QXF 2nd Gen. Cable Fabrication Procedure

Cable #: ……

Date : ……

Paste Cable Barcode here

- Fill this document using **BLUE PEN** only

Contents

I. Wire Information

I.1 Strand Map

The Strand Map should be pasted below by the Scientist/Engineer.

Commented [IP1]: Add here the colour length target.

From Scientist/Engineer's name + signature and date:

I.2 Excel file “Respool Log”

ATPP	The Respool Log file should be created from the Strand Map in the Master Database by the Scientist/Engineer and provided to the technician. Scientist/Engineer’s name + signature and date: ……..	

I.3 Re-spooling the wires

Task I.3 Start Date and Time: _____

I.3.1	Verify that there are 40 barcode labelled Al spools and spool brakes with wires securing the bolts.	
I.3.2	Verify that the wires to be re-spooled have a correct barcode reflecting their un-annealed/annealed status. Weigh if necessary to verify the approximate wire length, or respool to verify accurately in the case that the length is critical.	
I.3.3	Repeat the following steps for each of the 40 spools.	
I.3.4	Place an Al spool onto the re-spooling machine. Scan into the Excel file "Respool Log" • the ID of the strand • the ID of the Al spool • the ID of the spool brake	
I.3.5	Verify that the KEYANCE dual-axis micrometer and the computer for diameter data collection are turned on.	
I.3.6	[This is an empty box]	

I.3.7	For every new payout spool as well as at any point of suspicion, measure both 1.000 mm and 0.500 mm gauge pins (five times each). Make sure the optical micrometer gives an accurate reading. Report any irregularities or damage of the gauge pins. These measurements should be recorded in the file.	

I.3.8	Set the optical micrometer sampling frequency to 0.3 m, or record the actual sampling frequency used here: ……..	

I.3.9	Set the footage counter to zero.	

I.3.10	Start re-spooling. Make sure the wire is uniformly distributed along the length of the Al spool.	

I.3.11	For the first re-spool from a payout, record in the Excel file "Respool Log" the length of wire on the original spool. For the first re-spool from the first payout, colour the first 30 m and the last 30 m with a blue sharpy felt pen. Record in the Excel file "Respool Log" the colour applied. For the first re-spool from another selected payout, colour the first 30 m green and the last 30 m red. Record in the Excel file "Respool Log" the colour applied correctly according to the Al strand spool Hub/Top position. For the subsequent re-spools from the same payout, simply check that the length agrees with the specified length shown in the Excel File "Respool Log" and that the 'number of respools to go' is NOT zero.	

I.3.12	[This is an empty box]	

I.3.13	Cross-check the KEYANCE dual-axis optical micrometer with both 1.000 mm and 0.500 mm gauge pins when the payout spool is changed and also at the end. In the laptop that is connected to the optical micrometer, in the appropriate folder generate a new file and name it as: ***[Barcode of the Wire]_[yyyymmdd]_[Operator Initials]_[Length]*** Save the file which contains the wire diameter information. A single file *may* be used for a large payout spool.	

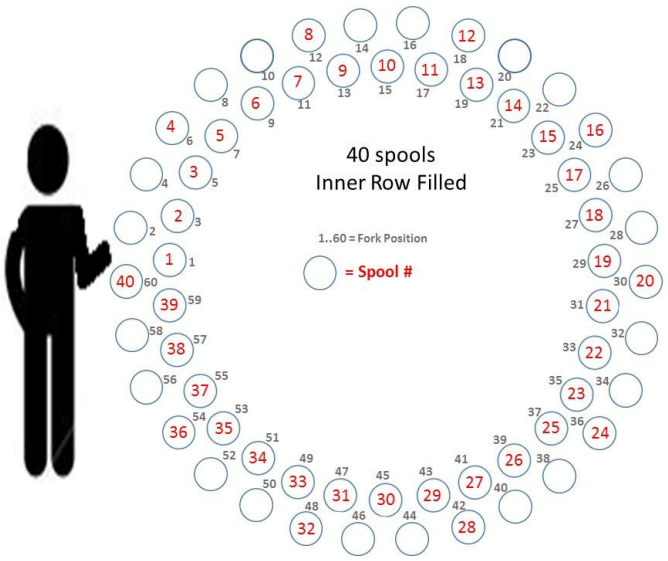
Task I.3 Finish Date and Time: _____

II. Preparation of the cabling machine

Tasks II.1 to II.4 can be carried out in some flexible order if necessary. For this reason, the start and finish date and time of each task should be recorded.

