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MATERIAL CERTIFICATION TRAINING

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REFERENCES

- Federal Specification QQ-N-286
  - Monel K500®
- Federal Specification QQ-N-281
  - Monel 400®
- American Society for Testing and Materials (ASTM) B150
- World-Wide Web for definitions and terminology

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OBJECTIVES

- Definitions & Terminology
- Super Alloys
  - Monel® K500
  - Alloy 400
- Material Certification requirements specialty metals

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DEFINITIONS & TERMINOLOGY

- Abbreviations
  - AGE HD = Aged Hardened
  - ANN = Annealed
  - CD = Cold Drawn
  - HF = Hot Finished
  - HR = Hot Rolled
  - SR = Stress Relieved
  - SSRT = Slow Strain Rate Tensile Test

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DEFINITIONS & TERMINOLOGY

- Age Hardening
  - The term applied to soft or low carbon steels, relates to slow, gradual changes that take place in properties of steel after the final treatment.
  - These changes, which bring about a condition of increased hardness, elastic limit, and tensile strength with a consequent loss in ductility, occur during the period in which the steel is at normal temperatures.
  - Used to increase the mechanical properties of the base metal, to increase the yield strength and tensile strength.

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DEFINITIONS & TERMINOLOGY

- Annealing
  - A heating and cooling operation implying usually a relatively slow cooling. Annealing is a comprehensive term. The process of such a heat treatment may be: to remove stresses; to induce softness; to alter ductility; toughness; electrical magnetic, or other physical properties; to refine the crystalline structure; to remove gases; to produce a definite micro-structure.
  - In annealing, the temperature of the operation and the rate of cooling depend upon the material being heat treated and the purpose of the treatment.
  - This is 100 percent wiping the slate: stresses are removed because the crystalline structure has relaxed and/or realigned itself. Done as a final step after all of the drawing or forming.

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DEFINITIONS & TERMINOLOGY

- Cold Drawn
  - Drawing material at a temperature below the softening point of the metal. This reduces thickness and increases hardness (cold work). Lower cost because heat is not added, but high residual stresses are added.
- Stress Relieved
  - Heating to a suitable temperature, holding long enough to reduce residual stresses and then cooling slowly enough to minimize developing new residual stresses. Quicker and cheaper than annealing albeit have not relaxed crystal structures. Done as a final step after all of the drawing or forming.

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DEFINITIONS & TERMINOLOGY

- Hot Finished
  - Performing a secondary operation on a metal post drawing: swaging, tapers, curves, etc. Heat helps reduce residual stress and allow for more flexibility.
- Hot Rolled
  - Rolling material at a temperature above the softening point of the metal. This reduces thickness and keeps hardness. Allows for less residual stress than cold working, however, some stresses will still be present.

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DEFINITIONS & TERMINOLOGY

- Slow Strain Rate Tensile Test (SSRT)
  - Determines if a lot of metal is susceptible to intergrannular cracking. The SSRT specimens shall be heat treated using the final heat treatment procedure used on the lot before being placed into service. Any lot that has been rejected shall not be submitted for acceptance.
  - Lots of material that are aged or re-solution annealed and aged with a heat treating procedure that is not equivalent, shall be re-tested using specimens taken from the material after the final heat treatment.

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SUPER ALLOYS

- Monel K500® - UNS N05500
  - Monel K500® is a nickel-copper alloy with the same corrosion resistance and characteristics as Monel 400®. Monel K500® has greater strength and hardness than 400, as a result of added aluminum and titanium.
  - This is the aged hardened version of Monel 400®. As such, it has increased strength with excellent resistance to sea water corrosion.

Chemical Analysis of Monel K500® (UNS N05500)								
C Co	MN P	Fe Pb	S Sn	Si Zn	Cu	Ni	Al	Ti
0.18 0.25	1.5 0.02	2.0 0.006	0.006 0.006	0.50 0.02	27.0-33.0	63.0 Min	2.30 – 3.15	0.35-0.85

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SUPER ALLOYS

- Alloy 400 – UNS N04400
  - Common Trade Names: Monel 400®, Nickelvac® 400, Nicorros® 400, Silverin® 400
  - Monel 400® is a nickel-copper alloy that is hardened by cold working only. Monel 400® has low corrosion rate in flowing sea water, therefore, it is widely used in marine applications. Monel 400® can be used in temperatures up to 1000°F. The alloy has great mechanical properties at subzero temperatures.

Chemical Analysis of Alloy 400 (UNS N04400)												
Class	C	MN	Fe	S	Si	Cu	Ni	Al	Pb	Sn	Zn	P
A	0.2	2.0	2.50	0.015	0.5	R	63-70	0.5	0.006	0.006	0.02	0.02
B	0.3	2.0	2.50	0.025-0.060	0.5	R	63-70	0.5	0.006	0.006	0.02	0.02

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REQUIREMENTS OF THE QQ-N-286 MATERIAL CERTIFICATION

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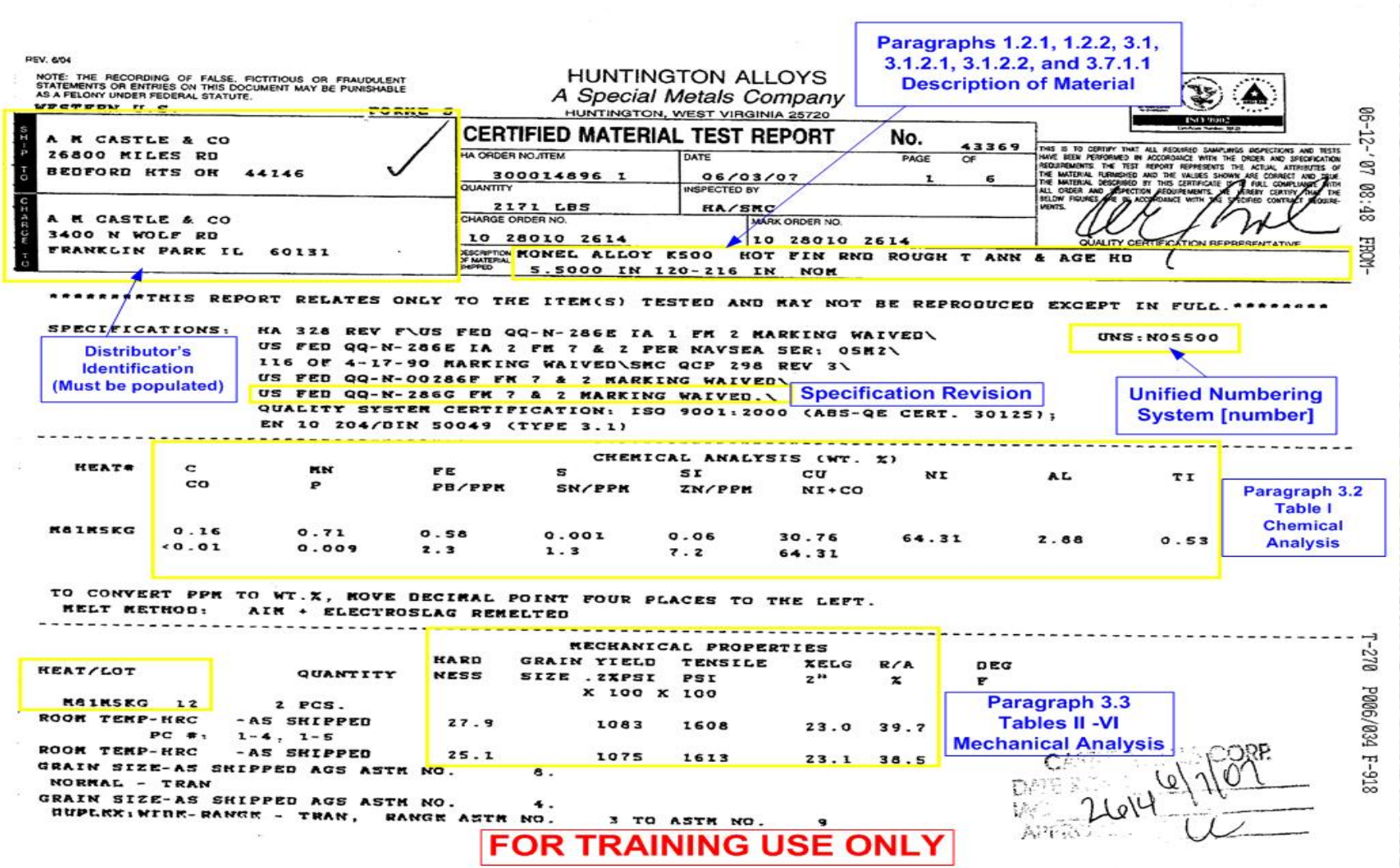
HUNTINGTON ALLOYS K500 MATERIAL



