/A388M, indications exceeding the resultant back reflection shall be recorded.

S20.2.3 The following conditions are subject to rejection, or repair if applicable.

S20.2.3.1 Complete loss of back reflection accompanied by an indication of a discontinuity. For this purpose, a back reflection less than 5 % of full screen height shall be considered complete loss of back reflection.

S20.2.3.2 An indication equal in amplitude to that of the back reflection established in an indication-free portion of the forging.

Level DA—Longitudinal Wave

S20.2.4 Reference blocks of acoustically similar metal shall be used for calibration. Blocks shall meet one of the following requirements:

S20.2.4.1 A comparison of the back reflections between equivalent thicknesses of the reference block material and the actual forging to be tested, without change in instrument setting shall not show a variation in excess of 25 %.

S20.2.4.2 The reference blocks shall be manufactured from steel that is similar in chemistry and processing history to the production forging being tested. The reference blocks shall be fabricated in accordance with the procedures of Practice E428.

S20.2.4.3 For test sections up to and including 12 in. [300 mm] thick, the reference blocks shall contain a 1/4 in. [6 mm] diameter flat-bottom hole; for over 12 in. [300 mm] up to and including 18 in. [300 to 450 mm], the hole diameter shall be 3/8 in. [10 mm]; and for over 18 in. [450 mm], it shall be 1/2 in. [13 mm].

S20.2.4.4 A distance-amplitude correction curve shall be established for the proper grade of steel and specified hole size.

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S20.2.4.5 A forging containing one or more indications equal in amplitude to that of the applicable reference hole, when properly corrected for distance, is subject to rejection, or repair if applicable.

Level S–Shear Wave

S20.2.5 Calibration notches, calibration reference, and method of scanning shall be in accordance with Practice A388/A388M. Unless otherwise agreed upon, a 60° V-notch shall be used.

S20.2.6 A forging containing a discontinuity that results in an indication exceeding the amplitude of the reference line is subject to rejection.

S20.2.7 The report of the ultrasonic examination shall be in compliance with Practice A388/A388M.

S20.2.8 Additional nondestructive examination or trepanning may be employed to resolve questions of interpretation of ultrasonic indications. The manufacturer shall accept responsibility for injurious conditions that will not be removed in final machining.

S21. Additional Test Coupon Heat Treatment

S21.1 When subcritical heat treatment, applied to a completed forging during subsequent fabrication, may affect the mechanical properties of the forging, then coupons for the mechanical testing required by the product specification shall be given a laboratory heat treatment, which simulates the anticipated subcritical heat treatment.

S21.2 The purchaser shall specify the required heat treatment temperature range, minimum time at temperature, and the rates of heating and cooling.

S21.3 The required number of test coupons shall be taken from the forging location described in the product specification.

S21.4 The test specimens shall meet the minimum mechanical test requirements of the product specification, as well as those of any additional tests agreed upon between producer and purchaser, after completion of the test coupon heat treatment.

S21.5 The forgings supplied in accordance with this supplementary requirement shall be marked in accordance with 17.1.7.

S21.6 The material test reports shall include the heat treatment of the as-delivered material and the results of the mechanical tests from the test coupons subjected to the purchaser specified heat treatments that represent fabrication.

S22. Ultrasonic Examination from Bore Surface

S22.1 Bored cylindrical forgings shall be examined from the bored surface in accordance with Test Method A939. The acceptance criteria shall be agreed upon between the purchaser and the producer.

S23. Magnetic Particle Examination Using AC Current

S23.1 The designated surfaces of ferromagnetic steel forgings shall be examined at the stage in machining specified by the purchaser in accordance with Test Method A966/A966M. The acceptance criteria for the examination shall be specified by the purchaser.

S24. J_{factor}

S24.1 The J_{factor}, calculated by means of the following equation, shall be established for each heat of steel used in forging manufacture:

$$J_{factor} = (Mn + Si)\,(P + Sn) \times 10^4$$

Has been found to be effective in reducing temper embrittlement effects.

S24.2 The purchaser shall specify the required maximum value of J_{factor} in both the inquiry and ordering documents.

S24.3 The determination of the tin content of the steel is necessary for the application of this supplementary requirement even if there is no chemical analysis requirement for tin in the product specification.

Note—In Dr. Paul Bates's paper,[6] it was noted that the Fracture Appearance Transition Temperature (FATT) fell steadily from J_{factor} 120 to 60, but below 20, the drop in FATT was much less apparent.

S25. Positive Material Identification

S25.1 Forgings shall receive positive material identification to ensure that forgings are of the ordered material grade prior to shipment.

S25.2 Forgings shall receive a positive material identification in accordance with Guide E1916.

S25.3 The entire ordered quantity of forgings shall be examined.

S25.4 Forgings not conforming to the ordered grade shall be rejected.

S25.5 Following this material identification examination, acceptable forgings shall be marked as agreed between the purchaser and producer.

S26. Pressure Equipment Directive—Mechanical Testing

S26.1 Charpy impact testing shall be done at the lowest scheduled operating temperature, but not higher than 68°F [20°C].

S26.2 The frequency of Charpy impact testing shall be the same as that specified in the product specification for the tension test, with one Charpy test (3 specimens) for each required tension test.

S26.3 The minimum individual absorbed energy for the Charpy impact test shall be 20 ft·lbf [27 J].

S26.4 The minimum elongation in the tension test shall be measured on a gauge length of five times the diameter of the test specimen (5D), and shall be not less than 14 %.

S26.5 The results of the impact and tension tests shall be included in the product certification.

S27. Heat Analysis for Remelted Ingots

S27.1 Instead of the heat analysis provisions in 8.1.6.2 of Specification A788/A788M for consumable electrode remelting processes, a heat analysis shall be obtained from each remelted ingot (or the product from it) from single master or parent heat.

[6] Bates, P., "The Production of Safety Critical Forgings for Pressure Vessel Applications," *International Forgemasters Conference* , Wiesbaden, Germany, September 2000.

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S27.2 The product analysis provisions of Specification A788/A788M shall not apply.

ANNEXES

(Mandatory Information)

A1. RECIRCULATION FACTOR

A1.1 The recirculation factor for the vacuum lift process is obtained as follows:

$$\frac{\text{Tons (kg) of Steel Lifted per Cycle} \times \text{Number of Cycles}}{\text{Heat Weight in Tons [kg]}}$$

A2. EXPLANATORY NOTE FOR WEIGHTED AVERAGE ANALYSIS

A2.1 A weighted average analysis is mandatory whenever an ingot is poured from the combination of two or more heats wherein the resultant chemistry of the ingot assumes an identity attributable to each heat involved in the combination. It is necessary to make this determination to ensure that each element in the official chemistry is represented by proportion to its amount in each individual furnace heat. An example of the determination of a weighted average analysis for an ingot made from a three-heat combination pour with varying weights and chemistry involved in each heat is shown below:

Furnace	Heat[A] Weight, tons	Individual Heat Chemistry, %								
		C	Mn	P	S	Si	Ni	Cr	Mo	V
A	25	0.20	0.50	0.010	0.020	0.34	0.92	0.32	0.12	0.03
B	50	0.25	0.50	0.013	0.015	0.38	0.98	0.32	0.12	0.02
C	50	0.25	0.50	0.015	0.018	0.38	0.94	0.34	0.13	0.02
	125[B]									

[A] This is individual heat contribution to the total ingot weight.
[B] Total ingot weight.

Step # 1—Determine furnace factor (FF) for each heat based on weight.

Furnace A = 25/125 = 20 %
Furnace B = 50/125 = 40 %
Furnace C = 50/125 = 40 %

$$FF = \frac{\text{(Individual Fnce Ht. Wt)}}{\text{(Combined Heat Weight)}} \times 100\ \%$$

Step # 2—Calculate the weighted average for each element. Examples for several elements shown below:

Weighted avg = sum of (% element in each furnace heat × FF)

° Weighted avg of Carbon (weighted avg):
Furnace A—0.20 % × 20 % = 0.04 %
Furnace B—0.25 % × 40 % = 0.10 %
Furnace C—0.25 % × 40 % = 0.10 %

Add to get weighted avg of 0.24 %

° Weighted avg of manganese:
Furnace A—0.50 % × 20 % = 0.10 %
Furnace B—0.50 % × 40 % = 0.20 %
Furnace C—0.50 % × 40 % = 0.20 %

Add to get weighted avg of 0.50 %

° Weighted avg of phosphorus:
Furnace A—0.010 % × 20 % = 0.002 %
Furnace B—0.013 % × 40 % = 0.0052 %
Furnace C—0.015 % × 40 % = 0.006 %

Add to get weighted avg of 0.013 %[A]

[A] (Round to significant figures in accordance with Practice E380.)
° The same procedure is used for all of the other elements.

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SUMMARY OF CHANGES

Committee A01 has identified the location of selected changes to this standard since the last issue (A788/A788M – 10) that may impact the use of this standard. (Approved Oct. 1, 2011.)

(*1*) Added ANSI/ASME B46.1 to 2.2.

(*2*) Added new 13.2.

Committee A01 has identified the location of selected changes to this standard since the last issue (A788/A788M – 08a) that may impact the use of this standard. (Approved Nov. 15, 2010.)

(*1*) Revised 1.1, 1.6, and 2.1.

(*2*) Added 4.1.5.

(*3*) Revised 10.1 and 10.2.

(*4*) Revised S13.2 and S14.1.1.

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Designation: F1470 – 12

Standard Practice for Fastener Sampling for Specified Mechanical Properties and Performance Inspection[1]

This standard is issued under the fixed designation F1470; 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.

INTRODUCTION

Throughout this practice the terms *detection* and *prevention* apply to quality control systems. A brief description of both is provided to assist the purchaser in the application of this practice.

The *detection system* relies on inspection as the primary means of controlling the quality of furnished material. Methods include in-process and final inspection. In-process inspection is typically performed by the individual performing the process and generally includes a first-piece inspection by someone other than the operator. Quality-control inspection may perform audit inspections on the process output during the course of the production run. In addition, a final inspection is performed by quality control inspectors according to a prescribed sample plan. The other sample plans utilize zero defects as their acceptance criteria.

The *prevention system* uses advanced quality planning in addition to many of the techniques used in the detection system. Quality planning incorporates a systems approach to quality control that focuses on defect prevention and continual improvement. In addition, Statistical Process Control (SPC) is usually applied to control the process, to achieve process stability and improve the capability by reducing the variability.

ISO 9001, ISO/TS 16949, ASQ Q9001, and Guide F2688[2] quality system standards, or a combination thereof, are models that may be used in establishing a prevention-based quality system.

1. Scope*

1.1 This practice provides sampling methods for determining how many fasteners to include in a random sample in order to determine the acceptability or disposition of a given lot of fasteners.

1.2 This practice is for mechanical properties, physical properties, performance properties, coating requirements, and other quality requirements specified in the standards of ASTM Committee F16. Dimensional and thread criteria sampling plans are the responsibility of ASME Committees B18.1 and B18.18.2M-B18.18.6M.

1.3 This practice provides for two sampling plans: one designated the "detection process," as described in Terminology F1789, and one designated the "prevention process," as described in Terminology F1789.

1.4 This practice is intended to be used as either a Final Inspection Plan for manufacturers, or as a Receiving Inspection Plan for purchasers/users. It is not valid for third-party qualification testing.

2. Referenced Documents

2.1 *ASTM Standards:*[3]

F1789 Terminology for F16 Mechanical Fasteners

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

F812/F812M Specification for Surface Discontinuities of Nuts, Inch and Metric Series

F2688 Guide for System-Based, Customer-Centered Quality Plan For Manufacturers

2.2 *ASME Standards:*

ASME B18.18.1 Inspection and Quality Assurance for General Purpose Fasteners

ASME B18.18.2M Inspection and Quality Assurance for High-Volume Machine Assembly Fasteners

[1] This practice is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.93 on Quality Assurance Provisions for Fasteners.

Current edition approved Nov. 15, 2012. Published December 2012. Originally approved in 1993. Last previous edition approved 2009 as F1470–09. DOI: 10.1520/F1470-12.

[2] A practice for developing a quality management system that does not require third party certification.

[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**

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ASME B18.18.3M Inspection and Quality Assurance for Special Purpose Fasteners[4]

ASME B18.18.5M Inspection and Quality Assurance Plan Requiring In-Process Inspection and Controls[4]

ASME B18.18.6M Quality Assurance Plan for Fasteners Produced in Third Party Accreditation System[4]

2.3 *ASQ Standards:*

ASQ Q9001 Quality Management Systems[4]

2.4 *ISO Standards:*

ISO 9001 Quality Management Systems Requirements[4]

ISO/TS 16949 Quality management systems—Particular requirements for the application of ISO 9001: 2000 for automotive production and relevant service part organizations.[4]

3. Terminology

3.1 Terms shall be defined in accordance with Terminology F1789.

3.2 *Definitions:*

3.2.1 *test, n*—an element of inspection that generally denotes the determination by technical means of the properties or elements of supplies, or components thereof and involves the application of established scientific principles and procedures.

4. Significance and Use

4.1 Sampling shall be selected in a random manner, ensuring that any unit in the lot has an equal chance of being chosen. Sampling should not be localized by selections being taken from the top of a container or from only one container of multicontainer lots.

4.2 The purchaser should be aware of the supplier's quality assurance system. This can be accomplished by auditing the supplier's quality system, if qualified auditors are available, or by third-party assessment certification, such as provided by ISO/TS 16949, or ISO 9001.

5. Ordering Information

5.1 The purchaser shall specify at the time of order inquiry, the specification number, the issue date and the sampling plan (detection process or prevention process) required from the supplier.

5.2 Guidelines for sampling plan selection are provided in Section 6.

6. Selection of Sampling Plans

6.1 Except as specified in 6.2, the detection process sampling level in accordance with Table 1 shall be applied.

6.2 If the manufacturer's quality system conforms with ASQ Q9001, ISO 9001, or Guide F2688 [2] the manufacturer shall be permitted to choose between the Prevention or Detection process for inspection and test purposes. Purchasers shall retain the right to specify the Prevention or Detection process at the time of inquiry or order (see Table 2).

7. Acceptance Criteria

7.1 The acceptance criteria for Table 3 is to accept the lot if zero nonconforming parts are detected in the random sample and reject the lot if at least one nonconforming part is detected in the random sample.

8. Disposition of Nonconforming Lots

8.1 *Manufacturer's Options*—The manufacturer shall choose one of the following options in the disposition of those fasteners that have been found to contain nonconformities prior to shipment. The fastener manufacturer shall maintain records of disposition.

8.1.1 They may be scrapped.

8.1.2 They may be 100 % sorted, and all nonconforming parts removed.

8.1.3 They may be reworked or reprocessed to correct the nonconforming characteristic(s).

8.1.4 The manufacturer may make concession by use of a documented internal review procedure and determine to ship product that is found to contain minor nonconformances that are not critical or key characteristics as determined by the end user. Nonconformance of critical or key characteristics shall need approval from the end user prior to shipment of product. (See 8.1.6.)

8.1.5 They may be regraded for alternative applications.

8.1.6 The end user may be informed of the nonconformity or nonconformities and his advice requested on their disposition. The user may consider the degree to which the characteristic(s) deviate(s) from specified requirements and the significance of the effect on the assembly or performance of the fasteners in their service application. The user may authorize a written release of the fasteners for completion of production or for shipment, as applicable.

8.2 *End User Options*—The end user shall choose one of the following options for the disposition of those fastener lots that have been rejected after delivery:

8.2.1 The end user considers the degree to which the characteristic(s) deviate(s) from specified requirements and the effect on their performance in the intended service application. The end user may authorize release of the parts or fastener lots for use.

8.2.2 They may be scrapped.

8.2.3 They may be 100 % sorted and nonconforming parts removed.

8.2.4 They may be reworked or reprocessed to correct the nonconforming characteristic(s).

8.2.5 They may be returned.

8.3 *Distributor Options*—The distributor shall choose one of the following options for the disposition of those fastener lots that have been rejected after delivery.

8.3.1 They may be scrapped.

8.3.2 They may be 100 % sorted, and nonconforming parts may be removed with the written agreement of the manufacturer. See Note 1.

NOTE 1—In general, product standards specify requirements for manufacturers' markings. Lot control, invoice information, and packaging may be another source of identification of the manufacturer.

[4] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

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TABLE 1 Sampling Level for the Detection Process

NOTE 1—Legend: WA—Where Applicable.
NA—Not Applicable.

Characteristic	Description of Control				
	Sample Level[A]	Internally Threaded Parts	Externally Threaded Parts	Non-threaded	Washers
Adhesion (coating)	C	WA	WA	WA	WA
Assembly tension test	B	NA	WA	NA	NA
Bend, body (nails)	A	NA	NA	WA	NA
Bend, notched (bolts)	B	NA	WA	NA	NA
Bend, body (track spikes)	C	NA	NA	WA	NA
Breaking strength (eyebolts)	C	NA	WA	NA	NA
Carbide precipitation	C	WA	WA	WA	WA
Case depth/decarburization	C	WA	WA	WA	WA
Chemistry[B]	—	WA	WA	WA	WA
Compression (washer direct tension)	A	NA	NA	NA	WA
Cone proof	C	WA	NA	NA	NA
Drill-Drive (self-drilling screws)	A	NA	WA	NA	NA
Drive test	A	WA	WA	NA	NA
Ductility (steel tapping screws)	B	NA	WA	WA	NA
Elongation—Machined specimen	C	NA	WA	WA	NA
Extension at failure	C	NA	WA	WA	NA
Grain size[C]	—	WA	WA	WA	WA
Hardness[D]	B	WA	WA	WA	WA
Bend, head (track spikes)	C	NA	NA	WA	NA
Humidity	B	WA	WA	WA	WA
Hydrogen embrittlement	B	WA	WA	WA	WA
Impact	C	NA	WA	WA	NA
Lubrication	B	WA	WA	WA	WA
Magnetic permeability	B	WA	WA	WA	WA
Packaging[E]	—	WA	WA	WA	WA
Plating/coating thickness (weight)	A	WA	WA	WA	WA
Product identification marking[F]	—	WA	WA	WA	WA
Proof load—Full size	C	WA	WA	NA	NA
Reduction of area—Machined specimen	C	NA	WA	WA	NA
Bend, rivet	B	NA	NA	WA	NA
Flattening, rivet	B	NA	NA	WA	NA
Rotational capacity	C	WA	WA	NA	WA
Salt spray[G]	B	WA	WA	WA	WA
Shear strength	C	NA	WA	WA	NA
Stress corrosion	B	WA	WA	WA	WA
Surface discontinuities[H]	B	WA	WA	WA	WA
Surface roughness	B	WA	WA	WA	WA
Tensile strength—Full size[I]	C	NA	WA	WA	NA
Tensile strength—Machined specimen	C	NA	WA	WA	NA
Torque[J] (prevailing)	C	WA	WA	NA	NA
Torque (torsional strength)	C	WA	WA	NA	NA
Yield strength—Full size	C	NA	WA	NA	NA
Yield strength—Machined specimen	C	NA	WA	NA	NA

[A] Quantity of samples is in Table 3, Sample Size.
[B] A certified copy of the material's chemical or product analysis shall be furnished with each shipping lot, and the shipping lot shall have documentation providing traceability to this chemical analysis. It is required that the purchaser of the raw material (used to manufacture) shall verify that the material is the material specified on the purchase order.
[C] The steel producer shall provide the steel making practice (course or fine grain) on their certification. The steel producer may specify grain size at their option.
[D] Surface or core, or both, as applicable.
[E] All packaging requirements shall be in conformance with the applicable packaging standard.
[F] Visual inspection for conformance.
[G] Continuous monitoring of salt spray performance in accordance with the recommendation of Table B in Appendix 1 of ASME B18.18.2M constitutes compliance with the requirements for salt spray testing outlined in this table.
[H] Includes all surface discontinuities contained within Specification F788/F788M and Specification F812/F812M.
[I] Wedge angle or axial test as applicable.
[J] Prevailing torque test includes thread start, all specified torque requirements, and retention of locking feature, when applicable.

8.3.3 They may be reworked or reprocessed to correct the nonconforming characteristic(s) with the written agreement of the manufacturer. See Note 1.

8.3.4 They may be returned. See Note 1.

8.4 *Reinspection*—All fastener lots that have been sorted, reworked, or reprocessed, or a combination thereof, under the jurisdiction of the manufacturer or distributor shall be reinspected for the characteristic(s) found nonconforming and all

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TABLE 2 Sampling Level for the Prevention Process

NOTE 1—Legend: WA—Where Applicable.
NA—Not Applicable.

Characteristic	Description of Control				
	Sample Level[A,B]	Internally Threaded Parts	Externally Threaded Parts	Non-threaded	Washers
Adhesion (coating)	D	WA	WA	WA	WA
Assembly tension test	C	NA	WA	NA	NA
Bend, body (nails)	B	NA	NA	WA	NA
Bend, notched (bolts)	C	NA	WA	NA	NA
Bend, body (track spikes)	D	NA	NA	WA	NA
Breaking strength (eyebolts)	D	NA	WA	NA	NA
Carbide precipitation	D	WA	WA	WA	WA
Case depth/decarburization	D	WA	WA	WA	WA
Chemistry[C]	—	WA	WA	WA	WA
Compression (washer direct tension)	B	NA	NA	NA	WA
Cone proof	D	WA	NA	NA	NA
Drill-Drive (self-drilling screws)	A	NA	WA	NA	NA
Drive test	B	WA	WA	NA	NA
Ductility (steel tapping screws)	C	NA	WA	WA	NA
Elongation—Machined specimen	D	NA	WA	WA	NA
Extension at failure	D	NA	WA	WA	NA
Grain size[D]	—	WA	WA	WA	WA
Hardness[E]	C	WA	WA	WA	WA
Bend, head (track spikes)	D	NA	NA	WA	NA
Humidity	C	WA	WA	WA	WA
Hydrogen embrittlement	C	WA	WA	WA	WA
Impact	D	NA	WA	WA	NA
Lubrication	C	WA	WA	WA	WA
Magnetic permeability	C	WA	WA	WA	WA
Packaging[F]	—	WA	WA	WA	WA
Plating/coating thickness (weight)	B	WA	WA	WA	WA
Product identification marking[G]	—	WA	WA	WA	WA
Proof load—Full size	D	WA	WA	NA	NA
Reduction of area—Machined specimen	D	NA	WA	WA	NA
Bend, rivet	C	NA	NA	WA	NA
Flattening, rivet	C	NA	NA	WA	NA
Rotational capacity	D	WA	WA	NA	WA
Salt spray[H]	C	WA	WA	WA	WA
Shear strength	D	NA	WA	WA	NA
Stress corrosion	C	WA	WA	WA	WA
Surface discontinuities[I]	C	WA	WA	WA	WA
Surface roughness	C	WA	WA	WA	WA
Tensile strength—Full size[J]	D	NA	WA	WA	NA
Tensile strength—Machined specimen	D	NA	WA	WA	NA
Torque[K] (prevailing)	D	WA	WA	NA	NA
Torque (torsional strength)	D	WA	WA	NA	NA
Yield strength—Full size	D	NA	WA	NA	NA
Yield strength—Machined specimen	D	NA	WA	NA	NA

[A] Final inspection of a characteristic may be carried out at any stage of manufacture, provided the characteristic is not subject to change in any further manufacturing or processing operation. Therefore, the testing of those samples may be deducted from the sample level specified.
[B] Quantity of samples is in Table 3, Sample Size.
[C] A certified copy of the material's chemical or product analysis shall be furnished with each shipping lot, and the shipping lot shall have documentation providing traceability to this chemical analysis. It is required that the purchaser of the raw material (used to manufacture) shall verify that the material is the material specified on the purchase order.
[D] Steel making practice (course or fine grain) shall be included with the material producer's chemical analysis report.
[E] Surface, core, or both, as applicable.
[F] All packaging requirements shall be in conformance with the applicable packaging standard.
[G] Visual inspection for conformance.
[H] Continuous monitoring of salt spray performance in accordance with the recommendation of Table B in Appendix 1 of ASME B18.18.2M constitutes compliance with the requirements for salt spray testing outlined in this table.
[I] Includes all surface discontinuities contained within Specification F788/F788M and Specification F812/F812M.
[J] Wedge angle or axial test as applicable.
[K] Prevailing torque test includes thread start, all specified torque requirements, and retention of locking feature, when applicable.

other characteristics that would be affected by the reworking or reprocessing operation(s). If no parts inspected are found nonconforming, the fastener lots may be approved for delivery or use, as applicable. Reinspection shall be performed using the same or a more stringent sample plan that was used in detecting the original nonconformance. The acceptance level shall be in accordance with 7.1.

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TABLE 3 Sample Size

NOTE 1—The acceptance number in all cases is zero defects.

Lot Size	Sample Size			
	A	B	C	D
1 to 2	2	1	1	[A]
3 to 15	3	2	1	[A]
16 to 25	4	3	1	[A]
26 to 50	5	4	1	[A]
51 to 90	6	5	2	1
91 to 150	7	6	2	1
151 to 280	10	7	2	1
281 to 500	11	9	3	2
501 to 1200	15	11	3	2
1201 to 3200	18	13	3	2
3201 to 10 000	22	15	4	3
10 001 to 35 000	29	15	4	3
35 001 to 150 000	29	15	5	3
150 001 to 500 000	29	15	6	4
500 001 and over	29	15	7	5

[A] Suppliers shall furnish certified test results from which the shipping lots originated. If certified test reports are not available, then the supplier must default to Sample Size C and conduct the tests required.

9. Control of Measuring and Test Equipment

9.1 Control should be maintained over all measuring and test equipment to provide confidence in decisions or actions based on measurement or test data. As a minimum, these controls shall follow the requirements/practices in either ISO/TS 16949, ISO 9001, ASQ 9001, or Guide F2688[2] on the portion that details the control of measuring and test equipment.

10. Keywords

10.1 detection systems; fasteners; inspection for mechanical properties; performance requirements; prevention systems; quality requirements; sampling plans; selection and size; statistical process control

SUMMARY OF CHANGES

Committee F16 has identified the location of selected changes to this standard since the last issue (F1470–09) that may impact the use of this standard.

(1) Added drill-drive and ductility to Table 1 and Table 2.

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ASME B1.13M-2005

(Revision of ASME B1.13M-2001)

Metric Screw Threads: M Profile

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Metric Screw Threads: M Profile

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FOREWORD

In 1966, ANSI Standards Committee B1 — Standardization and Unification of Screw Threads — started preparation of a document for ISO Metric Screw Threads based on the current ISO recommendations and draft documents. Since there were some uncertainties as to the acceptance of this thread by American industries, the information was published in August 1967 with the title, "Interpretative Document Metric Screw Threads B1.13." This document was never approved as an ANSI standard.

A revision of the information based on the then current ISO standards and recommendations was published in April 1972 with the title "B1 Report — ISO Metric Screw Threads." Again, the document was never approved as an ANSI standard. The document number was therefore removed and the status changed to a report.

Interest in metric screw threads has grown at a rapid pace over the past several years with the advent of greater import and export business. The American National Standards Institute, in April 1971, established a committee, ANSI Special Committee to Study Development of an Optimum Metric Fastener System (OMFS). Included in the scope was metric screw threads. Recommendations were submitted to a joint ISO/TC1/TC2 working group established in September 1973 to study the OMFS proposals.

An ISO/TC1/TC2 Ad Hoc Advisory Panel meeting in April 1975 in Munich reached a compromise between the OMFS recommendations and the existing ISO screw thread system. This compromise was approved, in the main, by the ISO/TC1 in its eleventh plenary meeting in Stockholm, June 1976.

(a) The first issue of this Standard, designated ANSI B1.13M, was approved as an American National Standard on February 12, 1979. It provided a system of metric screw threads for general fastening purposes in mechanisms and structures and was in basic agreement with ISO screw thread standards and resolutions current at that time. It featured detailed information for diameter-pitch combinations selected as preferred standard sizes.

(b) The 1983 issue of this Standard was designated ANSI/ASME B1.13M-1983 and was approved as an American National Standard on August 5, 1983. It updated the 1979 issue to include

(1) the addition of the new ISO tolerance position *f*

(2) the addition of a section on dimensional accommodation of coating or plating

(3) the addition of a section on lead and flank angle tolerances

(c) The 1995 issue of this Standard was designated ASME B1.13M-1995 and was approved as an American National Standard on February 20, 1995. It updated the 1983 issue to include

(1) the addition of an 8 mm pitch series

(2) the addition of standard size M10 × 1

(3) the provision for adjustment of internal thread tolerance class for short and long lengths of thread engagement, which may be used instead of external thread class adjustment

(4) changes in rounding procedures that follow the principles of ASME B1.30M

(d) The 2001 issue of this Standard was designated ASME B1.13M-2001 and was approved as an American National Standard on May 22, 2001. It updated the 1995 issue to include

(1) incorporation of changes made in the 1998 issue of ISO 261, including addition of diameters 125, 130, and 140 in the 8 mm pitch series; and changing of the 7 mm diameter from 3rd to 2nd choice in Table 6.

(2) recognition of changes made in the 1998 issue of ISO 965-1, including the stating of when International practice permits thread designation without thread class (not USA practice); and modifying the designation of multiple lead threads to be more in line with ISO practice.

(3) incorporation of the new 1998 International Standard, ISO 965-5, by adding Nonmandatory Appendix E for Class AX threads.

(4) minor changes in some thread root diameters due to modified calculation and rounding procedures added in ASME B1.30. ASME B1.30 uses rounding upward when the digit following

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the last rounded place is a 5 followed by zeros. Prior to issue of ASME B1.30, rounding was to the nearest even digit. Tabulated values appearing in ISO Standards are not subject to rounding rules of ASME B1.30.

(5) changes in Circular Runout tolerances.

(6) other required updates and corrections.

(e) This issue updates the 2001 edition and includes

(1) addition of a new Nonmandatory Appendix F to provide a new tolerance position *E*

(2) addition of tolerance class 6h as a preferred class

(3) addition of M8 x 1.25 – 6AX to Nonmandatory Appendix E

(4) revision of section 8 on "Dimensional Accommodation of Coating or Plating..." to include allowances at thread roots and to expand the information on internal threads

(5) revision of section 7 to provide thread designations in accordance with ASME Y14.6-2001

(6) revision of some tabulated inch translation values in Nonmandatory Appendix C and the examples of calculation of thread size values in para. 9.4, in accordance with ASME B1.30-2002

(7) addition of para. 7.9 for designation of a thread with adjusted size limits

(8) other required editorial updates and corrections

Suggestions for improvement of this Standard are welcome. They should be sent to Secretary, ASME B1 Standards Committee, Three Park Avenue, New York, NY 10016-5990.

This revision was approved as an American National Standard on September 29, 2005.

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Standardization and Unification of Screw Threads

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METRIC SCREW THREADS: M PROFILE

1 GENERAL

1.1 Scope

This Standard contains general metric standards for a 60 deg symmetrical screw thread with a basic ISO 68-1 profile designated M profile. The M profile threads of tolerance class 6H/6g are intended for metric applications where inch class 2A/2B have been used. At the minimum material limits, the 6H/6g results in a looser fit than the 2A/2B. Tabular data is also provided for a tighter tolerance fit external thread of class 4g6g, which is approximately equivalent to the inch class 3A but with an allowance applied. Formulation and tolerancing data is included for applications requiring other fits.

NOTE: A 4H5H/4h6h is approximately equivalent to a class 3A/3B fit in the inch system.

1.2 Interchangeability

Threads produced to this Standard are fully interchangeable with threads conforming to other National Standards that are based on ISO 68-1 basic profile and ISO 965-1 tolerance practices.

1.2.1 Assembly. Threads produced in accordance with M profile and MJ profile (ASME B1.21M) design data will assemble with each other. However, external MJ threads will encounter interference on the root radii with internal M thread crests when both threads are at maximum material condition.

1.3 References

The latest issues of the following documents form a part of this Standard to the extent specified herein.

ASME B1.3, Screw Thread Gaging Systems for Dimensional Acceptability — Inch and Metric Screw Threads (UN, UNR, UNJ, M, and MJ)
ASME B1.7M, Nomenclature, Definitions, and Letter Symbols for Screw Threads
ASME B1.16M, Gages and Gaging for Metric M Screw Threads
ASME B1.21M, Metric Screw Threads: MJ Profile
ASME B1.30, Screw Threads — Standard Practice for Calculating and Rounding Dimensions
ASME B47.1, Gage Blanks
ASME Y14.5, Dimensioning and Tolerancing
Publisher: The American Society of Mechanical Engineers (ASME), Three Park Avenue, New York, NY 10016-5990; Order Department: 22 Law Drive, Box 2900, Fairfield, NJ 07007-2900

ASTM F568M, Standard Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners
Publisher: The American Society for Testing and Materials (ASTM), 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

ISO 3, Preferred Numbers — Series of Preferred Numbers
ISO 68-1, ISO General Purpose Screw Threads — Basic Profile — Part 1: Metric Screw Threads
ISO 261, ISO General Purpose Metric Screw Threads — General Plan
ISO 724, ISO Metric Screw Threads — Basic Dimensions
ISO 898-1, Mechanical Properties of Fasteners — Part 1: Bolts, Screws, and Studs
ISO 965-1, ISO General Purpose Metric Screw Threads — Tolerances — Part 1: Principles and Basic Data
Publisher: International Organization for Standardization (ISO), 1 rue de Varembé, Case Postale 56, CH-1211, Genève 20, Switzerland/Suisse

SAE J1199, Mechanical and Material Requirements for Metric Externally Threaded Steel Fasteners
Publisher: Society of Automotive Engineers (SAE), 400 Commonwealth Drive, Warrendale, PA 15096-0001

1.4 Acceptability

Acceptability of product threads shall be in accordance with ASME B1.3. Gages and gaging are in accordance with ASME B1.16M.