II.1 Spools and brakes

Task II.1 Start Date and Time: _____

II.1.1	Apply LOTO and install the Al spools onto the planetary according to the following pattern:  Spools orientation with respect to fork should be randomized or alternating bolt-side. Snug bolts, do not torque them.	

II.1.2	After all the spools are installed, air brake LOTO can be removed. Hand tighten all the bolts with a spanner.	

Task II.1 Finish Date and Time: _____

II.2 Roll information

Task II.2 Start Date and Time: _____

NP	Inspect the vertical and horizontal rolls and report to the Scientist/Engineer: • the inspector • the inspection date • the inspected width and diameter in mm to 3 decimal places • the inspected angle in degrees (°) to 3 decimal places • the roll finish where appropriate • any other comments • and the quality (usable or otherwise) The vertical rolls are assigned by default as given in Table 1. The horizontal rolls selection is to be verified by the Scientist/Engineer.	

Table 1 – Vertical rolls and roll bearings information

	Specified	Ref. Info	Check if Ok
Top roll ID #	91 (2017 12 08)	Width: 18.062 mm Angle: 0.452° Diameter: 142 mm	
Bottom roll ID #	92 (2017 12 08)	Width: 18.057 mm Angle: 0.452° Diameter: 142 mm	
Top roll bearing ID #	91A		
	91B		
Bottom roll bearing ID #	92C		
	92D		

Commented [IP2]: These are autofilled for convenience. The rolls and bearings ID's do not form part of the procedure, but they are checked at II.6 ATPP.

II.2.1	Before installing the top and bottom rolls verify the edge rolls (or horizontal rolls) are open.	

II.2.2	Install the rolls on the Turkshead. (For reference, minor edge roller gap for alignment is ~1.462 mm or ~0.0575”; major edge roller gap is ~1.588 mm or 0.0625”.) Details of the location of the roll bearing are given in Figure 1.	

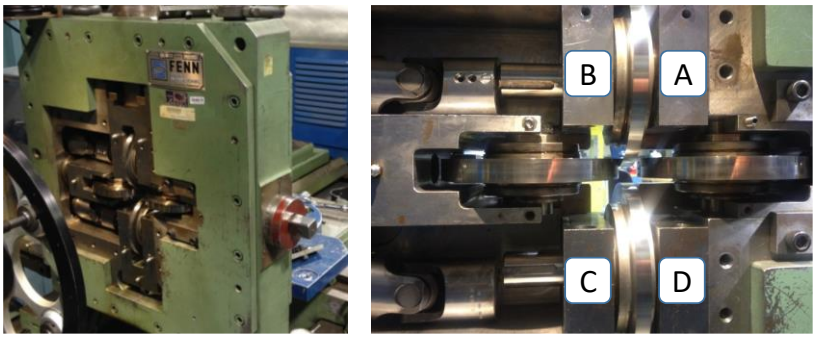


Figure 1 – Identification of the roll bearing location.

II.2.3	[This is an empty box]	

II.2.4	Tighten the bolt of the drive shaft. Torque: 4-20 set screw “snug”.	

II.2.5	Verify that the major edge is on the ‘High Bay’ side. Replace the cover plates.	

Task II.2 Finish Date and Time: _____

II.3 Mandrel information

Task II.3 Start Date and Time: _____

II.3.1	Select the mandrel given in Table 2.	

