



Perryman company

213 Vandale Drive Houston, PA 15342 USA

phone: 724-746-9390 fax: 724-746-9392

Certified Test Report

Customer: **TNS USA**
18881 Von Karman Ave.
STE 160
Irvine, CA 92612

Heat No: **PV10992**
Melting Source: **Perryman Company, USA**
Work Order No: **240601**

Date: **3/5/2024**
Quantity: **243** **KGS**

Customer Order No: **M2302**

Product: **Ti 6Al-4V ELI 3mm h6 (.1179/.1181") Dia. Precision CG Bar X 2500mm R/L**

Specification: **ASTM F136-13**

Condition: **Annealed 1300 F - 1 Hour**

Chemistry	Wt %	ASTM E 1447:	Post processing Hydrogen Determination	H: .0011
Metallographic Examination:		ASTM E407:	Microstructure - Equiax alpha-beta	ASTM E 407: Surface Contamination - No alpha case 500x
Etchant: PER1 & PER2				
Mechanical Properties		Tensile	.2% Yield	Elongation
ASTM E8/EN 2002-001:2005E		Strength	Strength	4D
Condition		ksi	ksi	%
As Shipped		149.0	130.2	23
				Reduction of Area
				49

100% Eddy Current Inspection at finished product - Passed

This is to certify that all test results conform to the specifications listed above and that all tests required were performed by Perryman Company.

The material did not come in contact with Mercury or radioactive contamination at Perryman.

Perryman utilizes a simple acceptance decision rule and does not consider measurement uncertainty when applying conformance statements.

Attached is a copy of the Ingot Chemistry. All testing performed at room temperature unless otherwise noted.

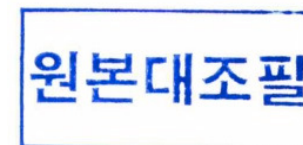
The test results relate only to the lots tested and are contained in the records of Perryman Company. The Certified Test Report cannot be reproduced except in full, without written approval. Made in USA.


Zachary S. Dragan
Laboratory Manager

3/5/2024



Materials Testing Laboratory





Perryman company
 625 Technology Dr., Coal Center, PA 15423
 phone: 724-746-9390 fax: 724-746-9392

SHIP TO

Perryman Company
 213 Vandale Drive
 Houston, PA 15342

CERTIFICATE OF TEST
For TITANIUM PRODUCTS

WORK ORDER
059931

HEAT NUMBER
PV10992

QUANTITY	PCS
12610 LBS	1

DESCRIPTION FORM: Ingot, Grade: Ti6Al4V Eli, Size: 30

SPECIFICATION CAPABILITY
P-104 Rev 4

Chemistry (WT%) Top

O	N	C	Fe	Al	V	Si	Cu	Pd	Y	H	B	Ru
.12	.007	.014	.18	6.00	4.11	.014	<.004	<.005	<.005	.0003	<.003	<.005

Chemistry (WT%) Bottom

O	N	C	Fe	Al	V	Si	Cu	Pd	Y	H	B	Ru
.12	.006	.013	.16	5.99	4.05	.012	<.004	<.005	<.005	.0003	<.003	<.005

Comments

Melting Process:
 EBCHR-VAR

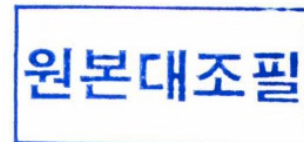
Calculated Beta Transus T/B:
 1795F/1795F

Calculated Beta Transus T/B C:
 979C/979C

Residual Elements, each < .05%
 Residual Elements, total < .20%
 Balance Titanium.

Melted in the United States of America.
 The material is free of radioactive and mercury contamination.
 Oxygen/Nitrogen tested in accordance with ASTM E1409.
 Carbon tested in accordance with ASTM E1941.
 Hydrogen tested in accordance with ASTM E1447.
 B tested in accordance with ASTM E2994.
 Metallics Tested By XRF in accordance with ASTM E539.

Elements not required by specification are included in Others(each) and Others(Total)



Materials Testing Laboratory

This material conforms to the chemistry and quality system requirements of the specifications and/or Purchase Order referenced. The results relate only to the lot tested and the results are contained in the records of Perryman Company.

The certificate of test cannot be reproduced except in full without the written approval of the laboratory, and the recording of false, fictitious, or fraudulent statements or entries on this document may be punished as a felony under federal law.

Michael DeAngelis
 Senior Laboratory Technician

Date Printed: 07/20/2023



195 Museum Road
 Washington, PA 15301
 Phone 724.228.1000
 Fax 724.229.4195

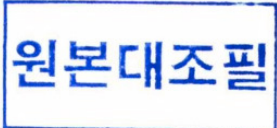

PRODUCT CERTIFICATION

WORK ORDER
543586

SALES ORDER / RLS
081209 / 001

SHIP TO

TNS USA
18881 Von Karman STE 160
Irvine, CA 92612
USA

CUSTOMER P.O. 12497	CUSTOMER PART	QUANTITY	LADING NO	SHIPMENT DATE						
		685 lbs	00120578	08/28/2023						
PART INFORMATION 121DD2AGC01980										
TI 6AL 4V ELI CG Bar - 0.1980" Dia.										
Specifications: ASTM F 136 Rev: 13; ISO 5832-3 Rev: 2021										
Size: 0.1980" Dia. +/- 0.0005"										
Length: 96" +/- 6"										
Chemical Report (Wt.%)										
Heat	Al T	Al B	C T	C B	Fe T	Fe B	N T	N B	O T	O B
9G72821	6.18	6.16	.033	.040	.21	.20	.006	.006	.10	.10
V T	V B	Y T	Y B	Ti	Ot E	TOE				
3.88	3.86	<.0010	<.0010	BAL	<.10	<.30				
Hydrogen (As Shipped)										
Hydrogen (%)										
0.0042										
As Shipped Properties										
UTS #1 (psi)	YS 0.2% #1 (psi)	EL #1 (%)	RA #1 (%)							
157300	145400	14	52							
Hardness (HRC)										
34										
Metallography Results										
Microstructure										
Alpha-Beta, Similar to ISO 20160 Plate: A1										
Alpha Case										
Material Free of Alpha Case										
Material Data										
 										