1.5 Reference Temperature

The reference temperature is 20°C for dimensions defined by this system.

1.6 General Symbols

The general symbols used to describe the metric screw thread forms are shown in Table 1.

1.7 Units

All dimensions and all values in the formulas are expressed in millimeters unless otherwise noted. Values in terms of sharp vee-thread height (height of fundamental triangle), H, are used to be consistent with ISO Standards, but actual formulations and calculations are based on values of pitch, P. See Table 2.

1.8 Federal Government Use

When this Standard is approved by the Department of Defense and Federal Agencies and is incorporated

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Table 1 General Symbols

Symbol [Note (1)]	Explanation	Symbol [Note (1)]	Explanation
D	Major diameter internal thread	EI	Lower deviation, internal thread allowance (fundamental deviation). See Fig. 4.
D_1	Minor diameter internal thread		
D_2	Pitch diameter internal thread	G, H	Letter designations for tolerance positions for lower deviation, internal thread
d	Major diameter external thread		
d_1	Minor diameter external thread	g, h	Letter designations for tolerance positions for upper deviation, external thread
d_2	Pitch diameter external thread		
d_3	Rounded form minor diameter external thread	es	Upper deviation, external thread allowance (fundamental deviation). See Fig. 4. In the ISO System, *es* is always negative for an allowance fit or zero for no allowance.
P	Pitch		
r	External thread root radius		
T	Tolerance	ei	Lower deviation, external thread [equals the allowance (fundamental deviation) plus the tolerance]. See Fig. 4. In the ISO system, *ei* is always negative for an allowance fit.
TD_1, TD_2	Tolerances for D_1, D_2		
Td, Td_2	Tolerances for d, d_2		
ES	Upper deviation, internal thread [equals the allowance (fundamental deviation) plus the tolerance]. See Fig. 4.	H	Height of fundamental triangle
		LE	Length of engagement
		LH	Left hand thread

NOTE:
(1) Subscripts "bsc," "max." and "min." indicate "basic," "maximum," and "minimum" sizes, respectively.

into FED-STD-H28/21, *Screw Thread Standards for Federal Services Section 21*, the use of this Standard by the Federal Government is subject to all the requirements and limitations of FED-STD-H28/21.

2 TERMINOLOGY

2.1 Definitions

allowance: the prescribed difference between the design (maximum material) size and the basic size. It is numerically equal to the absolute value of the ISO term *fundamental deviation.*

NOTE: *Allowance* is not an ISO metric screw thread term but will be used together with the ISO term *fundamental deviation.*

basic thread profile: the cyclic outline, in an axial plane, of the permanently established boundary between the provinces of the external and internal threads. All deviations are with respect to this boundary. See Figs. 1 and 4.

bolt thread (external thread): the term used in ISO metric thread standards to describe all external threads. All symbols associated with external threads are designated with lowercase letters. This Standard will refer only to *external threads* in accordance with U.S. practice.

crest diameter: the major diameter of an external thread and the minor diameter of an internal thread.

design profiles: the maximum material profiles permitted for external and internal threads for a specified tolerance class. See Figs. 2 and 3.

deviation: in ISO usage, the algebraic difference between a size (actual, maximum, minimum, etc.) and the corresponding basic size. The term *deviation* does not necessarily indicate an error.

fit: the general term used to signify range of tightness or looseness that results from application of a specific combination of allowances and tolerances in mating parts.

fundamental deviation: for standard threads, the deviation (upper or lower) closer to the basic size. It is the upper deviation, *es*, for an external thread and the lower deviation, *EI*, for an internal thread. See Fig. 4; also see *allowance* and *tolerance position.*

NOTE: The U.S. term *allowance* will be used as a primary term in this Standard, where applicable.

lower deviation: the algebraic difference between the minimum limit of size and the corresponding basic size. See para. 5.1.4.

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Table 2 Thread Data, M Profile

Pitch, P	Truncation of Internal Thread Root and External Thread Crest, $\frac{H}{8}$ $0.1082532P$	Addendum of Internal Thread and Truncation of Internal Thread, $\frac{H}{4}$ $0.2165064P$	Dedendum of Internal Thread and Addendum of External Thread, $\frac{3}{8}H$ $0.3247595P$	Difference Between Max. Theoretical Pitch Diam. and Max. Minor Diam. of External Thread, and Min. Theoretical Pitch Diam. and Min. Minor Diam. of Internal Thread, $\frac{H}{2}$ $0.4330127P$	Height of Internal Thread and Depth of Thread Engagement, $\frac{5}{8}H$ $0.5412659P$	Difference Between Min. Theoretical Pitch Diam. and Min. Design Minor Diam. of External Thread for $0.125P$ Root Radius, $0.711325H$ $0.6160254P$	Twice the External Thread Addendum, $\frac{3}{4}H$ $0.6495191P$	Difference Between Max. Major and Max. Theoretical Pitch Diam. of Internal Thread, $\frac{11}{12}H$ $0.7938566P$	Height of Sharp V-Thread, H $0.8660254P$	Double Height of Internal Thread, $\frac{5}{4}H$ $1.0825318P$
0.2	0.02165	0.04330	0.06495	0.08660	0.10825	0.12321	0.12990	0.15877	0.17321	0.21651
0.25	0.02706	0.05413	0.08119	0.10825	0.13532	0.15401	0.16238	0.19846	0.21651	0.27063
0.3	0.03248	0.06495	0.09743	0.12990	0.16238	0.18481	0.19486	0.23816	0.25981	0.32476
0.35	0.03789	0.07578	0.11367	0.15155	0.18944	0.21561	0.22733	0.27785	0.30311	0.37889
0.4	0.04330	0.08660	0.12990	0.17321	0.21651	0.24641	0.25981	0.31754	0.34641	0.43301
0.45	0.04871	0.09743	0.14614	0.19486	0.24357	0.27721	0.29228	0.35724	0.38971	0.48714
0.5	0.05413	0.10825	0.16238	0.21651	0.27063	0.30801	0.32476	0.39693	0.43301	0.54127
0.6	0.06495	0.12990	0.19486	0.25981	0.32476	0.36962	0.38971	0.47631	0.51962	0.64952
0.7	0.07578	0.15155	0.22733	0.30311	0.37889	0.43122	0.45466	0.55570	0.60622	0.75777
0.75	0.08119	0.16238	0.24357	0.32476	0.40595	0.46202	0.48714	0.59539	0.64952	0.81190
0.8	0.08660	0.17321	0.25981	0.34641	0.43301	0.49282	0.51962	0.63509	0.69282	0.86603
1	0.10825	0.21651	0.32476	0.43301	0.54127	0.61603	0.64952	0.79386	0.86603	1.08253
1.25	0.13532	0.27063	0.40595	0.54127	0.67658	0.77003	0.81190	0.99232	1.08253	1.35316
1.5	0.16238	0.32476	0.48714	0.64952	0.81190	0.92404	0.97428	1.19078	1.29904	1.62380
1.75	0.18944	0.37889	0.56833	0.75777	0.94722	1.07804	1.13666	1.38925	1.51554	1.89443
2	0.21651	0.43301	0.64952	0.86603	1.08253	1.23205	1.29904	1.58771	1.73205	2.16506
2.5	0.27063	0.54127	0.81190	1.08253	1.35316	1.54006	1.62380	1.98464	2.16506	2.70633
3	0.32476	0.64952	0.97428	1.29904	1.62380	1.84808	1.94856	2.38157	2.59808	3.24760
3.5	0.37889	0.75777	1.13666	1.51554	1.89443	2.15609	2.27332	2.77850	3.03109	3.78886
4	0.43301	0.86603	1.29904	1.73205	2.16506	2.46410	2.59808	3.17543	3.46410	4.33013
4.5	0.48714	0.97428	1.46142	1.94856	2.43570	2.77211	2.92284	3.57235	3.89711	4.87139
5	0.54127	1.08253	1.62380	2.16506	2.70633	3.08013	3.24760	3.96928	4.33013	5.41266
5.5	0.59539	1.19079	1.78618	2.38157	2.97696	3.38814	3.57236	4.36621	4.76314	5.95392
6	0.64952	1.29904	1.94856	2.59808	3.24760	3.69615	3.89711	4.76314	5.19615	6.49519
8	0.86603	1.73205	2.59808	3.46410	4.33013	4.92820	5.19615	6.35085	6.92820	8.66025

GENERAL NOTES:

(a) All dimensions are in millimeters.

(b) Rounding in accordance with ASME B1.30.

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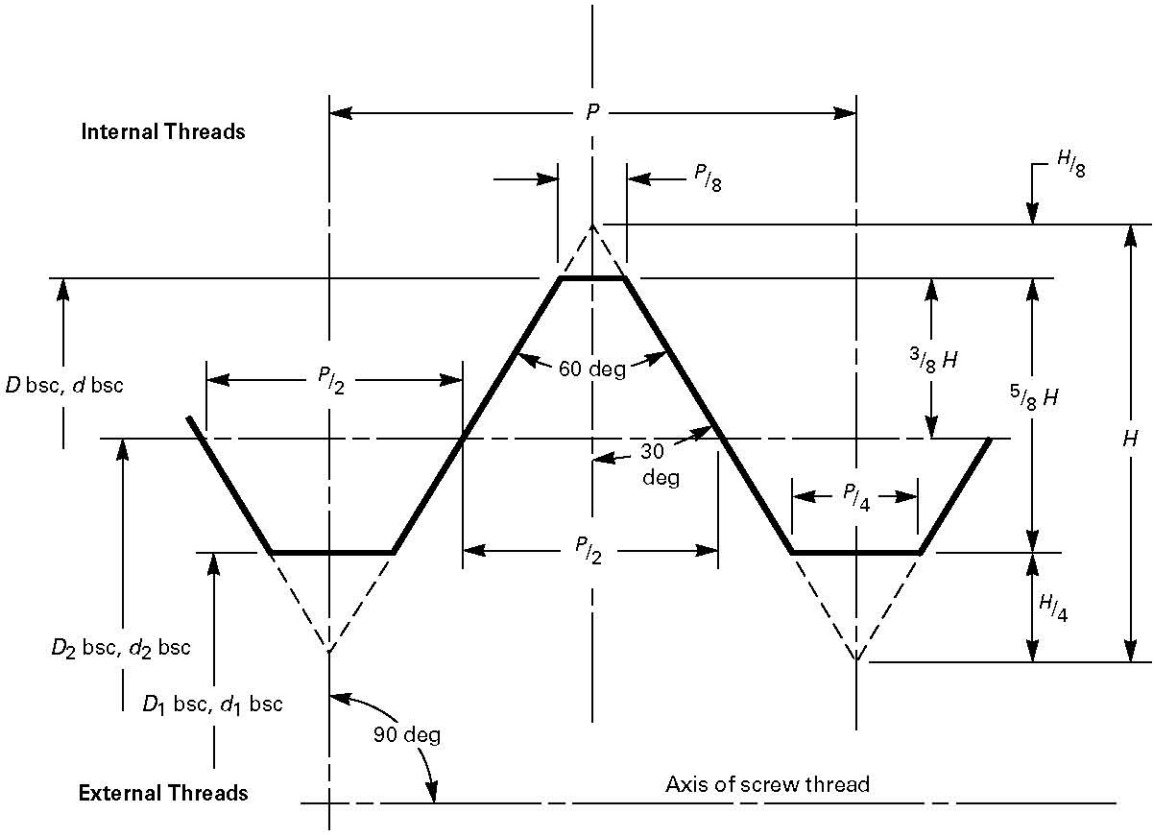

GENERAL NOTES: $H = \sqrt{3}/2 \times P = 0.866025\ P$

$0.125\ H = 0.108253\ P$
$0.250\ H = 0.216506\ P$
$0.375\ H = 0.324760\ P$
$0.625\ H = 0.541266\ P$

Fig. 1 Basic M Thread Profile (ISO 68-1 Basic Profile)

nut thread (internal thread): a term used in ISO metric thread standards to describe all internal threads. All symbols associated with internal threads are designated with uppercase letters. This Standard will refer to the term *internal thread* in accordance with U.S. practice.

tolerance: the total amount of variation permitted for the size of a dimension. It is the difference between the maximum limit of size and the minimum limit of size (i.e., algebraical difference between the upper deviation and the lower deviation). The tolerance is an absolute value without sign. Tolerance for threads is applied to the design size in the direction of minimum material. Therefore, tolerances are applied as negative values on external threads and as positive values on internal threads.

tolerance class: the combination of a tolerance position with a tolerance grade. It specifies the allowance (fundamental deviation) and tolerance for the pitch and major diameters of external threads and the pitch and minor diameters of internal threads.

tolerance grade: a numerical symbol that designates the tolerances of crest diameters and pitch diameters applied to the design profiles.

tolerance position: a letter symbol that designates the position of the tolerance zone in relation to the basic size. This position provides the allowance (fundamental deviation).

upper deviation: the algebraic difference between the maximum limit of size and the corresponding basic size. See para. 5.1.3.

3 SCREW THREAD PROFILE

3.1 Basic M Thread Profile

The basic M thread profile also known as the ISO 68-1 Basic Profile for metric screw threads is depicted in Fig. 1 with the associated dimensions listed in Table 2.

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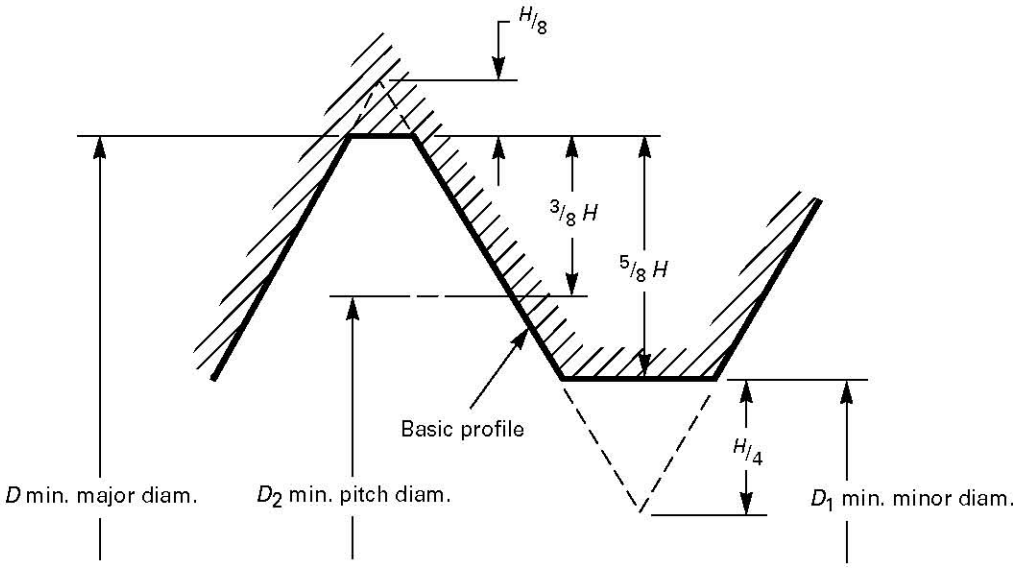
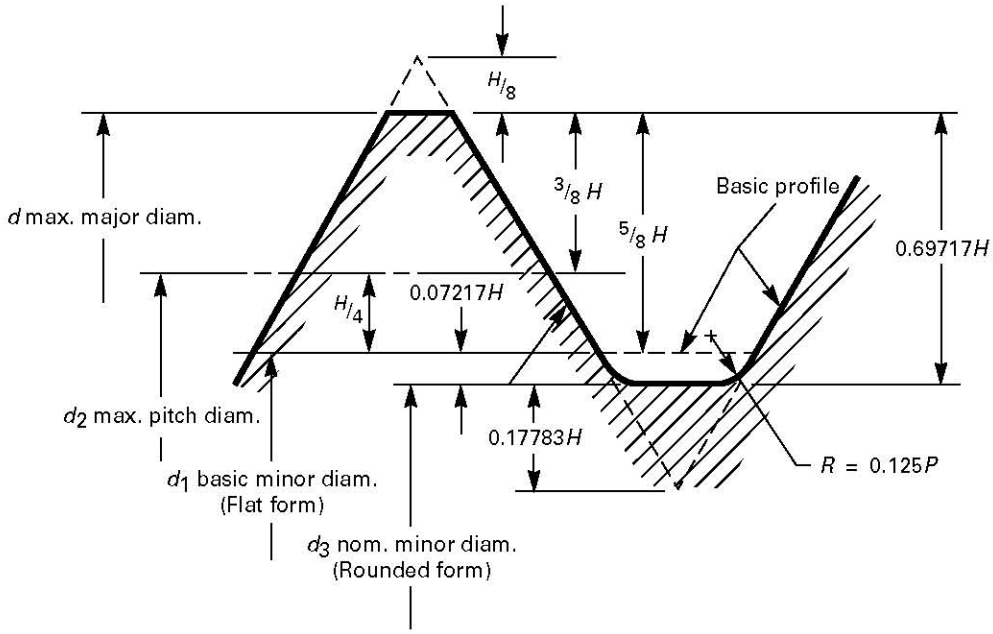


GENERAL NOTE: For dimensions, see Table 2.

Fig. 2 Internal Thread, Design M Profile With No Allowance (Fundamental Deviation) (Maximum Material Condition)



GENERAL NOTE: For dimensions, see Table 2.

Fig. 3 External Thread, Design M Profile With No Allowance (Fundamental Deviation) (Flanks at Maximum Material Condition)

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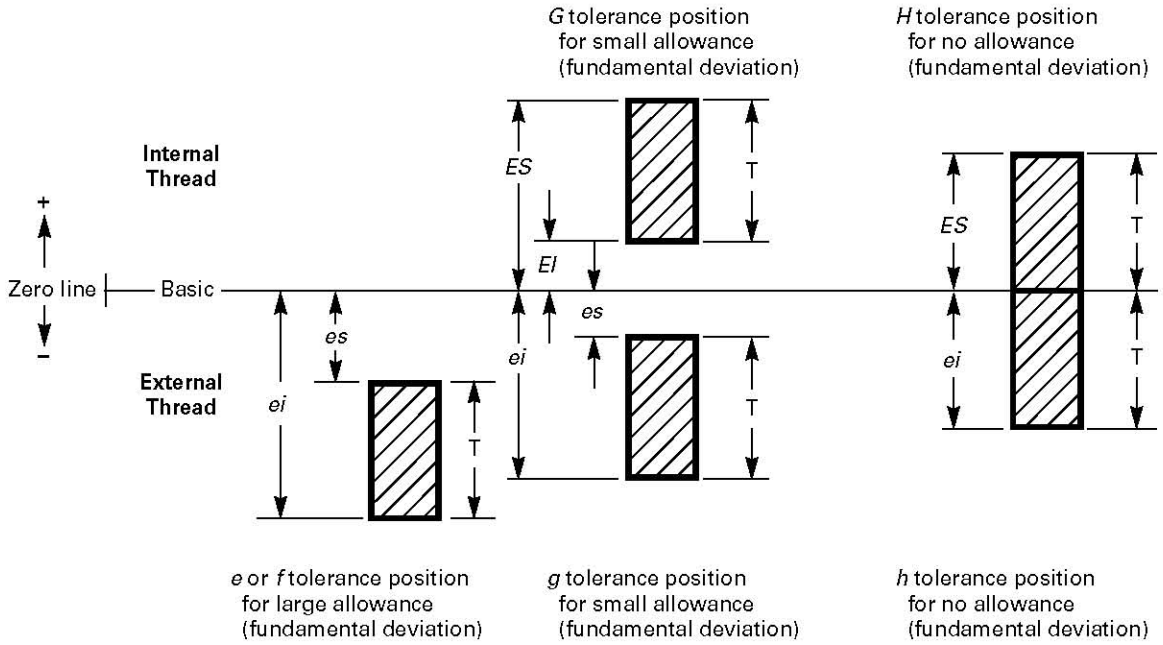

Fig. 4 Metric Tolerance System for Screw Threads

3.2 Design M Profiles

3.2.1 Internal Thread. The design M profile for the internal thread at the no allowance maximum material condition is the basic ISO 68-1 profile. See Fig. 2 and thread data in Table 2.

3.2.2 External Thread. The design M profile for the external thread at the no allowance maximum material condition is the basic ISO 68-1 profile except where a rounded root is required. For the standard 0.125*P* min. radius, the ISO 68-1 profile is modified at the root with a 0.17783*H* truncation blending into two arcs with radii of 0.125*P* tangent to the thread flanks. See Fig. 3 and thread data in Table 2.

3.3 Crest and Root Forms

3.3.1 Rounded Crest and Root Forms. The crest and root tolerance zones at the major and minor diameters will permit rounded crest and root forms in both the external and internal threads.

3.3.2 External Thread Root. The root profile of the thread shall lie within the section lined tolerance zone shown in Fig. 5. For the rounded root thread, the root profile of the external thread shall lie within the section lined rounded root tolerance zone shown in Fig. 5. The profile shall be a continuous smoothly blended nonreversing curve, no part of which shall have a radius of less than 0.125*P*, which is tangential to the thread flank. The profile may comprise tangent flank arcs that are joined by a tangential flat at the root. The limit values of the root radius *r* are specified in Table 3. The maximum truncation is:

$$\frac{H}{4} - r\ \text{min.}\left\{1 - \cos\left[60\ \text{deg} - \arccos\left(1 - \frac{Td_2}{4\,r\ \text{min.}}\right)\right]\right\}$$

and the minimum truncation is 0.14434*H*. (See Fig. 5.) The M profile with a minimum root radius of 0.125*P* on the external thread is desirable for all threads but is required for threaded mechanical fasteners of SAE J1199, ASTM F 568M, and ISO 898-1 property class 8.8 (minimum tensile strength 800 MPa) and stronger. (See Fig. 5.)

3.3.3 Internal Thread Root. The root profile shall not be smaller than the basic profile. The maximum major diameter shall not be sharp.

4 SERIES OF THREADS

4.1 Standard Coarse Pitch General Purpose and Mechanical Fastener Series, M Profile

The standard metric screw thread series for general purpose equipment's threaded components design and mechanical fasteners is a coarse thread series. Their diameter/pitch combinations are listed in Table 4.

NOTE: The words *coarse* and *fine* are given in order to conform to usage. No concept of quality shall be associated with these

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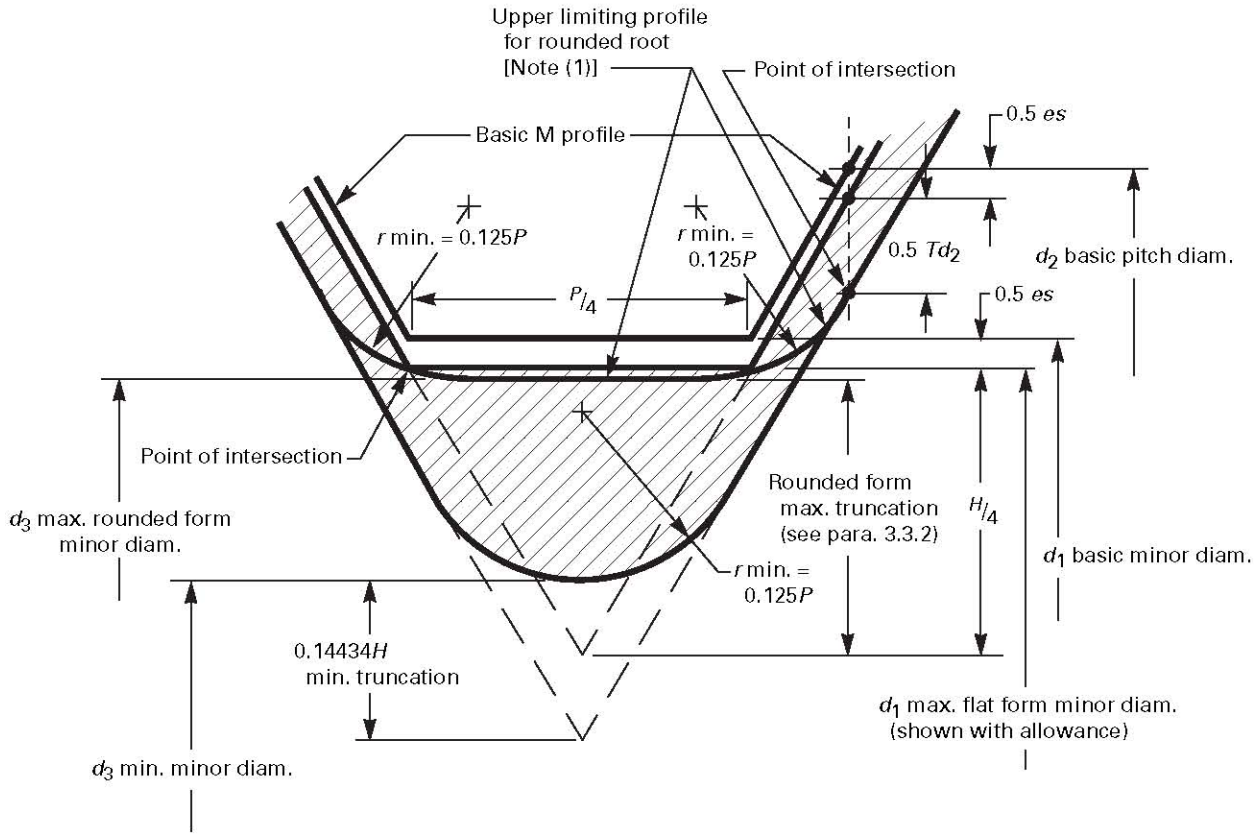

GENERAL NOTE: Section-lined portions identify tolerance zone and unshaded portions identify allowance (fundamental deviation).

NOTE:

(1) The upper limiting profile for rounded root form allows no tolerance for flank wear of a tool producing it and is therefore not to be used as a design profile. Rather, it is an indication of the limiting acceptable condition for the rounded root form which will pass a GO thread gage.

Fig. 5 M Profile, External Thread Root, Upper and Lower Limiting Profiles for *r* min. = 0.125*P* and for Flat Root Form (Shown for Tolerance Position *g*)

words. Coarse pitches only indicate the largest metric pitches used in current practice.

4.2 Standard Fine Pitch M Profile Screw Threads

Table 5 lists additional diameter/pitch combinations that are standard for general purpose equipment's threaded components design.

4.3 Preferred Sizes

Diameter/pitch combinations shown in Table 4 are the preferred sizes and should be the first choice, as applicable.

4.4 ISO Metric Thread Series

The Thread Series given in Table 6 are identical to those published in ISO 261 for diameters of 1.6 mm and larger. Diameter/pitch combinations from Tables 4 and 5 are shown in boldface. Selection of series shown in regular type shall be limited to unusual requirements where the selections in accordance with paras. 4.1, 4.2, and 4.3 cannot be used.

5 ALLOWANCES AND TOLERANCES

5.1 ISO System of Limits and Fits as Applied to Screw Threads

5.1.1 General. The international metric tolerance system is based on a system of limits and fits. The limits of the tolerances on the mating parts and their allowances (fundamental deviations) determine the fit of the assembly. For simplicity, the system is described for cylindrical parts. Holes are equivalent to internally threaded surfaces and shafts to externally threaded surfaces.

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Table 3 Limit Values for M Profile Minimum Rounded Root Radius

P	Min. Root Radius, 0.125*P*	*P*	Min. Root Radius, 0.125*P*
0.2	0.025	1.25	0.156
0.25	0.031	1.5	0.188
0.3	0.038	1.75	0.219
0.35	0.044	2	0.250
0.4	0.050	2.5	0.313
0.45	0.056	3	0.375
0.5	0.063	3.5	0.438
0.6	0.075	4	0.500
0.7	0.088	4.5	0.563
0.75	0.094	5	0.625
0.8	0.100	5.5	0.688
1	0.125	6	0.750
		8	1.000

GENERAL NOTE: All dimensions are in millimeters.

Table 4 Standard Coarse Pitch M Profile General Purpose and Mechanical Fastener Series

Nominal Size	Pitch	Nominal Size	Pitch
1.6	0.35	20	2.5
2	0.4	22	2.5 [Note (1)]
2.5	0.45	24	3
3	0.5	27	3 [Note (1)]
3.5	0.6	30	3.5
4	0.7	36	4
5	0.8	42	4.5
6	1	48	5
8	1.25	56	5.5
10	1.5	64	6
12	1.75	72	6 [Note (2)]
14	2	80	6 [Note (2)]
16	2	90	6 [Note (2)]
		100	6 [Note (2)]

GENERAL NOTE: All dimensions are in millimeters.

NOTES:

(1) For high strength structural steel fasteners only.

(2) Designated as part of 6 mm fine pitch series in ISO 261.

5.1.2 Basic Size. This is the zero line or surface at assembly, where the interface of the two mating parts have a common reference.

5.1.3 Upper Deviation. This is the algebraic difference between the maximum limit of size and the basic size. It is designated by the French term *écart superieur* (*ES* for holes and *es* for shafts).

Table 5 Standard Fine Pitch M Profile Screw Threads

Nominal Size	Pitch			Nominal Size	Pitch	
				55	1.5	...
8	1	...	...	56	...	2
10	0.75	1	1.25	60	1.5	...
12	1	1.5	1.25	64	...	2
14	...	...	1.5	65	1.5	...
15	1	...	...	70	1.5	...
16	...	...	1.5	72	...	2
17	1	...	...	75	1.5	...
18	...	...	1.5	80	1.5	2
20	1	...	1.5	85	...	2
22	...	...	1.5	90	...	2
24	...	...	2	95	...	2
25	1.5	...	...	100	...	2
27	...	...	2	105	...	2
30	1.5	...	2	110	...	2
33	...	...	2	120	...	2
35	1.5	...	...	130	...	2
36	...	...	2	140	...	2
39	...	...	2	150	...	2
40	1.5	...	...	160	...	3
42	...	...	2	170	...	3
45	1.5	...	...	180	...	3
48	...	...	2	190	...	3
50	1.5	...	...	200	...	3

GENERAL NOTE: All dimensions are in millimeters.

5.1.4 Lower Deviation. This is the algebraic difference between the minimum limit of size and the basic size. It is designated by the French term *écart inferieur* (*EI* for holes and *ei* for shafts).

5.1.5 Fundamental Deviations (Allowances). These are the deviations that are closest to the basic size. In Fig. 4 they would be *EI* and *es*. Fundamental deviations are designated by alphabetical letters. See para. 5.3.

5.1.6 Fits. Fits are determined by the fundamental deviation, which may be positive or negative, assigned to the mating parts. The selected fits can be clearance, transition, and interference. To illustrate fits schematically, a zero line is drawn to represent the basic size. By convention, the shaft always lies below the zero line and the hole lies above the zero line (except for interference fits). This makes the fundamental deviation negative for the shaft and equal to its upper deviation, *es*. The fundamental deviation is positive for the hole and equal to its lower deviation, *EI*. See Fig. 4.

5.1.7 Tolerance. Defined by a series of numerical grades, each grade provides numerical values for nominal sizes corresponding to the standard tolerance. See para. 5.2. When the tolerance is applied to the schematic

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Table 6 ISO 261 Diameter/Pitch Combinations From Which the Standards Were Selected

Nominal Diameters			Pitches										
				Fine									
Col. 1 1st Choice	Col. 2 2nd Choice	Col. 3 3rd Choice	Coarse	3	2	1.5	1.25	1	0.75	0.5	0.35	0.25	0.2
1.6			0.35	...	...	...	...	...	...	...	...	...	0.2
	1.8		0.35	...	...	...	...	...	...	...	...	...	0.2
2			0.4	...	...	...	...	...	...	...	...	0.25	...
	2.2		0.45	...	...	...	...	...	...	...	...	0.25	...
2.5			0.45	...	...	...	...	...	...	...	0.35	...	...
3			0.5	...	...	...	...	...	...	...	0.35	...	...
	3.5		0.6	...	...	...	...	...	...	...	0.35	...	...
4			0.7	...	...	...	...	...	...	0.5	...	...	...
	4.5		0.75	...	...	...	...	...	...	0.5	...	...	...
5			0.8	...	...	...	...	...	...	0.5	...	...	...
		5.5	...	...	...	...	...	...	...	0.5	...	...	...
6			1	...	...	...	...	...	0.75	...	...	...	...
	7		1	...	...	...	...	...	0.75	...	...	...	...
8			1.25	...	...	...	...	1	0.75	...	...	...	...
		9	1.25	...	...	...	...	1	0.75	...	...	...	...
10			1.5	...	...	...	1.25	1	0.75	...	...	...	...
		11	1.5	...	...	...	...	1	0.75	...	...	...	...
12			1.75	...	...	1.5	1.25	1	...	...	...	...	...
	14		2	...	...	1.5	1.25 [Note (1)]	1	...	...	...	...	...
		15	...	...	...	1.5	...	1	...	...	...	...	...
16			2	...	...	1.5	...	1	...	...	...	...	...
		17	...	...	...	1.5	...	1	...	...	...	...	...
	18		2.5	...	2	1.5	...	1	...	...	...	...	...
20			2.5	...	2	1.5	...	1	...	...	...	...	...
	22		2.5 [Note (2)]	...	2	1.5	...	1	...	...	...	...	...
24			3	...	2	1.5	...	1	...	...	...	...	...
		25	...	...	2	1.5	...	1	...	...	...	...	...
		26	...	...	...	1.5	...	...	...	...	...	...	...
	27		3 [Note (2)]	...	2	1.5	...	1	...	...	...	...	...
		28	...	...	2	1.5	...	1	...	...	...	...	...
30			3.5	(3) [Note (3)]	2	1.5	...	1	...	...	...	...	...
		32	...	...	2	1.5	...	...	...	...	...	...	...
	33		3.5	(3) [Note (3)]	2	1.5	...	...	...	...	...	...	...
		35 [Note (4)]	...	...	...	1.5	...	...	...	...	...	...	...
36			4	3	2	1.5	...	...	...	...	...	...	...
		38	...	...	...	1.5	...	...	...	...	...	...	...
	39		4	3	2	1.5	...	...	...	...	...	...	...

