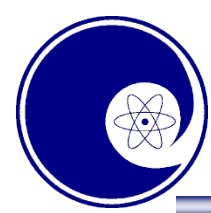


Requirements for Manufacturing Readiness: (Beamtube Assembly only)

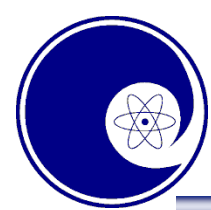
Due 1 month before start of
manufacturing for CERN approval



Requirement for Manufacturing Readiness

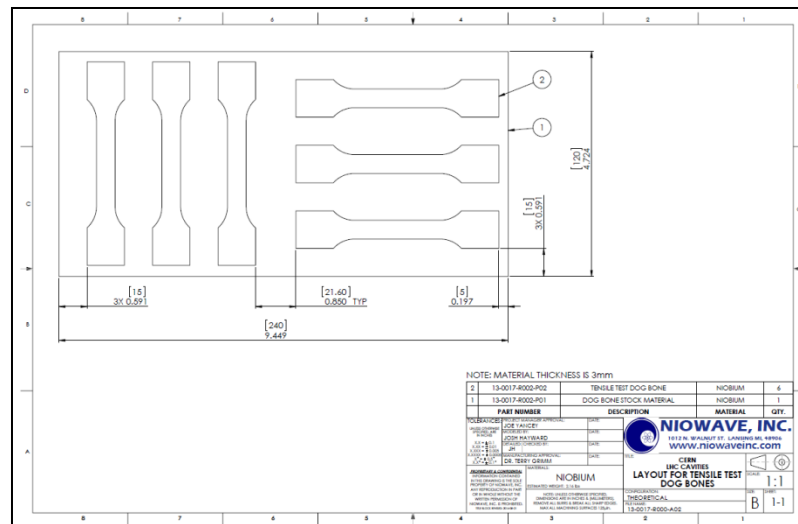
#	Requirements	Submitted to CERN	Approved by CERN
1	Niobium material samples according to Section 3.2	10/24/2014	10/31/2014
2	material certificates and quality control of raw materials (including RRR measurements)	10/24/2014	10/31/2014
3	material certificates of welding consumables (whenever applicable)	10/24/2014	10/31/2014
4	Functional and manufacturing drawings (with tolerances)	10/24/2014	11/5/2014
5	Design reports demonstrating that welds are designed to withstand the specified load cases (refer to Section 3.6.1)	10/13/2014	10/16/2014
6	Welding plan including:		
	Welding maps	11/7/2014	11/14/2014
	Welding and brazing procedure qualification record including CERN acceptance criteria in Section 4.2 (WPQR and BPQR)	11/7/2014	
	Welding and brazing procedure specification (WPS and BPS)	11/7/2014	11/14/2014
	Welders performance qualification (GTAW), Welding and Brazing Operators Performance Qualifications (electron-beam welding and vacuum brazing) - WPQ, WOPQ and BOPQ	11/14/2014 BOPQ only	
7	Manufacturing procedures (whenever required by Annex 6.3)	10/15/2014	
8	Test procedures (whenever required by Annex 6.3)	11/21/2014	
9	EB welded and vacuum brazed samples according to the requirements specified in Section 3.8.4	10/15/2014	10/31/2014
10	NDT personnel qualifications	11/14/2014	
11	Manufacturing and inspection plan (MIP) - list of all manufacturing and quality control operations	11/7/2014	

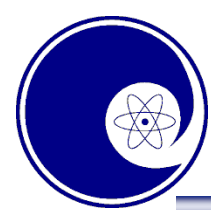




1. Niobium Material Samples

- Submitted:
 - Layout for Tensile Test Dog Bones (3mm Nb sheet)
 - L-shaped Dog Bone (25mm NbTi plate)
 - Round Dog Bone (16 mm Nb disk)
- Approved 10/31



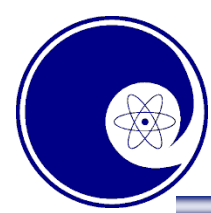


2. Material Certificates and Quality Control

- Initially submitted on October 13, 2014:
 - 3mm Niobium sheet (Ningxia)
 - 133mm diameter Niobium rod (Heraeus)
 - 25mm NbTi plate (Ningxia)
- Resubmitted to CERN with SS certs on 10/24
 - 316LN stainless
- Approved 10/31