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FORM 5

SHIP TO
A M CASTLE & CO
26800 MILES RD
BEDFORD HTS OH 44146

CHARGE TO
A M CASTLE & CO
3400 N WOLF RD
FRANKLIN PARK IL 60131

HUNTINGTON ALLOYS
A Special Metals Company
HUNTINGTON, WEST VIRGINIA 25720

CERTIFIED MATERIAL TEST REPORT No. 43369

HA ORDER NO./ITEM	DATE	PAGE	OF
300014896 1	06/03/07	1	6

QUANTITY: 2171 LBS
INSPECTED BY: HA/SMC
CHARGE ORDER NO.: 10 28010 2614
MARK ORDER NO.: 10 28010 2614
DESCRIPTION OF MATERIAL SHIPPED: MONEL ALLOY K500 HOT FIN RND ROUGH T ANN & AGE HD 5.5000 IN 120-216 IN NOM

THIS IS TO CERTIFY THAT ALL REQUIRED SAMPLINGS INSPECTIONS AND TESTS HAVE BEEN PERFORMED IN ACCORDANCE WITH THE ORDER AND SPECIFICATION REQUIREMENTS. THE TEST REPORT REPRESENTS THE ACTUAL ATTRIBUTES OF THE MATERIAL FURNISHED AND THE VALUES SHOWN ARE CORRECT AND TRUE. THE MATERIAL DESCRIBED BY THIS CERTIFICATE IS IN FULL COMPLIANCE WITH ALL ORDER AND INSPECTION REQUIREMENTS. WE HEREBY CERTIFY THAT THE BELOW FIGURES ARE IN ACCORDANCE WITH THE SPECIFIED CONTRACT REQUIREMENTS.

QUALITY CERTIFICATION REPRESENTATIVE

06-12-'07 08:48 FROM-

**********THIS REPORT RELATES ONLY TO THE ITEM(S) TESTED AND MAY NOT BE REPRODUCED EXCEPT IN FULL.**********

SPECIFICATIONS:
HA 328 REV F\US FED QQ-N-286E IA 1 FM 2 MARKING WAIVED\
US FED QQ-N-286E IA 2 FM 7 & 2 PER NAVSEA SER: 05M2\
116 OF 4-17-90 MARKING WAIVED\SMC QCP 298 REV 3\
US FED QQ-N-00286F FM 7 & 2 MARKING WAIVED\
US FED QQ-N-286G FM 7 & 2 MARKING WAIVED.\
QUALITY SYSTEM CERTIFICATION: ISO 9001:2000 (ABS-QE CERT. 30125);
EN 10 204/DIN 50049 (TYPE 3.1)

UNS:N05500

CHEMICAL ANALYSIS (WT. %)

HEAT#	C CO	MN P	FE PB/PPM	S SN/PPM	SI ZN/PPM	CU NI+CO	NI	AL	TI
M81M5KG	0.16 <0.01	0.71 0.009	0.58 2.3	0.001 1.3	0.06 7.2	30.76 64.31	64.31	2.68	0.53

TO CONVERT PPM TO WT.%, MOVE DECIMAL POINT FOUR PLACES TO THE LEFT.
MELT METHOD: AIM + ELECTROSLAG REMELTED

MECHANICAL PROPERTIES

HEAT/LOT	QUANTITY	HARDNESS	GRAIN SIZE	YIELD .2%PSI X 100	TENSILE PSI X 100	%ELG 2"	R/A %	DEG F
M81M5KG 12	2 PCS.							
ROOM TEMP-HRC -AS SHIPPED PC #: 1-4, 1-5		27.9		1083	1608	23.0	39.7	
ROOM TEMP-HRC -AS SHIPPED		25.1		1075	1613	23.1	38.5	
GRAIN SIZE-AS SHIPPED AGS ASTM NO. 8. NORMAL - TRAN								
GRAIN SIZE-AS SHIPPED AGS ASTM NO. 4. DUPLEX;WIDE-RANGE - TRAN, RANGE ASTM NO. 3 TO ASTM NO. 9								

T-270 P006/034 F-918

Paragraphs 1.2.1, 1.2.2, 3.1, 3.1.2.1, 3.1.2.2, and 3.7.1.1 Description of Material

Distributor's Identification (Must be populated)

Specification Revision

Unified Numbering System [number]

Paragraph 3.2 Table I Chemical Analysis

Paragraph 3.3 Tables II -VI Mechanical Analysis

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HUNTINGTON ALLOYS K500 MATERIAL

REV. 6/04

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A Special Metals Company
HUNTINGTON, WEST VIRGINIA 25720

CERTIFIED MATERIAL TEST REPORT No. 43369

SHIP TO: A M CASTLE & CO
26800 MILES RD
BEDFORD HTS OH 44146

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3400 N WOLF RD
FRANKLIN PARK IL 60131

HA ORDER NO./ITEM	DATE	PAGE	OF
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THE DIFFERENCE IN AVERAGE GRAIN SIZE BETWEEN THE COARSEST AND FINEST AREAS OF THE CROSS-SECTION IS '4' ASTM GRAIN SIZE NUMBERS.