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Table 6 ISO 261 Diameter/Pitch Combinations From Which the Standards Were Selected (Cont'd)

Nominal Diameters			Pitches						
				Fine					
Col. 1 1st Choice	Col. 2 2nd Choice	Col. 3 3rd Choice	Coarse	8	6	4	3	2	1.5
		40	...	...	...	...	3	2	**1.5**
42			**4.5**	...	...	4	3	**2**	1.5
	45		4.5	...	...	4	3	2	**1.5**
48			**5**	...	...	4	3	**2**	1.5
		50	...	...	...	...	3	2	**1.5**
	52		5	...	...	4	3	2	1.5
		55	...	...	...	4	3	2	**1.5**
56			**5.5**	...	...	4	3	**2**	1.5
		58	...	...	...	4	3	2	1.5
	60		5.5	...	...	4	3	2	**1.5**
		62	...	...	...	4	3	2	1.5
64			**6**	...	...	4	3	**2**	1.5
		65	...	...	...	4	3	2	**1.5**
	68		6	...	...	4	3	2	1.5
		70	...	...	6	4	3	2	**1.5**
72			...	...	**6**	4	3	**2**	1.5
		75	...	...	...	4	3	2	**1.5**
	76		...	...	6	4	3	2	1.5
		78	...	...	...	...	...	2	...
80			...	...	**6**	4	3	**2**	**1.5**
		82	...	...	...	...	...	2	...
	85		...	...	6	4	3	**2**	...
90			...	...	**6**	4	3	**2**	...
	95		...	...	6	4	3	**2**	...
100			...	...	**6**	4	3	**2**	...
	105		...	...	6	4	3	**2**	...
110			...	...	6	4	3	**2**	...
	115		...	...	6	4	3	2	...
	120		...	...	6	4	3	**2**	...
125			...	8	6	4	3	2	...
	130		...	8	6	4	3	**2**	...
		135	...	...	6	4	3	2	...
140			...	8	6	4	3	**2**	...
		145	...	...	6	4	3	2	...
	150		...	8	6	4	3	**2**	...
		155	...	...	6	4	3	...	...
160			...	8	6	4	**3**	...	...
		165	...	...	6	4	3	...	...
	170		...	8	6	4	**3**	...	...
		175	...	...	6	4	3	...	...
180			...	8	6	4	**3**	...	...

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Table 6 ISO 261 Diameter/Pitch Combinations From Which the Standards Were Selected (Cont'd)

Nominal Diameters			Pitches						
				Fine					
Col. 1 1st Choice	Col. 2 2nd Choice	Col. 3 3rd Choice	Coarse	8	6	4	3	2	1.5
		185	...	...	6	4	3	...	...
	190		...	8	6	4	**3**	...	...
		195	...	...	6	4	3	...	...
200			...	8	6	4	**3**	...	...
		205	...	...	6	4	3	...	...
	210		...	8	6	4	3	...	...
		215	...	...	6	4	3	...	...
220			...	8	6	4	3	...	...
		225	...	...	6	4	3	...	...
		230	...	8	6	4	3	...	...
		235	...	...	6	4	3	...	...
	240		...	8	6	4	3	...	...
		245	...	...	6	4	3	...	...
250			...	8	6	4	3	...	...
		255	...	...	6	4	...	...	...
	260		...	8	6	4	...	...	...
		265	...	...	6	4	...	...	...
		270	...	8	6	4	...	...	...
		275	...	...	6	4	...	...	...
280			...	8	6	4	...	...	...
		285	...	...	6	4	...	...	...
		290	...	8	6	4	...	...	...
		295	...	...	6	4	...	...	...
	300		...	8	6	4	...	...	...

GENERAL NOTE: All dimensions are in millimeters.

NOTES:

(1) Only for spark plugs for engines.

(2) Only for high strength structural steel fasteners.

(3) Pitches shown in parentheses are to be avoided as far as possible.

(4) Only for nuts for bearings.

diagram, the tolerance for the part (shaft) continues to be negative. Thus, the tolerance plus the fit define the lower deviation, *ei*. The tolerance for the mating part (hole) continues to be positive. Thus, the tolerance plus the fit define the upper deviation, *ES*. A schematic example of the metric tolerance system as applied to metric screw threads is shown in Fig. 4.

5.2 Tolerance Grade

(a) This is indicated by a number. The system provides for a series of tolerance grades for each of the four screw thread parameters (D_1, d, D_2, d_2). The tolerance grades for this Standard were selected from those given in ISO 965-1.

(b) The underlined tolerance grades are used with normal length of thread engagement.

Characteristic	Tolerance Grade	Applicable Table
Minor diameter of internal threads	4, 5, <u>6</u>, 7, 8	Table 9
Major diameter of external threads	4, <u>6</u>, 8	Table 10
Pitch diameter of internal threads	4, 5, <u>6</u>, 7, 8	Table 12
Pitch diameter of external threads	3, <u>4</u>, 5, <u>6</u>, 7, 8, 9	Table 11

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5.3 Tolerance Position

(a) This is indicated by a letter. This position is the allowance (fundamental deviation). A capital letter is used for internal threads and a lowercase letter for external threads. The system provides a series of tolerance positions for internal and external threads. These tolerance positions are as follows with the numerical values given in the appropriate table.

(b) The underlined letters are used in this Standard.

Internal Threads	G, H	Table 13
External Threads	e, f, g, h	Table 13

5.4 Allowance/Tolerance Formulas and Tables

(a) See section 6 for pitch and crest diameter allowance/tolerance formulas and tables.

(b) Functional diameter size includes the effects of all variations in pitch diameter, thread form, and profile. The variations in the individual thread characteristics such as flank angle, lead, taper, and roundness on a given thread, cause the measurements of the pitch diameter and functional diameter to vary from one another on most threads. The pitch diameter and functional diameter on a given thread are equal to one another only when the thread form is perfect. When required to inspect either the pitch diameter, the functional diameter, or both, for thread acceptance (see ASME B1.3), use the same limits of size for the appropriate thread size and class.

5.5 Selected Tolerance Classes

5.5.1 External Thread Tolerance Classes. Small allowance (fundamental deviation)

(a) for normal tolerance — tolerance class 6g6g

(b) for tighter tolerance — tolerance class 4g6g

(c) for a no-allowance fit at maximum material, such as for a plated 6g6g — tolerance class 6h6h

5.5.2 Internal Thread Tolerance Class. No allowance (fundamental deviation). Tolerance class 6H6H. Internal threads with allowance are not standard practice.

5.6 Length of Thread Engagement

5.6.1 Normal Length of Thread Engagement. The pitch diameter tolerances specified herein are applicable to the limits of the normal length of thread engagement *LE* in Table 7. The limits were calculated by formulas given in para. 6.4.

5.6.2 Short and Long Lengths of Thread Engagement When Gaged With Normal Length Contacts. For short *LE* length of thread engagement, reduce the pitch diameter tolerance of the external thread by one tolerance grade number. For long *LE* length of thread engagement, increase the allowance (fundamental deviation) at the pitch diameter of the external thread. For internal threads with long *LE* length of thread engagement, provide an allowance (fundamental deviation) corresponding to the next larger tolerance position. Thus, for the standard *H* position (no allowance), a tolerance position *G* would be provided. For assemblies with short or long lengths of engagement, the tolerance class adjustment may be applied to only one member. See Table 8.

5.7 Circular Runout

Circular runout is the full indicator movement (FIM) (see ASME Y14.5). Runout of the crest (minor diameter of internal thread or major diameter of external thread) relative to the pitch cylinder shall not be so great that the basic profile is transgressed.

5.7.1 Internal Thread. When measurement is specified, the runout of the minor diameter cylinder relative to the pitch cylinder on the internal thread shall not exceed the difference between the measured minor diameter and the basic minor diameter. An out-of-round pitch cylinder may reduce the available runout.

5.7.2 External Thread. When measurement is specified, the runout of the major diameter cylinder relative to the pitch cylinder on the external thread shall not exceed the difference between the measured major diameter and the basic major diameter. An out-of-round pitch cylinder may reduce the available runout.

5.8 Lead and Flank Angle Tolerances

See section 10.

5.9 Coated or Plated Threads

See section 8 for dimensional accommodation and limits for coated threads.

6 DESIGN FORMULAS AND TABULATED VALUES FOR ALLOWANCES AND TOLERANCES

6.1 General

This section provides the formulas and tabulated values for ISO allowances and tolerances in accordance with ISO 965-1. It is to be used for size limit calculation for non-standard threads, when required. See para. 9.2 for applications and limitations of formulas and tables.

6.2 Rounding Procedure for Tabulated Values

(a) The values for crest and pitch diameter tolerances (Tables 9, 10, 11, and 12), for length of engagement (Table 7), and for allowances/fundamental deviations (Table 13) have been calculated from formulas and then rounded off to the nearest values in the R40 series of preferred numbers in accordance with ISO 3 for the three decimal places required. If a fourth decimal place results, it is further rounded.

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Table 7 Length of Thread Engagement (ISO 965-1)

Basic Major Diameter, *d* bsc			Length of Thread Engagement			
			Short *LE*	Normal *LE*		Long *LE*
Over	Up to and Including	Pitch, *P*	Up to and Including	Over	Up to and Including	Over
1.5	2.8	0.2	0.5	0.5	1.5	1.5
		0.25	0.6	0.6	1.9	1.9
		0.35	0.8	0.8	2.6	2.6
		0.4	1	1	3	3
		0.45	1.3	1.3	3.8	3.8
2.8	5.6	0.35	1	1	3	3
		0.5	1.5	1.5	4.5	4.5
		0.6	1.7	1.7	5	5
		0.7	2	2	6	6
		0.75	2.2	2.2	6.7	6.7
		0.8	2.5	2.5	7.5	7.5
5.6	11.2	0.75	2.4	2.4	7.1	7.1
		1	3	3	9	9
		1.25	4	4	12	12
		1.5	5	5	15	15
11.2	22.4	1	3.8	3.8	11	11
		1.25	4.5	4.5	13	13
		1.5	5.6	5.6	16	16
		1.75	6	6	18	18
		2	8	8	24	24
		2.5	10	10	30	30
22.4	45	1	4	4	12	12
		1.5	6.3	6.3	19	19
		2	8.5	8.5	25	25
		3	12	12	36	36
		3.5	15	15	45	45
		4	18	18	53	53
		4.5	21	21	63	63
45	90	1.5	7.5	7.5	22	22
		2	9.5	9.5	28	28
		3	15	15	45	45
		4	19	19	56	56
		5	24	24	71	71
		5.5	28	28	85	85
		6	32	32	95	95
90	180	2	12	12	36	36
		3	18	18	53	53
		4	24	24	71	71
		6	36	36	106	106
		8	45	45	132	132
180	355	3	20	20	60	60
		4	26	26	80	80
		6	40	40	118	118
		8	50	50	150	150

GENERAL NOTE: All dimensions are in millimeters.

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Table 8 Examples of Tolerance Classes Required for Normal Gage Length Contacts With Various Thread Engagement Lengths

Normal *LE*	Short *LE*	Long *LE*
6g	5g6g	6e6g
4g6g	3g6g	4e6g
6h [Note (1)]	5h6h	6g6h
4h6h [Note (1)]	3h6h	4g6h
6H	5H	6G
4H6H	3H6H	4G6G

GENERAL NOTE: See para. 5.6.2.

NOTE:

(1) Applies to maximum material functional size (*GO* Thread gage) for plated 6g and 4g6g class threads, respectively.

Table 9 Minor Diameter Tolerances of Internal Thread, TD_1 (ISO 965-1)

Pitch, *P*	Tolerance Grade				
	4	5	6 [Note (1)]	7	8
0.2	0.038	. . .	. . .	. . .	. . .
0.25	0.045	0.056	. . .	. . .	. . .
0.3	0.053	0.067	0.085	. . .	. . .
0.35	0.063	0.080	0.100	. . .	. . .
0.4	0.071	0.090	0.112	. . .	. . .
0.45	0.080	0.100	0.125	. . .	. . .
0.5	0.090	0.112	0.140	0.180	. . .
0.6	0.100	0.125	0.160	0.200	. . .
0.7	0.112	0.140	0.180	0.224	. . .
0.75	0.118	0.150	0.190	0.236	. . .
0.8	0.125	0.160	0.200	0.250	0.315
1	0.150	0.190	0.236	0.300	0.375
1.25	0.170	0.212	0.265	0.335	0.425
1.5	0.190	0.236	0.300	0.375	0.475
1.75	0.212	0.265	0.335	0.425	0.530
2	0.236	0.300	0.375	0.475	0.600
2.5	0.280	0.355	0.450	0.560	0.710
3	0.315	0.400	0.500	0.630	0.800
3.5	0.355	0.450	0.560	0.710	0.900
4	0.375	0.475	0.600	0.750	0.950
4.5	0.425	0.530	0.670	0.850	1.060
5	0.450	0.560	0.710	0.900	1.120
5.5	0.475	0.600	0.750	0.950	1.180
6	0.500	0.630	0.800	1.000	1.250
8	0.630	0.800	1.000	1.250	1.600

GENERAL NOTE: All dimensions are in millimeters.

NOTE:

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Table 10 Major Diameter Tolerances of External Thread, *Td* (ISO 965-1)

Pitch, *P*	Tolerance Grade 4	6 [Note (1)]	8
0.2	0.036	0.056	...
0.25	0.042	0.067	...
0.3	0.048	0.075	...
0.35	0.053	0.085	...
0.4	0.060	0.095	...
0.45	0.063	0.100	...
0.5	0.067	0.106	...
0.6	0.080	0.125	...
0.7	0.090	0.140	...
0.75	0.090	0.140	...
0.8	0.095	0.150	0.236
1	0.112	0.180	0.280
1.25	0.132	0.212	0.335
1.5	0.150	0.236	0.375
1.75	0.170	0.265	0.425
2	0.180	0.280	0.450
2.5	0.212	0.335	0.530
3	0.236	0.375	0.600
3.5	0.265	0.425	0.670
4	0.300	0.475	0.750
4.5	0.315	0.500	0.800
5	0.335	0.530	0.850
5.5	0.355	0.560	0.900
6	0.375	0.600	0.950
8	0.450	0.710	1.180

GENERAL NOTE: All dimensions are in millimeters.

NOTE:

(1) Tabulated in this Standard for M External Threads.

(b) These rules of rounding have not always been used in order to produce a smooth progression. Same as ISO 965-1.

(c) The above procedures often result in a variation by one or more numerals in the last decimal place when comparing table and formula values.

6.3 Allowances (Fundamental Deviations)

The allowances (fundamental deviations) for internal and external threads have been calculated according to the following formulas and their rounded values given in Table 13. Allowance is the absolute value of fundamental deviation.

Internal	External
$EI_G = +(0.015 + 0.011P)$	$es_e = -(0.05 + 0.011P)$ [Note (1)]
$EI_H = 0$	$es_f = -(0.03 + 0.011P)$
	$es_g = -(0.015 + 0.011P)$
	$es_h = 0$

NOTE:

(1) Exceptions are values for threads with $P \leq 0.45$ mm.

6.4 Length of Thread Engagement

For the calculation of the limits of the normal length of thread engagement in Table 7, the following formulas have been used and their values rounded.

For each pitch, *P*, within a certain diameter range, *d* has been set equal to the smallest diameter within the table range.

$$\text{Normal } LE \text{ min.} = 2.24Pd^{0.2}$$

$$\text{Normal } LE \text{ max.} = 6.7Pd^{0.2}$$

6.5 Crest Diameter Tolerances

6.5.1 Tolerances for Minor Diameter of Internal Thread, TD_1. The TD_1 tolerances for grade 6 are calculated according to the following formulas and rounded:

(a) Pitches 0.2 mm to 0.8 mm

$$TD_1\,(6) = 0.433P - 0.190P^{1.22}$$

(b) Pitches 1 mm and coarser

$$TD_1\,(6) = 0.230P^{0.7}$$

6.5.1.1 The following rounded TD_1 tolerance values for the other grades are obtained from the TD_1 (6) values (in Table 9):

Tolerance Grade	Tolerance
4	$TD_1\,(4) = 0.63TD_1\,(6)$
5	$TD_1\,(5) = 0.8TD_1\,(6)$
6	$TD_1\,(6)$
7	$TD_1\,(7) = 1.25TD_1\,(6)$
8	$TD_1\,(8) = 1.6TD_1\,(6)$

6.5.2 Tolerances for Major Diameter of External Thread, *Td*, Grade 6. The *Td* tolerances for grade 6 are calculated according to the following formula and rounded:

$$Td\,(6) = 0.18\sqrt[3]{P^2} - \frac{0.00315}{\sqrt{P}}$$

6.5.2.1 The following rounded *Td* tolerance values for the other grades are obtained from the *Td* (6) values (see Table 10):

Tolerance Grade	Tolerance
4	$Td\,(4) = 0.63Td\,(6)$
6	$Td\,(6)$
8	$Td\,(8) = 1.6Td\,(6)$

6.6 Pitch Diameter Tolerances

6.6.1 Tolerances for Pitch Diameter of External Thread, Td_2. Td_2 (6) values in Table 11 are calculated according to the following formula and rounded. (*d* is equal to the

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Table 11 Pitch Diameter Tolerance of External Thread, Td_2 (ISO 965-1)

Basic Major Diameter, *d*			Tolerance Grade						
Over	Up to and Including	Pitch, *P*	3	4 [Note (1)]	5	6 [Note (1)]	7	8	9
1.5	2.8	0.2	0.025	0.032	0.040	0.050	...	...	...
		0.25	0.028	0.036	0.045	0.056	...	...	...
		0.35	0.032	0.040	0.050	0.063	0.080	...	...
		0.4	0.034	0.042	0.053	0.067	0.085	...	...
		0.45	0.036	0.045	0.056	0.071	0.090	...	...
2.8	5.6	0.35	0.034	0.042	0.053	0.067	0.085	...	...
		0.5	0.038	0.048	0.060	0.075	0.095	...	...
		0.6	0.042	0.053	0.067	0.085	0.106	...	...
		0.7	0.045	0.056	0.071	0.090	0.112	...	...
		0.75	0.045	0.056	0.071	0.090	0.112	...	...
		0.8	0.048	0.060	0.075	0.095	0.118	0.150	0.190
5.6	11.2	0.75	0.050	0.063	0.080	0.100	0.125	...	...
		1	0.056	0.071	0.090	0.112	0.140	0.180	0.224
		1.25	0.060	0.075	0.095	0.118	0.150	0.190	0.236
		1.5	0.067	0.085	0.106	0.132	0.170	0.212	0.265
11.2	22.4	1	0.060	0.075	0.095	0.118	0.150	0.190	0.236
		1.25	0.067	0.085	0.106	0.132	0.170	0.212	0.265
		1.5	0.071	0.090	0.112	0.140	0.180	0.224	0.280
		1.75	0.075	0.095	0.118	0.150	0.190	0.236	0.300
		2	0.080	0.100	0.125	0.160	0.200	0.250	0.315
		2.5	0.085	0.106	0.132	0.170	0.212	0.265	0.335
22.4	45	1	0.063	0.080	0.100	0.125	0.160	0.200	0.250
		1.5	0.075	0.095	0.118	0.150	0.190	0.236	0.300
		2	0.085	0.106	0.132	0.170	0.212	0.265	0.335
		3	0.100	0.125	0.160	0.200	0.250	0.315	0.400
		3.5	0.106	0.132	0.170	0.212	0.265	0.335	0.425
		4	0.112	0.140	0.180	0.224	0.280	0.355	0.450
		4.5	0.118	0.150	0.190	0.236	0.300	0.375	0.475
45	90	1.5	0.080	0.100	0.125	0.160	0.200	0.250	0.315
		2	0.090	0.112	0.140	0.180	0.224	0.280	0.355
		3	0.106	0.132	0.170	0.212	0.265	0.335	0.425
		4	0.118	0.150	0.190	0.236	0.300	0.375	0.475
		5	0.125	0.160	0.200	0.250	0.315	0.400	0.500
		5.5	0.132	0.170	0.212	0.265	0.335	0.425	0.530
		6	0.140	0.180	0.224	0.280	0.355	0.450	0.560
90	180	2	0.095	0.118	0.150	0.190	0.236	0.300	0.375
		3	0.112	0.140	0.180	0.224	0.280	0.355	0.450
		4	0.125	0.160	0.200	0.250	0.315	0.400	0.500
		6	0.150	0.190	0.236	0.300	0.375	0.475	0.600
		8	0.170	0.212	0.265	0.335	0.425	0.530	0.670
180	355	3	0.125	0.160	0.200	0.250	0.315	0.400	0.500
		4	0.140	0.180	0.224	0.280	0.355	0.450	0.560
		6	0.160	0.200	0.250	0.315	0.400	0.500	0.630
		8	0.180	0.224	0.280	0.355	0.450	0.560	0.710

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NOTE:

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Table 12 Pitch Diameter Tolerance of Internal Thread, TD_2 (ISO 965-1)

Basic Major Diameter, *D*			Tolerance Grade				
Over	Up to and Including	Pitch, *P*	4	5	6 [Note (1)]	7	8
1.5	2.8	0.2	0.042	. . .	. . .	. . .	. . .
		0.25	0.048	0.060	. . .	. . .	. . .
		0.35	0.053	0.067	0.085	. . .	. . .
		0.4	0.056	0.071	0.090	. . .	. . .
		0.45	0.060	0.075	0.095	. . .	. . .
2.8	5.6	0.35	0.056	0.071	0.090	. . .	. . .
		0.5	0.063	0.080	0.100	0.125	. . .
		0.6	0.071	0.090	0.112	0.140	. . .
		0.7	0.075	0.095	0.118	0.150	. . .
		0.75	0.075	0.095	0.118	0.150	. . .
		0.8	0.080	0.100	0.125	0.160	0.200
5.6	11.2	0.75	0.085	0.106	0.132	0.170	. . .
		1	0.095	0.118	0.150	0.190	0.236
		1.25	0.100	0.125	0.160	0.200	0.250
		1.5	0.112	0.140	0.180	0.224	0.280
11.2	22.4	1	0.100	0.125	0.160	0.200	0.250
		1.25	0.112	0.140	0.180	0.224	0.280
		1.5	0.118	0.150	0.190	0.236	0.300
		1.75	0.125	0.160	0.200	0.250	0.315
		2	0.132	0.170	0.212	0.265	0.335
		2.5	0.140	0.180	0.224	0.280	0.355
22.4	45	1	0.106	0.132	0.170	0.212	. . .
		1.5	0.125	0.160	0.200	0.250	0.315
		2	0.140	0.180	0.224	0.280	0.355
		3	0.170	0.212	0.265	0.335	0.425
		3.5	0.180	0.224	0.280	0.355	0.450
		4	0.190	0.236	0.300	0.375	0.475
		4.5	0.200	0.250	0.315	0.400	0.500
45	90	1.5	0.132	0.170	0.212	0.265	0.335
		2	0.150	0.190	0.236	0.300	0.375
		3	0.180	0.224	0.280	0.355	0.450
		4	0.200	0.250	0.315	0.400	0.500
		5	0.212	0.265	0.335	0.425	0.530
		5.5	0.224	0.280	0.355	0.450	0.560
		6	0.236	0.300	0.375	0.475	0.600
90	180	2	0.160	0.200	0.250	0.315	0.400
		3	0.190	0.236	0.300	0.375	0.475
		4	0.212	0.265	0.335	0.425	0.530
		6	0.250	0.315	0.400	0.500	0.630
		8	0.280	0.355	0.450	0.560	0.710
180	355	3	0.212	0.265	0.335	0.425	0.530
		4	0.236	0.300	0.375	0.475	0.600
		6	0.265	0.335	0.425	0.530	0.670
		8	0.300	0.375	0.475	0.600	0.750

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NOTE:

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Table 13 Allowance (Fundamental Deviation) for Internal and External Threads (ISO 965-1)

	Allowance (Fundamental Deviation) [Note (1)]					
	Internal Thread, D_2, D_1		External Thread, d, d_2			
Pitch, P	G, EI	H [Note (2)], EI	e, es	f, es	g [Note (3)], es	h, es
0.2	+0.017	0	. . .	. . .	−0.017	0
0.25	+0.018	0	. . .	. . .	−0.018	0
0.3	+0.018	0	. . .	. . .	−0.018	0
0.35	+0.019	0	. . .	−0.034	−0.019	0
0.4	+0.019	0	. . .	−0.034	−0.019	0
0.45	+0.020	0	. . .	−0.035	−0.020	0
0.5	+0.020	0	−0.050	−0.036	−0.020	0
0.6	+0.021	0	−0.053	−0.036	−0.021	0
0.7	+0.022	0	−0.056	−0.038	−0.022	0
0.75	+0.022	0	−0.056	−0.038	−0.022	0
0.8	+0.024	0	−0.060	−0.038	−0.024	0
1	+0.026	0	−0.060	−0.040	−0.026	0
1.25	+0.028	0	−0.063	−0.042	−0.028	0
1.5	+0.032	0	−0.067	−0.045	−0.032	0
1.75	+0.034	0	−0.071	−0.048	−0.034	0
2	+0.038	0	−0.071	−0.052	−0.038	0
2.5	+0.042	0	−0.080	−0.058	−0.042	0
3	+0.048	0	−0.085	−0.063	−0.048	0
3.5	+0.053	0	−0.090	−0.070	−0.053	0
4	+0.060	0	−0.095	−0.075	−0.060	0
4.5	+0.063	0	−0.100	−0.080	−0.063	0
5	+0.071	0	−0.106	−0.085	−0.071	0
5.5	+0.075	0	−0.112	−0.090	−0.075	0
6	+0.080	0	−0.118	−0.095	−0.080	0
8	+0.100	0	−0.140	−0.118	−0.100	0

NOTES:
(1) Allowance is the absolute value of Fundamental Deviation.
(2) Tabulated in this Standard for M Internal Threads.
(3) Tabulated in this Standard for M External Threads.

geometrical mean value of the diameter range limits, i.e., the square root of the product of smallest and largest diameters.)

$$Td_2\,(6) = 0.09P^{0.4}d^{0.1}$$

6.6.1.1 The following rounded Td_2 tolerance values for the other grades are obtained from the Td_2 (6) values (see Table 11). No Td_2 values are given in Table 11 when values calculated according to the given formula exceed the Td values in the tolerance grades, which are combined in the tables for recommended tolerance classes.

Tolerance Grade	Tolerance
3	$Td_2\,(3) = 0.5Td_2\,(6)$
4	$Td_2\,(4) = 0.63Td_2\,(6)$
5	$Td_2\,(5) = 0.8Td_2\,(6)$
6	$Td_2\,(6)$
7	$Td_2\,(7) = 1.25Td_2\,(6)$
8	$Td_2\,(8) = 1.6Td_2\,(6)$
9	$Td_2\,(9) = 2Td_2\,(6)$

6.6.2 Tolerances for Pitch Diameter of Internal Thread, TD_2. The rounded TD_2 tolerance values in Table 12 are calculated using formulas below and Td_2 (6) values from

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Table 11. No TD_2 values are given in Table 12 when values calculated according to the given formula exceed 0.25*P*.

Tolerance Grade	Tolerance
4	TD_2 (4) = $0.85Td_2$ (6)
5	TD_2 (5) = $1.06Td_2$ (6)
6	TD_2 (6) = $1.32Td_2$ (6)
7	TD_2 (7) = $1.7Td_2$ (6)
8	TD_2 (8) = $2.12Td_2$ (6)

7 DESIGNATION OF SCREW THREADS

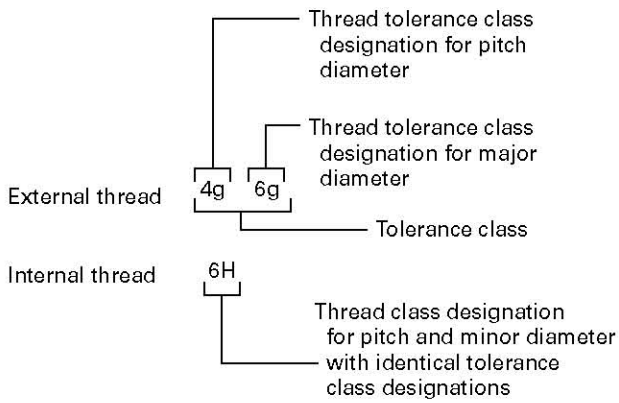
7.1 General

(a) The complete designation of a screw thread gives the thread symbol, the nominal size, the pitch, and the thread tolerance class.

(b) The tolerance class designation gives the class designation for the pitch diameter tolerance followed by a class designation for the crest diameter (major diameter for external thread and minor diameter for internal thread) tolerances.

(c) The class designation consists of a number indicating the tolerance grade followed by a letter indicating the tolerance position.

EXAMPLE:



7.2 Designation of Standard Screw Threads

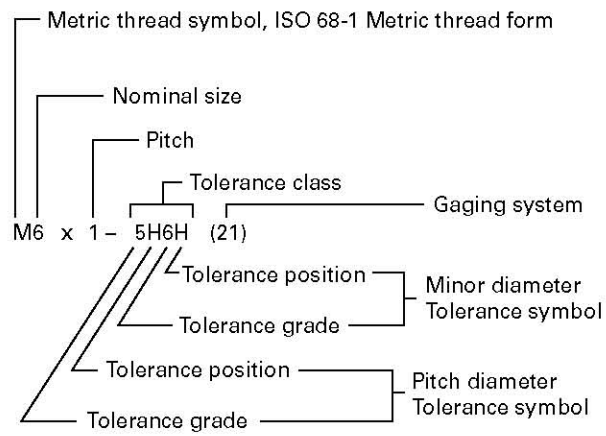
Metric screw threads are identified by the letter (M) for the thread form profile, followed by the nominal diameter size and the pitch expressed in millimeters, separated by the sign (×) and followed by the tolerance class separated by a dash (–) from the pitch.

The simplified international practice for designating coarse pitch M profile screw threads is to leave off the pitch. Thus a M14 × 2 thread is designated as just M14. To prevent misunderstanding, it is mandatory to use the value for pitch in all designations.

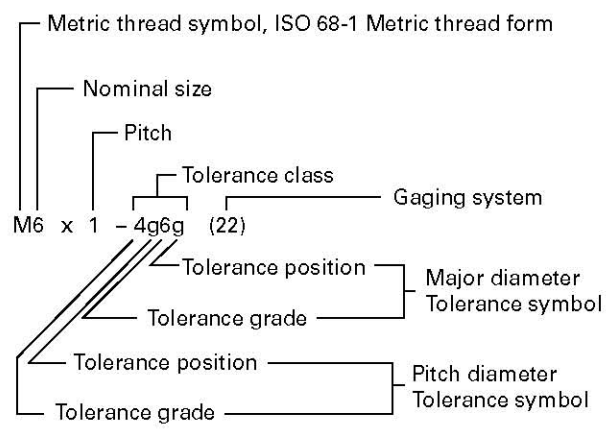
International practice permits a thread designation with tolerance class not specified for classes 6H and 6g. To prevent misunderstanding, it is mandatory to specify the tolerance class for all thread designations.

Thread acceptability gaging system requirements of ASME B1.3 may be added to the thread size designation as noted in examples or as specified in pertinent documentation, such as the drawing or procurement document.

(a) Internal Thread M Profile, Right Hand



(b) External Thread M Profile, Right Hand



Unless otherwise specified in the designation, the screw thread helix is right hand.

7.2.1 Designation of Left-Hand Thread. When left-hand thread is specified, the tolerance class designation is followed by a dash and LH.

EXAMPLE:

M6 × 1 – 5H6H – LH (23)

7.2.2 Designation of Identical Tolerance Classes. If the two tolerance class designations for a thread are identical, it is not necessary to repeat the symbols.

EXAMPLE:

M6 × 1 – 6H (21)

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7.2.3 Designations Using All Capital Letters. When computer and teletype thread designations use all capital letters, the external or internal thread may need further identification. Thus the tolerance class identification is followed by the abbreviations EXT or INT in capital letters.

EXAMPLES:

M6 × 1 – 4G6G EXT
M6 × 1 – 6H INT

7.3 Designation of Thread Fit

A fit between mating threads is indicated by the internal thread tolerance class followed by the external thread tolerance class separated by a slash.

EXAMPLES:

M6 × 1 – 6H/6g
M6 × 1 – 6H/4g6g

7.4 Designation of Rounded Root External Thread

7.4.1 Modified ISO 68-1 Thread With Radius Root *r* min. = 0.125*P*. For the mandatory condition-external fasteners of property class 8.8 and stronger (see para. 3.3.2), no special designation is required. Other parts requiring a 0.125*P* root radius must specify that radius as in para. 7.4.2.

7.4.2 Designation of Special Rounded Root Thread. When a special rounded root thread is required, its external thread designation is suffixed by the letter *R* and the minimum root radius value in millimeters.

EXAMPLE:

Minimum Root Radius

M42 × 4.5 – 6g – *R*0.63

7.5 Designation of Threads Having Modified Crests

Where the limits of size of the major diameter of an external thread or the minor diameter of an internal thread are modified, the thread designation is suffixed by the letters MOD followed by the modified diameter limits.

EXAMPLE: External thread M profile, major diameter reduced 0.075 mm.

M6 × 1 – 4h6h MOD
MAJOR DIA 5.745 – 5.925 MOD

EXAMPLE: Internal thread M profile, minor diameter increased 0.075 mm.

M6 × 1 – 4H5H MOD
MINOR DIA 5.101 – 5.291 MOD

7.6 Designation of Special Threads

Special diameter-pitch threads, developed in accordance with this Standard, shall be identified by the letters SPL following the tolerance class. Below the designation shall be specified the limits of size for major diameter, pitch diameter, and minor diameter.