Blatt 1/1		Abnahmeprüfzeugnis 3.1 Inspection certificate 3.1		Heraeus
Ausgabe: 01.08.2010 BK		EN 10204/3.1		
Customer	Niowave	product	Niobium RRR 200 rod	
Kunde		Produkt	133 x 635 mm	
part No.	81 067 316	Ident. No.	81 067 316	
123456		quantity	1 pcs	
specification No.		material	Nb	
Specification No.		Verstoff		
order No.	170 000 68	lot No.	3169 / B 103163	
order No.		Charge-Nr.		
purchase order No.	PO 10-1165-004			
bestell-Nr.	dated 19.03.2010			
Pos. No.	Prüfparameter inspection parameter	Nennwert nom. value	Istwert actual	Bemerkung remarks
	inget			chemical requirements according to ASTM B362-03-200410
1	Nb (ppm)	remainder	remainder	
2	Ta (ppm)	< 200	130	
3	Zr (ppm)	< 200	< 2	
4	Fe (ppm)	< 100	< 3	
5	Si (ppm)	< 50	< 7	
6	W (ppm)	< 500	< 6	
7	Hf (ppm)	< 50	< 3	
8	Mo (ppm)	< 200	< 4	
9	Cf (ppm)	< 200	< 4	
10	O (ppm)	< 100	2	
11	N (ppm)	< 100	7	
12	C (ppm)	< 200	3	
13	H (ppm)	< 15	1	
14	RRR	> 200	328	

Abnahmebeauftragter
acceptance signatory
Date
09.08.2010



3. Material Certificates of Welding & Brazing Consumables & Certs

- Approved 10/31
 - Braze inserts made from CERN supplied 316LN stainless



Prince & Lant Co.
NuTEC Metal Joining Products
12999 Plaza Drive
Cleveland, OH 44130
Phone: (216) 916-1116

CERTIFICATION

Sales Order No.: SORD-0063675
Invoice Date: 3/21/2014
Customer PO Number: 1406296
Reference No.

Sold To: [REDACTED] Shipped To: [REDACTED]

Alloy/ Cust Part No.	Customer Part Description	Rev. No.	AWS	AMS	ASTM	Fed. Spec.
AU35CU85	1.445 CD X .043 DIA GB3565					
35AU85CU1445	BUTT END					
	BUTT END					
	Press Fit into 1.440 O.D. Gauge					

Analysis of Actual Chemistries							
Lot No.	Sub Lot No.	Heat No.	Vendor Lot No.	Quantity	Unit of Measure	MFG Date	EXP Date
LOT-00035709		100841212	100849155	225	EA	3/21/2014	

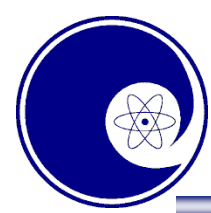
Quality Measure	Testing UoM	Result	Quality Measure	Testing UoM	Result
Gold	PCT	35.21	Copper	PCT	64.79

Prepared By: Mark Tallman

This report represents the actual attributes of the materials furnished and indicates full compliance with all applicable specification and contract requirements.

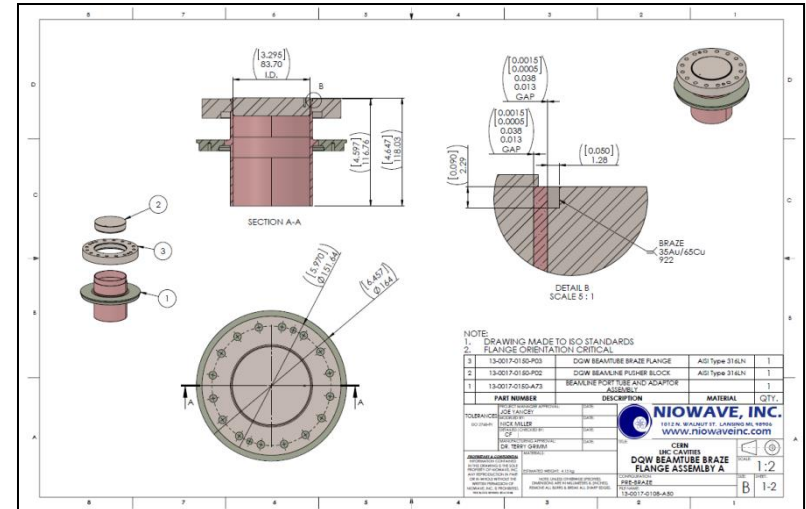
While in our possession the material supplied on this Purchase Order did not come into direct contact with Mercury (Hg) containing compounds or Mercury containing devices, employing only a single boundary of containment during our manufacturing, inspection or test.