YIELD STRENGTH WAS DETERMINED USING A STRESS STRAIN CURVE

FORM H-2245 HUNTINGTON ALLOYS CORPORATION
ULTRASONIC TEST REPORT

Paragraph 3.7.1
Ultrasonic Test Report Header

FORM H2245 IS COMPOSED OF THREE SECTIONS FOR EACH HEAT/LOT REPORTED.
SECTION I IS PRINTED ONE TIME FOR EACH HEAT AND LOT
SECTION II MAY BE PRINTED MULTIPLE TIMES FOR EACH HEAT AND LOT.
SECTION III IS PRINTED ONE TIME FOR EACH HEAT AND LOT.

SECTION <<I>> HEAT/LOT: M81M5KG12 MATERIAL TESTED 05/31/07 BY JAMES MCCOY
SERIAL #: N/A
PIECE #:14,15

1. IAII IDENTIFICATION: (A) SNT-TC-1A-LEVEL: II
(B) MIL-STD-2132: INSPECTOR

2. TESTED MATERIAL 2 PIECE(S) WERE TESTED PRIOR TO CUT LGTH/WDTH AT FINAL CROSS SECTION
YIELDING 2 PIECE(S) FOR SHIPMENT AFTER CUTTING

3. PROCEDURE
APPROVED PROCEDURE NUMBER, REVISION NUMBER, APPLICABLE SPECIFICATIONS AND/OR CONTRACTUAL REQUIREMENTS WHICH WERE USED FOR THE EXAMINATION ARE FOUND IN THE SPECIFICATION BLOCK AND REMARKS SECTION OF THE MATERIAL TEST REPORT.
QCP #:298 QCP-REV:_3 DATED:10/12/04

QA Clause# 6D
Procedure used for Ultrasonic Testing

4. EXAMINATION CONDITIONS:
TEST METHOD: AUTOMATIC IMMERSION
COUPLANT: WATER
SCANNING EQUIPMENT: TANK BRIDGE SCANNER

SECTION <<II>> HEAT/LOT: M81M5KG12 PART:01 OF 02.

T-270 MW/MJA F-918

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HUNTINGTON ALLOYS K500 MATERIAL

REV. 6/04

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HUNTINGTON, WEST VIRGINIA 25720

ISO 9002

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FRANKLIN PARK IL 60131

CERTIFIED MATERIAL TEST REPORT No. 43369

HA ORDER NO./ITEM	DATE	PAGE	OF
300014896 1	06/03/07	3	6

QUANTITY: 2171 LBS
INSPECTED BY: HA/SMC
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06-12-'07 08:49 FROM-

5. (A) TEST MODE: PITCH CATCH ANGLE BEAM
(B) WAVE PROPOGATION: AXIAL ONE-DIRECTION
(C) INSTRUMENT MANUFACTURER: SONIC MODEL:237
(D) SERIAL NUMBER: 237-155SA
(E) LINEARITY CALIBRATION DATE: 04/09/07
(F) SEARCH UNIT MANUFACTURER/SERIAL NUMBER: PANA./98112,98144 RMK-1
(G) FREQUENCY (MHZ): 1.0
(H) SIZE (INCHES): 1.00"
(I) TYPE: SINGLE FLAT-FACED
(J) FOCAL LENGTH (IN): N/A
(K) CABLE LENGTH (FT): 8
(L) ATTENUATION CORRECTION DB:000
(M) REFERENCE AMPLITUDE: %FS:80
(N) ALARM/EVAL LEVEL XCAL:ALL
(O) REJECT: OFF
(P) DISTANCE AMPLITUDE CORRECTION: NONE
(Q) AREA GATED:
NOT APPLICABLE
(R) CALIBRATION STANDARD(S):
(A) N/A
(S) FLAT BOTTOM HOLE(S):
NOT APPLICABLE
(T) NOTCH(ES):
NOT APPLICABLE

SECTION <<II>> HEAT/LOT: M81MSKG12 PART:02 OF 02.

5. (A) TEST MODE: PITCH CATCH ANGLE BEAM
(B) WAVE PROPOGATION: AXIAL ONE-DIRECTION
(C) INSTRUMENT MANUFACTURER: SONIC MODEL:237
(D) SERIAL NUMBER: 237-155SA
(E) LINEARITY CALIBRATION DATE: 04/09/07
(F) SEARCH UNIT MANUFACTURER/SERIAL NUMBER: KAR./93A580,W11156 RMK-2
(G) FREQUENCY (MHZ): 1.0

T-270 P008/024 F-918

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HUNTINGTON ALLOYS K500 MATERIAL

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HUNTINGTON, WEST VIRGINIA 25720

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CERTIFIED MATERIAL TEST REPORT No. 43369

HA ORDER NO./ITEM	DATE	PAGE	OF
300014896 1	06/03/07	4	6

QUANTITY	INSPECTED BY
2171 LBS	HA/SMC

CHARGE ORDER NO.	MARK ORDER NO.
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QUALITY CERTIFICATION REPRESENTATIVE

06-12-'07 08:49 FROM-

(H) SIZE (INCHES): .500"
(I) TYPE: SINGLE FLAT-FACED
(J) FOCAL LENGTH (IN): N/A
(K) CABLE LENGTH (FT): 8
(L) ATTENUATION CORRECTION DB:000
(M) REFERENCE AMPLITUDE: XFS:80
(N) ALARM/EVAL LEVEL XCAL:ALL
(O) REJECT: OFF
(P) DISTANCE AMPLITUDE CORRECTION: NONE
(Q) AREA GATED:
NOT APPLICABLE
(R) CALIBRATION STANDARD(S):
(A) N/A
(S) FLAT BOTTOM HOLE(S):
NOT APPLICABLE
(T) NOTCH(ES):
NOT APPLICABLE

SECTION <<III>> HEAT/LOT: M61MSKG12

6. SURFACE FINISH CALIBRATION STANDARD: N/A
SURFACE FINISH MATERIAL: LESS THAN 250 RHR.
7. ULTRASONIC EVALUATION OF WALL THICKNESS:N/A
8. INSPECTED MATERIAL ACCEPTED:YES
9. REMARKS:
RMK1; CENTER SCAN
RMK2; END SCAN
NOTE; CENTER SCAN PERFORMED BY THE IMMERSION METHOD, END SCAN PERFORMED BY THE CONTACT METHOD.
TRANSDUCER SN 98112,& 98144 - MODEL 302, GAIN 47.8 DB.
TRANSDUCER SN 93A580 & W11156 - MODEL AMB0108, ANGLE 45, GAIN- 44.0 DB
10. PITCH DATA:NOT APPLICABLE