EXAMPLE: External thread

M6.5 × 1 – 4h6h – SPL (22)
MAJOR DIA 6.320 – 6.500
PD 5.779 – 5.850
MINOR DIA 5.163 – 5.386

EXAMPLE: Internal thread

M6.5 × 1 – 4H5H – SPL (23)
MAJOR DIA 6.500 MIN.
PD 5.850 – 5.945
MINOR DIA 5.417 – 5.607

7.7 Designation of Multiple Start Threads

When a thread is required with a multiple start, it is designated by specifying sequentially M for metric thread, nominal diameter size, ×, L for lead, lead value, *P* for pitch, pitch value, parenthesis, number of starts, and the word "Starts," close parenthesis, dash, tolerance class.

EXAMPLES:

M16 × L4P2 (2 STARTS) – 4h6h
M14 × L6P2 (3 STARTS) – 6H

7.8 Designation of Coated or Plated Threads

7.8.1 Designation of Coated or Plated M Threads. Specify if the tolerance class is after coating or after plating. If no designation of after coating or after plating is specified, the tolerance class applies before coating or plating in accordance with ISO practice. After plating, the thread profile shall not transgress the maximum material limits for the tolerance position *H/h*.

EXAMPLES:

M6 × 1 – 6h AFTER COATING or AFTER PLATING
M6 × 1 – 6g AFTER COATING or AFTER PLATING

7.8.2 Where the tolerance position *G/g* is insufficient relief for the application to hold the threads within product limits, the coating or plating allowance may be specified as the maximum and minimum limits of size for threads before coating or plating. See section 8.

EXAMPLE: Allowance on external thread M profile based on 0.010 mm min. coating thickness

M6 × 1 – 4h6h – AFTER COATING

BEFORE COATING

MAJOR DIA 5.800 – 5.970
PD 5.239 – 5.290
MINOR DIA 4.887 MAX.

7.9 Designation of Threads With Adjusted Size Limits

If a standard thread requires adjustment of size limits of thread elements, so that standard allowances or tolerances do not apply, designation shall include the individual element sizes; each special size shall be identified as "SPL."

EXAMPLE: External thread with allowance of 0.100 and pitch/major diameter tolerance grade of 4

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M24 × 3 – SPL – EXT (22)
MAJOR DIA 23.664 – 23.900 SPL
PD 21.826 – 21.951 SPL
MINOR DIA 20.652 MAX. SPL

EXAMPLE: Internal thread with no allowance but with tolerance class 4G limits at minimum material.

M24 × 3 – SPL – INT (22)
MINOR DIA 20.752 – 21.115 SPL
PD 22.051 – 22.269 SPL
MAJOR DIA 24.000 MIN.

8 DIMENSIONAL ACCOMMODATION OF COATING OR PLATING FOR 60 deg THREADS

8.1 Introduction

It is not within the scope of this Standard to make recommendations for thickness of, or to specify limits for coatings. However, it will aid mechanical interchangeability if certain principles are followed wherever conditions permit. The following guides should be helpful in determining the amount and direction of the alterations to establish applicable limits of size before coating. Some commonly used and firmly established processes for heavy coatings, such as hot-dip galvanizing, do not fall within the scope of the section. Appendix E contains information on internal threads of tolerance class 6AX, which follow USA practice of overtapping to accommodate as-coated hot-dip galvanized external threads. Appendix F contains information on internal thread tolerance position *E*, which may be used where *G* does not provide sufficient allowance, but where AX would be excessive.

NOTE: The term *coating* refers to one or more applications of additive material to the threads, but not limited to, electroplated deposits, anodized deposits, dry film lubricants, dip-spin applied materials, and mechanically applied platings. It does not include soft or liquid lubricants that are readily displaced in assembly and gaging. Plating is therefore included as coating in the text.

8.2 Material Limits for Coated Threads

Unless otherwise specified, size limits for standard external thread tolerance classes 6g and 4g6g apply prior to coating. The external thread allowance may thus be used to accommodate the coating thickness on coated parts, provided that the maximum coating thickness is not more than ¼ of the allowance. Thus, a 6g thread after coating is subject to acceptance using a basic size 6h GO thread gage and a 4g6g thread, a 4h6h or 6h GO thread gage. (Basic thread sizes, tolerance position *h*, are tabulated in Appendix D and size limits for 6h threads are included in Table 14.) Minimum material, LO or NOT-GO gages would be 6g and 4g6g, respectively. Where external thread has no allowance or allowance must be maintained after coating, and for standard internal threads, sufficient allowance must be provided prior to coating to ensure that finished product threads do not exceed the maximum material limits specified. For thread classes with tolerance position *H* or *h*, coating allowances in accordance with Table 13 for positions *G* or *g* respectively, should be applied whenever possible. See paras. 8.4, 8.5, and 8.6.

8.3 Dimensional Effects of Coating

(a) On a cylindrical surface, the effect of coating is to change the diameter by twice the coating thickness — one coating thickness on each side of the cylinder. On a screw thread, this would apply to the major and minor diameters.

(b) Because the coating thickness is measured perpendicular to the coated surface, while the pitch diameter is measured perpendicular to the thread axis, the effect of a uniformly coated thread flank on the pitch diameter is a change 4 times the thickness of coating on the flank. (see Fig. 6). The diameters of external threads before coating will be smaller while the diameters of internal threads before coating will be larger than the coated diameters.

(c) Most coatings and platings do not apply uniformly on threads (see para. 8.7 and Fig. 7). Different coating materials and processes have different application characteristics. The threaded part's overall length and other configuration characteristics also affect the way coatings build up on the threads. Paragraphs 8.4, 8.5, and 8.6 provide general guidelines for calculating precoating thread size to allow for coating build-up while preventing interference in assembly. The exact precoating thread size for a given part with a given type of coating will frequently have to be developed by the producer experimentally.

8.4 External Thread With Allowance Available for Coating

8.4.1 Maximum and Minimum Coating Thickness Specified. The amount of the allowance on the pitch diameter is sufficient if 4 times the maximum coating thickness is equal to or less than the allowance tabulated in Table 13 or 14 or, if not in these tables, calculated per formula in para. 6.3.

8.4.2 Only Nominal or Minimum Coating Thickness Specified. If no coating thickness tolerance is given, it is recommended that a tolerance of plus 50% of the nominal or minimum thickness be assumed. Then, the amount of the allowance on the pitch diameter is sufficient if 6 times the specified coating thickness is equal to or less than the allowance tabulated in Table 13 or 14 or, if not in these tables, calculated per formula in para. 6.3.

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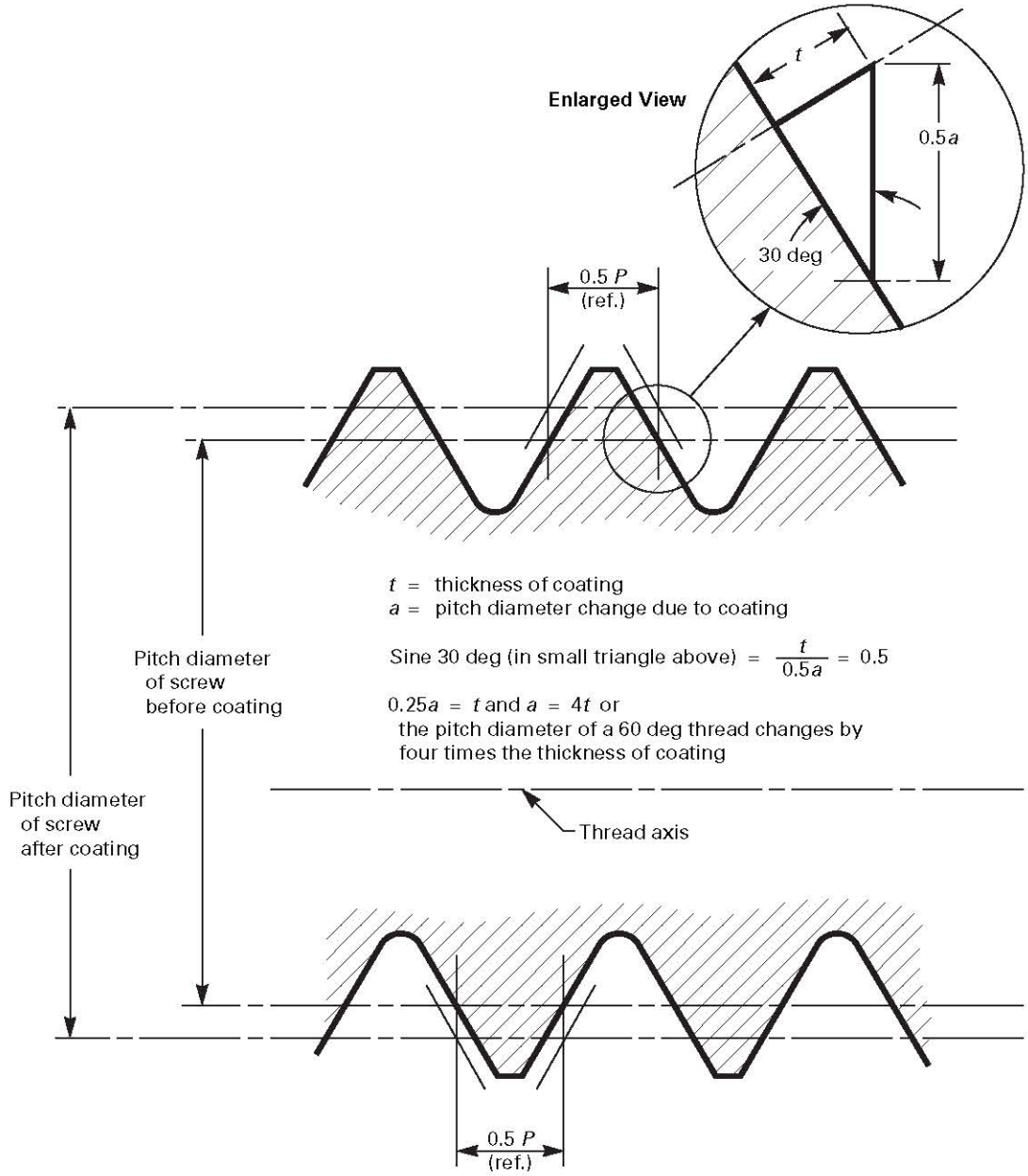

Fig. 6 Ratio of Pitch Diameter Change to Thickness of Coating on 60 deg Threads

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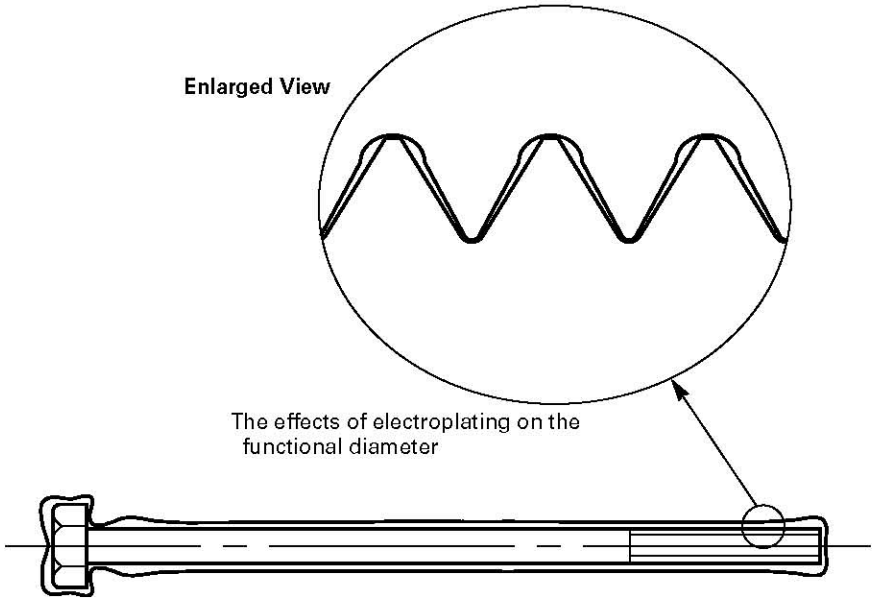

GENERAL NOTE: Electrodeposited coating builds up more heavily at sharp corners, is greater at the the extreme ends and edges of a length, and is least in the center and recessed areas.

Fig. 7 Effects of Electrodeposited Coating on 60 deg External Threads

8.5 External Thread With No Allowance for Coating

8.5.1 Maximum and Minimum Coating Thickness Specified. To determine before coating product limits, decrease

(a) maximum pitch diameter by 4 times maximum coating thickness

(b) minimum pitch diameter by 4 times minimum coating thickness

(c) maximum major diameter by 2 times maximum coating thickness

(d) minimum major diameter by 2 times minimum coating thickness

(e) maximum minor diameter by 2 times maximum coating thickness

EXAMPLE:

M10 × 1.5 – 6g After Coating
Coating Thickness 0.005 – 0.008

To determine the before coating maximum material sizes, decrease the maximum pitch diameter of 8.994 by 0.032 (4 × 0.008) to 8.962, the maximum major diameter of 9.968 by 0.016 (2 × 0.008) to 9.952, and the maximum minor diameter of 8.344 by 0.016 (2 × 0.008) to 8.328. For the before coating minimum sizes, decrease the minimum pitch diameter of 8.862 by 0.020 (4 × 0.005) to 8.842 and the minimum major diameter of 9.732 by 0.010 (2 × 0.005) to 9.722. The before coating sizes should be included in the thread designation. (See para. 7.8.2.)

8.5.2 Only Nominal or Minimum Coating Thickness Specified. If no coating thickness tolerance is given, it is recommended that a tolerance of plus 50% of the nominal or minimum thickness be assumed. Then, to determine before coating product limits, decrease

(a) maximum pitch diameter by 6 times coating thickness

(b) minimum pitch diameter by 4 times coating thickness

(c) maximum major diameter by 3 times coating thickness

(d) minimum major diameter by 2 times coating thickness

(e) maximum minor diameter by 3 times coating thickness

EXAMPLE:

M14 × 2 – 4h6h Coating Thickness 0.008

Since allowance for tolerance position *g* is 0.038, the maximum thickness of coating that may be applied is equal to 0.038 divided by 6 or 0.0063. This is not sufficient for the required coating of 0.008 so additional adjustments must be made.

To determine the before coating maximum material sizes, decrease the maximum pitch diameter of 12.701 by 0.048 (6 × 0.008) to 12.653, the maximum major diameter of 14.000 by 0.024 (3 × 0.008) to 13.976, and the maximum minor diameter of 11.835 by 0.024 (3 × 0.008) to 11.811. For the before coating minimum sizes, decrease the minimum pitch diameter of 12.601 by 0.032 (4 × 0.008) to 12.569 and the minimum major diameter

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of 13.720 by 0.016 (2 × 0.008) to 13.704. The before coating sizes should be included in the thread designation. (See para. 7.8.2.)

8.5.3 Adjusted Size Limits. It should be noted in the above examples that the before coating material limit tolerances are less than the tolerances after coating. This is because the coating tolerance consumes some of the product tolerance. In some instances there may be insufficient pitch diameter tolerance available in the before coating condition so that additional adjustments and controls will be necessary.

8.5.4 Strength. On small thread sizes (5 mm and smaller) there is a possibility that coating thickness adjustments will cause base material minimum material conditions that may significantly affect the strength of externally threaded parts. Limitations on coating thickness or part redesign may be necessary.

8.6 Internal Threads

8.6.1 Maximum and Minimum Coating Thickness Specified. Standard internal threads provide no allowance for coating thickness. Use the allowance provided by tolerance position *G* (see Table 13) if 4 times the maximum coating thickness specified is equal or less than this allowance. Otherwise, to determine before coating product limits, increase

(a) minimum pitch diameter by 4 times maximum coating thickness

(b) maximum pitch diameter by 4 times minimum coating thickness

(c) minimum minor diameter by 2 times maximum coating thickness

(d) maximum minor diameter by 2 times minimum coating thickness

(e) minimum major diameter by 2 times maximum coating thickness

EXAMPLE:

M12 × 1.75 – 6H Coating Thickness 0.006 – 0.010

Allowance provided by tolerance position *G* is 0.034. But 4 times the maximum coating thickness, the maximum diametral increase, is 0.040 (4 × 0.010). This is larger than the allowance provided by tolerance position *G* so additional adjustments must be made to the thread limits.

To determine the before coating minimum product sizes, increase the minimum pitch diameter of 10.863 by 0.040 (4 × 0.010) to 10.903, the minimum minor diameter of 10.106 by 0.020 (2 × 0.010) to 10.126, and the minimum major diameter of 12.000 by 0.020 (2 × 0.010) to 12.020. For the before coating maximum sizes, increase the maximum pitch diameter of 11.063 by 0.024 (4 × 0.006) to 11.087 and the maximum minor diameter of 10.441 by 0.012 (2 × 0.006) to 10.453. The before coating sizes should be included in the thread designation. (See para. 7.8.2.)

8.6.2 Only Nominal or Minimum Coating Thickness Specified. If no thickness tolerance is given, it is recommended that a tolerance of plus 50% of the nominal or minimum thickness be assumed. Since standard internal threads provide no allowance for coating thickness, use the allowance provided by tolerance position *G* (see Table 13) if 6 times the nominal or minimum coating thickness specified is equal or less than this allowance. Otherwise, to determine before coating product limits, increase

(a) minimum pitch diameter by 6 times the minimum or nominal coating thickness

(b) maximum pitch diameter by 4 times the minimum or nominal coating thickness

(c) minimum minor diameter by 3 times the minimum or nominal coating thickness

(d) maximum minor diameter by 2 times the minimum or nominal coating thickness

(e) minimum major diameter by 3 times the minimum or nominal coating thickness

EXAMPLE:

M20 × 2.5 – 6H Coating Thickness 0.010

Allowance provided by tolerance position *G* is 0.042. But 6 times the minimum or nominal coating thickness, the maximum diametral increase, is 0.060 (6 × 0.010). This is larger than the allowance provided by tolerance position *G* so additional adjustments must be made to the thread limits.

To determine the before coating minimum product sizes, increase the minimum pitch diameter of 18.376 by 0.060 (6 × 0.010) to 18.436, the minimum minor diameter of 17.294 by 0.030 (3 × 0.010) to 17.324, and the minimum major diameter of 20.000 by 0.030 (3 × 0.010) to 20.030. For the before coating maximum sizes, increase the maximum pitch diameter of 18.600 by 0.040 (4 × 0.010) to 18.640 and the maximum minor diameter of 17.744 by 0.020 (2 × 0.010) to 17.764. The before coating sizes should be included in the thread designation. (See para. 7.8.2.)

8.6.3 Adjusted Size Limits. It should be noted in the above examples that the before coating material limit tolerances are less than the tolerances after coating. This is because the coating tolerance consumes some of the product tolerance. In some instances there may be insufficient pitch diameter tolerance available in the before coating condition so that additional adjustments and controls will be necessary.

8.6.4 Strength. There is a possibility that coating thickness adjustments will cause base material minimum material conditions that may seriously affect strength of threaded parts. Limitations on coating thickness or part redesign may be necessary.

8.7 Electrodeposited Coatings

Electroplated coatings do not cover threads uniformly. Deposits build up more on thread crests than on thread

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flanks and coating thickness is greater on the lead end of a thread than on threads in the center of a part. The guidelines for calculating precoating thread sizes for uniformly coated threads can be used as a starting place in determining the precoating thread sizes on a given part, but the exact sizes for any given part may have to be determined by trial and error experimentation. One of the effects of electrodeposited coatings not applying uniformly is that the functional diameter of an external thread will generally increase by a greater magnitude than the increase of the pitch diameter on a given part. Depending on an externally threaded part's configuration, an electrodeposited coating of 0.0025 mm on a thread flank will probably result in a growth of the pitch diameter of approximately 0.0100 mm or more, but the functional diameter may change by as much as 0.0150 mm or more. In the case of internally threaded parts, electrodeposited coatings cause the pitch diameter and functional diameter to decrease in size, with the pitch diameter decreasing less than the functional diameter on a given part.

Another effect of the nonuniform build-up of electrodeposited coatings is that the coating thickness on the lead end of a thread is commonly greater than the thickness on the threads in the center of the part. This results in the pitch diameter and the functional diameter of a thread to be considerably larger on the end of the part than their comparable measurements away from the end. The longer the part, in the case of external threads, or the thicker the part, in the case of internal threads, the greater these differences tend to be. The part producer and the plater cannot control this phenomenon. It is the nature of electrodeposited coatings on threaded parts. It is conceivable that a part's dimensions can measure within limits on the lead threads and be beyond their limits on the threads away from the lead threads.

8.8 Other Considerations

It is essential to adequately review all possibilities and consider limitations in the threading and coating production processes before finalizing the coating process and the allowance required to accommodate the coating. A no-allowance thread after coating shall not transgress the basic profile and is, therefore, subject to acceptance using a basic (tolerance position *H/h*) size GO thread gage. Basic sizes for ISO series threads appear in Appendix D.

9 LIMITS OF SIZE

9.1 Standard Thread Series

(a) The limiting M profile for internal threads is shown in Fig. 8 with the associated dimensions in Table 15.

(b) The limiting M profiles for external threads are shown in Fig. 9 with the associated dimensions listed in Table 14.

(c) For information, basic dimensions of all ISO series metric screw threads, including the standard series, appear in Appendix D.

9.2 Determination of Size Limits

(a) Values listed in Tables 14 and 15 shall be used to determine limits of size.

(b) If required values are not listed in Tables 14 and 15, they shall be calculated using ISO data in Tables 7, 9, 10, 11, 12, and 13 and formulas in para. 9.3.

(c) If required data is not included in any of the tables listed above, calculate the missing data from formulas given in section 6 and in para. 9.3. Round in accordance with ASME B1.30, which includes rounding rules and examples.

(d) Examples in paras. 9.4.1 and 9.4.2, demonstrate the use of tabulated values of allowances and tolerances for calculating size limits for standard ISO 261 sizes (see Table 6). Examples in paras. 9.4.3 and 9.4.4, demonstrate the use of formulas for calculating values of allowances and tolerances for determining size limits for nonstandard thread sizes.

NOTE: If any tabulated values for allowance and tolerance are available, do not use formulas for calculation of these values. Calculate from formulas only when tabulated values do not exist.

9.3 Formulas for Calculating Limiting Dimensions for M Profile Screw Threads

9.3.1 Internal Thread

(a) Minimum major diameter = basic major diameter + EI (Table 13)

(b) Minimum pitch diameter = basic major diameter − 0.6495191P (Table 2) + EI for D_2 (Table 13)

(c) Maximum pitch diameter = minimum pitch diameter + TD_2 (Table 12)

(d) Maximum major diameter = maximum pitch diameter + 0.7938566P (Table 2)

(e) Minimum minor diameter = minimum major diameter − 1.0825318P (Table 2)

(f) Maximum minor diameter = minimum minor diameter + TD_1 (Table 9)

9.3.2 External Thread

(a) Maximum major diameter = basic major diameter − es (Table 13)

NOTE: es is absolute value.

(b) Minimum major diameter = maximum major diameter − Td (Table 10)

(c) Maximum pitch diameter = basic major diam. − 0.6495191P (Table 2) − es for d_2 (Table 13)

(d) Minimum pitch diameter = maximum pitch diameter − Td_2 (Table 11)

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Table 14 External Thread — Limiting Dimensions M Profile

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2) and (3)]			Max. Minor Diameter, (Flat Form), d_1 [Note (2)]	Min. Minor Diameter (Rounded Form), d_3 [Note (4)] (For Reference)
			Max.	Min.	Max.	Min.	Tol.		
M1.6 × 0.35	6g	0.019	1.581	1.496	1.354	1.291	0.063	1.202	1.075
M1.6 × 0.35	6h	0.000	1.600	1.515	1.373	1.310	0.063	1.221	1.094
M1.6 × 0.35	4g6g	0.019	1.581	1.496	1.354	1.314	0.040	1.202	1.098
M2 × 0.4	6g	0.019	1.981	1.886	1.721	1.654	0.067	1.548	1.408
M2 × 0.4	6h	0.000	2.000	1.905	1.740	1.673	0.067	1.567	1.427
M2 × 0.4	4g6g	0.019	1.981	1.886	1.721	1.679	0.042	1.548	1.433
M2.5 × 0.45	6g	0.020	2.480	2.380	2.188	2.117	0.071	1.993	1.840
M2.5 × 0.45	6h	0.000	2.500	2.400	2.208	2.137	0.071	2.013	1.860
M2.5 × 0.45	4g6g	0.020	2.480	2.380	2.188	2.143	0.045	1.993	1.866
M3 × 0.5	6g	0.020	2.980	2.874	2.655	2.580	0.075	2.438	2.272
M3 × 0.5	6h	0.000	3.000	2.894	2.675	2.600	0.075	2.458	2.292
M3 × 0.5	4g6g	0.020	2.980	2.874	2.655	2.607	0.048	2.438	2.299
M3.5 × 0.6	6g	0.021	3.479	3.354	3.089	3.004	0.085	2.829	2.634
M3.5 × 0.6	6h	0.000	3.500	3.375	3.110	3.025	0.085	2.850	2.655
M3.5 × 0.6	4g6g	0.021	3.479	3.354	3.089	3.036	0.053	2.829	2.666
M4 × 0.7	6g	0.022	3.978	3.838	3.523	3.433	0.090	3.220	3.002
M4 × 0.7	6h	0.000	4.000	3.860	3.545	3.455	0.090	3.242	3.024
M4 × 0.7	4g6g	0.022	3.978	3.838	3.523	3.467	0.056	3.220	3.036
M5 × 0.8	6g	0.024	4.976	4.826	4.456	4.361	0.095	4.110	3.868
M5 × 0.8	6h	0.000	5.000	4.850	4.480	4.385	0.095	4.134	3.892
M5 × 0.8	4g6g	0.024	4.976	4.826	4.456	4.396	0.060	4.110	3.903
M6 × 1	6g	0.026	5.974	5.794	5.324	5.212	0.112	4.891	4.596
M6 × 1	6h	0.000	6.000	5.820	5.350	5.238	0.112	4.917	4.622
M6 × 1	4g6g	0.026	5.974	5.794	5.324	5.253	0.071	4.891	4.637
M8 × 1.25	6g	0.028	7.972	7.760	7.160	7.042	0.118	6.619	6.272
M8 × 1.25	6h	0.000	8.000	7.788	7.188	7.070	0.118	6.647	6.300
M8 × 1.25	4g6g	0.028	7.972	7.760	7.160	7.085	0.075	6.619	6.315
M8 × 1	6g	0.026	7.974	7.794	7.324	7.212	0.112	6.891	6.596
M8 × 1	6h	0.000	8.000	7.820	7.350	7.238	0.112	6.917	6.622
M8 × 1	4g6g	0.026	7.974	7.794	7.324	7.253	0.071	6.891	6.637

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Table 14 External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2) and (3)]			Max. Minor Diameter, (Flat Form), d_1 [Note (2)]	Min. Minor Diameter (Rounded Form), d_3 [Note (4)] (For Reference)
			Max.	Min.	Max.	Min.	Tol.		
M10 × 1.5	6g	0.032	9.968	9.732	8.994	8.862	0.132	8.344	7.938
M10 × 1.5	6h	0.000	10.000	9.764	9.026	8.894	0.132	8.376	7.970
M10 × 1.5	4g6g	0.032	9.968	9.732	8.994	8.909	0.085	8.344	7.985
M10 × 1.25	6g	0.028	9.972	9.760	9.160	9.042	0.118	8.619	8.272
M10 × 1.25	6h	0.000	10.000	9.788	9.188	9.070	0.118	8.647	8.300
M10 × 1.25	4g6g	0.028	9.972	9.760	9.160	9.085	0.075	8.619	8.315
M10 × 1	6g	0.026	9.974	9.794	9.324	9.212	0.112	8.891	8.596
M10 × 1	6h	0.000	10.000	9.820	9.350	9.238	0.112	8.917	8.622
M10 × 1	4g6g	0.026	9.974	9.794	9.324	9.253	0.071	8.891	8.637
M10 × 0.75	6g	0.022	9.978	9.838	9.491	9.391	0.100	9.166	8.929
M10 × 0.75	6h	0.000	10.000	9.860	9.513	9.413	0.100	9.188	8.951
M10 × 0.75	4g6g	0.022	9.978	9.838	9.491	9.428	0.063	9.166	8.966
M12 × 1.75	6g	0.034	11.966	11.701	10.829	10.679	0.150	10.071	9.601
M12 × 1.75	6h	0.000	12.000	11.735	10.863	10.713	0.150	10.105	9.635
M12 × 1.75	4g6g	0.034	11.966	11.701	10.829	10.734	0.095	10.071	9.656
M12 × 1.5	6g	0.032	11.968	11.732	10.994	10.854	0.140	10.344	9.930
M12 × 1.5	6h	0.000	12.000	11.764	11.026	10.886	0.140	10.376	9.962
M12 × 1.5	4g6g	0.032	11.968	11.732	10.994	10.904	0.090	10.344	9.980
M12 × 1.25	6g	0.028	11.972	11.760	11.160	11.028	0.132	10.619	10.258
M12 × 1.25	6h	0.000	12.000	11.788	11.188	11.056	0.132	10.647	10.286
M12 × 1.25	4g6g	0.028	11.972	11.760	11.160	11.075	0.085	10.619	10.305
M12 × 1	6g	0.026	11.974	11.794	11.324	11.206	0.118	10.891	10.590
M12 × 1	6h	0.000	12.000	11.820	11.350	11.232	0.118	10.917	10.616
M12 × 1	4g6g	0.026	11.974	11.794	11.324	11.249	0.075	10.891	10.633
M14 × 2	6g	0.038	13.962	13.682	12.663	12.503	0.160	11.797	11.271
M14 × 2	6h	0.000	14.000	13.720	12.701	12.541	0.160	11.835	11.309
M14 × 2	4g6g	0.038	13.962	13.682	12.663	12.563	0.100	11.797	11.331
M14 × 1.5	6g	0.032	13.968	13.732	12.994	12.854	0.140	12.344	11.930
M14 × 1.5	6h	0.000	14.000	13.764	13.026	12.886	0.140	12.376	11.962
M14 × 1.5	4g6g	0.032	13.968	13.732	12.994	12.904	0.090	12.344	11.980
M15 × 1	6g	0.026	14.974	14.794	14.324	14.206	0.118	13.891	13.590
M15 × 1	6h	0.000	15.000	14.820	14.350	14.232	0.118	13.917	13.616
M15 × 1	4g6g	0.026	14.974	14.794	14.324	14.249	0.075	13.891	13.633

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Table 14 External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2) and (3)]			Max. Minor Diameter, (Flat Form), d_1 [Note (2)]	Min. Minor Diameter (Rounded Form), d_3 [Note (4)] (For Reference)
			Max.	Min.	Max.	Min.	Tol.		
M16 × 2	6g	0.038	15.962	15.682	14.663	14.503	0.160	13.797	13.271
M16 × 2	6h	0.000	16.000	15.720	14.701	14.541	0.160	13.835	13.309
M16 × 2	4g6g	0.038	15.962	15.682	14.663	14.563	0.100	13.797	13.331
M16 × 1.5	6g	0.032	15.968	15.732	14.994	14.854	0.140	14.344	13.930
M16 × 1.5	6h	0.000	16.000	15.764	15.026	14.886	0.140	14.376	13.962
M16 × 1.5	4g6g	0.032	15.968	15.732	14.994	14.904	0.090	14.344	13.980
M17 × 1	6g	0.026	16.974	16.794	16.324	16.206	0.118	15.891	15.590
M17 × 1	6h	0.000	17.000	16.820	16.350	16.232	0.118	15.917	15.616
M17 × 1	4g6g	0.026	16.974	16.794	16.324	16.249	0.075	15.891	15.633
M18 × 1.5	6g	0.032	17.968	17.732	16.994	16.854	0.140	16.344	15.930
M18 × 1.5	6h	0.000	18.000	17.764	17.026	16.886	0.140	16.376	15.962
M18 × 1.5	4g6g	0.032	17.968	17.732	16.994	16.904	0.090	16.344	15.980
M20 × 2.5	6g	0.042	19.958	19.623	18.334	18.164	0.170	17.251	16.624
M20 × 2.5	6h	0.000	20.000	19.665	18.376	18.206	0.170	17.293	16.666
M20 × 2.5	4g6g	0.042	19.958	19.623	18.334	18.228	0.106	17.251	16.688
M20 × 1.5	6g	0.032	19.968	19.732	18.994	18.854	0.140	18.344	17.930
M20 × 1.5	6h	0.000	20.000	19.764	19.026	18.886	0.140	18.376	17.962
M20 × 1.5	4g6g	0.032	19.968	19.732	18.994	18.904	0.090	18.344	17.980
M20 × 1	6g	0.026	19.974	19.794	19.324	19.206	0.118	18.891	18.590
M20 × 1	6h	0.000	20.000	19.820	19.350	19.232	0.118	18.917	18.616
M20 × 1	4g6g	0.026	19.974	19.794	19.324	19.249	0.075	18.891	18.633
M22 × 2.5	6g	0.042	21.958	21.623	20.334	20.164	0.170	19.251	18.624
M22 × 2.5	6h	0.000	22.000	21.665	20.376	20.206	0.170	19.293	18.666
M22 × 1.5	6g	0.032	21.968	21.732	20.994	20.854	0.140	20.344	19.930
M22 × 1.5	6h	0.000	22.000	21.764	21.026	20.886	0.140	20.376	19.962
M22 × 1.5	4g6g	0.032	21.968	21.732	20.994	20.904	0.090	20.344	19.980
M24 × 3	6g	0.048	23.952	23.577	22.003	21.803	0.200	20.704	19.955
M24 × 3	6h	0.000	24.000	23.625	22.051	21.851	0.200	20.752	20.003
M24 × 3	4g6g	0.048	23.952	23.577	22.003	21.878	0.125	20.704	20.030
M24 × 2	6g	0.038	23.962	23.682	22.663	22.493	0.170	21.797	21.261
M24 × 2	6h	0.000	24.000	23.720	22.701	22.531	0.170	21.835	21.299
M24 × 2	4g6g	0.038	23.962	23.682	22.663	22.557	0.106	21.797	21.325