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 Fax 724.229.4195

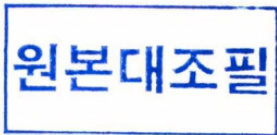

PRODUCT CERTIFICATION

WORK ORDER
543586

SALES ORDER / RLS
081209 / 001

SHIP TO

TNS USA
18881 Von Karman STE 160
Irvine, CA 92612
USA

CUSTOMER P.O.	CUSTOMER PART	QUANTITY	LADING NO	SHIPMENT DATE
12497		685 lbs	00120578	08/28/2023
Melt Origin		Bt	Tr °F	
USA			1792	
Melt Source		Bt	Tr °C	
RMI Titanium Co LLC Niles, OH			978	
Certification Information				
As Shipped Condition				
Annealed 1300°F 2 Hours A/C				
 				



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 Washington, PA 15301
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 Fax 724.229.4195


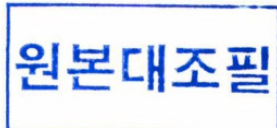

PRODUCT CERTIFICATION

WORK ORDER
543586

SALES ORDER / RLS
081209 / 001

SHIP TO

TNS USA
18881 Von Karman STE 160
Irvine, CA 92612
USA

CUSTOMER P.O.	CUSTOMER PART	QUANTITY	LADING NO	SHIPMENT DATE
12497		685	lbs 00120578	08/28/2023
<p>CERTIFICATION REQUIREMENTS</p> <p>Hydrogen analysis from final product. Material tested in 5D gage length. Material free of mercury and radioactive contamination. Material eddy-current inspected at the finished diameter - All Accepted Complete copy of the original material chemistry attached.</p> <div style="text-align: right; margin-top: 200px;">  Luis Perez Authorized Quality Released Agent </div> <p style="text-align: center; margin-top: 100px;">End of Certification</p> <p>This is to certify that the above test results are correct as contained in the records of the company</p> <p>Certification shall not be reproduced except in full without the approval of Dynamet Inc. The recording of false, fictitious or fraudulent statements or entries on this document may be punished as a felony under Federal Law.</p> <div style="text-align: right; margin-top: 100px;">   </div>				

SHIP TO

TNS USA
18881 Von Karman STE 160
Irvine, CA 92612
USA

CUSTOMER P.O.	CUSTOMER PART	QUANTITY	LADING NO	SHIPMENT DATE
DITCO 12408		2,232 lbs	00114786	03/31/2022

PART INFORMATION **121DD2ABD01579**
TI 6AL 4V ELI CG Bar - 0.1579" Dia.
Specifications: ASTM F 136 Rev: 13
Size: 0.1579" Dia. +0" / -0.001"
Length: 96" +/- 6"
option to ship 10% shorts down to 6'

Chemical Report (Wt.%)

Heat	Al T	Al B	C T	C B	Fe T	Fe B	N T	N B	O T	O B
8T69522	6.08	6.09	.013	.030	.24	.20	.004	.006	.11	.12
V T	V B	Y T	Y B	Ti	Ot E	TOE				
4.06	3.96	<.0010	<.0010	BAL	<.10	<.30				

Hydrogen (As Shipped)

Hydrogen (%)
0.0034

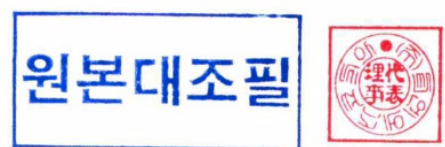
As Shipped Properties

UTS #1 (psi)	YS 0.2% #1 (psi)	EL #1 (%)	RA #1 (%)
150900	131100	21	49
Hardness (HRC)			
30			

Metallography Results

Microstructure
Alpha-Beta, Grain Size: ASTM #9.5
Alpha Case
Material Free of Alpha Case

Material Data



SHIP TO

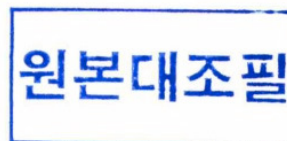
TNS USA
18881 Von Karman STE 160
Irvine, CA 92612
USA

CUSTOMER P.O.	CUSTOMER PART	QUANTITY	LADING NO	SHIPMENT DATE
DITCO 12408		2,232 lbs	00114786	03/31/2022
Melt Origin		Bt Tr	°F	
USA			1776	
Melt Source	Melt Type	Bt Tr	°C	
RMI Titanium Co LLC Canton, OH	PAM-VAR		969	

Certification Information

As Shipped Condition

Annealed 1300°F 2 Hours A/C



SHIP TO

TNS USA
18881 Von Karman STE 160
Irvine, CA 92612
USA

CUSTOMER P.O.	CUSTOMER PART	QUANTITY	LADING NO	SHIPMENT DATE
DITCO 12408		2,232 lbs	00114786	03/31/2022

CERTIFICATION REQUIREMENTS

Hydrogen analysis from final product.
Material tested in 4D gage length.
Material free of mercury and radioactive contamination.
Material 100% eddy-current inspected at the finished diameter- All Accepted



Ken Pike
Authorized Quality Release Agent

End of Certification

This is to certify that the above test results are correct as contained in the records of the company

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Fort Wayne Metals Research Products, LLC

PHN 260.747.4154
FAX 260.747.0398

9609 Ardmore Avenue
Fort Wayne, IN 46809

fwmetals.com



FORT WAYNE METALS

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F-QM-50
rev. February 27, 2022

CERTIFICATION OF COMPLIANCE

Certification: 1498950-1	Manufactured Date: 03/24/2023	Batch: 20563367	
Customer: TNS Korea		Sales Order: 1167266	
Customer Part: -		Purchase Order: 220810-006	Inspector
Quantity Shipped: 21.591 kg (1612 ea)			24 March, 2023
Finish: Etched			Date
Alloy: Ti-6Al-4V ELI		Condition: Annealed	
Size: 1.25 mm x 2500 mm			
Specification: ASTM F136	The material in this shipment has been certified to comply to the above specification		

RAW MATERIAL CHARACTERISTICS

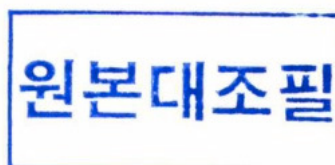
Heat Number: T2831G			
Batch Description: Coil			
Aluminum (Al) (%)	6.3900	Balance	Titanium
Carbon (C) (%)	0.0100	Cobalt (Co) (%)	< 0.0100
Hydrogen (H) (%)	0.0030	Iron (Fe) (%)	0.2200
Nitrogen (N) (%)	< 0.0100	Other Single Trace (%)	< 0.1000
Oxygen (O) (%)	0.1100	Total Trace Elements (%)	< 0.1000
Vanadium (V) (%)	4.2300	Yttrium (Y) (%)	< 0.0010
RM Country of Origin	Japan	RM DFARS Compliant	Compliant
RM Melt Method	Plasma Progressive Casting + VAR	Ultrasonic Tested	Yes

FINISHED GOOD MATERIAL CHARACTERISTICS

Size Tolerance: Diameter +0.000 / -0.025 mm		Discrete Part Length +12.7 / -12.7 mm	
Batch Description: Straight and Cut			
Diameter (mm)	1.241	Discrete Part Length (mm)	2,498.7
Breakload (kg)	133.5	Tensile Strength (Mpa)	1,081
Elongation (%)	10.7	Yield Load (kg)	103.3
Yield Strength (Mpa)	837	Alpha Case Free	Pass
Hydrogen (H) (%)	0.0010	Microstructure	A1
MetLab Report Number	23-03-87187	Straightness	Pass

Made in the USA from domestic and foreign materials.