Paragraph 3.7.1
Ultrasonic Testing Acceptance

T-270 P009/034 F-918

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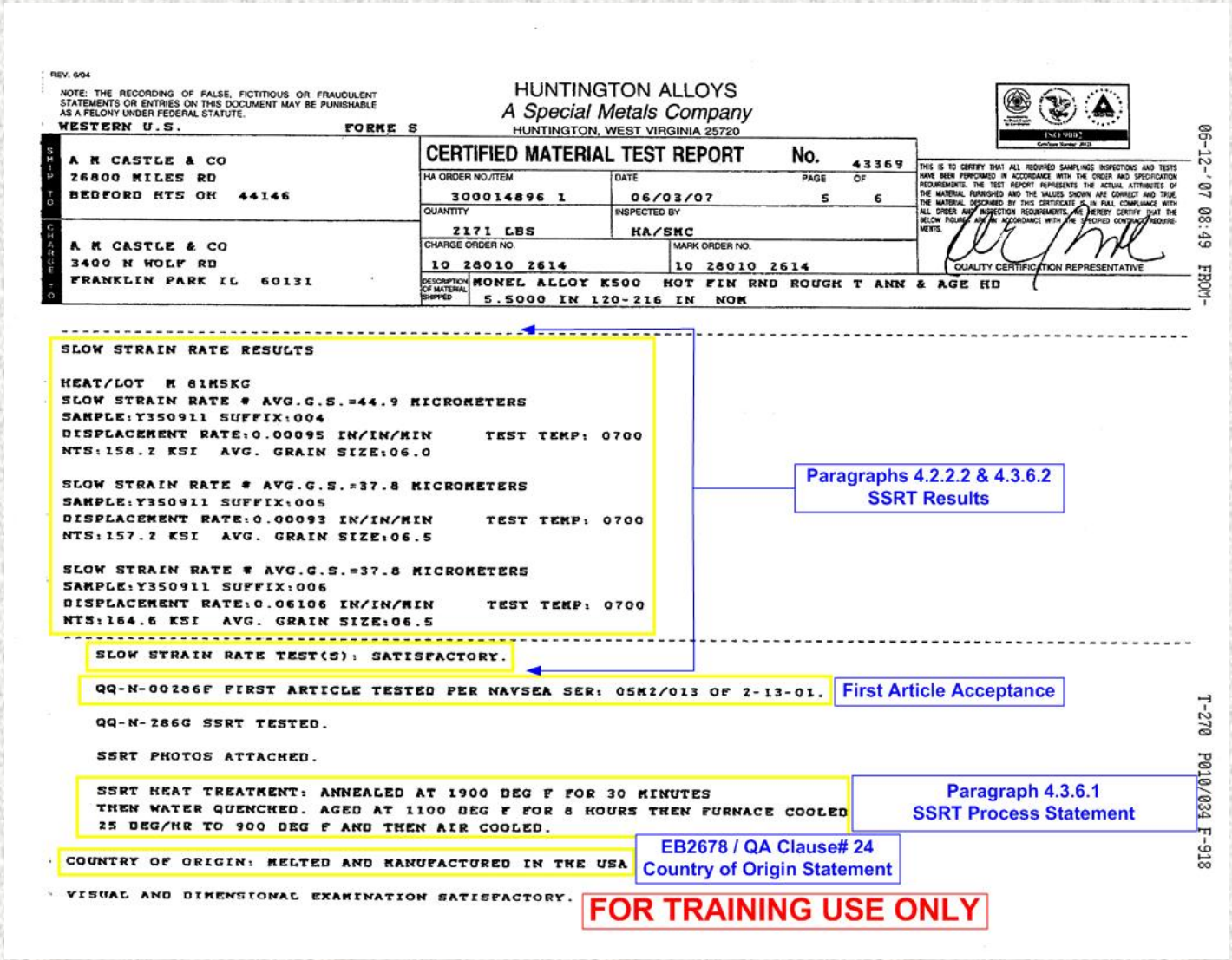
HUNTINGTON ALLOYS K500 MATERIAL



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A Special Metals Company
HUNTINGTON, WEST VIRGINIA 25720

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300014896 1	06/03/07	5	6

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SLOW STRAIN RATE RESULTS

HEAT/LOT M 81MSKG
SLOW STRAIN RATE @ AVG.G.S.=44.9 MICROMETERS
SAMPLE:Y350911 SUFFIX:004
DISPLACEMENT RATE:0.00095 IN/IN/MIN TEST TEMP: 0700
NTS:158.2 KSI AVG. GRAIN SIZE:06.0

SLOW STRAIN RATE @ AVG.G.S.=37.8 MICROMETERS
SAMPLE:Y350911 SUFFIX:005
DISPLACEMENT RATE:0.00093 IN/IN/MIN TEST TEMP: 0700
NTS:157.2 KSI AVG. GRAIN SIZE:06.5

SLOW STRAIN RATE @ AVG.G.S.=37.8 MICROMETERS
SAMPLE:Y350911 SUFFIX:006
DISPLACEMENT RATE:0.06106 IN/IN/MIN TEST TEMP: 0700
NTS:164.6 KSI AVG. GRAIN SIZE:06.5

Paragraphs 4.2.2.2 & 4.3.6.2
SSRT Results

SLOW STRAIN RATE TEST(S): SATISFACTORY.

QQ-N-00286F FIRST ARTICLE TESTED PER NAVSEA SER: 05M2/013 OF 2-13-01.

First Article Acceptance

QQ-N-286G SSRT TESTED.

SSRT PHOTOS ATTACHED.

SSRT HEAT TREATMENT: ANNEALED AT 1900 DEG F FOR 30 MINUTES THEN WATER QUENCHED. AGED AT 1100 DEG F FOR 8 HOURS THEN FURNACE COOLED 25 DEG/HR TO 900 DEG F AND THEN AIR COOLED.

Paragraph 4.3.6.1
SSRT Process Statement

COUNTRY OF ORIGIN: MELTED AND MANUFACTURED IN THE USA

EB2678 / QA Clause# 24
Country of Origin Statement

VISUAL AND DIMENSIONAL EXAMINATION SATISFACTORY.

T-270 P010/034 F-918

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HUNTINGTON ALLOYS K500 MATERIAL

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QUALITY CERTIFICATION REPRESENTATIVE

QA Clause# 4 Mercury-Free Statement

MATERIAL, WHEN SHIPPED, IS FREE FROM CONTAMINATION BY MERCURY, RADIUM, ALPHA SOURCE, & LOW MELTING ELEMENTS

"CHEMICAL ANALYSIS AS REQUIRED FOR CARBON,SULFUR,NITROGEN OR OXYGEN IS PERFORMED BY COMBUSTION TECHNIQUES. ALL OTHER REPORTED ELEMENTS ARE ANALYZED BY X-RAY AND/OR EMISSION SPECTROSCOPY."