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Table 14 External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2) and (3)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diameter (Rounded Form), d_3 [Note (4)] (For Reference)
			Max.	Min.	Max.	Min.	Tol.		
M25 × 1.5	6g	0.032	24.968	24.732	23.994	23.844	0.150	23.344	22.920
M25 × 1.5	6h	0.000	25.000	24.764	24.026	23.876	0.150	23.376	22.952
M25 × 1.5	4g6g	0.032	24.968	24.732	23.994	23.899	0.095	23.344	22.975
M27 × 3	6g	0.048	26.952	26.577	25.003	24.803	0.200	23.704	22.955
M27 × 3	6h	0.000	27.000	26.625	25.051	24.851	0.200	23.752	23.003
M27 × 2	6g	0.038	26.962	26.682	25.663	25.493	0.170	24.797	24.261
M27 × 2	6h	0.000	27.000	26.720	25.701	25.531	0.170	24.835	24.299
M27 × 2	4g6g	0.038	26.962	26.682	25.663	25.557	0.106	24.797	24.325
M30 × 3.5	6g	0.053	29.947	29.522	27.674	27.462	0.212	26.158	25.306
M30 × 3.5	6h	0.000	30.000	29.575	27.727	27.515	0.212	26.211	25.359
M30 × 3.5	4g6g	0.053	29.947	29.522	27.674	27.542	0.132	26.158	25.386
M30 × 2	6g	0.038	29.962	29.682	28.663	28.493	0.170	27.797	27.261
M30 × 2	6h	0.000	30.000	29.720	28.701	28.531	0.170	27.835	27.299
M30 × 2	4g6g	0.038	29.962	29.682	28.663	28.557	0.106	27.797	27.325
M30 × 1.5	6g	0.032	29.968	29.732	28.994	28.844	0.150	28.344	27.920
M30 × 1.5	6h	0.000	30.000	29.764	29.026	28.876	0.150	28.376	27.952
M30 × 1.5	4g6g	0.032	29.968	29.732	28.994	28.899	0.095	28.344	27.975
M33 × 2	6g	0.038	32.962	32.682	31.663	31.493	0.170	30.797	30.261
M33 × 2	6h	0.000	33.000	32.720	31.701	31.531	0.170	30.835	30.299
M33 × 2	4g6g	0.038	32.962	32.682	31.663	31.557	0.106	30.797	30.325
M35 × 1.5	6g	0.032	34.968	34.732	33.994	33.844	0.150	33.344	32.920
M35 × 1.5	6h	0.000	35.000	34.764	34.026	33.876	0.150	33.376	32.952
M36 × 4	6g	0.060	35.940	35.465	33.342	33.118	0.224	31.610	30.654
M36 × 4	6h	0.000	36.000	35.525	33.402	33.178	0.224	31.670	30.714
M36 × 4	4g6g	0.060	35.940	35.465	33.342	33.202	0.140	31.610	30.738
M36 × 2	6g	0.038	35.962	35.682	34.663	34.493	0.170	33.797	33.261
M36 × 2	6h	0.000	36.000	35.720	34.701	34.531	0.170	33.835	33.299
M36 × 2	4g6g	0.038	35.962	35.682	34.663	34.557	0.106	33.797	33.325
M39 × 2	6g	0.038	38.962	38.682	37.663	37.493	0.170	36.797	36.261
M39 × 2	6h	0.000	39.000	38.720	37.701	37.531	0.170	36.835	36.299
M39 × 2	4g6g	0.038	38.962	38.682	37.663	37.557	0.106	36.797	36.325
M40 × 1.5	6g	0.032	39.968	39.732	38.994	38.844	0.150	38.344	37.920
M40 × 1.5	6h	0.000	40.000	39.764	39.026	38.876	0.150	38.376	37.952

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Table 14 External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2) and (3)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diameter (Rounded Form), d_3 [Note (4)] (For Reference)
			Max.	Min.	Max.	Min.	Tol.		
M40 × 1.5	4g6g	0.032	39.968	39.732	38.994	38.899	0.095	38.344	37.975
M42 × 4.5	6g	0.063	41.937	41.437	39.014	38.778	0.236	37.065	36.006
M42 × 4.5	6h	0.000	42.000	41.500	39.077	38.841	0.236	37.128	36.069
M42 × 4.5	4g6g	0.063	41.937	41.437	39.014	38.864	0.150	37.065	36.092
M42 × 2	6g	0.038	41.962	41.682	40.663	40.493	0.170	39.797	39.261
M42 × 2	6h	0.000	42.000	41.720	40.701	40.531	0.170	39.835	39.299
M42 × 2	4g6g	0.038	41.962	41.682	40.663	40.557	0.106	39.797	39.325
M45 × 1.5	6g	0.032	44.968	44.732	43.994	43.844	0.150	43.344	42.920
M45 × 1.5	6h	0.000	45.000	44.764	44.026	43.876	0.150	43.376	42.952
M45 × 1.5	4g6g	0.032	44.968	44.732	43.994	43.899	0.095	43.344	42.975
M48 × 5	6g	0.071	47.929	47.399	44.681	44.431	0.250	42.516	41.351
M48 × 5	6h	0.000	48.000	47.470	44.752	44.502	0.250	42.587	41.422
M48 × 5	4g6g	0.071	47.929	47.399	44.681	44.521	0.160	42.516	41.441
M48 × 2	6g	0.038	47.962	47.682	46.663	46.483	0.180	45.797	45.251
M48 × 2	6h	0.000	48.000	47.720	46.701	46.521	0.180	45.835	45.289
M48 × 2	4g6g	0.038	47.962	47.682	46.663	46.551	0.112	45.797	45.319
M50 × 1.5	6g	0.032	49.968	49.732	48.994	48.834	0.160	48.344	47.910
M50 × 1.5	6h	0.000	50.000	49.764	49.026	48.866	0.160	48.376	47.942
M50 × 1.5	4g6g	0.032	49.968	49.732	48.994	48.894	0.100	48.344	47.970
M55 × 1.5	6g	0.032	54.968	54.732	53.994	53.834	0.160	53.344	52.910
M55 × 1.5	6h	0.000	55.000	54.764	54.026	53.866	0.160	53.376	52.942
M55 × 1.5	4g6g	0.032	54.968	54.732	53.994	53.894	0.100	53.344	52.970
M56 × 5.5	6g	0.075	55.925	55.365	52.353	52.088	0.265	49.971	48.700
M56 × 5.5	6h	0.000	56.000	55.440	52.428	52.163	0.265	50.046	48.775
M56 × 5.5	4g6g	0.075	55.925	55.365	52.353	52.183	0.170	49.971	48.795
M56 × 2	6g	0.038	55.962	55.682	54.663	54.483	0.180	53.797	53.251
M56 × 2	6h	0.000	56.000	55.720	54.701	54.521	0.180	53.835	53.289
M56 × 2	4g6g	0.038	55.962	55.682	54.663	54.551	0.112	53.797	53.319
M60 × 1.5	6g	0.032	59.968	59.732	58.994	58.834	0.160	58.344	57.910
M60 × 1.5	6h	0.000	60.000	59.764	59.026	58.866	0.160	58.376	57.942
M60 × 1.5	4g6g	0.032	59.968	59.732	58.994	58.894	0.100	58.344	57.970

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Table 14 External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2) and (3)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diameter (Rounded Form), d_3 [Note (4)] (For Reference)
			Max.	Min.	Max.	Min.	Tol.		
M64 × 6	6g	0.080	63.920	63.320	60.023	59.743	0.280	57.425	56.047
M64 × 6	6h	0.000	64.000	63.400	60.103	59.823	0.280	57.505	56.127
M64 × 6	4g6g	0.080	63.920	63.320	60.023	59.843	0.180	57.425	56.147
M64 × 2	6g	0.038	63.962	63.682	62.663	62.483	0.180	61.797	61.251
M64 × 2	6h	0.000	64.000	63.720	62.701	62.521	0.180	61.835	61.289
M64 × 2	4g6g	0.038	63.962	63.682	62.663	62.551	0.112	61.797	61.319
M65 × 1.5	6g	0.032	64.968	64.732	63.994	63.834	0.160	63.344	62.910
M65 × 1.5	6h	0.000	65.000	64.764	64.026	63.866	0.160	63.376	62.942
M65 × 1.5	4g6g	0.032	64.968	64.732	63.994	63.894	0.100	63.344	62.970
M70 × 1.5	6g	0.032	69.968	69.732	68.994	68.834	0.160	68.344	67.910
M70 × 1.5	6h	0.000	70.000	69.764	69.026	68.866	0.160	68.376	67.942
M70 × 1.5	4g6g	0.032	69.968	69.732	68.994	68.894	0.100	68.344	67.970
M72 × 6	6g	0.080	71.920	71.320	68.023	67.743	0.280	65.425	64.047
M72 × 6	6h	0.000	72.000	71.400	68.103	67.823	0.280	65.505	64.127
M72 × 6	4g6g	0.080	71.920	71.320	68.023	67.843	0.180	65.425	64.147
M72 × 2	6g	0.038	71.962	71.682	70.663	70.483	0.180	69.797	69.251
M72 × 2	6h	0.000	72.000	71.720	70.701	70.521	0.180	69.835	69.289
M72 × 2	4g6g	0.038	71.962	71.682	70.663	70.551	0.112	69.797	69.319
M75 × 1.5	6g	0.032	74.968	74.732	73.994	73.834	0.160	73.344	72.910
M75 × 1.5	6h	0.000	75.000	74.764	74.026	73.866	0.160	73.376	72.942
M75 × 1.5	4g6g	0.032	74.968	74.732	73.994	73.894	0.100	73.344	72.970
M80 × 6	6g	0.080	79.920	79.320	76.023	75.743	0.280	73.425	72.047
M80 × 6	6h	0.000	80.000	79.400	76.103	75.823	0.280	73.505	72.127
M80 × 6	4g6g	0.080	79.920	79.320	76.023	75.843	0.180	73.425	72.147
M80 × 2	6g	0.038	79.962	79.682	78.663	78.483	0.180	77.797	77.251
M80 × 2	6h	0.000	80.000	79.720	78.701	78.521	0.180	77.835	77.289
M80 × 2	4g6g	0.038	79.962	79.682	78.663	78.551	0.112	77.797	77.319
M80 × 1.5	6g	0.032	79.968	79.732	78.994	78.834	0.160	78.344	77.910
M80 × 1.5	6h	0.000	80.000	79.764	79.026	78.866	0.160	78.376	77.942
M80 × 1.5	4g6g	0.032	79.968	79.732	78.994	78.894	0.100	78.344	77.970
M85 × 2	6g	0.038	84.962	84.682	83.663	83.483	0.180	82.797	82.251
M85 × 2	6h	0.000	85.000	84.720	83.701	83.521	0.180	82.835	82.289

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Table 14 External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2) and (3)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diameter (Rounded Form), d_3 [Note (4)] (For Reference)
			Max.	Min.	Max.	Min.	Tol.		
M85 × 2	4g6g	0.038	84.962	84.682	83.663	83.551	0.112	82.797	82.319
M90 × 6	6g	0.080	89.920	89.320	86.023	85.743	0.280	83.425	82.047
M90 × 6	6h	0.000	90.000	89.400	86.103	85.823	0.280	83.505	82.127
M90 × 6	4g6g	0.080	89.920	89.320	86.023	85.843	0.180	83.425	82.147
M90 × 2	6g	0.038	89.962	89.682	88.663	88.483	0.180	87.797	87.251
M90 × 2	6h	0.000	90.000	89.720	88.701	88.521	0.180	87.835	87.289
M90 × 2	4g6g	0.038	89.962	89.682	88.663	88.551	0.112	87.797	87.319
M95 × 2	6g	0.038	94.962	94.682	93.663	93.473	0.190	92.797	92.241
M95 × 2	6h	0.000	95.000	94.720	93.701	93.511	0.190	92.835	92.279
M95 × 2	4g6g	0.038	94.962	94.682	93.663	93.545	0.118	92.797	92.313
M100 × 6	6g	0.080	99.920	99.320	96.023	95.723	0.300	93.425	92.027
M100 × 6	6h	0.000	100.000	99.400	96.103	95.803	0.300	93.505	92.107
M100 × 6	4g6g	0.080	99.920	99.320	96.023	95.833	0.190	93.425	92.137
M100 × 2	6g	0.038	99.962	99.682	98.663	98.473	0.190	97.797	97.241
M100 × 2	6h	0.000	100.000	99.720	98.701	98.511	0.190	97.835	97.279
M100 × 2	4g6g	0.038	99.962	99.682	98.663	98.545	0.118	97.797	97.313
M105 × 2	6g	0.038	104.962	104.682	103.663	103.473	0.190	102.797	102.241
M105 × 2	6h	0.000	105.000	104.720	103.701	103.511	0.190	102.835	102.279
M105 × 2	4g6g	0.038	104.962	104.682	103.663	103.545	0.118	102.797	102.313
M110 × 2	6g	0.038	109.962	109.682	108.663	108.473	0.190	107.797	107.241
M110 × 2	6h	0.000	110.000	109.720	108.701	108.511	0.190	107.835	107.279
M110 × 2	4g6g	0.038	109.962	109.682	108.663	108.545	0.118	107.797	107.313
M120 × 2	6g	0.038	119.962	119.682	118.663	118.473	0.190	117.797	117.241
M120 × 2	6h	0.000	120.000	119.720	118.701	118.511	0.190	117.835	117.279
M120 × 2	4g6g	0.038	119.962	119.682	118.663	118.545	0.118	117.797	117.313
M130 × 2	6g	0.038	129.962	129.682	128.663	128.473	0.190	127.797	127.241
M130 × 2	6h	0.000	130.000	129.720	128.701	128.511	0.190	127.835	127.279
M130 × 2	4g6g	0.038	129.962	129.682	128.663	128.545	0.118	127.797	127.313
M140 × 2	6g	0.038	139.962	139.682	138.663	138.473	0.190	137.797	137.241
M140 × 2	6h	0.000	140.000	139.720	138.701	138.511	0.190	137.835	137.279
M140 × 2	4g6g	0.038	139.962	139.682	138.663	138.545	0.118	137.797	137.313

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Table 14 External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2) and (3)]			Max Minor Diameter (Flat Form) d_1 [Note (2)]	Min. Minor Diameter (Rounded Form), d_3 [Note (4)] (For Reference)
			Max.	Min.	Max.	Min.	Tol.		
M150 × 2	6g	0.038	149.962	149.682	148.663	148.473	0.190	147.797	147.241
M150 × 2	6h	0.000	150.000	149.720	148.701	148.511	0.190	147.835	147.279
M150 × 2	4g6g	0.038	149.962	149.682	148.663	148.545	0.118	147.797	147.313
M160 × 3	6g	0.048	159.952	159.577	158.003	157.779	0.224	156.704	155.931
M160 × 3	6h	0.000	160.000	159.625	158.051	157.827	0.224	156.752	155.979
M160 × 3	4g6g	0.048	159.952	159.577	158.003	157.863	0.140	156.704	156.015
M170 × 3	6g	0.048	169.952	169.577	168.003	167.779	0.224	166.704	165.931
M170 × 3	6h	0.000	170.000	169.625	168.051	167.827	0.224	166.752	165.979
M170 × 3	4g6g	0.048	169.952	169.577	168.003	167.863	0.140	166.704	166.015
M180 × 3	6g	0.048	179.952	179.577	178.003	177.779	0.224	176.704	175.931
M180 × 3	6h	0.000	180.000	179.625	178.051	177.827	0.224	176.752	175.979
M180 × 3	4g6g	0.048	179.952	179.577	178.003	177.863	0.140	176.704	176.015
M190 × 3	6g	0.048	189.952	189.577	188.003	187.753	0.250	186.704	185.905
M190 × 3	6h	0.000	190.000	189.625	188.051	187.801	0.250	186.752	185.953
M190 × 3	4g6g	0.048	189.952	189.577	188.003	187.843	0.160	186.704	185.995
M200 × 3	6g	0.048	199.952	199.577	198.003	197.753	0.250	196.704	195.905
M200 × 3	6h	0.000	200.000	199.625	198.051	197.801	0.250	196.752	195.953
M200 × 3	4g6g	0.048	199.952	199.577	198.003	197.843	0.160	196.704	195.995

GENERAL NOTE: All dimensions are in millimeters.

NOTES:

(1) *es* is absolute value.

(2) For coated threads with tolerance classes 6g or 4g6g, see para. 8.2.

(3) See para. 5.4(b).

(4) Dimension used in the design of tools, etc. In dimensioning external threads it is not normally specified. Generally, minor diameter acceptance is based on maximum material condition gaging.

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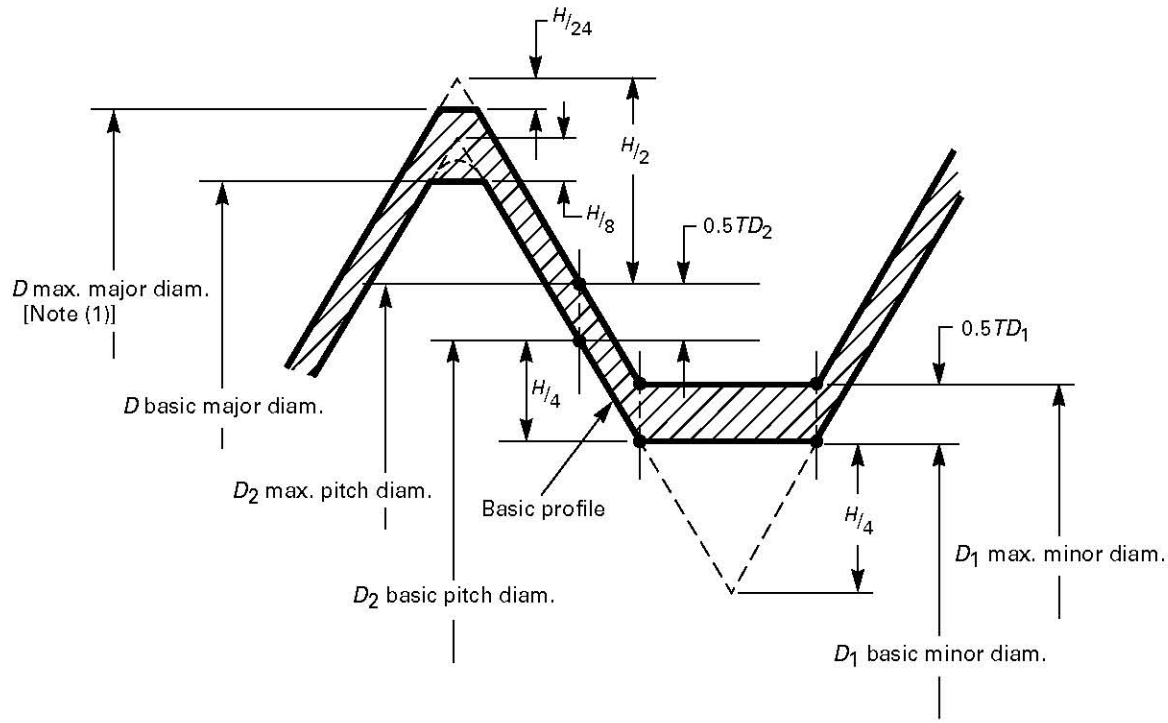

GENERAL NOTE: Section-lined portions identify tolerance zone.

NOTE:

(1) Dimension is used in the design of tools, etc. In dimensioning internal threads it is not normally specified. Generally major diameter acceptance is based upon a maximum material condition gaging.

Fig. 8 Internal Thread — Limiting M Profile, Tolerance Position *H*

(e) Maximum flat form minor diameter = maximum pitch diameter − 0.4330127*P* (Table 2)

(f) Maximum rounded form minor diameter =

$$\text{max. pitch diam.} - \left\{ 0.5H + 2r\ \text{min.} \left\{ 1 - \cos\left[60\ \text{deg} - \arccos\left(1 - \frac{Td_2}{4r\ \text{min.}} \right) \right] \right\} \right\}$$

(for 0.125*P* min. root radius)

(g) Minimum rounded form minor diameter = minimum pitch diameter − 0.6160254*P* (Table 2)

$$r\ \text{min.} = 0.125P\ \text{(Table 3)}$$

9.4 Examples of Calculations of Size Limits

Tables 16A through 16D show examples that are based upon the practices for calculating and rounding screw thread dimensions as specified in ASME B1.30. Dimensions are expressed in millimeters.

9.4.1 External Screw Thread, Standard Size. The example in Table 16A shows how tabulated values for allowances and tolerances (in accordance with ISO 965-1) are used for the calculation of size limits in ASME B1.13M tables for standard external thread sizes listed in ISO 261. See para. 9.4.3 for an example with a size not listed in ISO 261.

9.4.2 Internal Metric Screw Thread, Standard Size. The example in Table 16B shows how tabulated values for allowances and tolerances (in accordance with ISO 965-1) are used for the calculation of size limits in ASME B1.13M tables for standard internal thread sizes listed in ISO 261. See para. 9.4.4 for an example with a size not listed in ISO 261.

9.4.3 Metric External Screw Thread, Non-Standard Size. The example in Table 16C shows how size limit calculations are made by use of formulas for sizes not listed in ISO 261. For an example of how tabulated values for allowances and tolerances (in accordance with ISO 965-1) are used for the calculation of size limits in ASME B1.13M tables for standard external thread sizes listed in ISO 261, see para. 9.4.1.

9.4.4 Internal Metric Screw Thread, Non-Standard Size. The example in Table 16D shows how size limit calculations are made by use of formulas for sizes not listed in ISO 261. For an example of how tabulated values for allowances and tolerances (in accordance with ISO 965-1) are used for the calculation of size limits in

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Table 15 Internal Thread — Limiting Dimensions M Profile

Basic Thread Designation	Tolerance Class	Minor Diam., D_1		Pitch Diam., D_2 and Functional Diam. [Note (1)]			Major Diam., D	
		Min.	Max.	Min.	Max.	Tol.	Min.	Max. [Note (2)] (For Reference)
M1.6 × 0.35	6H	1.221	1.321	1.373	1.458	0.085	1.600	1.736
M2 × 0.4	6H	1.567	1.679	1.740	1.830	0.090	2.000	2.148
M2.5 × 0.45	6H	2.013	2.138	2.208	2.303	0.095	2.500	2.660
M3 × 0.5	6H	2.459	2.599	2.675	2.775	0.100	3.000	3.172
M3.5 × 0.6	6H	2.850	3.010	3.110	3.222	0.112	3.500	3.698
M4 × 0.7	6H	3.242	3.422	3.545	3.663	0.118	4.000	4.219
M5 × 0.8	6H	4.134	4.334	4.480	4.605	0.125	5.000	5.240
M6 × 1	6H	4.917	5.153	5.350	5.500	0.150	6.000	6.294
M8 × 1.25	6H	6.647	6.912	7.188	7.348	0.160	8.000	8.340
M8 × 1	6H	6.917	7.153	7.350	7.500	0.150	8.000	8.294
M10 × 1.5	6H	8.376	8.676	9.026	9.206	0.180	10.000	10.397
M10 × 1.25	6H	8.647	8.912	9.188	9.348	0.160	10.000	10.340
M10 × 1	6H	8.917	9.153	9.350	9.500	0.150	10.000	10.294
M10 × 0.75	6H	9.188	9.378	9.513	9.645	0.132	10.000	10.240
M12 × 1.75	6H	10.106	10.441	10.863	11.063	0.200	12.000	12.452
M12 × 1.5	6H	10.376	10.676	11.026	11.216	0.190	12.000	12.407
M12 × 1.25	6H	10.647	10.912	11.188	11.368	0.180	12.000	12.360
M12 × 1	6H	10.917	11.153	11.350	11.510	0.160	12.000	12.304
M14 × 2	6H	11.835	12.210	12.701	12.913	0.212	14.000	14.501
M14 × 1.5	6H	12.376	12.676	13.026	13.216	0.190	14.000	14.407
M15 × 1	6H	13.917	14.153	14.350	14.510	0.160	15.000	15.304
M16 × 2	6H	13.835	14.210	14.701	14.913	0.212	16.000	16.501
M16 × 1.5	6H	14.376	14.676	15.026	15.216	0.190	16.000	16.407
M17 × 1	6H	15.917	16.153	16.350	16.510	0.160	17.000	17.304
M18 × 1.5	6H	16.376	16.676	17.026	17.216	0.190	18.000	18.407
M20 × 2.5	6H	17.294	17.744	18.376	18.600	0.224	20.000	20.585
M20 × 1.5	6H	18.376	18.676	19.026	19.216	0.190	20.000	20.407
M20 × 1	6H	18.917	19.153	19.350	19.510	0.160	20.000	20.304
M22 × 2.5	6H	19.294	19.744	20.376	20.600	0.224	22.000	22.585
M22 × 1.5	6H	20.376	20.676	21.026	21.216	0.190	22.000	22.407
M24 × 3	6H	20.752	21.252	22.051	22.316	0.265	24.000	24.698
M24 × 2	6H	21.835	22.210	22.701	22.925	0.224	24.000	24.513
M25 × 1.5	6H	23.376	23.676	24.026	24.226	0.200	25.000	25.417
M27 × 3	6H	23.752	24.252	25.051	25.316	0.265	27.000	27.698
M27 × 2	6H	24.835	25.210	25.701	25.925	0.224	27.000	27.513
M30 × 3.5	6H	26.211	26.771	27.727	28.007	0.280	30.000	30.786
M30 × 2	6H	27.835	28.210	28.701	28.925	0.224	30.000	30.513
M30 × 1.5	6H	28.376	28.676	29.026	29.226	0.200	30.000	30.417
M33 × 2	6H	30.835	31.210	31.701	31.925	0.224	33.000	33.513
M35 × 1.5	6H	33.376	33.676	34.026	34.226	0.200	35.000	35.417
M36 × 4	6H	31.670	32.270	33.402	33.702	0.300	36.000	36.877
M36 × 2	6H	33.835	34.210	34.701	34.925	0.224	36.000	36.513
M39 × 2	6H	36.835	37.210	37.701	37.925	0.224	39.000	39.513
M40 × 1.5	6H	38.376	38.676	39.026	39.226	0.200	40.000	40.417
M42 × 4.5	6H	37.129	37.799	39.077	39.392	0.315	42.000	42.964

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Table 15 Internal Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Minor Diam., D_1		Pitch Diam., D_2 and Functional Diam. [Note (1)]			Major Diam., D	
		Min.	Max.	Min.	Max.	Tol.	Min.	Max. [Note (2)] (For Reference)
M42 × 2	6H	39.835	40.210	40.701	40.925	0.224	42.000	42.513
M45 × 1.5	6H	43.376	43.676	44.026	44.226	0.200	45.000	45.417
M48 × 5	6H	42.587	43.297	44.752	45.087	0.335	48.000	49.056
M48 × 2	6H	45.835	46.210	46.701	46.937	0.236	48.000	48.525
M50 × 1.5	6H	48.376	48.676	49.026	49.238	0.212	50.000	50.429
M55 × 1.5	6H	53.376	53.676	54.026	54.238	0.212	55.000	55.429
M56 × 5.5	6H	50.046	50.796	52.428	52.783	0.355	56.000	57.149
M56 × 2	6H	53.835	54.210	54.701	54.937	0.236	56.000	56.525
M60 × 1.5	6H	58.376	58.676	59.026	59.238	0.212	60.000	60.429
M64 × 6	6H	57.505	58.305	60.103	60.478	0.375	64.000	65.241
M64 × 2	6H	61.835	62.210	62.701	62.937	0.236	64.000	64.525
M65 × 1.5	6H	63.376	63.676	64.026	64.238	0.212	65.000	65.429
M70 × 1.5	6H	68.376	68.676	69.026	69.238	0.212	70.000	70.429
M72 × 6	6H	65.505	66.305	68.103	68.478	0.375	72.000	73.241
M72 × 2	6H	69.835	70.210	70.701	70.937	0.236	72.000	72.525
M75 × 1.5	6H	73.376	73.676	74.026	74.238	0.212	75.000	75.429
M80 × 6	6H	73.505	74.305	76.103	76.478	0.375	80.000	81.241
M80 × 2	6H	77.835	78.210	78.701	78.937	0.236	80.000	80.525
M80 × 1.5	6H	78.376	78.676	79.026	79.238	0.212	80.000	80.429
M85 × 2	6H	82.835	83.210	83.701	83.937	0.236	85.000	85.525
M90 × 6	6H	83.505	84.305	86.103	86.478	0.375	90.000	91.241
M90 × 2	6H	87.835	88.210	88.701	88.937	0.236	90.000	90.525
M95 × 2	6H	92.835	93.210	93.701	93.951	0.250	95.000	95.539
M100 × 6	6H	93.505	94.305	96.103	96.503	0.400	100.000	101.266
M100 × 2	6H	97.835	98.210	98.701	98.951	0.250	100.000	100.539
M105 × 2	6H	102.835	103.210	103.701	103.951	0.250	105.000	105.539
M110 × 2	6H	107.835	108.210	108.701	108.951	0.250	110.000	110.539
M120 × 2	6H	117.835	118.210	118.701	118.951	0.250	120.000	120.539
M130 × 2	6H	127.835	128.210	128.701	128.951	0.250	130.000	130.539
M140 × 2	6H	137.835	138.210	138.701	138.951	0.250	140.000	140.539
M150 × 2	6H	147.835	148.210	148.701	148.951	0.250	150.000	150.539
M160 × 3	6H	156.752	157.252	158.051	158.351	0.300	160.000	160.733
M170 × 3	6H	166.752	167.252	168.051	168.351	0.300	170.000	170.733
M180 × 3	6H	176.752	177.252	178.051	178.351	0.300	180.000	180.733
M190 × 3	6H	186.752	187.252	188.051	188.386	0.335	190.000	190.768
M200 × 3	6H	196.752	197.252	198.051	198.386	0.335	200.000	200.768

GENERAL NOTE: All dimensions are in millimeters.

NOTES:

(1) See para. 5.4(b).

(2) Dimension is used in the design of tools, etc. In dimensioning internal threads it is not normally specified. Generally, major diameter acceptance is based on maximum material condition gaging.

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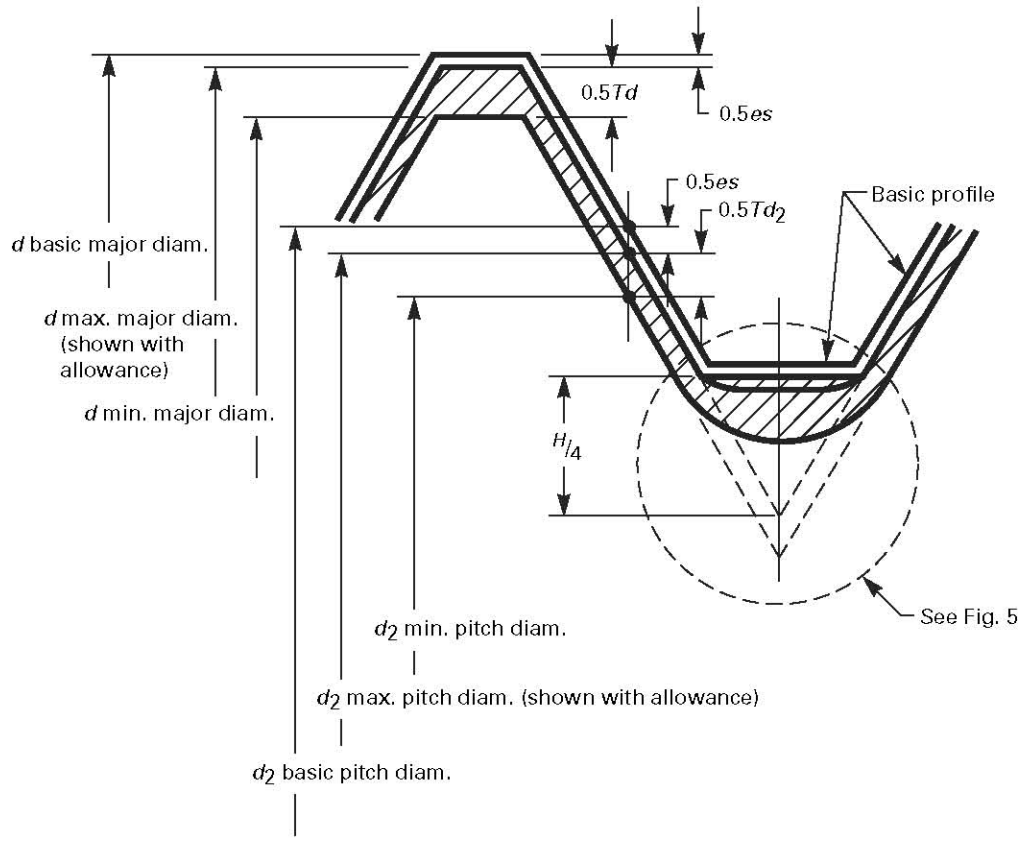

GENERAL NOTES:
(a) Section-lined portions identify tolerance zone and unshaded portions identify allowance (fundamental deviation).
(b) Tolerance position *g* is shown. For position *h*, allowance *es* is zero.

Fig. 9 External Thread — Limiting M Thread Profile

ASME B1.13M tables for standard internal thread sizes listed in ISO 261, see para. 9.4.2.

10 LEAD AND FLANK ANGLE TOLERANCES

10.1 Lead and Flank Angle Acceptance

Acceptance of lead and flank angles of product screw threads shall be in accordance with paras. 10.1.1 through 10.1.6. These factors also contribute to visual identification of gross defects in thread profile.