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rev. February 27, 2022

CERTIFICATION OF COMPLIANCE

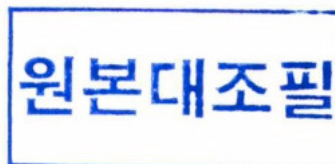
Certification: 1498950-1	Manufactured Date: 03/24/2023	Batch: 20563367	
Customer: TNS Korea		Sales Order: 1167266	Certified By Graham Gentis Inspector
Customer Part: -		Purchase Order: 220810-006	
Quantity Shipped: 21.591 kg (1612 ea)			24 March, 2023
Finish: Etched			Date
Alloy: Ti-6Al-4V ELI		Condition: Annealed	
Size: 1.25 mm x 2500 mm			
Specification: ASTM F136	The material in this shipment has been certified to comply to the above specification		

TESTING PROPERTIES

Crosshead Speed (mm/min)	1.7780	Secondary Crosshead Speed (mm/min)	25.4000
Gauge Length (mm)	254.0000		

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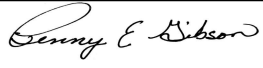


F-QM-50
rev. November04, 2018

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CERTIFICATION OF COMPLIANCE

Certification: 1383582-1	Manufactured Date: 09/03/2021	Batch: 16241072	
Customer: TNS Korea		Sales Order: 1108580	
Customer Part: FWMTNS001HR022		Purchase Order: TNS #200221-005 2of9	Inspector
Quantity Shipped: 426.467 kg (3065 ea)			3 September, 2021
Finish: Centerless Ground & Polished, Chamfer			Date
Alloy: Ti-6Al-4V ELI		Condition: Hard	
Size: 4.0 mm x 2500 mm			
Specification: ASTM F136	The material in this shipment has been certified to comply to the above specification		

RAW MATERIAL CHARACTERISTICS

Heat Number: 8R64962
Batch Description: Coil

Aluminum (Al) (%)	6.1850	Balance	Titanium
Carbon (C) (%)	0.0180	Cobalt (Co) (%)	< 0.1000
Hydrogen (H) (%)	0.0036	Iron (Fe) (%)	0.1950
Nitrogen (N) (%)	0.0055	Other Single Trace (%)	< 0.1000
Oxygen (O) (%)	0.1150	Total Trace Elements (%)	< 0.3000
Vanadium (V) (%)	3.8000	Yttrium (Y) (%)	< 0.0010
RM Country of Origin	USA	RM DFARS Compliant	Compliant
RM Melt Method	PAM + VAR	Ultrasonic Tested	Yes

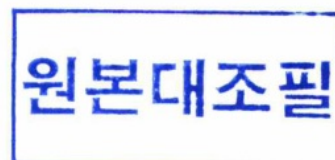
FINISHED GOOD MATERIAL CHARACTERISTICS

Size Tolerance: Diameter +0.00000 / -0.00787 mm	Discrete Part Length +24.9987 / -24.9987 mm
Batch Description: Centerless Ground and Polish	

Diameter (mm)	3.99415	Discrete Part Length (mm)	2,508.2500
Breakload (kg)	1,530	Tensile Strength (Mpa)	1,198
Elongation (%)	16.2	Yield Load (kg)	1,270
Yield Strength (Mpa)	994	Hydrogen (H) (%)	0.0090
Cold Work (%)	48.1	Beta Transus (°C)	973.0000
Alpha Case Free	Pass	Microstructure	A1
MetLab Report Number	21-07-75340	Reduction of Area (%)	38.0
Rockwell Hardness C (ea)	37.00		

Made in the USA from domestic and foreign materials.

FDA registered and ISO 13485 certified · ISO 9001 and AS 9100 certified



Fort Wayne Metals Research Products Corp

PHN 260.747.4154 9609 Ardmore Avenue
 FAX 260.747.0398 Fort Wayne, IN 46809

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 rev. November04, 2018

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CERTIFICATION OF COMPLIANCE

Certification: 1383582-1	Manufactured Date: 09/03/2021	Batch: 16241072	
Customer: TNS Korea		Sales Order: 1108580	
Customer Part: FWMTNS001HR022		Purchase Order: TNS #200221-005 2of9	Inspector
Quantity Shipped: 426.467 kg (3065 ea)			3 September, 2021
Finish: Centerless Ground & Polished, Chamfer			Date
Alloy: Ti-6Al-4V ELI		Condition: Hard	
Size: 4.0 mm x 2500 mm			
Specification: ASTM F136	The material in this shipment has been certified to comply to the above specification		

TESTING PROPERTIES

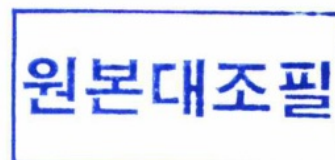
Crosshead Speed (mm/min)	1,2446	Secondary Crosshead Speed (mm/min)	25,4000
Gauge Length (mm)	50,8000		

Batch Description: **Eddy Current Tested**

Eddy Current Test Pass

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rev. November04, 2018

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CERTIFICATION OF COMPLIANCE

Certification: 1379961-1	Manufactured Date: 09/15/2021	Batch: 16241180	
Customer: TNS Korea		Sales Order: 1108584	
Customer Part: FWMTNS001HR002		Purchase Order: TNS #200221-005 3of9	Certified By Penny Gibson Inspector
Quantity Shipped: 797.506 kg (3668 ea)			
Finish: Centerless Ground & Polished, Chamfer			15 September, 2021
Alloy: Ti-6Al-4V ELI			Date
Size: 5 mm x 2500 mm		Condition: Annealed	
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