"QUALITY SYSTEM MEETS REQUIREMENTS OF DIRECTIVE 97/23/EC (PRESSURE EQUIPMENT DIRECTIVE), ANNEX 1, CHAPTER 4.3 PER ABS GROUP LTD CERTIFICATE 008(EXPIRES AUGUST 2008) AND TUV CERTIFICATE 20674928 (EXPIRES MAY 2008)"

AUTHORIZED QUALITY CERTIFICATION REPRESENTATIVES :
W.E. BOLEN, P.D. CUSTER, M.A. MORRISON, P. WAUGH

QA Clause# 3
Certifying Authority's
Name & Signature

06-12-'07 08:49 FROM-

T-270 P011/034 F-918

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ELECTRALLOY K500 MATERIAL

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ELECTRALLOY K500 MATERIAL

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SCOT FORGE K500 MATERIAL

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REQUIREMENTS OF THE QQ-N-281 MATERIAL CERTIFICATION

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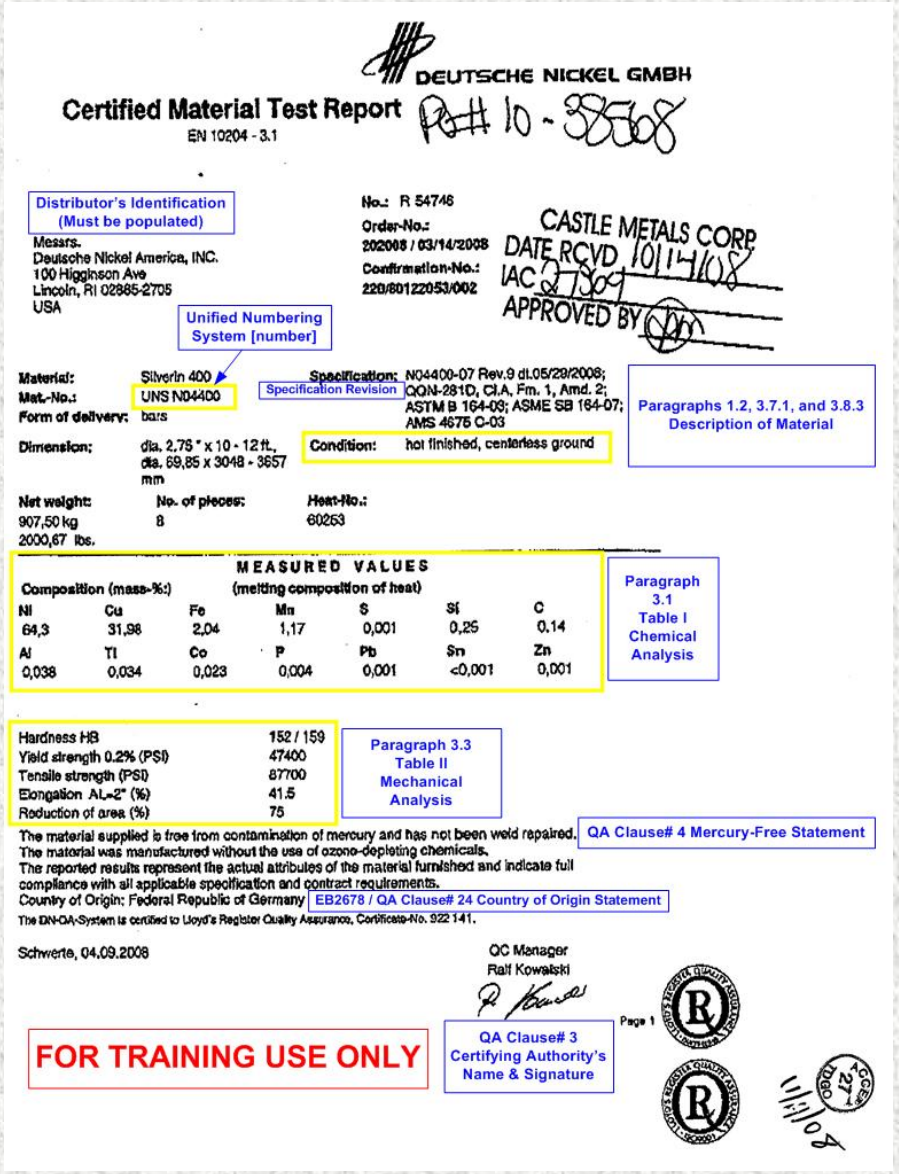
DEUTSCHE NICKEL MONEL 400 MATERIAL



DEUTSCHE NICKEL GMBH

Certified Material Test Report P# 10 - 38568

EN 10204 - 3.1

Distributor's Identification (Must be populated)

Messrs.
Deutsche Nickel America, INC.
100 Higginson Ave
Lincoln, RI 02865-2705
USA

No.: R 54746
Order-No.:
202008 / 03/14/2008
Confirmation-No.:
220/60122053/002

CASTLE METALS CORP
DATE RCVD 10/14/08
IAC 21309
APPROVED BY

Unified Numbering System [number]

Material: Silverin 400
Mat.-No.: UNS N04400
Form of delivery: bars

Specification: N04400-07 Rev.9 dt.05/29/2008; QQN-281D, Cl.A, Fm. 1, Amd. 2; ASTM B 164-03; ASME SB 164-07; AMS 4675 C-03
Specification Revision

Dimension: dia. 2,75 " x 10 - 12 ft., dia. 69,85 x 3048 - 3657 mm

Condition: hot finished, centerless ground

Paragraphs 1.2, 3.7.1, and 3.8.3 Description of Material

Net weight: 907,50 kg 2000,67 lbs.
No. of pieces: 8
Heat-No.: 60253

MEASURED VALUES
(melting composition of heat)

Composition (mass-%:)

Ni	Cu	Fe	Mn	S	Si	C
64,3	31,98	2,04	1,17	0,001	0,25	0,14
Al	**Ti**	**Co**	**P**	**Pb**	**Sn**	**Zn**
0,038	0,034	0,023	0,004	0,001	<0,001	0,001

Paragraph 3.1 Table I Chemical Analysis

Hardness HB	152 / 159
Yield strength 0.2% (PSI)	47400
Tensile strength (PSI)	87700
Elongation AL=2" (%)	41.5
Reduction of area (%)	75

Paragraph 3.3 Table II Mechanical Analysis

The material supplied is free from contamination of mercury and has not been weld repaired. QA Clause# 4 Mercury-Free Statement
The material was manufactured without the use of ozone-depleting chemicals.
The reported results represent the actual attributes of the material furnished and indicate full compliance with all applicable specification and contract requirements.
Country of Origin: Federal Republic of Germany EB2678 / QA Clause# 24 Country of Origin Statement
The DN-QA-System is certified to Lloyd's Register Quality Assurance, Certificate-No. 922 141.