10.1.1 When Thread Gaging System 21 of ASME B1.3 is specified, product thread lead (including helix) and flank angle variations are not considered.

10.1.2 When Thread Gaging System 22 of ASME B1.3 is specified, with the pitch diameter or thread groove diameter inspection required, the product thread lead (including helix) and flank angles shall be considered acceptable when the minimum material characteristic (pitch diameter or thread groove diameter in Tables 1 and 2, Cols. C and D of ASME B1.3) and the maximum material characteristic (GO in Tables 1 and 2, Col. A of ASME B1.3) are accepted by the gages specified for System 22, over the standard GO thread gage length.

When Thread Gaging System 22 is specified with NOT-GO (LO) functional diameter combined with control of lead and flank option, agreements must be reached between the purchaser and the supplier on lead and flank angle limits and method of evaluation.

10.1.3 When Thread Gaging System 23 of ASME B1.3 is specified, product thread lead and flank angles shall be acceptable if within the allowable variations as specified in Tables 17 and 18. Also, the minimum material characteristic (pitch diameter or thread groove diameter in Tables 1 and 2, Cols. C and D of ASME B1.3) and the maximum material characteristic (GO in Tables 1 and 2, Col. A of ASME B1.3) must be accepted by the gages specified for System 23, over the standard GO thread gage length.

Allowable variations in lead and flank angles are maximum values. Maximum variation in these and pitch

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diameter tolerance cannot be taken simultaneously. See paras. 10.1.5 and 10.1.6.

10.1.4 When individual inspections of lead (including helix) and flank angle variations are required, in addition to Thread Gaging System 21 or 22 of ASME B1.3, the allowable variations for these characteristics shall be specified.

10.1.5 For sizes not included in Tables 17 and 18, the allowable lead variation is equal to 0.57735 times one-half the pitch diameter tolerance. This is the lead variation that causes a change in functional diameter equal to one-half the pitch diameter tolerance. The allowable flank half-angle variation in minutes of arc is equal to 125 divided by the square root of pitch for pitch diameter tolerance grade 6 and 80 divided by the square root of pitch for pitch diameter tolerance grade 4. For other standard tolerance grades, multiply allowable angle variations for tolerance grade 6 by the multipliers in para. 6.6.1.1. Round calculated angle variations to the nearest 5 min.

10.1.6 For requirements of paras. 10.1.4 and 10.1.5, lead variation values tabulated or calculated are the maximum variations from specified lead between any two points not farther apart than the length of the standard GO thread gage. (See ASME B47.1.) Flank angle variation values are maximum variations from the basic 30 deg angle between thread flanks and perpendiculars to the thread axis.

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Table 16A Example of External Screw Thread, Standard Size

Thread Size = M12 x 1.75–4g6g		
Characteristic Description	**Example of Size Calculation**	**Additional Information**
(1) Maximum external major diameter ($d$max.) = Basic major diameter ($d$bsc) – allowance (es)	$d$max. = $d$bsc – $\lvert es \rvert$; $\lvert es \rvert$ is absolute value	. . .
	$d$bsc = 12.000	From thread size.
	$\lvert es_g \rvert$ = 0.034	From Allowance in Table 13.
	$d$max. = 12.000 – 0.034 = 11.966	Final value is rounded to three decimal places so no further rounding is necessary.
(2) Minimum external major diameter ($d$min.) = Maximum external major diameter ($d$max.) – major diameter tolerance (Td)	$d$min. = $d$max. – Td	. . .
	$d$max. = 11.966	[See Table 16A, (1).]
	Td = 0.265	From Major Diameter Tolerance in Table 10.
	$d$min. = 11.966 – 0.265 = 11.701	Final value is rounded to three decimal places so no further rounding is necessary.
(3) Maximum external pitch diameter ($d_2$max.) = Basic major diameter ($d$bsc) – allowance (es) – 0.6495191P or maximum external major diameter ($d$max.) – 0.6495191P	$d_2$max. = $d$max. – 0.6495191P	. . .
	$d$max. = 11.966	[See Table 16A, (1).]
	0.6495191P = (0.6495191)(1.75)	. . .
	0.6495191P = 1.1366584	This figure is rounded to five decimal places which is two places beyond the three decimal place final value of $d_2$max.
	0.6495191P = 1.13666	This value may also be found in Thread Data in Table 2.
	$d_2$max. = 11.966 – 1.13666	. . .
	$d_2$max. = 10.82934	This figure is rounded to three decimal places to obtain the final value of $d_2$max.
	$d_2$max. = 10.829, when rounded	. . .
(4) Minimum external pitch diameter ($d_2$min.) = Maximum external pitch diameter ($d_2$max.) – external pitch diameter tolerance (Td_2)	$d_2$min. = $d_2$max. – Td_2	. . .
	$d_2$max. = 10.829	[See Table 16A, (3).]
	Td_2 = 0.095	From Pitch Diameter Tolerance in Table 11.
	$d_2$min. = 10.829 – 0.095 = 10.734	Final value is rounded to three decimal places so no further rounding is necessary.

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Table 16A Example of External Screw Thread, Standard Size (Cont'd)

Thread Size = M12 x 1.75–4g6g		
Characteristic Description	**Example of Size Calculation**	**Additional Information**
(5) Maximum external minor diameter ($d_1$max.) (flat form) = Maximum external pitch diameter ($d_2$max.) − 0.4330127P	$d_1$max. = $d_2$max. − 0.4330127P	. . .
	$d_2$max. = 10.829	[See Table 16A, (3).]
	0.4330127P = (0.4330127)(1.75)	. . .
	0.4330127P = 0.7577722	This figure is rounded to five decimal places which is two places beyond the three decimal place final value of $d_1$max.
	0.4330127P = 0.75777	This value may also be found in Thread Data in Table 2.
	$d_1$max. = 10.829 − 0.75777	. . .
	$d_1$max. = 10.07123	This figure is rounded to three decimal places to obtain the final value of $d_1$max.
	$d_1$max. = 10.071, when rounded	. . .
(6) For Reference: Minimum external minor diameter ($d_3$min.) (round form) = Minimum external pitch diameter ($d_2$min.) − 0.6160254P	$d_3$min. = $d_2$min. − 0.6160254P	. . .
	$d_2$min. = 10.734	[See Table 16A, (4).]
	0.6160254P = (0.6160254)(1.75)	. . .
	0.6160254P = 1.0780445	This figure is rounded to five decimal places which is two places beyond the three decimal place final value of $d_3$min.
	0.6160254P = 1.07804	This value may also be found in Thread Data in Table 2.
	$d_3$min. = 10.734 − 1.07804 = 9.65596	This figure is rounded to three decimal places to obtain the final value of $d_3$min.
	$d_3$min. = 9.656, when rounded	. . .

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Table 16B Example of Internal Metric Screw Thread, Standard Size

Thread Size = M12 x 1.75–6H		
Characteristic Description	**Example of Size Calculation**	**Additional Information**
(1) Minimum internal major diameter (Dmin.)	Dmin. = Dbsc + $\lvert El \rvert$; $\lvert El \rvert$ is absolute value	. . .
= Basic internal major diameter (Dbsc) + allowance (El)	Dbsc = $d$bsc = 12.000	From thread size.
	$\lvert El_H \rvert = 0$	From Allowance in Table 13.
	Dmin. = 12.000 + 0.000 = 12.000	Final value is rounded to three decimal places so no further rounding is necessary.
(2) Minimum internal pitch diameter (D_2min.)	D_2min. = Dmin. − 0.6495191P	. . .
= Basic internal major diameter	Dmin. = 12.000	[See Table 16B, (1).]
(Dbsc) − 0.6495191P + allowance (El)	0.6495191P = 0.6495191 (1.75)	. . .
or minimum internal major diameter (Dmin.) − 0.6495191P	0.6495191P = 1.1366584	This figure is rounded to five decimal places which is two places beyond the three decimal place final value of D_2min.
	0.6495191P = 1.13666	This value may also be found in Thread Data in Table 2.
	D_2min. = 12.000 − 1.13666	. . .
	D_2min. = 10.86334	This figure is rounded to obtain the final value of minimum pitch diameter.
	D_2min. = 10.863, when rounded	. . .
(3) Maximum internal pitch diameter (D_2max.)	D_2max. = D_2min. + TD_2	. . .
= Minimum internal pitch diameter (D_2min.) + internal pitch diameter tolerance (TD_2)	D_2min. = 10.863	[See Table 16B, (2).]
	TD_2 (6) = 0.200	From Pitch Diameter Tolerance in Table 12.
	D_2max. = 10.863 + 0.200 = 11.063	Final value is rounded to three decimal places so no further rounding is necessary.
(4) Minimum internal minor diameter (D_1min.)	D_1min. = Dmin. − 1.0825318P	. . .
= Minimum internal major diameter (Dmin.) − 1.0825318P	Dmin. = 12.000	[See Table 16B, (1).]
	1.0825318P = (1.0825318)(1.75)	. . .
	1.0825318P = 1.8944306	This figure is rounded to five decimal places which is two places beyond the three decimal place final value D_1min.
	1.0825318P = 1.89443	This value may also be found in Thread Data in Table 2.
	D_1min. = 12.000 − 1.89443	. . .
	D_1min. = 10.10557	This figure is rounded to three decimal places to obtain the final value of minimum pitch diameter.
	D_1min. = 10.106, when rounded	. . .

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Table 16B Example of Internal Metric Screw Thread, Standard Size (Cont'd)

Thread Size = M12 x 1.75–6H		
Characteristic Description	**Example of Size Calculation**	**Additional Information**
(5) Maximum internal minor diameter (D_1max.) = Minimum internal minor diameter (D_1min.) + internal minor diameter tolerance (TD_1)	D_1max. = D_1min. + TD_1	. . .
	D_1min. = 10.106	[See Table 16B, (4).]
	TD_1 (6) = 0.335	From Minor Diameter Tolerance in Table 9.
	D_1max. = 10.106 + 0.335 = 10.441	Final value is rounded to three decimal places so no further rounding is necessary.
(6) For Reference: Maximum internal major diameter (Dmax.) = Maximum internal pitch diameter (D_2max.) + 0.7938566P	Dmax. = D_2max. + 0.7938566P	. . .
	D_2max. = 11.063	[See Table 16B, (3).]
	0.7938566P = (0.7938566) 1.75	. . .
	0.7938566P = 1.3892490	This figure is rounded to five decimal places which is two places beyond the three decimal place final value of Dmax.
	0.7938566P = 1.38925	This value may also be found in Thread Data in Table 2.
	Dmax. = 11.063 + 1.38925	. . .
	Dmax. = 12.45225	This figure is rounded to three decimal places to obtain the final value of maximum major diameter.
	Dmax. = 12.452, when rounded	. . .

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Table 16C Example of External Metric Screw Thread, Non-Standard Size

Thread Size = M13 x 0.9–4g6g

Characteristic Description	Example of Size Calculation	Additional Information
(1) Maximum external major diameter ($d$max.) = Basic major diameter ($d$bsc) – allowance (es)	$d$max. = $d$bsc – $\lvert es \rvert$; $\lvert es \rvert$ is absolute value	. . .
	$d$bsc = 13.000	This is the final value of the basic major diameter and is therefore expressed with three decimal places.
	$\lvert es_g \rvert = 0.015 + 0.011P$	es for tolerance position g is not tabulated for $P = 0.9$ so it must be calculated.
	$\lvert es_g \rvert = 0.015 + 0.011(0.9)$	. . .
	$\lvert es_g \rvert = 0.0249$	This figure is rounded to three decimal places to obtain the final absolute value of allowance for tolerance position g.
	$\lvert es_g \rvert$ = 0.025, when rounded	. . .
	$d$max. = 13.000 – 0.025 = 12.975	Final value is rounded to three decimal places so no further rounding is necessary.
(2) Minimum external major diameter ($d$min.) = Maximum external major diameter ($d$max.) – tolerance (Td)	$d$min. = $d$max. – Td	. . .
	$d$max. = 12.975	[See Table 16C, (1).]
	$Td\ (6) = 0.18\sqrt[3]{P^2} - \frac{0.00315}{\sqrt{P}}$	Td for tolerance grade 6 is not tabulated for $P = 0.9$ so it must be calculated.
	$Td\ (6) = 0.18\sqrt[3]{0.9^2} - \frac{0.00315}{\sqrt{0.9}}$	. . .
	$Td\ (6) = 0.18\sqrt[3]{0.81000} - \frac{0.00315}{0.94868}$	. . .
	$Td\ (6) = 0.18\ (0.93217) - \frac{0.00315}{0.94868}$	. . .
	Td (6) = 0.16779–0.00332	. . .
	Td (6) = 0.16447	This figure is rounded to three decimal places to obtain the final value of major diameter tolerance for tolerance grade 6.
	Td (6) = 0.164, when rounded	. . .
	$d$min. = 12.975 – 0.164 = 12.811	Final value is rounded to three decimal places so no further rounding is necessary.
(3) Maximum external pitch diameter ($d_2$max.) = [Basic major diameter ($d$bsc) – allowance (es)] – 06495191P or maximum external major diameter ($d$max.) – 06495191P	$d_2$max. = $d$max. – 0.6495191P	. . .
	$d$max. = 12.975	[See Table 16C, (1).]
	0.6495191P = 0.6495191(0.9)	. . .
	0.6495191P = 0.5845672	This figure is rounded to five decimal places to obtain the final value.
	0.6495191P = 0.58457	. . .
	$d_2$max. = 12.975 – 0.58457	. . .
	$d_2$max. = 12.39043	This figure is rounded to obtain the final value of $d_2$max.
	$d_2$max. = 12.390, when rounded	. . .

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Table 16C Example of External Metric Screw Thread, Non-Standard Size (Cont'd)

Thread Size = M13 x 0.9–4g6g		
Characteristic Description	**Example of Size Calculation**	**Additional Information**
(4) Minimum external pitch diameter ($d_2$min.) = Maximum external pitch diameter ($d_2$max.) – external pitch diameter tolerance (Td_2)	$d_2$min. = $d_2$max. – Td_2	. . .
	$d_2$max. = 12.390	[See Table 16C, (3).]
	Td_2 (4) = 0.63Td_2 (6)	Td_2 for tolerance grade 4 is not tabulated for P=0.9 so it must be calculated.
	Td_2 (4) = 0.63 [0.09$P^{0.4}d^{0.1}$]	. . .
	Td_2 (4) = 0.63 [0.09 $(0.9)^{0.4}(13)^{0.1}$]	. . .
	Td_2 (4) = 0.63 [0.09 (0.95873) (1.29239)]	. . .
	Td_2 (4) = 0.63 [(0.09)(1.23905)]	. . .
	Td_2 (4) = (0.63)(0.11151)	. . .
	Td_2 (4) = 0.07025	This figure is rounded to three decimal places to obtain the final value of pitch diameter tolerance for tolerance grade 4.
	Td_2 (4) = 0.070, when rounded	. . .
	$d_2$min. = 12.390 – 0.070 = 12.320	Final value is rounded to three decimal places so no further rounding is necessary.
(5) Maximum external minor diameter ($d_1$max.) (flat form) = Maximum external pitch diameter ($d_2$max.) – 0.4330127P	$d_1$max. = $d_2$max. – 0.4330127P	. . .
	$d_2$max. = 12.390	[See Table 16C, (3).]
	0.4330127P = 0.4330127 (0.9)	. . .
	0.4330127P = 0.3897114	This figure is rounded to five decimal places, which is two decimal places beyond the three decimal place value of $d_1$max.
	0.4330127P = 0.38971	. . .
	$d_1$max. = 12.390 – 0.38971	. . .
	$d_1$max. = 12.00029	This figure is rounded to three decimal places to obtain the final value of maximum minor diameter
	$d_1$max. = 12.000, when rounded	. . .
(6) For Reference: Minimum external minor diameter ($d_3$min.)(round form) = Minimum external pitch diameter ($d_2$min.) – 0.6160254P	$d_3$min. = $d_2$min. – 0.6160254P	. . .
	$d_2$min. = 12.320	[See Table 16C, (4).]
	0.6160254P = 0.6160254 (0.9)	. . .
	0.6160254P = 0.5544229	This figure is rounded to five decimal places, which is two decimal places beyond the three decimal place final value of $d_3$min.
	0.6160254P = 0.55442	. . .
	$d_3$min. = 12.320 – 0.55442	. . .
	$d_3$min. = 11.76558	This figure is rounded to obtain the final value of minimum minor diameter.
	$d_3$min. = 11.766, when rounded	. . .

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Table 16D Example of Internal Metric Screw Thread, Non-Standard Size

Thread Size = M13 x 0.9–6H		
Characteristic Description	**Example of Size Calculation**	**Additional Information**
(1) Minimum internal major diameter (*D*min.) = Basic internal major diameter (*D*bsc) + allowance (*EI*)	*D*min. = *D*bsc + |*EI*|; |*EI*| is absolute value	. . .
	*D*bsc = *d*bsc = 13.000	[See Table 16C, (1)]
	$EI_H = 0$	From Allowance for tolerance position *H* in Table 13.
	*D*min. = 13.000 + 0.000 = 13.000	Final value is rounded to three decimal places so no further rounding is necessary.
(2) Minimum internal pitch diameter (D_2min.) = Basic internal major diameter (*D*min.) − 0.6495191*P* + allowance (*EI*); or minimum internal major diameter (*D*min.) − 0.6495191*P*	D_2min. = *D*min. − 0.6495191*P*	. . .
	*D*min. = 13.000	[See Table 16D, (1).]
	0.6495191*P* = 0.6495191 (0.9)	. . .
	0.6495191*P* = 0.5845672	This figure is rounded to five decimal places, which is two places beyond the three decimal place final value of D_2min.
	0.6495191*P* = 0.58457	. . .
	D_2min. = 13.000 − 0.58457	. . .
	D_2min. = 12.41543	This figure is rounded to obtain the final value of minimum pitch diameter.
	D_2min. = 12.415, when rounded	. . .
(3) Maximum internal pitch diameter (D_2max.) = Minimum internal pitch diameter (D_2min.) + internal pitch diameter tolerance (TD_2)	D_2max. = D_2min. + TD_2	. . .
	D_2min. = 12.415	[See Table 16D, (2).]
	TD_2 (6) = 1.32Td_2 (6)	TD_2 (or Td_2) for tolerance grade 6 is not tabulated for *P* = 0.9 so it must be calculated.
	TD_2 (6) = 1.32 [$0.09P^{0.4}d^{0.1}$]	. . .
	TD_2 (6) = 1.32 [$0.09\ (0.9)^{0.4}(13)^{0.1}$]	. . .
	TD_2 (6) = 1.32 [0.09 (0.95873)(1.29239)]	. . .
	TD_2 (6) = 0.14720	This figure is rounded to three decimal places to obtain the final value of pitch diameter tolerance for tolerance grade 6.
	TD_2 (6) = 0.147, when rounded	. . .
	D_2max. = 12.415 + 0.147 = 12.562	Final value is rounded to three decimal places so no further rounding is necessary.
(4) Minimum internal minor diameter (D_1min.) = Minimum internal major diameter (*D*min.) − 1.0825318*P*	D_1min. = *D*min. − 1.0825318*P*	. . .
	*D*min. = 13.000	[See Table 16D, (1).]
	1.0825318*P* = 1.0825318 (0.9)	. . .
	1.0825318*P* = 0.9742786	This figure is rounded to five decimal places, which is two places beyond the three decimal place final value of D_1min.
	1.0825318*P* = 0.97428	. . .
	D_1min. = 13.000 − 0.97428	. . .
	D_1min. = 12.02572	This figure is rounded to three decimal places to obtain the final value of minimum pitch diameter
	D_1min. = 12.026, when rounded	. . .

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Table 16D Example of Internal Metric Screw Thread, Non-Standard Size (Cont'd)

Thread Size = M13 x 0.9–6H		
Characteristic Description	**Example of Size Calculation**	**Additional Information**
(5) Maximum internal minor diameter (D_1max.) = Minimum internal minor diameter (D_1min.) + tolerance (TD_1)	D_1max. = D_1min. + TD_1	. . .
	D_1min. = 12.026	[See Table 16D, (4).]
	TD_1 (6) = 0.218	P = 0.9 is not tabulated nor is there any ISO formula applicable to this pitch. Therefore, a tolerance midway between the tabulated values for P = 0.8 and P = 1.0 has been selected. This value is TD_1 (6) = 0.218.
	D_1max. = 12.026 + 0.218 = 12.244	Final value is rounded to three decimal places so no further rounding is necessary.
(6) For Reference: Maximum internal major diameter (Dmax.) = Maximum internal pitch diameter (D_2max.) + 0.7938566P	Dmax. = D_2max. + 0.7938566P	. . .
	D_2max. = 12.562	[See Table 16D, (3).]
	0.7938566P = 0.7938566 (0.9)	. . .
	0.7938566P = 0.7144709	This figure is rounded to five decimal places, which is two places beyond the three decimal place value of Dmax.
	0.7938566P = 0.71447	. . .
	Dmax. = 12.562 + 0.71447	. . .
	Dmax. = 13.27647	This figure is rounded to three decimal places to obtain the final value of maximum major diameter.
	Dmax. = 13.276, when rounded	. . .

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Table 17 Allowable Variations in Lead and Equivalent Change in Functional Diameter

(See paras. 10.1.3 through 10.1.6 for applicability.)

	External Threads			Internal Threads		
Basic Thread Designation	Tolerance Class	Allowable Variation in Lead (±)	Equivalent Change in Functional Diameter (+)	Tolerance Class	Allowable Variation in Lead (±)	Equivalent Change in Functional Diameter (−)
M1.6 × 0.35	6g	0.018	0.032	6H	0.025	0.042
	4g6g	0.012	0.020	. . .	. . .	. . .
M2 × 0.4	6g	0.019	0.034	6H	0.026	0.045
	4g6g	0.012	0.021	. . .	. . .	. . .
M2.5 × 0.45	6g	0.020	0.036	6H	0.027	0.048
	4g6g	0.013	0.022	. . .	. . .	. . .
M3 × 0.5	6g	0.022	0.038	6H	0.029	0.050
	4g6g	0.014	0.024	. . .	. . .	. . .
M3.5 × 0.6	6g	0.025	0.042	6H	0.032	0.056
	4g6g	0.015	0.026	. . .	. . .	. . .
M4 × 0.7	6g	0.026	0.045	6H	0.034	0.059
	4g6g	0.016	0.028	. . .	. . .	. . .
M5 × 0.8	6g	0.027	0.048	6H	0.036	0.062
	4g6g	0.017	0.030	. . .	. . .	. . .
M6 × 1	6g	0.032	0.056	6H	0.043	0.075
	4g6g	0.020	0.036	. . .	. . .	. . .
M8 × 1.25	6g	0.034	0.059	6H	0.046	0.080
	4g6g	0.022	0.038	. . .	. . .	. . .
M8 × 1	6g	0.032	0.056	6H	0.043	0.075
	4g6g	0.020	0.036	. . .	. . .	. . .
M10 × 1.5	6g	0.038	0.066	6H	0.052	0.090
	4g6g	0.025	0.042	. . .	. . .	. . .
M10 × 1.25	6g	0.034	0.059	6H	0.046	0.080
	4g6g	0.022	0.038	. . .	. . .	. . .
M10 × 1	6g	0.032	0.056	6H	0.043	0.075
	4g6g	0.020	0.036	. . .	. . .	. . .
M10 × 0.75	6g	0.029	0.050	6H	0.038	0.066
	4g6g	0.019	0.032	. . .	. . .	. . .
M12 × 1.75	6g	0.043	0.075	6H	0.058	0.100
	4g6g	0.027	0.048	. . .	. . .	. . .
M12 × 1.5	6g	0.040	0.070	6H	0.055	0.095
	4g6g	0.026	0.045	. . .	. . .	. . .
M12 × 1.25	6g	0.038	0.066	6H	0.052	0.090
	4g6g	0.025	0.042	. . .	. . .	. . .
M12 × 1	6g	0.034	0.059	6H	0.055	0.080
	4g6g	0.022	0.038	. . .	. . .	. . .
M14 × 2	6g	0.046	0.080	6H	0.061	0.106
	4g6g	0.029	0.050	. . .	. . .	. . .
M14 × 1.5	6g	0.040	0.070	6H	0.055	0.095
	4g6g	0.026	0.045	. . .	. . .	. . .
M15 × 1	6g	0.034	0.059	6H	0.055	0.080
	4g6g	0.022	0.038	. . .	. . .	. . .
M16 × 2	6g	0.046	0.080	6H	0.061	0.106
	4g6g	0.029	0.050	. . .	. . .	. . .
M16 × 1.5	6g	0.040	0.070	6H	0.055	0.095
	4g6g	0.026	0.045	. . .	. . .	. . .
M17 × 1	6g	0.034	0.059	6H	0.046	0.080
	4g6g	0.022	0.038	. . .	. . .	. . .

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Table 17 Allowable Variations in Lead and Equivalent Change in Functional Diameter (Cont'd)

(See paras. 10.1.3 through 10.1.6 for applicability.)

	External Threads			Internal Threads		
Basic Thread Designation	Tolerance Class	Allowable Variation in Lead (±)	Equivalent Change in Functional Diameter (+)	Tolerance Class	Allowable Variation in Lead (±)	Equivalent Change in Functional Diameter (−)
M18 × 1.5	6g	0.040	0.070	6H	0.055	0.095
	4g6g	0.026	0.045	. . .	. . .	. . .
M20 × 2.5	6g	0.049	0.085	6H	0.065	0.112
	4g6g	0.031	0.053	. . .	. . .	. . .
M20 × 1.5	6g	0.040	0.070	6H	0.055	0.095
	4g6g	0.026	0.045	. . .	. . .	. . .
M20 × 1	6g	0.034	0.059	6H	0.046	0.080
	4g6g	0.022	0.038	. . .	. . .	. . .
M22 × 2.5	6g	0.049	0.085	6H	0.065	0.112
M22 × 1.5	6g	0.040	0.070	6H	0.055	0.095
	4g6g	0.026	0.045	. . .	. . .	. . .
M24 × 3	6g	0.058	0.100	6H	0.076	0.132
	4g6g	0.036	0.062	. . .	. . .	. . .
M24 × 2	6g	0.049	0.085	6H	0.065	0.112
	4g6g	0.031	0.053	. . .	. . .	. . .
M25 × 1.5	6g	0.043	0.075	6H	0.058	0.100
	4g6g	0.025	0.042	. . .	. . .	. . .
M27 × 3	6g	0.058	0.100	6H	0.076	0.132
M27 × 2	6g	0.049	0.085	6H	0.065	0.112
	4g6g	0.031	0.053	. . .	. . .	. . .
M30 × 3.5	6g	0.061	0.106	6H	0.081	0.140
	4g6g	0.038	0.066	. . .	. . .	. . .
M30 × 2	6g	0.049	0.085	6H	0.065	0.112
	4g6g	0.031	0.053	. . .	. . .	. . .
M30 × 1.5	6g	0.043	0.075	6H	0.058	0.100
	4g6g	0.025	0.042	. . .	. . .	. . .
M33 × 2	6g	0.049	0.085	6H	0.065	0.112
	4g6g	0.031	0.053	. . .	. . .	. . .
M35 × 1.5	6g	0.043	0.075	6H	0.058	0.100
M36 × 4	6g	0.065	0.112	6H	0.087	0.150
	4g6g	0.040	0.070	. . .	. . .	. . .
M36 × 2	6g	0.049	0.085	6H	0.065	0.112
	4g6g	0.031	0.053	. . .	. . .	. . .
M39 × 2	6g	0.049	0.085	6H	0.065	0.112
	4g6g	0.031	0.053	. . .	. . .	. . .
M40 × 1.5	6g	0.043	0.075	6H	0.058	0.100
	4g6g	0.025	0.042	. . .	. . .	. . .
M42 × 4.5	6g	0.068	0.118	6H	0.091	0.158
	4g6g	0.043	0.075	. . .	. . .	. . .
M42 × 2	6g	0.049	0.085	6H	0.065	0.112
	4g6g	0.031	0.053	. . .	. . .	. . .
M45 × 1.5	6g	0.043	0.075	6H	0.058	0.100
	4g6g	0.025	0.042	. . .	. . .	. . .
M48 × 5	6g	0.072	0.125	6H	0.097	0.168
	4g6g	0.046	0.080	. . .	. . .	. . .
M48 × 2	6g	0.052	0.090	6H	0.068	0.118
	4g6g	0.032	0.056	. . .	. . .	. . .
M50 × 1.5	6g	0.046	0.080	6H	0.061	0.106
	4g6g	0.029	0.050	. . .	. . .	. . .

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Table 17 Allowable Variations in Lead and Equivalent Change in Functional Diameter (Cont'd)

(See paras. 10.1.3 through 10.1.6 for applicability.)

	External Threads			Internal Threads		
Basic Thread Designation	Tolerance Class	Allowable Variation in Lead (±)	Equivalent Change in Functional Diameter (+)	Tolerance Class	Allowable Variation in Lead (±)	Equivalent Change in Functional Diameter (−)
M55 × 1.5	6g	0.046	0.080	6H	0.061	0.106
	4g6g	0.029	0.050	. . .	. . .	. . .
M56 × 5.5	6g	0.076	0.132	6H	0.102	0.178
	4g6g	0.049	0.085	. . .	. . .	. . .
M56 × 2	6g	0.052	0.090	6H	0.068	0.118
	4g6g	0.032	0.056	. . .	. . .	. . .
M60 × 1.5	6g	0.046	0.080	6H	0.061	0.106
	4g6g	0.029	0.050	. . .	. . .	. . .
M64 × 6	6g	0.081	0.140	6H	0.108	0.188
	4g6g	0.052	0.090	. . .	. . .	. . .
M64 × 2	6g	0.052	0.090	6H	0.068	0.118
	4g6g	0.032	0.056	. . .	. . .	. . .
M65 × 1.5	6g	0.046	0.080	6H	0.061	0.106
	4g6g	0.029	0.050	. . .	. . .	. . .
M70 × 1.5	6g	0.046	0.080	6H	0.061	0.106
	4g6g	0.029	0.050	. . .	. . .	. . .
M72 × 6	6g	0.081	0.140	6H	0.108	0.188
	4g6g	0.052	0.090	. . .	. . .	. . .
M72 × 2	6g	0.052	0.090	6H	0.068	0.118
	4g6g	0.032	0.056	. . .	. . .	. . .
M75 × 1.5	6g	0.046	0.080	6H	0.061	0.106
	4g6g	0.029	0.050	. . .	. . .	. . .
M80 × 6	6g	0.081	0.140	6H	0.108	0.188
	4g6g	0.052	0.090	. . .	. . .	. . .
M80 × 2	6g	0.052	0.090	6H	0.068	0.118
	4g6g	0.032	0.056	. . .	. . .	. . .
M80 × 1.5	6g	0.046	0.080	6H	0.061	0.106
	4g6g	0.029	0.050	. . .	. . .	. . .
M85 × 2	6g	0.052	0.090	6H	0.068	0.118
	4g6g	0.032	0.056	. . .	. . .	. . .
M90 × 6	6g	0.081	0.140	6H	0.108	0.188
	4g6g	0.052	0.090	. . .	. . .	. . .
M90 × 2	6g	0.052	0.090	6H	0.068	0.118
	4g6g	0.032	0.056	. . .	. . .	. . .
M95 × 2	6g	0.055	0.095	6H	0.072	0.125
	4g6g	0.034	0.059	. . .	. . .	. . .
M100 × 6	6g	0.087	0.150	6H	0.115	0.200
	4g6g	0.055	0.095	. . .	. . .	. . .
M100 × 2	6g	0.055	0.095	6H	0.072	0.125
	4g6g	0.034	0.059	. . .	. . .	. . .
M105 × 2	6g	0.055	0.095	6H	0.072	0.125
	4g6g	0.034	0.059	. . .	. . .	. . .
M110 × 2	6g	0.055	0.095	6H	0.072	0.125
	4g6g	0.034	0.059	. . .	. . .	. . .
M120 × 2	6g	0.055	0.095	6H	0.072	0.125
	4g6g	0.034	0.059	. . .	. . .	. . .
M130 × 2	6g	0.055	0.095	6H	0.072	0.125
	4g6g	0.034	0.059	. . .	. . .	. . .

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Table 17 Allowable Variations in Lead and Equivalent Change in Functional Diameter (Cont'd)

(See paras. 10.1.3 through 10.1.6 for applicability.)

	External Threads			Internal Threads		
Basic Thread Designation	Tolerance Class	Allowable Variation in Lead (±)	Equivalent Change in Functional Diameter (+)	Tolerance Class	Allowable Variation in Lead (±)	Equivalent Change in Functional Diameter (−)
M140 × 2	6g	0.055	0.095	6H	0.072	0.125
	4g6g	0.034	0.059	. . .	. . .	. . .
M150 × 2	6g	0.055	0.095	6H	0.072	0.125
	4g6g	0.034	0.059	. . .	. . .	. . .
M160 × 3	6g	0.065	0.112	6H	0.087	0.150
	4g6g	0.040	0.070	. . .	. . .	. . .
M170 × 3	6g	0.065	0.112	6H	0.087	0.150
	4g6g	0.040	0.070	. . .	. . .	. . .
M180 × 3	6g	0.065	0.112	6H	0.087	0.150
	4g6g	0.040	0.070	. . .	. . .	. . .
M190 × 3	6g	0.072	0.125	6H	0.097	0.168
	4g6g	0.046	0.080	. . .	. . .	. . .
M200 × 3	6g	0.072	0.125	6H	0.097	0.168
	4g6g	0.046	0.080	. . .	. . .	. . .

GENERAL NOTE: All dimensions are in millimeters.