RAW MATERIAL CHARACTERISTICS

Heat Number: W1B17			
Batch Description: Coil			
Aluminum (Al) (%)	5.9150	Balance	Titanium
Carbon (C) (%)	0.0200	Cobalt (Co) (%)	< 0.0100
Hydrogen (H) (%)	0.0015	Iron (Fe) (%)	0.1500
Nitrogen (N) (%)	0.0100	Other Single Trace (%)	0.1000
Oxygen (O) (%)	0.1100	Total Trace Elements (%)	0.4000
Vanadium (V) (%)	3.9600	Yttrium (Y) (%)	< 0.0009
RM Country of Origin	USA	RM DFARS Compliant	Compliant
RM Melt Method	VAR + VAR	Ultrasonic Tested	Yes

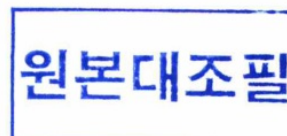
FINISHED GOOD MATERIAL CHARACTERISTICS

Size Tolerance: Diameter +0.00000 / -0.00787 mm		Discrete Part Length +24.9987 / -24.9987 mm	
Batch Description: Annealed			
Diameter (mm)	4.99745	Discrete Part Length (mm)	2,508.2500
Breakload (kg)	1,913	Tensile Strength (mpa)	956
Elongation (%)	19.2	Yield Load (kg)	1,613
Yield Strength (mpa)	807	Hydrogen (H) (%)	0.0020
Cold Work (%)	0.0	MetLab Report Number	21-08-76353
Beta Transus (°C)	997.5000	Reduction of Area (%)	46.9
Microstructure	A1	Rockwell Hardness C (ea)	30.00

TESTING PROPERTIES

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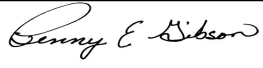


F-QM-50
 rev. November 04, 2018

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CERTIFICATION OF COMPLIANCE

Certification: 1379961-1	Manufactured Date: 09/15/2021	Batch: 16241180	
Customer: TNS Korea		Sales Order: 1108584	
Customer Part: FWMTNS001HR002		Purchase Order: TNS #200221-005 3of9	Inspector
Quantity Shipped: 797.506 kg (3668 ea)			15 September, 2021
Finish: Centerless Ground & Polished, Chamfer			Date
Alloy: Ti-6Al-4V ELI	Condition: Annealed		
Size: 5 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

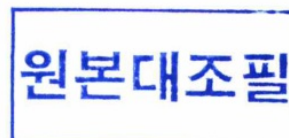
Crosshead Speed (mm/min)	1.2446	Secondary Crosshead Speed (mm/min)	25.4000
Gauge Length (mm)	50.8000		

Batch Description: **Centerless Ground and Polish**

Eddy Current Test Pass

Made in the USA from domestic and foreign materials.

FDA registered and ISO 13485 certified · ISO 9001 and AS 9100 certified



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F-QM-50
rev. November04, 2018

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CERTIFICATION OF COMPLIANCE

Certification: 1379451-1	Manufactured Date: 09/10/2021	Batch: 16286427	
Customer: TNS Korea	Sales Order: 1109201		
Customer Part: FWMTNS001HR029	Purchase Order: TNS #200221-005 2of10		Certified By Chase Strader Inspector
Quantity Shipped: 240.313 kg (3075 ea)			10 September, 2021 Date
Finish: Centerless Ground & Polished, Chamfer			
Alloy: Ti-6Al-4V ELI	Condition: Annealed		
Size: 3 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

RAW MATERIAL CHARACTERISTICS

Heat Number: W1B17			
Batch Description: Coil			
Aluminum (Al) (%)	5.9150	Balance	Titanium
Carbon (C) (%)	0.0200	Cobalt (Co) (%)	< 0.0100
Hydrogen (H) (%)	0.0015	Iron (Fe) (%)	0.1500
Nitrogen (N) (%)	0.0100	Other Single Trace (%)	0.1000
Oxygen (O) (%)	0.1100	Total Trace Elements (%)	0.4000
Vanadium (V) (%)	3.9600	Yttrium (Y) (%)	< 0.0009
RM Country of Origin	USA	RM DFARS Compliant	Compliant
RM Melt Method	VAR + VAR	Ultrasonic Tested	Yes

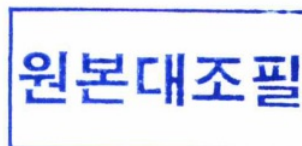
FINISHED GOOD MATERIAL CHARACTERISTICS

Size Tolerance: Diameter +0.00000 / -0.00584 mm		Discrete Part Length +24.9987 / -24.9987 mm	
Batch Description: Centerless Ground and Polish			
Diameter (mm)	2.99847	Discrete Part Length (mm)	2,501.9000
Breakload (kg)	710	Tensile Strength (mpa)	987
Elongation (%)	23	Yield Load (kg)	592
Yield Strength (mpa)	822	Hydrogen (H) (%)	0.0015
Cold Work (%)	9.6	MetLab Report Number	21-06-74696
Beta Transus (°C)	977.5000	Reduction of Area (%)	46.8
Microstructure	A1	Rockwell Hardness C (ea)	28.00

TESTING PROPERTIES

Made in the USA from domestic and foreign materials.

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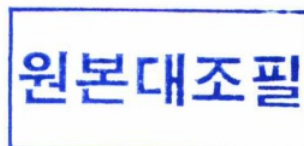
CERTIFICATION OF COMPLIANCE

Certification: 1379451-1	Manufactured Date: 09/10/2021	Batch: 16286427	
Customer: TNS Korea	Sales Order: 1109201		
Customer Part: FWMTNS001HR029	Purchase Order: TNS #200221-005 2of10		Certified By Chase Strader Inspector
Quantity Shipped: 240.313 kg (3075 ea)			10 September, 2021 Date
Finish: Centerless Ground & Polished, Chamfer			
Alloy: Ti-6Al-4V ELI	Condition: Annealed		
Size: 3 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

Crosshead Speed (mm/min)	1.2446	Secondary Crosshead Speed (mm/min)	25.4000
Gauge Length (mm)	50.8000		

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CERTIFICATION OF COMPLIANCE

Certification: 1366334-1	Manufactured Date: 06/03/2021	Batch: 17836882	 Certified By Kim Wolf Department Team Leader
Customer: TNS Korea		Sales Order: 1108584	
Customer Part: FWMTNS001HR002		Purchase Order: TNS #200221-005 3of9	3 June, 2021 Date
Quantity Shipped: 420.299 kg (1933 ea)			
Finish: Centerless Ground & Polished, Chamfer			
Alloy: Ti-6Al-4V ELI		Condition: Annealed	
Size: 5 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