Schwerte, 04.09.2008

QC Manager
Ralf Kowalski

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QA Clause# 3 Certifying Authority's Name & Signature

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REQUIREMENTS OF THE ASTM B150 MATERIAL CERTIFICATION FOR Al-Ni-Br UNS Nos. C63000 & C63200

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GENERAL REQUIREMENTS FOR RECEIPT INSPECTION OF C63XXX

- TDGO Policy - Material shall be lotted in by Heat and Batch (Lot No.) [in this order]
- Mercury-free statement is mandatory
- When C63000 is specified, standard strength or high strength temper shall be specified also (paragraph 4.1.3.1)
- C63200 shall be heat-treated per paragraph 5.2

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CHEMICAL REQUIREMENTS

B 150/B 150M

TABLE 1 Chemical Requirements

Elements	Composition, %									
	Copper Alloy UNS No.									
	C61300	C61400	C61900	C62300	C62400	C63000	C63020	C63200	C64200	C64210
Aluminum	6.0–7.5	6.0–8.0	8.5–10.0	8.5–10.0	10.0–11.5	9.0–11.0	10.0–11.0	8.7–9.5	6.3–7.6	6.3–7.0
Copper, incl silver	remainder	remainder	remainder	remainder	remainder	remainder	74.5 min	remainder	remainder	remainder
Iron	2.0–3.0	1.5–3.5	3.0–4.5	2.0–4.0	2.0–4.5	2.0–4.0	4.0–5.5	3.5–4.3[A]	0.30 max	0.30 max
Nickel, incl cobalt	0.15 max	. . .	. . .	1.0 max	. . .	4.0–5.5	4.2–6.0	4.0–4.8[A]	0.25 max	0.25 max
Manganese	0.20 max	1.0 max	. . .	0.50 max	0.30 max	1.5 max	1.5 max	1.2–2.0	0.10 max	0.10 max
Silicon	0.10 max	. . .	. . .	0.25 max	0.25 max	0.25 max	. . .	0.10 max	1.5–2.2	1.5–2.0
Tin	0.20–0.50	. . .	0.6 max	0.6 max	0.20 max	0.20 max	0.25 max	. . .	0.20 max	0.20 max
Zinc, max	0.10[B]	0.20	0.8	. . .	. . .	0.30	0.30	. . .	0.50	0.50
Lead, max	0.01	0.01	0.02	. . .	. . .	. . .	0.03	0.02	0.05	0.05
Arsenic, max	. . .		. . .	. . .	. . .	. . .	. . .	. . .	0.15	0.15
Phosphorus, max	0.015	0.015	. . .	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Other named elements	[B]						[C]			

[A] Iron content shall not exceed nickel content.

[B] When the product is for subsequent welding applications and is so specified by the purchaser, chromium shall be 0.05 % max, cadmium 0.05 % max, zirconium 0.05 % max, and zinc 0.05 % max.

[C] Chromium shall be 0.05 max and cobalt shall be 0.20 max.

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MECHANICAL REQUIREMENTS FOR C63000

TABLE 2 *Continued*

Temper Designation		Diameter or Distance Between Parallel Surfaces,[A] in. [mm]	Tensile Strength, min ksi [MPa]	Yield Strength, min ksi [MPa], at 0.5 % Extension Under Load	Elongation in 4 × Diameter or Thickness of Specimen min, %[B]
Code	Name				
		Copper Alloy UNS No. C63000			
HR50	drawn and stress relieved	*1—standard strength rod:*			
		⅛ [12] to 1 [25], incl	100 [690]	50 [345]	5
		over 1 [25] to 2 [50], incl	90 [620]	45 [310]	6
		over 2 [50] to 3 [80], incl	85 [585]	42.5 [295]	10
M20, M30, O20, O25, O30, HR50	as hot rolled, as hot extruded, hot forged and annealed, hot rolled and annealed, hot extruded and annealed, drawn and stress relieved	over 3 [80] to 4 [100], incl	85 [585]	42.5 [295]	10
		over 4 [100]	80 [550]	40 [275]	12
HR50	drawn and stress relieved	*bar:*			
		⅛ [12] to 1 [25], incl	100 [690]	50 [345]	5
		over 1 [25] to 2 [50], incl	90 [620]	45 [310]	6
M20, M30, O20, O25, O30, HR50	as hot rolled, as hot extruded, hot forged and annealed, hot rolled and annealed, hot extruded and annealed, drawn and stress relieved	over 2 [50] to 4 [100], incl	85 [585]	42.5 [295]	10
		over 4 [100]	80 [550]	40 [275]	12
M20, M30, O20, O25, O30, HR50	as hot rolled, as hot extruded, hot forged and annealed, hot rolled and annealed, hot extruded and annealed, drawn and stress relieved	*shapes, all sizes*	85 [585]	42.5 [295]	10
HR50	drawn and stress relieved	*2—high strength rod:*			
		1 [25] and under	110 [760]	68 [470]	10
		over 1 [25] to 2 [50], incl	110 [760]	60 [415]	10
		over 2 [50] to 3 [80], incl	105 [725]	55 [380]	10
TQ50	quench hardened and temper annealed	over 3 [80] to 5 [125], incl	100 [690]	50 [345]	10