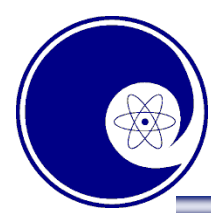
The recording of false, fictitious, or fraudulent statements or entries on this document may be punished as a felony under federal statutes, including Federal Law Title 18, Chapter 47.



4. Functional and Manufacturing Drawings

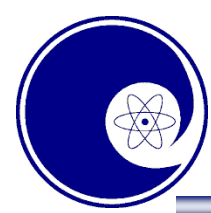
- Initially submitted on October 13, 2014:
 - Beamtube braze flange assembly A
 - Beamline port tube and adapter assembly
 - Transition ring pipe
 - Beamline transition ring
 - Beamtube A part 1
 - Beamtube A part 2
 - Beamline pusher block
 - Beamtube braze flange
 - 83.1 mm tube blank 30" long
- Approved 11/5





5. Weld Design Reports

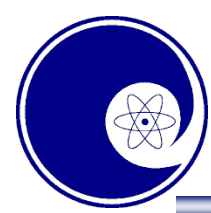
- Design reports demonstrating that welds are designed to withstand the specified load cases as specified in Section 3.6.1
 - Required on an as needed basis if design changes from specification drawing
 - CERN to complete design reports if necessary
- NO Design Reports for the Beamtube assembly at this time
- Approved by CERN on 10/16



6. Welding Plans

- Documents for Beamtube Assembly:
 - Weld map (submitted 11/7)
 - Weld matrix (submitted 11/7)
 - Braze procedure specification (BPS) (submitted 11/7)
 - Nb to SS
 - Welding procedure specification (WPS) (submitted 11/7)
 - Nb to Nb
 - Nb to NbTi
 - Welding and brazing procedure qualification records (submitted 11/7)
 - Welder and braze tech performance qualification*
 - Braze operator qualification to be submitted 11/14
 - Weld operator qualification in progress

*Supplier to provide operator qualification



7. Manufacturing Procedures

- Submitted October 15, 2014
 - Nb forming and handling procedure
 - Acid etching procedure
 - Cleanroom processing
 - Dimensional controls
- Feedback received 11/5

Niowave Proprietary
Niobium Handling and Machining Processes

Niobium Received
Checked into inventory, sharpie Niowave #

Need Niobium for a project or etch coupons?
Contact vault supervisor – Fill out a niobium requisition

If Nb being waterjet...
Label all expected parts and scrap piece locations with Niowave #
Wrap entire sheet in contact paper.

If Nb being sheared...
Wrap entire sheet with protective film.

THROUGH ALL MACHINING

STAMPING

- Ensure all stamping dies and Nb are cleaned with acetone and methanol
- Always use ample clean motor oil in between Nb and stamping dies
- Perform all stamping force calculations for proper tonnage prior to operation

MACHINING

- Never machine Nb over 200°C – Nb takes in oxygen and other airborne impurities
 - Always use ample cutting fluid, especially when machining RRR samples

FILING / DUBRRING

- Always use Nb files – there are silver-handled files in the machine shop
- Always use either unused or previously used on Nb ScotchBrite pads and dynabrade pads

SCRAP

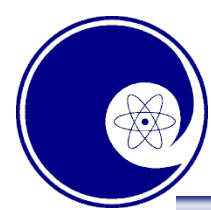
- Have scrap deburred and wiped of any oils
- Ensure Niowave# is marked on each scrap piece
- Return scrap to Matt or Tyler to have checked back into inventory

Ensure Nb is transported safely and stored in a safe location with proper precautions (Use Foam)

Ensure Nb is packaged properly for shipping offsite (Foam, Crates, etc.)

Page 1 of 1
Niowave Proprietary

10-6-2014



8. Test Procedures

- Test procedures to be provided
 - Radiography (ASTM E1032-12, contractor)
 - Leak check (Niowave)
- To be submitted 11/14



Leak Check Certificate

NIOWAVE, INC
1012 North Walnut Street
Lansing, MI 48906
Phone: (517) 999-3475
Fax: (517) 999-3626
www.niowaveinc.com

**Certification of Processing
Sub-Assembly Leak-check**

Cavity ID: _____
Sub-Assembly: _____
Assembly ID: _____

(Reference PO # 13-0017-238)

Procedure:

- Cold-shock assembly in liquid nitrogen (x5)
- Install blank with copper gasket on flange surface
- Perform helium leak-check
 - Install the assembly on leak-check port
 - Calibrate the leak checker
 - Pump down the assembly to less than 10^{-3} Torr
 - Spray dry helium around welds, braze joints, and gasket seals
 - Monitor the displayed leak rate throughout the test
- Remove conflat blanks and gaskets
- Clean all sealing surfaces
- Re-install protective flange covers

Setup Verification:

Signature: _____ Date: _____
Joseph Yancey
Mechanical Engineer

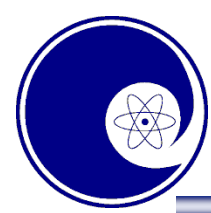
Check One

Cavity conforms to Niowave helium leak check specification
(No detectable signal found with a minimum sensitivity of at least $\leq 1 \times 10^{-10}$ mbar L/s)

Cavity failed leak check

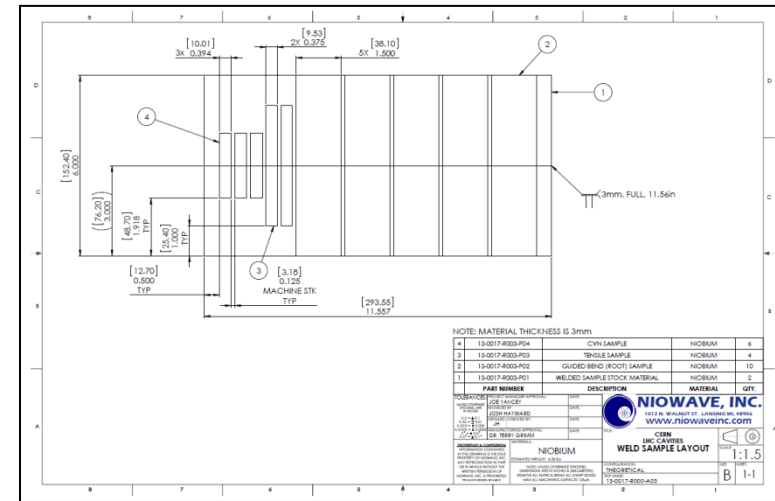
Signature: _____ Date: _____
Joshua Wyskowski
E.B. Weld Coordinator

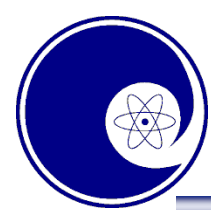
10



9. EB Welded & Vacuum Brazed Samples

- Sent October 15, 2014:
 - Braze coupon tension test
 - Braze coupon peel test
 - Weld sample for RRR test
 - NWV-EBW-001 Weld sample layout
 - NWV-EBW-002 Weld sample layout
 - NWV-EBW-003 Weld sample layout
 - NWV-EBW-004 Weld sample layout
 - NWV-EBW-005 Weld sample layout
- Approved 10/31





10. NDT Personnel Qualifications

- Qualifications for all NDT test technicians to be provided
 - Leak check technicians (Niowave)
 - Radiography technicians (supplier)
- To be submitted 11/14



NDT Technician **NIOWAVE, INC** Qualifications

1012 North Walnut Street
Lansing, MI 48906
Phone: (517) 999-3475
Fax: (517) 999-3626
www.niowaveinc.com

Niowave Leak Detection Operator Qualification

Niowave personnel responsible for leak checking components are trained in using the helium mass spectrometer system. This training occurs in the technician's first 90 days of employment. Our senior technician has 7+ years of experience, and has trained our other technicians to properly use the mass spectrometer to leak check systems.

The mass spectrometer leak detection system has a sensitivity of 10^{-11} Torr-L/s. Our leak check process is checked by two technicians and the project manager. The process follows the best practices guidelines set forth from the mass spectrometer manufacturer. See below.

Leak Checking for Reliability

The accuracy, reliability, and stability of any mass spectrometer leak detector depend upon the leak free integrity of its own vacuum system. Inherent helium background, and its effect on sensitivity demands elimination of all detectable leaks. If performance degrades during operation or after some part of the vacuum system is opened for service a methodical leak check eliminates the possibility of a leak as the cause.

NOTE: To ensure reliable testing, the leak detector must be leak checked before performing testing after servicing any part of the vacuum system.