RAW MATERIAL CHARACTERISTICS

Heat Number: 8V64240			
Batch Description: Coil			
Aluminum (Al) (%)	6.0900	Balance	Titanium
Carbon (C) (%)	0.0245	Cobalt (Co) (%)	< 0.1000
Hydrogen (H) (%)	0.0053	Iron (Fe) (%)	0.2000
Nitrogen (N) (%)	0.0045	Other Single Trace (%)	< 0.1000
Oxygen (O) (%)	0.1100	Total Trace Elements (%)	< 0.3000
Vanadium (V) (%)	3.8900	Yttrium (Y) (%)	< 0.0010
RM Country of Origin	USA	RM DFARS Compliant	Compliant
Ultrasonic Tested	Yes		

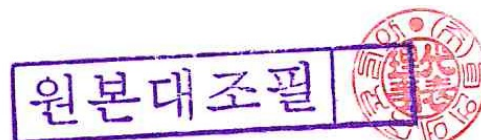
FINISHED GOOD MATERIAL CHARACTERISTICS

Size Tolerance: Diameter +0.00000 / -0.00787 mm		Discrete Part Length +24.9987 / -24.9987 mm	
Batch Description: Centerless Ground and Polish			
Diameter (mm)	4.99491	Discrete Part Length (mm)	2,517.7750
Breakload (kg)	1,998	Tensile Strength (mpa)	1,000
Elongation (%)	17.4	Yield Load (kg)	1,660
Yield Strength (mpa)	831	Hydrogen (H) (%)	0.0020
Cold Work (%)	7.1	MetLab Report Number	21-05-74407
Beta Transus (°C)	972.0000	Reduction of Area (%)	41.8
Microstructure	A1	Rockwell Hardness C (ea)	37.00

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CERTIFICATION OF COMPLIANCE

Certification: 1366334-1	Manufactured Date: 06/03/2021	Batch: 17836882	 Certified By Kim Wolf Department Team Leader
Customer: TNS Korea		Sales Order: 1108584	
Customer Part: FWMTNS001HR002		Purchase Order: TNS #200221-005 3of9	3 June, 2021 Date
Quantity Shipped: 420.299 kg (1933 ea)			
Finish: Centerless Ground & Polished, Chamfer			
Alloy: Ti-6Al-4V ELI	Condition: Annealed		
Size: 5 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

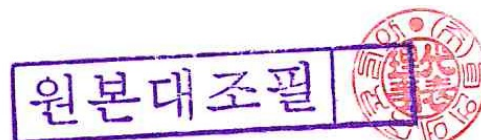
Crosshead Speed (mm/min)	1.2446	Secondary Crosshead Speed (mm/min)	25.4000
Gauge Length (mm)	50.8000		

Batch Description: **Eddy Current Tested**

Eddy Current Test Pass

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CERTIFICATION OF COMPLIANCE

Certification: 1350725-1	Manufactured Date: 02/04/2021	Batch: 16281896	
Customer: TNS Korea	Sales Order: 1109201		
Customer Part: FWMTNS001HR029	Purchase Order: TNS #200221-005 2of10		Certified By Chase Strader Inspector
Quantity Shipped: 122.923 kg (1571 ea)			4 February, 2021 Date
Finish: Centerless Ground & Polished, Chamfer			
Alloy: Ti-6Al-4V ELI	Condition: Annealed		
Size: 3 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

RAW MATERIAL CHARACTERISTICS

Heat Number: A9K98			
Batch Description: Coil			
Aluminum (Al) (%)	5.8850	Balance	Titanium
Carbon (C) (%)	< 0.0100	Cobalt (Co) (%)	< 0.0100
Hydrogen (H) (%)	0.0013	Iron (Fe) (%)	0.1800
Nitrogen (N) (%)	< 0.0100	Other Single Trace (%)	0.1000
Oxygen (O) (%)	0.1100	Total Trace Elements (%)	0.4000
Vanadium (V) (%)	3.9000	Yttrium (Y) (%)	< 0.0010
RM Country of Origin	USA	RM DFARS Compliant	Compliant
Ultrasonic Tested	Yes		

FINISHED GOOD MATERIAL CHARACTERISTICS

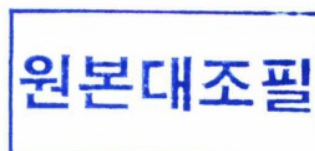
Size Tolerance: Diameter +0.00000 / -0.00584 mm		Discrete Part Length +24.9987 / -24.9987 mm	
Batch Description: Centerless Ground and Polish			
Diameter (mm)	2.99593	Discrete Part Length (mm)	2,501.9000
Breakload (kg)	713	Tensile Strength (mpa)	992
Elongation (%)	21	Yield Load (kg)	609
Yield Strength (mpa)	847	Hydrogen (H) (%)	0.0020
Cold Work (%)	9.5	MetLab Report Number	20-12-71598
Beta Transus (°C)	973.0000	Reduction of Area (%)	48.1
Microstructure	A1	Rockwell Hardness C (ea)	31.00

TESTING PROPERTIES

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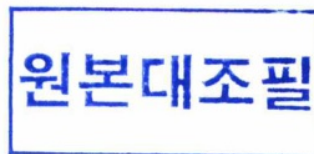
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CERTIFICATION OF COMPLIANCE

Certification: 1350725-1	Manufactured Date: 02/04/2021	Batch: 16281896	
Customer: TNS Korea		Sales Order: 1109201	
Customer Part: FWMTNS001HR029		Purchase Order: TNS #200221-005 2of10	Certified By Chase Strader Inspector
Quantity Shipped: 122.923 kg (1571 ea)			4 February, 2021 Date
Finish: Centerless Ground & Polished, Chamfer			
Alloy: Ti-6Al-4V ELI		Condition: Annealed	
Size: 3 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

Crosshead Speed (mm/min)	0.3556	Secondary Crosshead Speed (mm/min)	6.3500
Gauge Length (mm)	50.8000		



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Information contained herein may be subject to the International Traffic in Arms Regulations "ITAR" (22 CFR Parts 120 - 130) or the Export Administration Regulations "EAR" (15 CFR Parts 300 - 799) and may not be transferred to a Foreign Person, either within the United States or abroad, without an export license or other authorization from the US Department of State or US Department of Commerce. Violations of these export laws may be subject to civil and/or criminal penalties.