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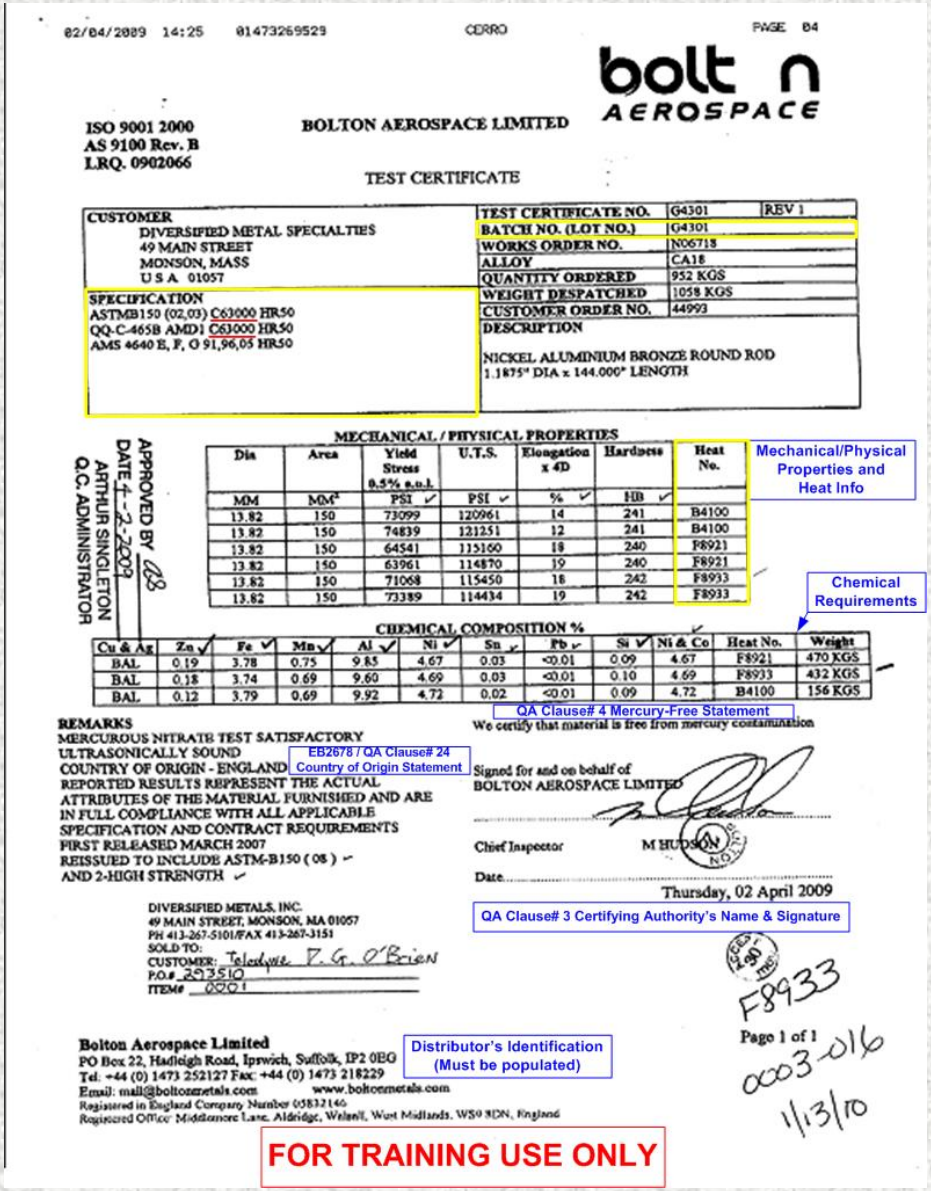
BOLTON AEROSPACE C63000 MATERIAL



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bolton AEROSPACE

ISO 9001 2000
AS 9100 Rev. B
LRQ. 0902066

BOLTON AEROSPACE LIMITED

TEST CERTIFICATE

CUSTOMER DIVERSIFIED METAL SPECIALTIES 49 MAIN STREET MONSON, MASS U S A 01057	TEST CERTIFICATE NO. G4301 REV 1 BATCH NO. (LOT NO.) G4301 WORKS ORDER NO. N06718 ALLOY CA18 QUANTITY ORDERED 952 KGS WEIGHT DESPATCHED 1058 KGS CUSTOMER ORDER NO. 44993
SPECIFICATION ASTMB150 (02,03) C63000 HR50 QQ-C-465B AMD1 C63000 HR50 AMS 4640 E, F, G 91,96,05 HR50	DESCRIPTION NICKEL ALUMINIUM BRONZE ROUND ROD 1.1875" DIA x 144.000" LENGTH

MECHANICAL / PHYSICAL PROPERTIES

Dia	Area	Yield Stress 0.5% e.u.l.	U.T.S.	Elongation x 4D	Hardness	Heat No.
MM	MM²	PSI ✓	PSI ✓	% ✓	HB ✓	
13.82	150	73099	120961	14	241	B4100
13.82	150	74839	121251	12	241	B4100
13.82	150	64541	113160	18	240	F8921
13.82	150	63961	114870	19	240	F8921
13.82	150	71068	115450	18	242	F8933
13.82	150	73389	114434	19	242	F8933

Mechanical/Physical Properties and Heat Info

APPROVED BY
DATE 4-2-2009
ARTHUR SINGLETON
Q.C. ADMINISTRATOR

Chemical Requirements

CHEMICAL COMPOSITION %

Cu & Ag	Zn ✓	Fe ✓	Mn ✓	Al ✓	Ni ✓	Sn ✓	Pb ✓	Si ✓	Ni & Co	Heat No.	Weight
BAL	0.19	3.78	0.75	9.85	4.67	0.03	<0.01	0.09	4.67	F8921	470 KGS
BAL	0.18	3.74	0.69	9.60	4.69	0.03	<0.01	0.10	4.69	F8933	432 KGS
BAL	0.12	3.79	0.69	9.92	4.72	0.02	<0.01	0.09	4.72	B4100	156 KGS

QA Clause# 4 Mercury-Free Statement

REMARKS
MERCUROUS NITRATE TEST SATISFACTORY
ULTRASONICALLY SOUND
COUNTRY OF ORIGIN - ENGLAND
REPORTED RESULTS REPRESENT THE ACTUAL ATTRIBUTES OF THE MATERIAL FURNISHED AND ARE IN FULL COMPLIANCE WITH ALL APPLICABLE SPECIFICATION AND CONTRACT REQUIREMENTS
FIRST RELEASED MARCH 2007
REISSUED TO INCLUDE ASTM-B150 (08) ✓
AND 2-HIGH STRENGTH ✓

EB2678 / QA Clause# 24 Country of Origin Statement

We certify that material is free from mercury contamination

Signed for and on behalf of
BOLTON AEROSPACE LIMITED

Chief Inspector M HUDSON

Date Thursday, 02 April 2009

QA Clause# 3 Certifying Authority's Name & Signature

DIVERSIFIED METALS, INC.
49 MAIN STREET, MONSON, MA 01057
PH 413-267-5101/FAX 413-267-3151
SOLD TO:
CUSTOMER: Teledyne D. G. O'Brien
P.O.# 293510
ITEM# 0001

F8933

Page 1 of 1

0003-016

1/13/10

Bolton Aerospace Limited
PO Box 22, Hadleigh Road, Ipswich, Suffolk, IP2 0EG
Tel. +44 (0) 1473 252127 Fax: +44 (0) 1473 218229
Email: mail@boltonmetals.com www.boltonmetals.com
Registered in England Company Number 05832146
Registered Office: Middlemore Lane, Aldridge, Walsall, West Midlands, WS9 8DN, England

Distributor's Identification (Must be populated)

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MECHANICAL REQUIREMENTS FOR C63200

B 150/B 150M

TABLE 2 *Continued*

Temper Designation		Diameter or Distance Between Parallel Surfaces,[A] in. [mm]	Tensile Strength, min ksi [MPa]	Yield Strength, min ksi [MPa], at 0.5 % Extension Under Load	Elongation in 4 × Diameter or Thickness of Specimen min, %[B]
Code	Name				
		Copper Alloy UNS No. C63200			
TQ50	quench hardened and temper annealed	*rod and bar:*			
		up to 3 [80], incl	90 [620]	50 [345]	15
TQ55	quench hardened, temper annealed, drawn, and stress relieved	over 3 [80] to 5 [125], incl	90 [620]	45 [310]	15
		over 5 [125] to 12 [300], incl	90 [620]	40 [275]	15
		shapes, all sizes	90 [620]	40 [275]	15
O20	hot forged and annealed	bar and shapes			
O25	hot rolled and annealed	all sizes	90 [620]	40 [275]	15