Best Practices for Leak Checking

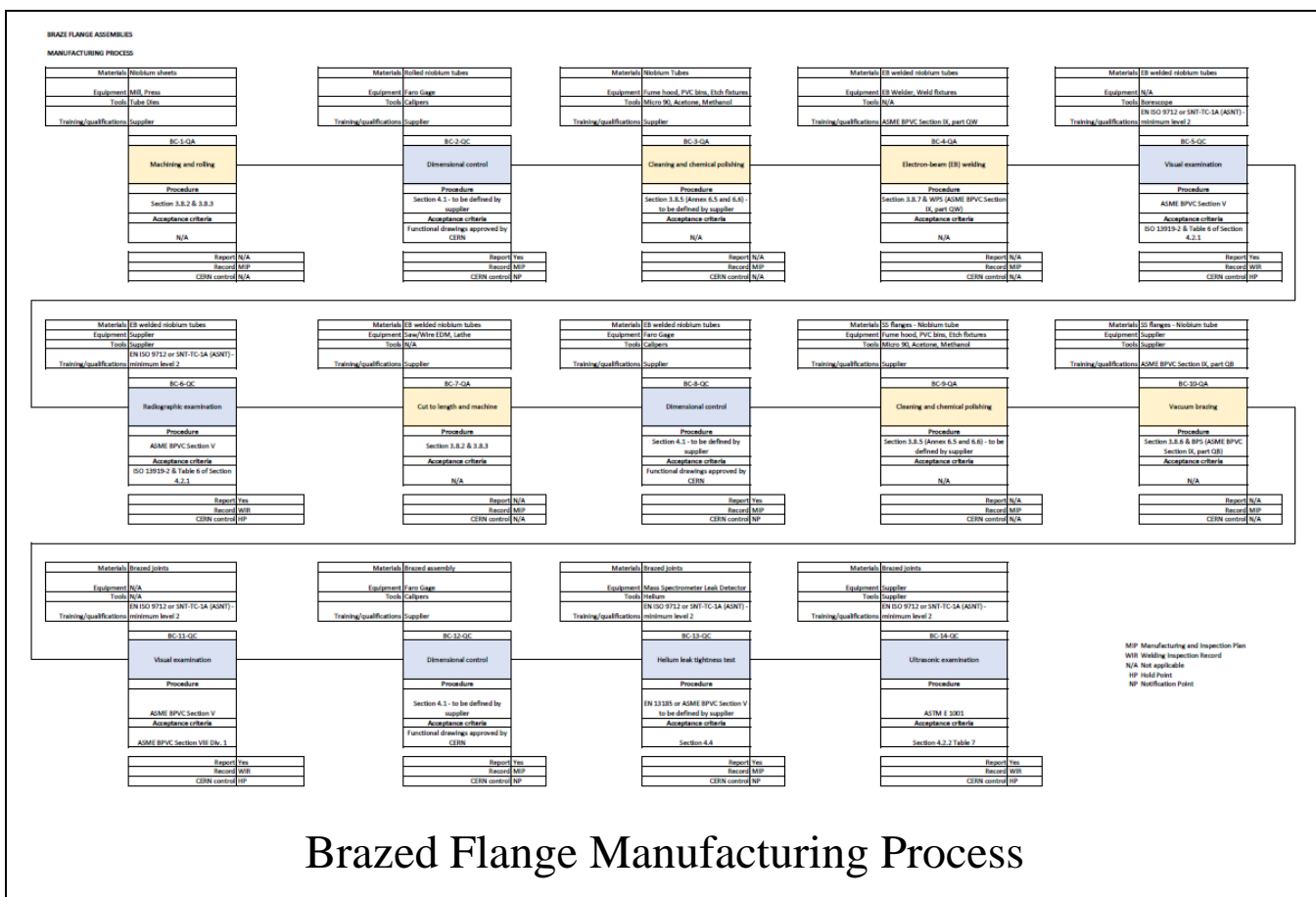
The following suggestions apply whether leak checking components, systems, or the leak detector itself:

- When spraying suspected leak locations:
 - Always apply helium sparingly.
 - Since helium rises, start at the highest points first.
 - Apply helium downstream from the source of a draft first, or deflect the draft until leak checks are completed.
- If vent grooves exist at flanges or other assembled seals, apply helium to these points (rather than spraying a general area) to:
 - Obtain the most positive response.
 - Minimize the use of helium.
 - Save time in checking.
- Locate and repair large leaks before attempting to locate extremely small leaks.
- Limit the search to a general area of the test piece by isolation methods to shorten the time required to locate both large and small leaks. Isolation methods include:
 - Bagging
 - Masking
 - Shielding with tape, plastic film or duct seal (if applied properly)
- Use only enough helium to reach the leaks. Do not flood the area.



11. Manufacturing and Inspection Plan (MIP)

- MIP for Beamtube Assembly is established
- Submitted 11/7



Brazed Flange Manufacturing Process