Table 18 Allowable Variations in 30 deg Basic Half-Angle of Screw Threads

External and Internal Threads				
	Allowable Variation in Half-Angle			
	Pitch Diam. Tol. Grade 6		Pitch Diam. Tol. Grade 4	
Pitch	± deg	Min.	± deg	Min.
0.35	3	30	2	15
0.4	3	20	2	05
0.45	3	05	2	00
0.5	2	55	1	55
0.6	2	40	1	45
0.7	2	30	1	35
0.75	2	25	1	30
0.8	2	20	1	30
1	2	05	1	20
1.25	1	50	1	10
1.5	1	40	1	05
1.75	1	35	1	00
2	1	30	0	55
2.5	1	20	0	50
3	1	10	0	45
3.5	1	05	0	45
4	1	05	0	40
4.5	1	00	0	40
5	0	55	0	35
5.5	0	55	0	35
6	0	50	0	35
8	0	45	0	30

GENERAL NOTE: See paras. 10.1.3 through 10.1.6 for applicability.

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NONMANDATORY APPENDIX A
STANDARD RULES FOR ROUNDING

See ASME B1.30 for rounding rules and examples.

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NONMANDATORY APPENDIX B
THREAD STRENGTH DESIGN FORMULAS

B-1 THREAD TENSILE STRESS AREA

The following tensile stress area formula is used for the purpose of product acceptance computations per ISO 898-1. This formula is based upon the area at a section midway between the basic pitch diameter and the basic rounded form minor diameter with radius of 0.144*P*.

Tensile stress Area, mm^2

$$As = 0.7854\,(d\text{bsc} - 0.9382P)^2$$

B-2 THREAD SHEAR AREA

The following formulas for thread shear areas are geometric minimum values. Shear (Thread Stripping) strength of screw threads under load are dependent, in addition, on mating component relative material strengths, nut geometry, and coefficient of friction between thread bearing surfaces. Effective shear areas are therefore somewhat less than the geometric values.

Thread Geometric Shear Areas:

$$AS_n = \frac{3.1416}{P}\,LE\,d\text{ min.}\left[\frac{P}{2} + 0.57735\,(d\text{ min.} - D_2\text{ max.})\right]$$

$$AS_s = \frac{3.1416}{P}\,LE\,D_1\text{ max.}\left[\frac{P}{2} + 0.57735\,(d_2\text{ min.} - D_1\text{ max.})\right]$$

where

AS_n = minimum thread shear area for internal threads, mm^2

AS_s = minimum thread shear area for external threads, mm^2

LE = length of engagement

B-3 LENGTH OF THREAD ENGAGEMENT

In general the length of engagement of mating threads is selected to utilize full tensile strength of a bolt prior to shearing of nut threads. Other applications may require internal thread shear prior to failure of the externally threaded part. For noncritical design, the following formulas are often used for approximation:

Tensile strength of externally threaded part, kN

$$= \frac{S_t A_s}{1\,000}$$

Shear strength of threads, kN

$$= S_t\,(AS_n \text{ or } AS_s)/2\,000$$

where

S_t = Ultimate tensile strength of material, MPa

An internationally accepted study on the subject has been published in the 1977 Transactions of the Society of Automotive Engineers as Paper number 770420, *Analysis and Design of Threaded Assemblies* by E. M. Alexander.

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NONMANDATORY APPENDIX C
LIMITING DIMENSIONS M PROFILE SCREW THREADS — INCH TRANSLATION

This Appendix (see Tables C-1 and C-2) presents an inch translation of limiting dimensions for M profile screw threads appearing in Tables 14 and 15. Data appearing here are for reference only. Dimensions have been calculated by dividing millimeter values in Tables 14 and 15, respectively, by 25.400 and rounding to 5 decimal places in accordance with ASME B1.30.

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Table C-1 Inch Translation for External Thread — Limiting Dimensions M Profile

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2), (3), and (4)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diam., (Rounded Form), d_3 [Note (5)] (For Reference)	Nominal Pitch, *P*
			Max.	Min.	Max.	Min.	Tol.			
M1.6 × 0.35	6g	0.00075	0.06224	0.05890	0.05331	0.05083	0.00248	0.04732	0.04232	0.01378
M1.6 × 0.35	6h	0.00000	0.06299	0.05965	0.05406	0.05157	0.00248	0.04807	0.04307	0.01378
M1.6 × 0.35	4g6g	0.00075	0.06224	0.05890	0.05331	0.05173	0.00158	0.04732	0.04323	0.01378
M2 × 0.4	6g	0.00075	0.07799	0.07425	0.06776	0.06512	0.00264	0.06094	0.05543	0.01575
M2 × 0.4	6h	0.00000	0.07874	0.07500	0.06850	0.06587	0.00264	0.06169	0.05618	0.01575
M2 × 0.4	4g6g	0.00075	0.07799	0.07425	0.06776	0.06610	0.00166	0.06094	0.05642	0.01575
M2.5 × 0.45	6g	0.00079	0.09764	0.09370	0.08614	0.08335	0.00280	0.07846	0.07244	0.01772
M2.5 × 0.45	6h	0.00000	0.09843	0.09449	0.08693	0.08413	0.00280	0.07925	0.07323	0.01772
M2.5 × 0.45	4g6g	0.00079	0.09764	0.09370	0.08614	0.08437	0.00177	0.07846	0.07346	0.01772
M3 × 0.5	6g	0.00079	0.11732	0.11315	0.10453	0.10157	0.00295	0.09598	0.08945	0.01969
M3 × 0.5	6h	0.00000	0.11811	0.11394	0.10531	0.10236	0.00295	0.09677	0.09024	0.01969
M3 × 0.5	4g6g	0.00079	0.11732	0.11315	0.10453	0.10264	0.00189	0.09598	0.09051	0.01969
M3.5 × 0.6	6g	0.00083	0.13697	0.13205	0.12161	0.11827	0.00335	0.11138	0.10370	0.02362
M3.5 × 0.6	6h	0.00000	0.13780	0.13287	0.12244	0.11909	0.00335	0.11220	0.10453	0.02362
M3.5 × 0.6	4g6g	0.00083	0.13697	0.13205	0.12161	0.11953	0.00208	0.11138	0.10496	0.02362
M4 × 0.7	6g	0.00087	0.15661	0.15110	0.13870	0.13516	0.00354	0.12677	0.11819	0.02756
M4 × 0.7	6h	0.00000	0.15748	0.15197	0.13957	0.13602	0.00354	0.12764	0.11906	0.02756
M4 × 0.7	4g6g	0.00087	0.15661	0.15110	0.13870	0.13650	0.00220	0.12677	0.11953	0.02756
M5 × 0.8	6g	0.00094	0.19591	0.19000	0.17543	0.17169	0.00374	0.16181	0.15228	0.03150
M5 × 0.8	6h	0.00000	0.19685	0.19094	0.17638	0.17264	0.00374	0.16276	0.15323	0.03150
M5 × 0.8	4g6g	0.00094	0.19591	0.19000	0.17543	0.17307	0.00236	0.16181	0.15366	0.03150
M6 × 1	6g	0.00102	0.23520	0.22811	0.20961	0.20520	0.00441	0.19256	0.18094	0.03937
M6 × 1	6h	0.00000	0.23622	0.22913	0.21063	0.20622	0.00441	0.19358	0.18197	0.03937
M6 × 1	4g6g	0.00102	0.23520	0.22811	0.20961	0.20681	0.00280	0.19256	0.18256	0.03937
M8 × 1.25	6g	0.00110	0.31386	0.30551	0.28189	0.27724	0.00465	0.26059	0.24693	0.04921
M8 × 1.25	6h	0.00000	0.31496	0.30661	0.28299	0.27835	0.00465	0.26169	0.24803	0.04921
M8 × 1.25	4g6g	0.00110	0.31386	0.30551	0.28189	0.27894	0.00295	0.26059	0.24862	0.04921
M8 × 1	6g	0.00102	0.31394	0.30685	0.28835	0.28394	0.00441	0.27130	0.25969	0.03937
M8 × 1	6h	0.00000	0.31496	0.30787	0.28937	0.28496	0.00441	0.27232	0.26071	0.03937
M8 × 1	4g6g	0.00102	0.31394	0.30685	0.28835	0.28555	0.00280	0.27130	0.26130	0.03937
M10 × 1.5	6g	0.00126	0.39244	0.38315	0.35409	0.34890	0.00520	0.32850	0.31252	0.05906
M10 × 1.5	6h	0.00000	0.39370	0.38441	0.35535	0.35016	0.00520	0.32976	0.31378	0.05906

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Table C-1 Inch Translation for External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2), (3), and (4)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diam. (Rounded Form), d_3 [Note (5)] (For Reference)	Nominal Pitch, *P*
			Max.	Min.	Max.	Min.	Tol.			
M10 × 1.5	4g6g	0.00126	0.39244	0.38315	0.35409	0.35075	0.00334	0.32850	0.31437	0.05906
M10 × 1.25	6g	0.00110	0.39260	0.38425	0.36063	0.35598	0.00465	0.33933	0.32567	0.04921
M10 × 1.25	6h	0.00000	0.39370	0.38535	0.36173	0.35709	0.00465	0.34043	0.32677	0.04921
M10 × 1.25	4g6g	0.00110	0.39260	0.38425	0.36063	0.35768	0.00295	0.33933	0.32736	0.04921
M10 × 1	6g	0.00102	0.39268	0.38559	0.36709	0.36268	0.00441	0.35004	0.33843	0.03937
M10 × 1	6h	0.00000	0.39370	0.38661	0.36811	0.36370	0.00441	0.35106	0.33945	0.03937
M10 × 1	4g6g	0.00102	0.39268	0.38559	0.36709	0.36429	0.00280	0.35004	0.34004	0.03937
M10 × 0.75	6g	0.00087	0.39283	0.38732	0.37366	0.36972	0.00394	0.36087	0.35154	0.02953
M10 × 0.75	6h	0.00000	0.39370	0.38819	0.37453	0.37059	0.00394	0.36173	0.35240	0.02953
M10 × 0.75	4g6g	0.00087	0.39283	0.38732	0.37366	0.37118	0.00248	0.36087	0.35299	0.02953
M12 × 1.75	6g	0.00134	0.47110	0.46067	0.42634	0.42023	0.00591	0.39650	0.37799	0.06890
M12 × 1.75	6h	0.00000	0.47244	0.46201	0.42768	0.42177	0.00591	0.39783	0.37933	0.06890
M12 × 1.75	4g6g	0.00134	0.47110	0.46067	0.42634	0.42260	0.00374	0.39650	0.38016	0.06890
M12 × 1.5	6g	0.00126	0.47118	0.46189	0.43283	0.42732	0.00551	0.40724	0.39094	0.05906
M12 × 1.5	6h	0.00000	0.47244	0.46315	0.43409	0.42858	0.00551	0.40850	0.39220	0.05906
M12 × 1.5	4g6g	0.00126	0.47118	0.46189	0.43283	0.42929	0.00354	0.40724	0.39291	0.05906
M12 × 1.25	6g	0.00110	0.47134	0.46299	0.43937	0.43417	0.00520	0.41807	0.40386	0.04921
M12 × 1.25	6h	0.00000	0.47244	0.46409	0.44047	0.43528	0.00520	0.41917	0.40496	0.04921
M12 × 1.25	4g6g	0.00110	0.47134	0.46299	0.43937	0.43602	0.00335	0.41807	0.40571	0.04921
M12 × 1	6g	0.00102	0.47142	0.46433	0.44583	0.44118	0.00465	0.42878	0.41693	0.03937
M12 × 1	6h	0.00000	0.47244	0.46535	0.44685	0.44220	0.00465	0.42980	0.41795	0.03937
M12 × 1	4g6g	0.00102	0.47142	0.46433	0.44583	0.44287	0.00296	0.42878	0.41862	0.03937
M14 × 2	6g	0.00150	0.54969	0.53866	0.49854	0.49224	0.00630	0.46445	0.44374	0.07874
M14 × 2	6h	0.00000	0.55118	0.54016	0.50004	0.49374	0.00630	0.46594	0.44524	0.07874
M14 × 2	4g6g	0.00150	0.54969	0.53866	0.49854	0.49461	0.00393	0.46445	0.44610	0.07874
M14 × 1.5	6g	0.00126	0.54992	0.54063	0.51157	0.50606	0.00551	0.48598	0.46969	0.05906
M14 × 1.5	6h	0.00000	0.55118	0.54189	0.51283	0.50732	0.00551	0.48724	0.47094	0.05906
M14 × 1.5	4g6g	0.00126	0.54992	0.54063	0.51157	0.50803	0.00354	0.48598	0.47165	0.05906
M15 × 1	6g	0.00102	0.58953	0.58244	0.56394	0.55929	0.00465	0.54689	0.53504	0.03937
M15 × 1	6h	0.00000	0.59055	0.58346	0.56496	0.56031	0.00465	0.54791	0.53606	0.03937
M15 × 1	4g6g	0.00102	0.58953	0.58244	0.56394	0.56098	0.00296	0.54689	0.53673	0.03937
M16 × 2	6g	0.00150	0.62843	0.61740	0.57728	0.57098	0.00630	0.54319	0.52248	0.07874
M16 × 2	6h	0.00000	0.62992	0.61890	0.57878	0.57248	0.00630	0.54469	0.52398	0.07874
M16 × 2	4g6g	0.00150	0.62843	0.61740	0.57728	0.57335	0.00393	0.54319	0.52484	0.07874

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Table C-1 Inch Translation for External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2), (3), and (4)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diam. (Rounded Form), d_3 [Note (5)] (For Reference)	Nominal Pitch, *P*
			Max.	Min.	Max.	Min.	Tol.			
M16 × 1.5	6g	0.00126	0.62866	0.61937	0.59031	0.58480	0.00551	0.56472	0.54843	0.05906
M16 × 1.5	6h	0.00000	0.62992	0.62063	0.59157	0.58606	0.00551	0.56598	0.54969	0.05906
M16 × 1.5	4g6g	0.00126	0.62866	0.61937	0.59031	0.58677	0.00354	0.56472	0.55039	0.05906
M17 × 1	6g	0.00102	0.66827	0.66118	0.64268	0.63803	0.00465	0.62563	0.61378	0.03937
M17 × 1	6h	0.00000	0.66929	0.66220	0.64370	0.63906	0.00465	0.62665	0.61480	0.03937
M17 × 1	4g6g	0.00102	0.66827	0.66118	0.64268	0.63972	0.00296	0.62563	0.61547	0.03937
M18 × 1.5	6g	0.00126	0.70740	0.69811	0.66906	0.66354	0.00551	0.64346	0.62717	0.05906
M18 × 1.5	6h	0.00000	0.70866	0.69937	0.67031	0.66480	0.00551	0.64472	0.62843	0.05906
M18 × 1.5	4g6g	0.00126	0.70740	0.69811	0.66906	0.66551	0.00355	0.64346	0.62913	0.05906
M20 × 2.5	6g	0.00165	0.78575	0.77256	0.72181	0.71512	0.00669	0.67917	0.65449	0.09843
M20 × 2.5	6h	0.00000	0.78740	0.77421	0.72346	0.71677	0.00669	0.68083	0.65614	0.09843
M20 × 2.5	4g6g	0.00165	0.78575	0.77256	0.72181	0.71764	0.00417	0.67917	0.65701	0.09843
M20 × 1.5	6g	0.00126	0.78614	0.77685	0.74780	0.74228	0.00551	0.72220	0.70591	0.05906
M20 × 1.5	6h	0.00000	0.78740	0.77811	0.74906	0.74354	0.00551	0.72346	0.70717	0.05906
M20 × 1.5	4g6g	0.00126	0.78614	0.77685	0.74780	0.74425	0.00355	0.72220	0.70787	0.05906
M20 × 1	6g	0.00102	0.78638	0.77929	0.76079	0.75614	0.00465	0.74374	0.73189	0.03937
M20 × 1	6h	0.00000	0.78740	0.78031	0.76181	0.75717	0.00465	0.74476	0.73291	0.03937
M20 × 1	4g6g	0.00102	0.78638	0.77929	0.76079	0.75783	0.00296	0.74374	0.73358	0.03937
M22 × 2.5	6g	0.00165	0.86449	0.85130	0.80055	0.79386	0.00669	0.75791	0.73323	0.09843
M22 × 2.5	6h	0.00000	0.86614	0.85295	0.80220	0.79551	0.00669	0.75957	0.73488	0.09843
M22 × 1.5	6g	0.00126	0.86488	0.85559	0.82654	0.82102	0.00551	0.80094	0.78465	0.05906
M22 × 1.5	6h	0.00000	0.86614	0.85685	0.82780	0.82228	0.00551	0.80220	0.78591	0.05906
M22 × 1.5	4g6g	0.00126	0.86488	0.85559	0.82654	0.82299	0.00355	0.80094	0.78661	0.05906
M24 × 3	6g	0.00189	0.94299	0.92823	0.86626	0.85839	0.00787	0.81512	0.78563	0.11811
M24 × 3	6h	0.00000	0.94488	0.93012	0.86815	0.86028	0.00787	0.81701	0.78752	0.11811
M24 × 3	4g6g	0.00189	0.94299	0.92823	0.86626	0.86134	0.00492	0.81512	0.78858	0.11811
M24 × 2	6g	0.00150	0.94339	0.93236	0.89224	0.88555	0.00669	0.85815	0.83705	0.07874
M24 × 2	6h	0.00000	0.94488	0.93386	0.89374	0.88705	0.00669	0.85965	0.83854	0.07874
M24 × 2	4g6g	0.00150	0.94339	0.93236	0.89224	0.88807	0.00417	0.85815	0.83957	0.07874
M25 × 1.5	6g	0.00126	0.98299	0.97370	0.94465	0.93874	0.00591	0.91906	0.90236	0.05906
M25 × 1.5	6h	0.00000	0.98425	0.97496	0.94591	0.94000	0.00591	0.92031	0.90362	0.05906
M25 ×1.5	4g6g	0.00126	0.98299	0.97370	0.94465	0.94091	0.00374	0.91906	0.90453	0.05906

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Table C-1 Inch Translation for External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2), (3), and (4)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diam. (Rounded Form), d_3 [Note (5)] (For Reference)	Nominal Pitch, *P*
			Max.	Min.	Max.	Min.	Tol.			
M27 × 3	6g	0.00189	1.06110	1.04634	0.98437	0.97650	0.00787	0.93323	0.90374	0.11811
M27 × 3	6h	0.00000	1.06299	1.04823	0.98626	0.97839	0.00787	0.93512	0.90563	0.11811
M27 × 2	6g	0.00150	1.06150	1.05047	1.01035	1.00366	0.00669	0.97626	0.95516	0.07874
M27 × 2	6h	0.00000	1.06299	1.05197	1.01185	1.00516	0.00669	0.97776	0.95665	0.07874
M27 × 2	4g6g	0.00150	1.06150	1.05047	1.01035	1.00618	0.00417	0.97626	0.95768	0.07874
M30 × 3.5	6g	0.00209	1.17902	1.16228	1.08953	1.08118	0.00835	1.02984	0.99630	0.13780
M30 × 3.5	6h	0.00000	1.18110	1.16437	1.09161	1.08327	0.00835	1.03193	0.99839	0.13780
M30 × 3.5	4g6g	0.00209	1.17902	1.16228	1.08953	1.08433	0.00520	1.02984	0.99945	0.13780
M30 × 2	6g	0.00150	1.17961	1.16858	1.12846	1.12177	0.00669	1.09437	1.07327	0.07874
M30 × 2	6h	0.00000	1.18110	1.17008	1.12996	1.12327	0.00669	1.09587	1.07476	0.07874
M30 × 2	4g6g	0.00150	1.17961	1.16858	1.12846	1.12429	0.00417	1.09437	1.07579	0.07874
M30 × 1.5	6g	0.00126	1.17984	1.17055	1.14150	1.13559	0.00591	1.11591	1.09921	0.05906
M30 × 1.5	6h	0.00000	1.18110	1.17181	1.14276	1.13685	0.00591	1.11717	1.10047	0.05906
M30 × 1.5	4g6g	0.00126	1.17984	1.17055	1.14150	1.13776	0.00374	1.11591	1.10138	0.05906
M33 × 2	6g	0.00150	1.29772	1.28669	1.24657	1.23988	0.00669	1.21248	1.19138	0.07874
M33 × 2	6h	0.00000	1.29921	1.28819	1.24807	1.24138	0.00669	1.21398	1.19287	0.07874
M33 × 2	4g6g	0.00150	1.29772	1.28669	1.24657	1.24240	0.00417	1.21248	1.19390	0.07874
M35 × 1.5	6g	0.00126	1.37669	1.36740	1.33835	1.33244	0.00591	1.31276	1.29606	0.05906
M35 × 1.5	6h	0.00000	1.37795	1.36866	1.33961	1.33370	0.00591	1.31402	1.29732	0.05906
M36 × 4	6g	0.00236	1.41496	1.39626	1.31268	1.30386	0.00882	1.24449	1.20685	0.15748
M36 × 4	6h	0.00000	1.41732	1.39862	1.31504	1.30622	0.00882	1.24685	1.20921	0.15748
M36 × 4	4g6g	0.00236	1.41496	1.39626	1.31268	1.30717	0.00551	1.24449	1.21016	0.15748
M36 × 2	6g	0.00150	1.41583	1.40480	1.36469	1.35799	0.00669	1.33059	1.30949	0.07874
M36 × 2	6h	0.00000	1.41732	1.40630	1.36618	1.35949	0.00669	1.33209	1.31098	0.07874
M36 × 2	4g6g	0.00150	1.41583	1.40480	1.36469	1.36051	0.00418	1.33059	1.31201	0.07874
M39 × 2	6g	0.00150	1.53394	1.52291	1.48280	1.47610	0.00669	1.44870	1.42760	0.07874
M39 × 2	6h	0.00000	1.53543	1.52441	1.48429	1.47760	0.00669	1.45020	1.42909	0.07874
M39 × 2	4g6g	0.00150	1.53394	1.52291	1.48280	1.47862	0.00418	1.44870	1.43012	0.07874
M40 × 1.5	6g	0.00126	1.57354	1.56425	1.53520	1.52929	0.00591	1.50961	1.49291	0.05906
M40 × 1.5	6h	0.00000	1.57480	1.56551	1.53646	1.53055	0.00591	1.51087	1.49417	0.05906
M40 × 1.5	4g6g	0.00126	1.57354	1.56425	1.53520	1.53146	0.00374	1.50961	1.49508	0.05906
M42 × 4.5	6g	0.00248	1.65106	1.63138	1.53598	1.52669	0.00929	1.45925	1.41756	0.17717
M42 × 4.5	6h	0.00000	1.65354	1.63386	1.53846	1.52917	0.00929	1.46173	1.42004	0.17717

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Table C-1 Inch Translation for External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2), (3), and (4)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diam. (Rounded Form), d_3 [Note (5)] (For Reference)	Nominal Pitch, *P*
			Max.	Min.	Max.	Min.	Tol.			
M42 × 4.5	4g6g	0.00248	1.65106	1.63138	1.53598	1.53008	0.00590	1.45925	1.42094	0.17717
M42 × 2	6g	0.00150	1.65205	1.64102	1.60091	1.59421	0.00669	1.56681	1.54571	0.07874
M42 × 2	6h	0.00000	1.65354	1.64252	1.60240	1.59571	0.00669	1.56831	1.54720	0.07874
M42 × 2	4g6g	0.00150	1.65205	1.64102	1.60091	1.59673	0.00418	1.56681	1.54823	0.07874
M45 × 1.5	6g	0.00126	1.77039	1.76110	1.73205	1.72614	0.00591	1.70646	1.68976	0.05906
M45 × 1.5	6h	0.00000	1.77165	1.76236	1.73331	1.72740	0.00591	1.70772	1.69102	0.05906
M45 × 1.5	4g6g	0.00126	1.77039	1.76110	1.73205	1.72831	0.00374	1.70646	1.69193	0.05906
M48 × 5	6g	0.00280	1.88697	1.86610	1.75909	1.74925	0.00984	1.67386	1.62799	0.19685
M48 × 5	6h	0.00000	1.88976	1.86890	1.76189	1.75205	0.00984	1.67665	1.63079	0.19685
M48 × 5	4g6g	0.00280	1.88697	1.86610	1.75909	1.75280	0.00629	1.67386	1.63154	0.19685
M48 × 2	6g	0.00150	1.88827	1.87724	1.83713	1.83004	0.00709	1.80303	1.78154	0.07874
M48 × 2	6h	0.00000	1.88976	1.87874	1.83862	1.83154	0.00709	1.80453	1.78303	0.07874
M48 × 2	4g6g	0.00150	1.88827	1.87724	1.83713	1.83272	0.00441	1.80303	1.78421	0.07874
M50 × 1.5	6g	0.00126	1.96724	1.95795	1.92890	1.92260	0.00630	1.90331	1.88622	0.05906
M50 × 1.5	6h	0.00000	1.96850	1.95921	1.93016	1.92386	0.00630	1.90457	1.88748	0.05906
M50 × 1.5	4g6g	0.00126	1.96724	1.95795	1.92890	1.92496	0.00394	1.90331	1.88858	0.05906
M55 × 1.5	6g	0.00126	2.16409	2.15480	2.12575	2.11945	0.00630	2.10016	2.08307	0.05906
M55 × 1.5	6h	0.00000	2.16535	2.15606	2.12701	2.12071	0.00630	2.10142	2.08433	0.05906
M55 × 1.5	4g6g	0.00126	2.16409	2.15480	2.12575	2.12181	0.00394	2.10016	2.08543	0.05906
M56 × 5.5	6g	0.00295	2.20177	2.17972	2.06114	2.05071	0.01043	1.96736	1.91732	0.21654
M56 × 5.5	6h	0.00000	2.20472	2.18268	2.06409	2.05366	0.01043	1.97031	1.92028	0.21654
M56 × 5.5	4g6g	0.00295	2.20177	2.17972	2.06114	2.05445	0.00669	1.96736	1.92106	0.21654
M56 × 2	6g	0.00150	2.20323	2.19220	2.15209	2.14500	0.00709	2.11799	2.09650	0.07874
M56 × 2	6h	0.00000	2.20472	2.19370	2.15358	2.14650	0.00709	2.11949	2.09799	0.07874
M56 × 2	4g6g	0.00150	2.20323	2.19220	2.15209	2.14768	0.00441	2.11799	2.09917	0.07874
M60 × 1.5	6g	0.00126	2.36094	2.35165	2.32260	2.31630	0.00630	2.29701	2.27992	0.05906
M60 × 1.5	6h	0.00000	2.36220	2.35291	2.32386	2.31756	0.00630	2.29827	2.28118	0.05906
M60 × 1.5	4g6g	0.00126	2.36094	2.35165	2.32260	2.31866	0.00394	2.29701	2.28228	0.05906
M64 × 6	6g	0.00315	2.51654	2.49291	2.36311	2.35209	0.01102	2.26083	2.20657	0.23622
M64 × 6	6h	0.00000	2.51969	2.49606	2.36626	2.35524	0.01102	2.26398	2.20972	0.23622
M64 × 6	4g6g	0.00315	2.51654	2.49291	2.36311	2.35602	0.00709	2.26083	2.21051	0.23622

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Table C-1 Inch Translation for External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diam., d_2 and Functional Diameter [Notes (2), (3), and (4)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diam. (Rounded Form), d_3 [Note (5)], (For Reference)	Nominal Pitch, *P*
			Max.	Min.	Max.	Min.	Tol.			
M64 × 2	6g	0.00150	2.51819	2.50717	2.46705	2.45996	0.00709	2.43295	2.41146	0.07874
M64 × 2	6h	0.00000	2.51969	2.50866	2.46854	2.46146	0.00709	2.43445	2.41295	0.07874
M64 × 2	4g6g	0.00150	2.51819	2.50717	2.46705	2.46264	0.00441	2.43295	2.41413	0.07874
M65 × 1.5	6g	0.00126	2.55780	2.54850	2.51945	2.51315	0.00630	2.49386	2.47677	0.05906
M65 × 1.5	6h	0.00000	2.55906	2.54976	2.52071	2.51441	0.00630	2.49512	2.47803	0.05906
M65 × 1.5	4g6g	0.00126	2.55780	2.54850	2.51945	2.51551	0.00394	2.49386	2.47913	0.05906
M70 ×1.5	6g	0.00126	2.75465	2.74535	2.71630	2.71000	0.00630	2.69071	2.67362	0.05906
M70 × 1.5	6h	0.00000	2.75591	2.74661	2.71756	2.71126	0.00630	2.69197	2.67488	0.05906
M70 ×1.5	4g6g	0.00126	2.75465	2.74535	2.71630	2.71236	0.00394	2.69071	2.67598	0.05906
M72 × 6	6g	0.00315	2.83150	2.80787	2.67807	2.66705	0.01102	2.57579	2.52154	0.23622
M72 × 6	6h	0.00000	2.83465	2.81102	2.68122	2.67020	0.01102	2.57894	2.52469	0.23622
M72 × 6	4g6g	0.00315	2.83150	2.80787	2.67807	2.67098	0.00709	2.57579	2.52547	0.23622
M72 × 2	6g	0.00150	2.83315	2.82213	2.78201	2.77492	0.00709	2.74791	2.72642	0.07874
M72 × 2	6h	0.00000	2.83465	2.82362	2.78350	2.77642	0.00709	2.74941	2.72791	0.07874
M72 × 2	4g6g	0.00150	2.83315	2.82213	2.78201	2.77760	0.00441	2.74791	2.72909	0.07874
M75 × 1.5	6g	0.00126	2.95150	2.94220	2.91315	2.90685	0.00630	2.88756	2.87047	0.05906
M75 × 1.5	6h	0.00000	2.95276	2.94346	2.91441	2.90811	0.00630	2.88882	2.87173	0.05906
M75 × 1.5	4g6g	0.00126	2.95150	2.94220	2.91315	2.90921	0.00394	2.88756	2.87283	0.05906
M80 × 6	6g	0.00315	3.14646	3.12283	2.99303	2.98201	0.01102	2.89075	2.83650	0.23622
M80 × 6	6h	0.00000	3.14961	3.12598	2.99618	2.98516	0.01102	2.89390	2.83965	0.23622
M80 × 6	4g6g	0.00315	3.14646	3.12283	2.99303	2.98594	0.00709	2.89075	2.84043	0.23622
M80 × 2	6g	0.00150	3.14811	3.13709	3.09697	3.08988	0.00709	3.06287	3.04138	0.07874
M80 × 2	6h	0.00000	3.14961	3.13858	3.09846	3.09138	0.00709	3.06437	3.04287	0.07874
M80 × 2	4g6g	0.00150	3.14811	3.13709	3.09697	3.09256	0.00441	3.06287	3.04406	0.07874
M80 × 1.5	6g	0.00126	3.14835	3.13906	3.11000	3.10370	0.00630	3.08441	3.06732	0.05906
M80 × 1.5	6h	0.00000	3.14961	3.14031	3.11126	3.10496	0.00630	3.08567	3.06858	0.05906
M80 × 1.5	4g6g	0.00126	3.14835	3.13906	3.11000	3.10606	0.00394	3.08441	3.06969	0.05906
M85 × 2	6g	0.00150	3.34496	3.33394	3.29382	3.28673	0.00709	3.25972	3.23823	0.07874
M85 × 2	6h	0.00000	3.34646	3.33543	3.29531	3.28823	0.00709	3.26122	3.23972	0.07874
M85 × 2	4g6g	0.00150	3.34496	3.33394	3.29382	3.28941	0.00441	3.25972	3.24091	0.07874
M90 × 6	6g	0.00315	3.54016	3.51654	3.38673	3.37571	0.01102	3.28445	3.23020	0.23622
M90 × 6	6h	0.00000	3.54331	3.51969	3.38988	3.37886	0.01102	3.28760	3.23335	0.23622

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Table C-1 Inch Translation for External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2), (3), and (4)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diam. (Rounded Form), d_3 [Note (5)] (For Reference)	Nominal Pitch, *P*
			Max.	Min.	Max.	Min.	Tol.			
M90 × 6	4g6g	0.00315	3.54016	3.51654	3.38673	3.37965	0.00708	3.28445	3.23413	0.23622
M90 × 2	6g	0.00150	3.54181	3.53079	3.49067	3.48358	0.00709	3.45657	3.43508	0.07874
M90 × 2	6h	0.00000	3.54331	3.53228	3.49217	3.48508	0.00709	3.45807	3.43657	0.07874
M90 × 2	4g6g	0.00150	3.54181	3.53079	3.49067	3.48626	0.00441	3.45657	3.43776	0.07874
M95 × 2	6g	0.00150	3.73866	3.72764	3.68752	3.68004	0.00748	3.65343	3.63154	0.07874
M95 × 2	6h	0.00000	3.74016	3.72913	3.68902	3.68154	0.00748	3.65492	3.63303	0.07874
M95 × 2	4g6g	0.00150	3.73866	3.72764	3.68752	3.68287	0.00465	3.65343	3.63437	0.07874
M100 × 6	6g	0.00315	3.93386	3.91024	3.78043	3.76862	0.01181	3.67815	3.62311	0.23622
M100 × 6	6h	0.00000	3.93701	3.91339	3.78358	3.77177	0.01181	3.68130	3.62626	0.23622
M100 × 6	4g6g	0.00315	3.93386	3.91024	3.78043	3.77295	0.00748	3.67815	3.62744	0.23622
M100 × 2	6g	0.00150	3.93551	3.92449	3.88437	3.87689	0.00748	3.85028	3.82839	0.07874
M100 × 2	6h	0.00000	3.93701	3.92598	3.88587	3.87839	0.00748	3.85177	3.82988	0.07874
M100 × 2	4g6g	0.00150	3.93551	3.92449	3.88437	3.87972	0.00465	3.85028	3.83122	0.07874
M105 × 2	6g	0.00150	4.13236	4.12134	4.08122	4.07374	0.00748	4.04713	4.02524	0.07874
M105 × 2	6h	0.00000	4.13386	4.12283	4.08272	4.07524	0.00748	4.04862	4.02673	0.07874
M105 × 2	4g6g	0.00150	4.13236	4.12134	4.08122	4.07657	0.00465	4.04713	4.02807	0.07874
M110 × 2	6g	0.00150	4.32921	4.31819	4.27807	4.27059	0.00748	4.24398	4.22209	0.07874
M110 × 2	6h	0.00000	4.33071	4.31969	4.27957	4.27209	0.00748	4.24547	4.22358	0.07874
M110 × 2	4g6g	0.00150	4.32921	4.31819	4.27807	4.27343	0.00464	4.24398	4.22492	0.07874
M120 × 2	6g	0.00150	4.72291	4.71189	4.67177	4.66429	0.00748	4.63768	4.61579	0.07874
M120 × 2	6h	0.00000	4.72441	4.71339	4.67327	4.66579	0.00748	4.63917	4.61728	0.07874
M120 × 2	4g6g	0.00150	4.72291	4.71189	4.67177	4.66713	0.00464	4.63768	4.61862	0.07874
M130 × 2	6g	0.00150	5.11661	5.10559	5.06547	5.05799	0.00748	5.03138	5.00949	0.07874
M130 × 2	6h	0.00000	5.11811	5.10709	5.06697	5.05949	0.00748	5.03287	5.01098	0.07874
M130 × 2	4g6g	0.00150	5.11661	5.10559	5.06547	5.06083	0.00464	5.03138	5.01232	0.07874
M140 × 2	6g	0.00150	5.51031	5.49929	5.45917	5.45169	0.00748	5.42508	5.40319	0.07874
M140 × 2	6h	0.00000	5.51181	5.50079	5.46067	5.45319	0.00748	5.42657	5.40469	0.07874
M140 × 2	4g6g	0.00150	5.51031	5.49929	5.45917	5.45453	0.00464	5.42508	5.40602	0.07874
M150 × 2	6g	0.00150	5.90402	5.89299	5.85287	5.84539	0.00748	5.81878	5.79689	0.07874
M150 × 2	6h	0.00000	5.90551	5.89449	5.85437	5.84689	0.00748	5.82028	5.79839	0.07874
M150 × 2	4g6g	0.00150	5.90402	5.89299	5.85287	5.84823	0.00464	5.81878	5.79972	0.07874

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Table C-1 Inch Translation for External Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Allowance, *es* [Note (1)]	Major Diameter, *d* [Note (2)]		Pitch Diameter, d_2 and Functional Diameter [Notes (2), (3), and (4)]			Max. Minor Diameter (Flat Form), d_1 [Note (2)]	Min. Minor Diam. (Rounded Form), d_3 [Note (5)] (For Reference)	Nominal Pitch, *P*
			Max.	Min.	Max.	Min.	Tol.			
M160 × 3	6g	0.00189	6.29732	6.28256	6.22059	6.21177	0.00882	6.16945	6.13902	0.11811
M160 × 3	6h	0.00000	6.29921	6.28445	6.22248	6.21366	0.00882	6.17134	6.14091	0.11811
M160 × 3	4g6g	0.00189	6.29732	6.28256	6.22059	6.21508	0.00551	6.16945	6.14232	0.11811
M170 × 3	6g	0.00189	6.69102	6.67626	6.61429	6.60547	0.00882	6.56315	6.53272	0.11811
M170 × 3	6h	0.00000	6.69291	6.67815	6.61618	6.60736	0.00882	6.56504	6.53461	0.11811
M170 × 3	4g6g	0.00189	6.69102	6.67626	6.61429	6.60878	0.00551	6.56315	6.53602	0.11811
M180 × 3	6g	0.00189	7.08472	7.06996	7.00799	6.99917	0.00882	6.95685	6.92642	0.11811
M180 × 3	6h	0.00000	7.08661	7.07185	7.00988	7.00106	0.00882	6.95874	6.92831	0.11811
M180 × 3	4g6g	0.00189	7.08472	7.06996	7.00799	7.00248	0.00551	6.95685	6.92972	0.11811
M190 × 3	6g	0.00189	7.47843	7.46366	7.40169	7.39185	0.00984	7.35055	7.31909	0.11811
M190 × 3	6h	0.00000	7.48031	7.46555	7.40358	7.39374	0.00984	7.35244	7.32098	0.11811
M190 × 3	4g6g	0.00189	7.47843	7.46366	7.40169	7.39539	0.00630	7.35055	7.32264	0.11811
M200 × 3	6g	0.00189	7.87213	7.85736	7.79539	7.78555	0.00984	7.74425	7.71280	0.11811
M200 × 3	6h	0.00000	7.87402	7.85925	7.79728	7.78744	0.00984	7.74614	7.71469	0.11811
M200 × 3	4g6g	0.00189	7.87213	7.85736	7.79539	7.78909	0.00630	7.74425	7.71634	0.11811

GENERAL NOTE: All dimensions are in inches.