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Perryman company
625 Technology Dr., Coal Center, PA 15423
phone: 724-746-9390 fax: 724-746-9392

SHIP TO

Perryman Company
213 Vandale Drive
Houston, PA 15342

CERTIFICATE OF TEST
For TITANIUM INGOT

WORK ORDER
049686

HEAT NUMBER
PV09019

QUANTITY		PCS										
12680 LBS		1										
DESCRIPTION	FORM: Ingot, Grade: Ti6Al4V Eli, Size: 30											
SPECIFICATION CAPABILITY P-132 Rev 3												
Chemistry (WT%) Top												
O	N	C	Fe	Al	V	Si	Cu	Pd	Y	H	B	Ru
.08	.005	.012	.10	6.08	3.98	.018	<.004	<.005	<.005	.0004	<.003	<.005
Chemistry (WT%) Bottom												
O	N	C	Fe	Al	V	Si	Cu	Pd	Y	H	B	Ru
.09	.005	.009	.10	6.05	4.09	.014	<.004	<.005	<.005	.0003	<.003	<.005
Comments												
Melting Process: EBCHR-VAR												
Calculated Beta Transus T/B: 1786F/1786F												
Calculated Beta Transus T/B C: 974C/974C												
Residual Elements, each < .03%												
Residual Elements, total < .10%												
Balance Titanium.												
Melted in the United States of America.												
The material is free of radioactive and mercury contamination.												
Oxygen/Nitrogen tested in accordance with ASTM E1409.												
Carbon tested in accordance with ASTM E1941.												
Hydrogen tested in accordance with ASTM E1447.												
B tested in accordance with ASTM E2994.												
Metallics Tested By XRF in accordance with ASTM E539.												
Elements not required by specification are included in Others(each) and Others(Total)												



Materials Testing Laboratory

This material conforms to the chemistry and quality system requirements of the specifications and/or Purchase Order referenced. The results relate only to the lot tested and the results are contained in the records of Perryman Company.
The certificate of test cannot be reproduced except in full without the written approval of the laboratory, and the recording of false, fictitious, or fraudulent statements or entries on this document may be punished as a felony under federal law.

Michael DeAngelis
Senior Laboratory Technician

Date Printed: 01/31/2022



Perryman company
 213 Vandale Drive Houston, PA 15342 USA
 phone: 724-746-9390 fax: 724-746-9392

Certified Test Report

Customer: TNS Korea
 42-59, Sinheung-dong 3-ga
 Jung-gu
 Incheon22339
 Korea

Heat No: PV09019
 Melting Source: Perryman Company, USA
 Work Order No: 180425

Date: 2/10/2023
 Quantity: 52.66 KGS

Customer Order No: 221119-006
 Specification: ASTM F136-13

Product: Ti 6Al-4V ELI 2 mm +/-0.0254 mm
 (0.0787" +/-0.001") Dia. Fine Wire Round

Condition: Annealed + Acid Etched

Chemistry Wt %
 ASTM E 1447: Post processing Hydrogen Determination H: .0017
 ASTM E 407: Surface Contamination - No alpha case 500x

Microstructure - Equiax alpha-beta

Tensile Strength	ksi	148
.2% Yield Strength	ksi	125
Elongation	%	14

Metallographic Examination:
 Etchant: PER1 & PER2
 Mechanical Properties
 ASTM E8/EN 2002-001:2005E
 Condition
 As Shipped

This is to certify that all test results conform to the specifications listed above and that all tests required were performed by Perryman Company. The material did not come in contact with Mercury or radioactive contamination at Perryman. Attached is a copy of the Ingot Chemistry. All testing performed at room temperature unless otherwise noted. The test results relate only to the lots tested and are contained in the records of Perryman Company. The Certified Test Report cannot be reproduced except in full, without written approval. Made in USA.

Zachary S. Diagan
 Laboratory Manager
 2/10/2023

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CERTIFICATION OF COMPLIANCE

Certification: 1365949-1	Manufactured Date: 06/07/2021	Batch: 16241179	
Customer: TNS Korea		Sales Order: 1108584	
Customer Part: FWMTNS001HR002		Purchase Order: TNS #200221-005 3of9	Certified By Kim Wolf Department Team Leader
Quantity Shipped: 213.188 kg (980 ea)			
Finish: Centerless Ground & Polished, Chamfer			7 June, 2021 Date
Alloy: Ti-6Al-4V ELI		Condition: Annealed	
Size: 5 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

RAW MATERIAL CHARACTERISTICS

Heat Number: 8T63873			
Batch Description: Coil			
Aluminum (Al) (%)	5.9700	Balance	Titanium
Carbon (C) (%)	0.0205	Cobalt (Co) (%)	< 0.1000
Hydrogen (H) (%)	0.0021	Iron (Fe) (%)	0.1800
Nitrogen (N) (%)	0.0065	Other Single Trace (%)	< 0.1000
Oxygen (O) (%)	0.1250	Total Trace Elements (%)	< 0.3000
Vanadium (V) (%)	3.9350	Yttrium (Y) (%)	< 0.0010
RM Country of Origin	USA	RM DFARS Compliant	Compliant
Ultrasonic Tested	Yes		

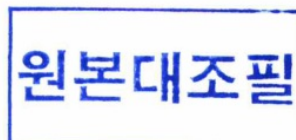
FINISHED GOOD MATERIAL CHARACTERISTICS

Size Tolerance: Diameter +0.00000 / -0.00787 mm		Discrete Part Length +24.9987 / -24.9987 mm	
Batch Description: Centerless Ground and Polish			
Diameter (mm)	4.99745	Discrete Part Length (mm)	2,508.2500
Breakload (kg)	1,961	Tensile Strength (mpa)	981
Elongation (%)	18.7	Yield Load (kg)	1,623
Yield Strength (mpa)	812	Hydrogen (H) (%)	0.0010
Cold Work (%)	7.0	MetLab Report Number	21-05-74209
Beta Transus (°C)	971.0000	Reduction of Area (%)	47.9
Microstructure	A1	Rockwell Hardness C (ea)	34.00

TESTING PROPERTIES

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CERTIFICATION OF COMPLIANCE

Certification: 1365949-1	Manufactured Date: 06/07/2021	Batch: 16241179	 Certified By Kim Wolf Department Team Leader
Customer: TNS Korea		Sales Order: 1108584	
Customer Part: FWMTNS001HR002		Purchase Order: TNS #200221-005 3of9	7 June, 2021 Date
Quantity Shipped: 213.188 kg (980 ea)			
Finish: Centerless Ground & Polished, Chamfer			
Alloy: Ti-6Al-4V ELI		Condition: Annealed	
Size: 5 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