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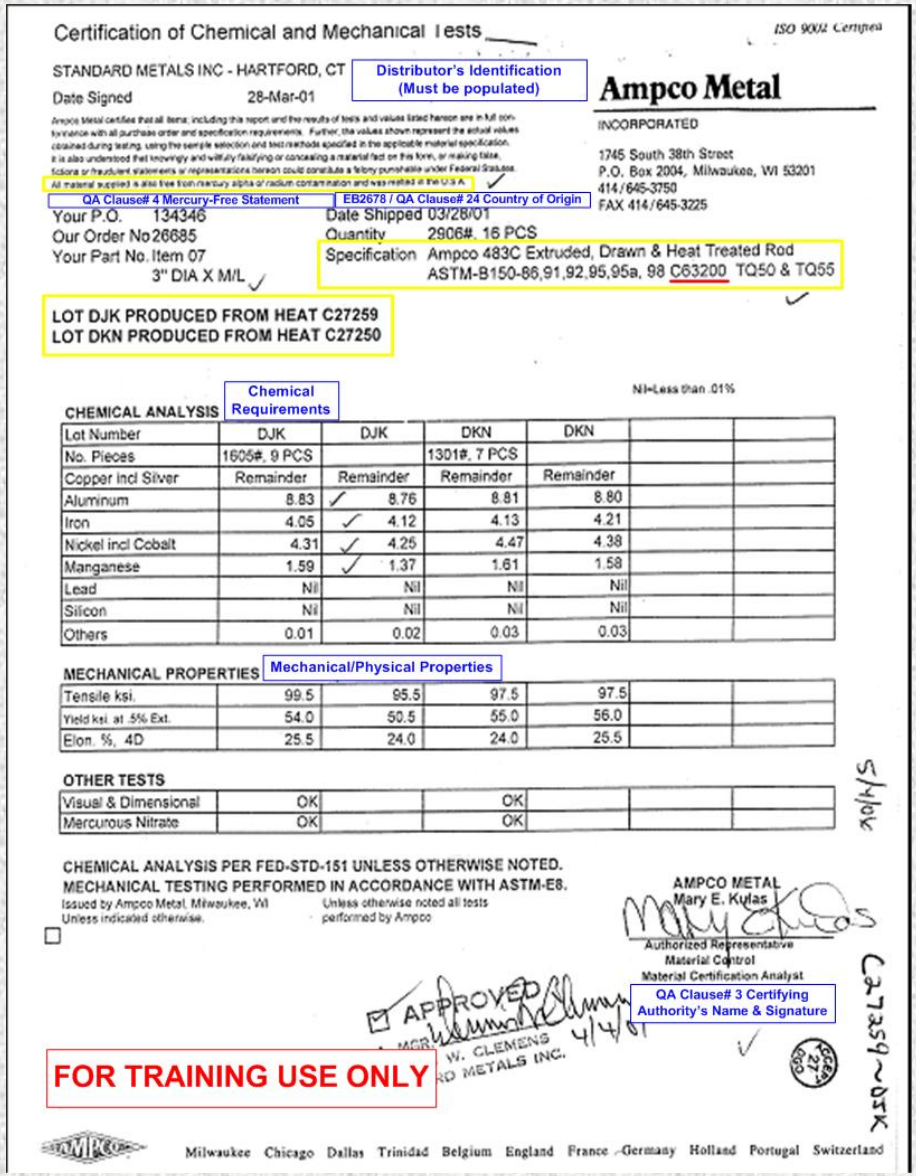
AMPCO METAL C63200 MATERIAL



Certification of Chemical and Mechanical Tests

ISO 9001 Certified

STANDARD METALS INC - HARTFORD, CT

Distributor's Identification (Must be populated)

Date Signed 28-Mar-01

Ampco Metal
INCORPORATED
1745 South 38th Street
P.O. Box 2004, Milwaukee, WI 53201
414/645-3750
FAX 414/645-3225

Ampco Metal certifies that all items, including this report and the results of tests and values listed hereon are in full conformance with all purchase order and specification requirements. Further, the values shown represent the actual values obtained during testing. Using the sample selection and test methods specified in the applicable material specification. It is also understood that knowingly and willfully falsifying or concealing a material fact on this form, or making false, fictions or fraudulent statements or representations hereon could constitute a felony punishable under Federal Statutes.

All material supplied is also free from mercury alpha or radium contamination and was melted in the U.S.A.

QA Clause# 4 Mercury-Free Statement

EB2678 / QA Clause# 24 Country of Origin

Your P.O. 134346
Our Order No 26685
Your Part No. Item 07
3" DIA X M/L

Date Shipped 03/28/01
Quantity 2906#, 16 PCS
Specification Ampco 483C Extruded, Drawn & Heat Treated Rod
ASTM-B150-86,91,92,95,95a, 98 C63200 TQ50 & TQ55

LOT DJK PRODUCED FROM HEAT C27259
LOT DKN PRODUCED FROM HEAT C27250

CHEMICAL ANALYSIS — Chemical Requirements

Ni=Less than .01%

Lot Number	DJK	DJK	DKN	DKN		
No. Pieces	1605#, 9 PCS		1301#, 7 PCS			
Copper incl Silver	Remainder	Remainder	Remainder	Remainder		
Aluminum	8.83	8.76	8.81	8.80		
Iron	4.05	4.12	4.13	4.21		
Nickel incl Cobalt	4.31	4.25	4.47	4.38		
Manganese	1.59	1.37	1.61	1.58		
Lead	Nil	Nil	Nil	Nil		
Silicon	Nil	Nil	Nil	Nil		
Others	0.01	0.02	0.03	0.03		

MECHANICAL PROPERTIES — Mechanical/Physical Properties

Tensile ksi.	99.5	95.5	97.5	97.5		
Yield ksi. at .5% Ext.	54.0	50.5	55.0	56.0		
Elon. %, 4D	25.5	24.0	24.0	25.5		

OTHER TESTS

Visual & Dimensional	OK		OK			
Mercurous Nitrate	OK		OK			

CHEMICAL ANALYSIS PER FED-STD-151 UNLESS OTHERWISE NOTED.
MECHANICAL TESTING PERFORMED IN ACCORDANCE WITH ASTM-E8.
Issued by Ampco Metal, Milwaukee, WI
Unless indicated otherwise.
Unless otherwise noted all tests performed by Ampco

AMPCO METAL
Mary E. Kulas
Authorized Representative
Material Control
Material Certification Analyst

QA Clause# 3 Certifying Authority's Name & Signature

APPROVED
W. CLEMENS
METALS INC.
4/4/01

C27359~DJK

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SUMMARY

- Annealed versus Age Hardened
- Monel® K500 versus Alloy 400
- Aluminum Bronze Rod C63000 versus C63200
- Material Certification requirements

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QUESTIONS & ANSWERS

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