NOTES:

(1) *es* is absolute value.

(2) For coated threads with tolerance classes 6g or 4g6g, see para. 8.2.

(3) See para. 5.4(b).

(4) Since these tabulated tolerance values have been converted and then rounded, they may differ slightly from the difference between tabulated maximum and minimum values.

(5) Dimension used in the design of tools, etc. In dimensioning external threads it is not normally specified. Generally, minor diameter acceptance is based on maximum material condition gaging.

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Table C-2 Inch Translation for Internal Thread — Limiting Dimensions M Profile

Basic Thread Designation	Tolerance Class	Minor Diam., D_1		Pitch Diam., D_2 and Functional Diam. [Notes (1) and (2)]			Major Diam., D		Nominal Pitch, P
		Min.	Max.	Min.	Max.	Tol.	Min.	Max. [Note (3)] (Reference)	
M1.6 × 0.35	6H	0.04807	0.05201	0.05406	0.05740	0.00335	0.06299	0.06835	0.01378
M2 × 0.4	6H	0.06169	0.06610	0.06850	0.07205	0.00354	0.07874	0.08457	0.01575
M2.5 × 0.45	6H	0.07925	0.08417	0.08693	0.09067	0.00374	0.09843	0.10472	0.01772
M3 × 0.5	6H	0.09681	0.10232	0.10531	0.10925	0.00394	0.11811	0.12488	0.01969
M3.5 × 0.6	6H	0.11220	0.11850	0.12244	0.12685	0.00441	0.13780	0.14559	0.02362
M4 × 0.7	6H	0.12764	0.13472	0.13957	0.14421	0.00465	0.15748	0.16610	0.02756
M5 × 0.8	6H	0.16276	0.17063	0.17638	0.18130	0.00492	0.19685	0.20630	0.03150
M6 × 1	6H	0.19358	0.20287	0.21063	0.21654	0.00591	0.23622	0.24780	0.03937
M8 × 1.25	6H	0.26169	0.27213	0.28299	0.28929	0.00630	0.31496	0.32835	0.04921
M8 × 1	6H	0.27232	0.28161	0.28937	0.29528	0.00591	0.31496	0.32654	0.03937
M10 × 1.5	6H	0.32976	0.34157	0.35535	0.36244	0.00709	0.39370	0.40933	0.05906
M10 × 1.25	6H	0.34043	0.35087	0.36173	0.36803	0.00630	0.39370	0.40709	0.04921
M10 × 1	6H	0.35106	0.36035	0.36811	0.37402	0.00591	0.39370	0.40528	0.03937
M10 × 0.75	6H	0.36173	0.36921	0.37453	0.37972	0.00520	0.39370	0.40315	0.02953
M12 × 1.75	6H	0.39787	0.41106	0.42768	0.43555	0.00787	0.47244	0.49024	0.06890
M12 × 1.5	6H	0.40850	0.42031	0.43409	0.44157	0.00748	0.47244	0.48846	0.05906
M12 × 1.25	6H	0.41917	0.42961	0.44047	0.44756	0.00709	0.47244	0.48661	0.04921
M12 × 1	6H	0.42980	0.43909	0.44685	0.45315	0.00630	0.47244	0.48441	0.03937
M14 × 2	6H	0.46594	0.48071	0.50004	0.50839	0.00835	0.55118	0.57091	0.07874
M14 × 1.5	6H	0.48724	0.49906	0.51283	0.52031	0.00748	0.55118	0.56720	0.05906
M15 × 1	6H	0.54791	0.55720	0.56496	0.57126	0.00630	0.59055	0.60252	0.03937
M16 × 2	6H	0.54469	0.55945	0.57878	0.58713	0.00835	0.62992	0.64965	0.07874
M16 × 1.5	6H	0.56598	0.57780	0.59157	0.59906	0.00748	0.62992	0.64594	0.05906
M17 × 1	6H	0.62665	0.63594	0.64370	0.65000	0.00630	0.66929	0.68126	0.03937
M18 × 1.5	6H	0.64472	0.65654	0.67031	0.67780	0.00748	0.70866	0.72469	0.05906
M20 × 2.5	6H	0.68087	0.69858	0.72346	0.73228	0.00882	0.78740	0.81043	0.09843
M20 × 1.5	6H	0.72346	0.73528	0.74906	0.75654	0.00748	0.78740	0.80343	0.05906
M20 × 1	6H	0.74476	0.75406	0.76181	0.76811	0.00630	0.78740	0.79937	0.03937
M22 × 2.5	6H	0.75961	0.77732	0.80220	0.81102	0.00882	0.86614	0.88917	0.09843
M22 × 1.5	6H	0.80220	0.81402	0.82780	0.83528	0.00748	0.86614	0.88217	0.05906
M24 × 3	6H	0.81701	0.83669	0.86815	0.87858	0.01043	0.94488	0.97236	0.11811
M24 × 2	6H	0.85965	0.87441	0.89374	0.90256	0.00882	0.94488	0.96508	0.07874
M25 × 1.5	6H	0.92031	0.93213	0.94591	0.95378	0.00787	0.98425	1.00067	0.05906
M27 × 3	6H	0.93512	0.95480	0.98626	0.99669	0.01043	1.06299	1.09047	0.11811
M27 × 2	6H	0.97776	0.99252	1.01185	1.02067	0.00882	1.06299	1.08319	0.07874
M30 × 3.5	6H	1.03193	1.05398	1.09161	1.10264	0.01102	1.18110	1.21205	0.13780
M30 × 2	6H	1.09587	1.11063	1.12996	1.13878	0.00882	1.18110	1.20130	0.07874
M30 × 1.5	6H	1.11717	1.12898	1.14276	1.15063	0.00787	1.18110	1.19752	0.05906
M33 × 2	6H	1.21398	1.22874	1.24807	1.25689	0.00882	1.29921	1.31941	0.07874
M35 × 1.5	6H	1.31402	1.32583	1.33961	1.34748	0.00787	1.37795	1.39437	0.05906
M36 × 4	6H	1.24685	1.27047	1.31504	1.32685	0.01181	1.41732	1.45185	0.15748
M36 × 2	6H	1.33209	1.34685	1.36618	1.37500	0.00882	1.41732	1.43752	0.07874
M39 × 2	6H	1.45020	1.46496	1.48429	1.49311	0.00882	1.53543	1.55563	0.07874
M40 × 1.5	6H	1.51087	1.52268	1.53646	1.54433	0.00787	1.57480	1.59122	0.05906
M42 × 4.5	6H	1.46177	1.48815	1.53846	1.55087	0.01240	1.65354	1.69150	0.17717

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Table C-2 Inch Translation for Internal Thread — Limiting Dimensions M Profile (Cont'd)

Basic Thread Designation	Tolerance Class	Minor Diam., D_1		Pitch Diam., D_2 and Functional Diam. [Notes (1) and (2)]			Major Diam., D		Nominal Pitch, P
		Min.	Max.	Min.	Max.	Tol.	Min.	Max. [Note (3)] (Reference)	
M42 × 2	6H	1.56831	1.58307	1.60240	1.61122	0.00882	1.65354	1.67374	0.07874
M45 × 1.5	6H	1.70772	1.71953	1.73331	1.74118	0.00787	1.77165	1.78807	0.05906
M48 × 5	6H	1.67665	1.70461	1.76189	1.77508	0.01319	1.88976	1.93134	0.19685
M48 × 2	6H	1.80453	1.81929	1.83862	1.84791	0.00929	1.88976	1.91043	0.07874
M50 × 1.5	6H	1.90457	1.91638	1.93016	1.93850	0.00835	1.96850	1.98539	0.05906
M55 × 1.5	6H	2.10142	2.11323	2.12701	2.13535	0.00835	2.16535	2.18224	0.05906
M56 × 5.5	6H	1.97031	1.99984	2.06409	2.07807	0.01398	2.20472	2.24996	0.21654
M56 × 2	6H	2.11949	2.13425	2.15358	2.16287	0.00929	2.20472	2.22539	0.07874
M60 × 1.5	6H	2.29827	2.31008	2.32386	2.33220	0.00835	2.36220	2.37909	0.05906
M64 × 6	6H	2.26398	2.29547	2.36626	2.38102	0.01476	2.51969	2.56854	0.23622
M64 × 2	6H	2.43445	2.44921	2.46854	2.47783	0.00929	2.51969	2.54035	0.07874
M65 × 1.5	6H	2.49512	2.50693	2.52071	2.52906	0.00835	2.55906	2.57594	0.05906
M70 × 1.5	6H	2.69197	2.70378	2.71756	2.72591	0.00835	2.75591	2.77280	0.05906
M72 × 6	6H	2.57894	2.61043	2.68122	2.69598	0.01476	2.83465	2.88350	0.23622
M72 × 2	6H	2.74941	2.76417	2.78350	2.79280	0.00929	2.83465	2.85531	0.07874
M75 × 1.5	6H	2.88882	2.90063	2.91441	2.92276	0.00835	2.95276	2.96965	0.05906
M80 × 6	6H	2.89390	2.92539	2.99618	3.01094	0.01476	3.14961	3.19846	0.23622
M80 × 2	6H	3.06437	3.07913	3.09846	3.10776	0.00929	3.14961	3.17028	0.07874
M80 × 1.5	6H	3.08567	3.09748	3.11126	3.11961	0.00835	3.14961	3.16650	0.05906
M85 × 2	6H	3.26122	3.27598	3.29531	3.30461	0.00929	3.34646	3.36713	0.07874
M90 × 6	6H	3.28760	3.31909	3.38988	3.40465	0.01476	3.54331	3.59217	0.23622
M90 × 2	6H	3.45807	3.47283	3.49217	3.50146	0.00929	3.54331	3.56398	0.07874
M95 × 2	6H	3.65492	3.66969	3.68902	3.69886	0.00984	3.74016	3.76138	0.07874
M100 × 6	6H	3.68130	3.71280	3.78358	3.79933	0.01575	3.93701	3.98685	0.23622
M100 × 2	6H	3.85177	3.86654	3.88587	3.89571	0.00984	3.93701	3.95823	0.07874
M105 × 2	6H	4.04862	4.06339	4.08272	4.09256	0.00984	4.13386	4.15508	0.07874
M110 × 2	6H	4.24547	4.26024	4.27957	4.28941	0.00984	4.33071	4.35193	0.07874
M120 × 2	6H	4.63917	4.65394	4.67327	4.68311	0.00984	4.72441	4.74563	0.07874
M130 × 2	6H	5.03287	5.04764	5.06697	5.07681	0.00984	5.11811	5.13933	0.07874
M140 × 2	6H	5.42657	5.44134	5.46067	5.47051	0.00984	5.51181	5.53303	0.07874
M150 × 2	6H	5.82028	5.83504	5.85437	5.86421	0.00984	5.90551	5.92673	0.07874
M160 × 3	6H	6.17134	6.19102	6.22248	6.23429	0.01181	6.29921	6.32807	0.11811
M170 × 3	6H	6.56504	6.58472	6.61618	6.62799	0.01181	6.69291	6.72177	0.11811
M180 × 3	6H	6.95874	6.97843	7.00988	7.02169	0.01181	7.08661	7.11547	0.11811
M190 × 3	6H	7.35244	7.37213	7.40358	7.41677	0.01319	7.48031	7.51055	0.11811
M200 × 3	6H	7.74614	7.76583	7.79728	7.81047	0.01319	7.87402	7.90425	0.11811

GENERAL NOTE: All dimensions are in inches.

NOTES:

(1) See para. 5.4.2.

(2) Since these tablulated tolerance values have been converted and then rounded, they may differ slightly from the difference between tabulated maximum and minimum values.

(3) Dimension is used in the design of tools, etc. In dimensioning internal threads it is not normally specified. Generally, major diameter acceptance is based on maximum material condition gaging.

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NONMANDATORY APPENDIX D
BASIC DIMENSIONS FOR ISO SERIES METRIC SCREW THREADS FROM ISO 724

Table D-1

Nom. Diam. = Major Diam., D, d	Pitch, P	Pitch Diameter, D_2, d_2	Minor Diameter, D_1, d_1
1.6	0.35	1.373	1.221
	0.2	1.470	1.383
1.8	0.35	1.573	1.421
	0.2	1.670	1.583
2	0.4	1.740	1.567
	0.25	1.838	1.729
2.2	0.45	1.908	1.713
	0.25	2.038	1.929
2.5	0.45	2.208	2.013
	0.35	2.273	2.121
3	0.5	2.675	2.459
	0.35	2.773	2.621
3.5	0.6	3.110	2.850
	0.35	3.273	3.121
4	0.7	3.545	3.242
	0.5	3.675	3.459
4.5	0.75	4.013	3.688
	0.5	4.175	3.959
5	0.8	4.480	4.134
	0.5	4.675	4.459
5.5	0.5	5.175	4.959
6	1	5.350	4.917
	0.75	5.513	5.188
7	1	6.350	5.917
	0.75	6.513	6.188
8	1.25	7.188	6.647
	1	7.350	6.917
	0.75	7.513	7.188
9	1.25	8.188	7.647
	1	8.350	7.917
	0.75	8.513	8.188
10	1.5	9.026	8.376
	1.25	9.188	8.647
	1	9.350	8.917
	0.75	9.513	9.188
11	1.5	10.026	9.376
	1	10.350	9.917
	0.75	10.513	10.188

Table D-1 (Cont'd)

Nom. Diam. = Major Diam., D, d	Pitch, P	Pitch Diameter, D_2, d_2	Minor Diameter, D_1, d_1
12	1.75	10.863	10.106
	1.5	11.026	10.376
	1.25	11.188	10.647
	1	11.350	10.917
14	2	12.701	11.835
	1.5	13.026	12.376
	1.25	13.188	12.647
	1	13.350	12.917
15	1.5	14.026	13.376
	1	14.350	13.917
16	2	14.701	13.835
	1.5	15.026	14.376
	1	15.350	14.917
17	1.5	16.026	15.376
	1	16.350	15.917
18	2.5	16.376	15.294
	2	16.701	15.835
	1.5	17.026	16.376
	1	17.350	16.917
20	2.5	18.376	17.294
	2	18.701	17.835
	1.5	19.026	18.376
	1	19.350	18.917
22	2.5	20.376	19.294
	2	20.701	19.835
	1.5	21.026	20.376
	1	21.350	20.917
24	3	22.051	20.752
	2	22.701	21.835
	1.5	23.026	22.376
	1	23.350	22.917
25	2	23.701	22.835
	1.5	24.026	23.376
	1	24.350	23.917
26	1.5	25.026	24.376
27	3	25.051	23.752
	2	25.701	24.835
	1.5	26.026	25.376
	1	26.350	25.917
28	2	26.701	25.835
	1.5	27.026	26.376
	1	27.350	26.917

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Table D-1 (Cont'd)

Nom. Diam. = Major Diam., D, d	Pitch, P	Pitch Diameter, D_2, d_2	Minor Diameter, D_1, d_1
30	3.5	27.727	26.211
	3	28.051	26.752
	2	28.701	27.835
	1.5	29.026	28.376
	1	29.350	28.917
32	2	30.701	29.835
	1.5	31.026	30.376
33	3.5	30.727	29.211
	3	31.051	29.752
	2	31.701	30.835
	1.5	32.026	31.376
35	1.5	34.026	33.376
36	4	33.402	31.670
	3	34.051	32.752
	2	34.701	33.835
	1.5	35.026	34.376
38	1.5	37.026	36.376
39	4	36.402	34.670
	3	37.051	35.752
	2	37.701	36.835
	1.5	38.026	37.376
40	3	38.051	36.752
	2	38.701	37.835
	1.5	39.026	38.376
42	4.5	39.077	37.129
	4	39.402	37.670
	3	40.051	38.752
	2	40.701	39.835
	1.5	41.026	40.376
45	4.5	42.077	40.129
	4	42.402	40.670
	3	43.051	41.752
	2	43.701	42.835
	1.5	44.026	43.376
48	5	44.752	42.587
	4	45.402	43.670
	3	46.051	44.752
	2	46.701	45.835
	1.5	47.026	46.376
50	3	48.051	46.752
	2	48.701	47.835
	1.5	49.026	48.376
52	5	48.752	46.587
	4	49.402	47.670
	3	50.051	48.752
	2	50.701	49.835
	1.5	51.026	50.376
55	4	52.402	50.670
	3	53.051	51.752
	2	53.701	52.835
	1.5	54.026	53.376

Table D-1 (Cont'd)

Nom. Diam. = Major Diam., D, d	Pitch, P	Pitch Diameter, D_2, d_2	Minor Diameter, D_1, d_1
56	5.5	52.428	50.046
	4	53.402	51.670
	3	54.051	52.752
	2	54.701	53.835
	1.5	55.026	54.376
58	4	55.402	53.670
	3	56.051	54.752
	2	56.701	55.835
	1.5	57.026	56.376
60	5.5	56.428	54.046
	4	57.402	55.670
	3	58.051	56.752
	2	58.701	57.835
	1.5	59.026	58.376
62	4	59.402	57.670
	3	60.051	58.752
	2	60.701	59.835
	1.5	61.026	60.376
64	6	60.103	57.505
	4	61.402	59.670
	3	62.051	60.752
	2	62.701	61.835
	1.5	63.026	62.376
65	4	62.402	60.670
	3	63.051	61.752
	2	63.701	62.835
	1.5	64.026	63.376
68	6	64.103	61.505
	4	65.402	63.670
	3	66.051	64.752
	2	66.701	65.835
	1.5	67.026	66.376
70	6	66.103	63.505
	4	67.402	65.670
	3	68.051	66.752
	2	68.701	67.835
	1.5	69.026	68.376
72	6	68.103	65.505
	4	69.402	67.670
	3	70.051	68.752
	2	70.701	69.835
	1.5	71.026	70.376
75	4	72.402	70.670
	3	73.051	71.752
	2	73.701	72.835
	1.5	74.026	73.376
76	6	72.103	69.505
	4	73.402	71.670
	3	74.051	72.752
	2	74.701	73.835
	1.5	75.026	74.376
78	2	76.700	75.835

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Table D-1 (Cont'd)

Nom. Diam. = Major Diam., D, d	Pitch, P	Pitch Diameter, D_2, d_2	Minor Diameter, D_1, d_1
80	6	76.103	73.505
	4	77.402	75.670
	3	78.051	76.752
	2	78.701	77.835
	1.5	79.026	78.376
82	2	80.701	79.835
85	6	81.103	78.505
	4	82.402	80.670
	3	83.051	81.752
	2	83.701	82.835
90	6	86.103	83.505
	4	87.402	85.670
	3	88.051	86.752
	2	88.701	87.835
95	6	91.103	88.505
	4	92.402	90.670
	3	93.051	91.752
	2	93.701	92.835
100	6	96.103	93.505
	4	97.402	95.670
	3	98.051	96.752
	2	98.701	97.835
105	6	101.103	98.505
	4	102.402	100.670
	3	103.051	101.752
	2	103.701	102.835
110	6	106.103	103.505
	4	107.402	105.670
	3	108.051	106.752
	2	108.701	107.835
115	6	111.103	108.505
	4	112.402	110.670
	3	113.051	111.752
	2	113.701	112.835
120	6	116.103	113.505
	4	117.402	115.670
	3	118.051	116.752
	2	118.701	117.835
125	8 [Note(1)]	119.804	116.340
	6	121.103	118.505
	4	122.402	120.670
	3	123.051	121.752
	2	123.701	122.835
130	8 [Note(1)]	124.804	121.340
	6	126.103	123.505
	4	127.402	125.670
	3	128.051	126.752
	2	128.701	127.835
135	6	131.103	128.505
	4	132.402	130.670
	3	133.051	131.752
	2	133.701	132.835

Table D-1 (Cont'd)

Nom. Diam. = Major Diam., D, d	Pitch, P	Pitch Diameter, D_2, d_2	Minor Diameter, D_1, d_1
140	8 [Note (1)]	134.804	131.340
	6	136.103	133.505
	4	137.402	135.670
	3	138.051	136.752
	2	138.701	137.835
145	6	141.103	138.505
	4	142.402	140.670
	3	143.051	141.752
	2	143.701	142.835
150	8	144.804	141.340
	6	146.103	143.505
	4	147.402	145.670
	3	148.051	146.752
	2	148.701	147.835
155	6	151.103	148.505
	4	152.402	150.670
	3	153.051	151.752
160	8	154.804	151.340
	6	156.103	153.505
	4	157.402	155.670
	3	158.051	156.752
165	6	161.103	158.505
	4	162.402	160.670
	3	163.051	161.752
170	8	164.804	161.340
	6	166.103	163.505
	4	167.402	165.670
	3	168.051	166.752
175	6	171.103	168.505
	4	172.402	170.670
	3	173.051	171.752
180	8	174.804	171.340
	6	176.103	173.505
	4	177.402	175.670
	3	178.051	176.752
185	6	181.103	178.505
	4	182.402	180.670
	3	183.051	181.752
190	8	184.804	181.340
	6	186.103	183.505
	4	187.402	185.670
	3	188.051	186.752
195	6	191.103	188.505
	4	192.402	190.670
	3	193.051	191.752
200	8	194.804	191.340
	6	196.103	193.505
	4	197.402	195.670
	3	198.051	196.752
205	6	201.103	198.505
	4	202.402	200.670
	3	203.051	201.752

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Table D-1 (Cont'd)

Nom. Diam. = Major Diam., D, d	Pitch, P	Pitch Diameter, D_2, d_2	Minor Diameter, D_1, d_1
210	8	204.804	201.340
	6	206.103	203.505
	4	207.402	205.670
	3	208.051	206.752
215	6	211.103	208.505
	4	212.402	210.670
	3	213.051	211.752
220	8	214.804	211.340
	6	216.103	213.505
	4	217.402	215.670
	3	218.051	216.752
225	6	221.103	218.505
	4	222.402	220.670
	3	223.051	221.752
230	8	224.804	221.340
	6	226.103	223.505
	4	227.402	225.670
	3	228.051	226.752
235	6	231.103	228.505
	4	232.402	230.670
	3	233.051	231.752
240	8	234.804	231.340
	6	236.103	233.505
	4	237.402	235.670
	3	238.051	236.752
245	6	241.103	238.505
	4	242.402	240.670
	3	243.051	241.752
250	8	244.804	241.340
	6	246.103	243.505
	4	247.402	245.670
	3	248.051	246.752

Table D-1 (Cont'd)

Nom. Diam. = Major Diam., D, d	Pitch, P	Pitch Diameter, D_2, d_2	Minor Diameter, D_1, d_1
255	6	251.103	248.505
	4	252.402	250.670
260	8	254.804	251.340
	6	256.103	253.505
	4	257.402	255.670
265	6	261.103	258.505
	4	262.402	260.670
270	8	264.804	261.340
	6	266.103	263.505
	4	267.402	265.670
275	6	271.103	268.505
	4	272.402	270.670
280	8	274.804	271.340
	6	276.103	273.505
	4	277.402	275.670
285	6	281.103	278.505
	4	282.402	280.670
290	8	284.804	281.340
	6	286.103	283.505
	4	287.402	285.670
295	6	291.103	288.505
	4	292.402	290.670
300	8	294.804	291.340
	6	296.103	293.505
	4	297.402	295.670

GENERAL NOTE: All dimensions are in millimeters.

NOTE:

(1) Not yet incorporated in ISO 724.

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NONMANDATORY APPENDIX E
OVERTAPPED NUT THREAD CLASS 6AX

This Appendix (see Tables E-1 and E-2) contains information on internal threads of tolerance class 6AX, which follow current USA practice of overtapping to accommodate as-coated hot-dip galvanized external threads of tolerance class 6g prior to coating. It incorporates thread size limits from ISO 965-5 and is consistent with average galvanizing practice as stated in ASTM A153.

Table E-1 Allowance (Fundamental Deviation), Tolerance Position AX (ISO 965-5)

Pitch, *P*	Allowance (Fundamental Deviation), *EI* [Note (1)]
1.25 [Note (2)]	+0.255
1.5	+0.310
1.75	+0.365
2	+0.420
2.5	+0.530
3	+0.640
3.5	+0.750
4	+0.860
4.5	+0.970
5	+1.080
5.5	+1.190
6	+1.300

GENERAL NOTE: All dimensions are in millimeters.

NOTES:

(1) Allowance = + (0.220*P* − 0.020).

(2) 1.25 pitch is not included in ISO 965-5.

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Table E-2 Internal Thread — Limiting Dimensions, Tolerance Class 6AX for Normal Length of Engagement (ISO 965-5)

Size	Minor Diameter [Note (1)]		Pitch Diameter [Note (2)]			Min. Major Diameter [Note (2)]
	Min.	Max.	Min.	Max.	Tol.	
M8 × 1.25 [Note (3)]	6.902	7.167	7.443	7.603	0.160	8.255
M10 × 1.5	8.686	8.986	9.336	9.516	0.180	10.310
M12 × 1.75	10.471	10.806	11.228	11.428	0.200	12.365
M14 × 2	12.255	12.630	13.121	13.333	0.212	14.420
M16 × 2	14.255	14.630	15.121	15.333	0.212	16.420
M20 × 2.5	17.824	18.274	18.906	19.130	0.224	20.530
M22 × 2.5	19.824	20.274	20.906	21.130	0.224	22.530
M24 × 3	21.392	21.892	22.691	22.956	0.265	24.640
M27 × 3	24.392	24.892	25.691	25.956	0.265	27.640
M30 × 3.5	26.961	27.521	28.477	28.757	0.280	30.750
M36 × 4	32.530	33.130	34.262	34.562	0.300	36.860
M42 × 4.5	38.099	38.769	40.047	40.362	0.315	42.970
M48 × 5	43.667	44.377	45.832	46.167	0.335	49.080
M56 × 5.5	51.236	51.986	53.618	53.973	0.355	57.190
M64 × 6	58.805	59.605	61.403	61.778	0.375	65.300

GENERAL NOTE: All dimensions are in millimeters.

NOTES:

(1) Dimensions apply before galvanizing or after removal of zinc fragments.

(2) Dimensions apply after galvanizing and tapping oversize.

(3) M8 × 1.25 – 6AX is not included in ISO 965-5.

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NONMANDATORY APPENDIX F
INTERNAL THREAD ALLOWANCE (FUNDAMENTAL DEVIATION) TOLERANCE POSITION *E*

This Appendix (see Table F-1) contains information on internal threads of tolerance position *E* for use in special applications where *G* does not provide sufficient allowance. It uses the numerical values of external thread tolerance position *e* applied in the opposite direction.

Table F-1 Allowance (Fundamental Deviation), Tolerance Position *E*

Pitch, *P*	Allowance (Fundamental Deviation), *EI* [Note (1)]	Pitch, *P*	Allowance (Fundamental Deviation), *EI* [Note (1)]
0.5	+0.050	2	+0.071
0.6	+0.053	2.5	+0.080
0.7	+0.056	3	+0.085
0.75	+0.056	3.5	+0.090
0.8	+0.060	4	+0.095
1	+0.060	4.5	+0.100
1.25	+0.063	5	+0.106
1.5	+0.067	5.5	+0.112
1.75	+0.071	6	+0.118
		8	+0.140

GENERAL NOTE: All dimensions are in millimeters (mm).

NOTE:

(1) Allowance = +(0.05 + 0.011*P*).

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B1 OTHER STANDARDS FOR SCREW THREADS

Unified Inch Screw Threads (UN and UNR Thread Form) B1.1-2003
Gages and Gaging for Unified Inch Screw Threads B1.2-1983 (R2001)
Screw Thread Gaging Systems for Dimensional Acceptability —
Inch and Metric Screw Threads (UN, UNR, UNJ, M, and MJ) B1.3M-1992 (R2001)
Acme Screw Threads B1.5-1997 (R2004)
Nomenclature, Definitions, and Letter Symbols for Screw Threads B1.7M-1984 (R2001)
Stub Acme Screw Threads B1.8-1988 (R2001)
Buttress Inch Screw Threads 7°/45° Form With 0.6 Pitch Basic Height of Thread Engagement B1.9-1973 (R2001)
Unified Miniature Screw Threads B1.10M-2004
Microscope Objective Thread B1.11-1958 (R2001)
Class 5 Interference-Fit Thread B1.12-1987 (R2003)
Metric Screw Threads: M Profile B1.13M-2005
Unified Inch Screw Threads (UNJ Thread Form) B1.15-1995
Gages and Gaging for Metric M Screw Threads B1.16M-1984 (R2001)
Pipe Threads, General Purpose (Inch) B1.20.1-1983 (R2001)
Dryseal Pipe Threads (Inch) B1.20.3-1976 (R2003)
Gaging for Dryseal Pipe Threads (Inch) B1.20.5-1991 (R2004)
Hose Coupling Screw Threads (Inch) B1.20.7-1991 (R2003)
Metric Screw Threads: MJ Profile B1.21M-1997 (R2003)
Gages and Gaging for MJ Series Metric Screw Threads B1.22M-1985 (R2001)
Screw Threads: Standard Practice for Calculating and Rounding Dimensions B1.30-2002

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