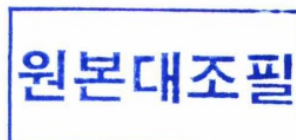
Crosshead Speed (mm/min)	1.2446	Secondary Crosshead Speed (mm/min)	25.4000
Gauge Length (mm)	50.8000		

Batch Description: **Eddy Current Tested**

Eddy Current Test Pass

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CERTIFICATION OF COMPLIANCE

Certification: 1383582-1	Manufactured Date: 09/03/2021	Batch: 16241072	
Customer: TNS Korea	Sales Order: 1108580		
Customer Part: FWMTNS001HR022	Purchase Order: TNS #200221-005 2of9		Certified By Penny Gibson Inspector
Quantity Shipped: 426.467 kg (3065 ea)			
Finish: Centerless Ground & Polished, Chamfer			3 September, 2021 Date
Alloy: Ti-6Al-4V ELI	Condition: Hard		
Size: 4.0 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

RAW MATERIAL CHARACTERISTICS

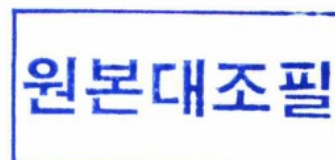
Heat Number: 8R64962			
Batch Description: Coil			
Aluminum (Al) (%)	6.1850	Balance	Titanium
Carbon (C) (%)	0.0180	Cobalt (Co) (%)	< 0.1000
Hydrogen (H) (%)	0.0036	Iron (Fe) (%)	0.1950
Nitrogen (N) (%)	0.0055	Other Single Trace (%)	< 0.1000
Oxygen (O) (%)	0.1150	Total Trace Elements (%)	< 0.3000
Vanadium (V) (%)	3.8000	Yttrium (Y) (%)	< 0.0010
RM Country of Origin	USA	RM DFARS Compliant	Compliant
RM Melt Method	PAM + VAR	Ultrasonic Tested	Yes

FINISHED GOOD MATERIAL CHARACTERISTICS

Size Tolerance: Diameter +0.00000 / -0.00787 mm		Discrete Part Length +24.9987 / -24.9987 mm	
Batch Description: Centerless Ground and Polish			
Diameter (mm)	3.99415	Discrete Part Length (mm)	2,508.2500
Breakload (kg)	1,530	Tensile Strength (Mpa)	1,198
Elongation (%)	16.2	Yield Load (kg)	1,270
Yield Strength (Mpa)	994	Hydrogen (H) (%)	0.0090
Cold Work (%)	48.1	Beta Transus (°C)	973.0000
Alpha Case Free	Pass	Microstructure	A1
MetLab Report Number	21-07-75340	Reduction of Area (%)	38.0
Rockwell Hardness C (ea)	37.00		

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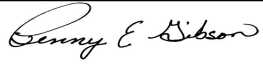


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CERTIFICATION OF COMPLIANCE

Certification: 1383582-1	Manufactured Date: 09/03/2021	Batch: 16241072	
Customer: TNS Korea		Sales Order: 1108580	
Customer Part: FWMTNS001HR022		Purchase Order: TNS #200221-005 2of9	Inspector
Quantity Shipped: 426.467 kg (3065 ea)			3 September, 2021
Finish: Centerless Ground & Polished, Chamfer			Date
Alloy: Ti-6Al-4V ELI	Condition: Hard		
Size: 4.0 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

TESTING PROPERTIES

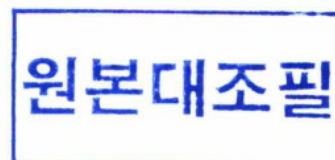
Crosshead Speed (mm/min)	1,2446	Secondary Crosshead Speed (mm/min)	25,4000
Gauge Length (mm)	50,8000		

Batch Description: **Eddy Current Tested**

Eddy Current Test Pass

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fax 260.747.0198

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CERTIFICATION OF COMPLIANCE

Certification: 1351862-1	Manufactured Date: 02/26/2021	Batch: 16241404	 Certified By: NATHAN DAVIS Inspector 26 February, 2021 Date
Customer: TNS Korea	Sales Order: 1908591		
Customer Part: FWHMTHS000HR004	Purchase Order: TNS #200229-005 6of9		
Quantity Shipped: 208.653 kg (374 ea)	Finish: Centerless Ground & Polished, Chamfer		
Alloy: Ti-6Al-4V ELI	Condition: Annealed		
Size: 8 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

RAW MATERIAL CHARACTERISTICS

Heat Number: BT63873			
Batch Description: Coil			
Aluminum (Al) (%)	5.9700	Balance	Titanium
Carbon (C) (%)	0.0205	Cobalt (Co) (%)	< 0.1000
Hydrogen (H) (%)	0.0022	Iron (Fe) (%)	0.1800
Nitrogen (N) (%)	0.0065	Other Single Trace (%)	< 0.1000
Oxygen (O) (%)	0.0250	Total Trace Elements (%)	< 0.5000
Vanadium (V) (%)	3.9350	Yttrium (Y) (%)	< 0.0010
RM Country of Origin	USA	RM DFARS Compliant	Compliant
Ultrasonic Tested	Yes		

FINISHED GOOD MATERIAL CHARACTERISTICS

Size Tolerance: Diameter +0.00000 / -0.00889 mm		Discrete Part Length +49.9999 / -49.7439 mm	
Batch Description: Centerless Ground and Polish			
Diameter (mm)	7.99719	Discrete Part Length (mm)	2,527.3000
Breakload (kg)	5,267	Tensile Strength (mpa)	1,028
Elongation (%)	17.4	4D Elongation (%)	17.4
Yield Load (kg)	4,466	Yield Strength (mpa)	872
Cold Work (%)	37.2	Hydrogen (H) (%)	0.0030
Beta Transus (°C)	971.0000	MetLab Report Number	21-01-71868
Microstructure	A1	Rockwell Hardness C (ea)	34.00
Reduction of Area (%)	49.9		

TNS KOREA CO.,LTD
 CERTIFIED THAT THIS IS COPY OF THE ORIGINAL
 MSL TEST REPORT NOW ON FILE RECEIVED AND INSPECTED

2021-04-08

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BY


NATHAN KWON / CEO

Fort Wayne Metals Research Products Corp

PHN 260.747.4154
FAX 260.747.0398

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Fort Wayne, IN 46809

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CERTIFICATION OF COMPLIANCE

Certification: 1379961-1	Manufactured Date: 09/15/2021	Batch: 16241180	
Customer: TNS Korea		Sales Order: 1108584	
Customer Part: FWMTNS001HR002		Purchase Order: TNS #200221-005 3of9	Certified By Penny Gibson Inspector
Quantity Shipped: 797.506 kg (3668 ea)			
Finish: Centerless Ground & Polished, Chamfer			15 September, 2021
Alloy: Ti-6Al-4V ELI			Date
Size: 5 mm x 2500 mm		Condition: Annealed	
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

RAW MATERIAL CHARACTERISTICS

Heat Number: W1B17			
Batch Description: Coil			
Aluminum (Al) (%)	5.9150	Balance	Titanium
Carbon (C) (%)	0.0200	Cobalt (Co) (%)	< 0.0100
Hydrogen (H) (%)	0.0015	Iron (Fe) (%)	0.1500
Nitrogen (N) (%)	0.0100	Other Single Trace (%)	0.1000
Oxygen (O) (%)	0.1100	Total Trace Elements (%)	0.4000
Vanadium (V) (%)	3.9600	Yttrium (Y) (%)	< 0.0009
RM Country of Origin	USA	RM DFARS Compliant	Compliant
RM Melt Method	VAR + VAR	Ultrasonic Tested	Yes

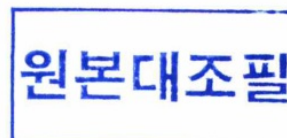
FINISHED GOOD MATERIAL CHARACTERISTICS

Size Tolerance: Diameter +0.00000 / -0.00787 mm		Discrete Part Length +24.9987 / -24.9987 mm	
Batch Description: Annealed			
Diameter (mm)	4.99745	Discrete Part Length (mm)	2,508.2500
Breakload (kg)	1,913	Tensile Strength (mpa)	956
Elongation (%)	19.2	Yield Load (kg)	1,613
Yield Strength (mpa)	807	Hydrogen (H) (%)	0.0020
Cold Work (%)	0.0	MetLab Report Number	21-08-76353
Beta Transus (°C)	997.5000	Reduction of Area (%)	46.9
Microstructure	A1	Rockwell Hardness C (ea)	30.00

TESTING PROPERTIES

Made in the USA from domestic and foreign materials.

FDA registered and ISO 13485 certified · ISO 9001 and AS 9100 certified



Fort Wayne Metals Research Products Corp

PHN 260.747.4154 9609 Ardmore Avenue
 FAX 260.747.0398 Fort Wayne, IN 46809

fwmetals.com



F-QM-50
 rev. November 04, 2018

FORT WAYNE METALS

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CERTIFICATION OF COMPLIANCE

Certification: 1379961-1	Manufactured Date: 09/15/2021	Batch: 16241180	
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Customer Part: FWMTNS001HR002	Purchase Order: TNS #200221-005 3of9		Certified By Penny Gibson Inspector
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Finish: Centerless Ground & Polished, Chamfer			15 September, 2021 Date
Alloy: Ti-6Al-4V ELI		Condition: Annealed	
Size: 5 mm x 2500 mm			
Specification: ASTM F136			
The material in this shipment has been certified to comply to the above specification			

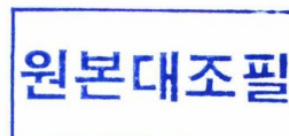
Crosshead Speed (mm/min)	1.2446	Secondary Crosshead Speed (mm/min)	25.4000
Gauge Length (mm)	50.8000		

Batch Description: **Centerless Ground and Polish**

Eddy Current Test Pass

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CERTIFICATION OF COMPLIANCE

Certification: 1389588-1	Manufactured Date: 08/10/2021	Batch: 18374585	<i>Chase Strader</i>
Customer: TNS Korea		Sales Order: 1138249	
Customer Part: -		Purchase Order: TNS #210623-004	Certified By Chase Strader Inspector
Quantity Shipped: 49.477 kg			10 August, 2021 Date
Finish: Etched		Condition: Annealed	
Alloy: Ti-6Al-4V ELI			
Size: 1.63 mm			
Specification: ASTM F136	The material in this shipment has been certified to comply to the above specification		

RAW MATERIAL CHARACTERISTICS

Heat Number: H33385
Batch Description: Round Wire

Aluminum (Al) (%)	6.0450	Balance	Titanium
Carbon (C) (%)	0.0190	Cobalt (Co) (%)	< 0.1000
Hydrogen (H) (%)	0.0029	Iron (Fe) (%)	0.1700
Nitrogen (N) (%)	0.0090	Other Single Trace (%)	< 0.1000
Oxygen (O) (%)	0.1050	Total Trace Elements (%)	< 0.3000
Vanadium (V) (%)	4.0000	Yttrium (Y) (%)	< 0.0004
RM Country of Origin	USA	RM DFARS Compliant	Compliant
Ultrasonic Tested	Yes		

FINISHED GOOD MATERIAL CHARACTERISTICS

Size Tolerance: Diameter +0.0127 / -0.0127 mm
Batch Description: Annealed

Diameter (mm)	1.6261	Breakload (kg)	225
Tensile Strength (Mpa)	1,062	Elongation (%)	10.7
Yield Load (kg)	171.5	Yield Strength (Mpa)	810
Hydrogen (H) (%)	0.0050	Alpha Case Free	Pass
Beta Transus (°C)	967.0000	MetLab Report Number	21-08-75962
Microstructure	A1		

TESTING PROPERTIES

Crosshead Speed (mm/min)	1.7780	Secondary Crosshead Speed (mm/min)	25.4000
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CERTIFIES THAT THIS IS COPY OF THE ORIGINAL
ALL TEST REPORTS MUST BE RECEIVED AND INSPECTED

2021-11-18

BY *[Signature]*
NATHAN KWON / CEO

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fwm Metals.com



F-QM-50
rev. November 04, 2018

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CERTIFICATION OF COMPLIANCE

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Customer: TNS Korea		Sales Order: 1138249	
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Finish: Etched		Condition: Annealed	
Alloy: Ti-6Al-4V ELI			
Size: 1.63 mm			
Specification: ASTM F136	The material in this shipment has been certified to comply to the above specification		

Gauge Length (mm) 254.0000

TNS KOREA CO., LTD
CERTIFIES THAT THIS IS COPY OF THE ORIGINAL
MILL TEST REPORT NOW ON FILE RECEIVED AND INSPECTED

2021-11-18

BY

Nathan Kwon
NATHAN KWON / CEO

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