Table 2 – Mandrel information

	Specification	Check
Mandrel ID #	**27i7683-B (modified 2017 09 05)**	
Mandrel surface finish	**CLEAN**	
Mandrel tip width	**17.35 mm**	
Mandrel tip thickness	**0.73 mm**	
Mandrel tip angle	**+ 3º**	
Mandrel slot location	**Biased towards major edge**	
Mandrel slot width	**12.1 mm**	

Commented [IP3]: These are autofilled for convenience. The mandrel ID does not form part of the procedure, but it is checked at II.6 ATPP.

NP ***(conditional)***	Inspect the mandrel, and report to the Scientist/Engineer if any of the following items are modified: • the inspector • the inspection date • the inspected tip width and thickness in mm to 1 decimal place • the inspected tip angle in degrees (°) • the slot width in mm to 1 decimal place and the slot position. • any other comments • and visual inspection for defect (usable or otherwise)	

II.3.2	Cover the mandrel tip with a cover.	

II.3.3	Install the mandrel on the machine (keep the mandrel tip cover).	

II.3.4	Align the mandrel (keep the mandrel tip cover).	

Task II.3 Finish Date and Time: _____

II.4 Stainless-steel core

Task II.4 Start Date and Time: _____

II.4.1	Verify the core width and thickness meet specifications: Width = 12.0 ± 0.3 mm and Thickness = 0.0254 mm. The barcode ID is	
II.4.2	Install the core on the cabling machine so that it pays out in the anti-clockwise direction when viewed from above. Pay attention not to let the core slip (uncoil vertically) while installing.	
II.4.3	In the Excel File "Respool Log", Scan the barcode of the brake in the stainless steel core spool, and the barcode on the stainless steel core spool itself.	
II.4.4	Verify the core brake tension (target: 0.25 kg) Actual: ……..	

Task II.4 Finish Date and Time: _____

II.5 Brakes

II.5.1	Open the Excel File “Respool Log”, Starting from the fork #1 scan the barcodes of all the Capstan brakes. If there is no brake, scan “empty” from the fork (inside of the fork).	

II.5.2	Still in the Excel File “Respool Log”, Starting from the fork #1 scan all the Al spools. If there is no spool, scan “empty” from the fork (inside of the fork).	

II.5.3	Still in the Excel File “Respool Log”, After zero-ing the gauge at horizontal position, measure the wire tension due to the Spool+Capstan brakes (target 5.8 kg). Record the values (‘Total Tension before Cable Run”) in the Excel File “Respool Log”. Adjust the tension to 5.8 kg if necessary and record the measured values. String the wires.	

NP	When all the wires are strung, save and send a copy of the Excel File “Respool Log” to the Scientist/Engineer.	

II.6 Start Up Check List

II.6.1	Go through the check list in Table 3.	

Table 3 – QXF Cable run start-up check list.

	Specification		check
Cable pitch length	**Value**	**109 mm**	
	Machine setting	**BF 1-5/8**	
Planetary wire twist	**Value**	**-0.57**	
	# of teeth Drive	**13**	
	# of teeth Driven	**54**	
Cable lay direction and pitch	**Left lay (so that the wires follow the same rotation as a left-hand screw thread).**		
Mandrel	**Aligned**		
Verify edge Rolls position	**Rolls closed**		
	Pre-load Torque	**TBD**	
Mandrel position (pinch point)	**1x – 3x wire diameters**		
Wire path check	**→**		
Spool # verification	**40**		
Lubricant type	**4BR**		
Lubricant flow rate	**3 drops/pitch length at speed, sufficient in tank**		
Wire detector	**ON**		
Core detector	**ON**		
Bias core toward major edge?			

II.6.2	Make sure the battery of the core detector is still good.	

II.6.3	Make sure the chain for the planetary motion of the spools is in place and in good condition.	

ATPP	Stop work and obtain authorization before proceeding. Scientist/Engineer's name + signature and date: ……..	

III. Tuning of the cabling machine parameters

III.1.1	Verify that the CME machine has been calibrated using the reference gauge block for thickness, width, and keystone angle. Side pressure should be set at 20 psi and transverse pressure at 17 MPa. The tension on the cable when measurements are made must be less than 60 lb. Name Technician 1: ……. Name Technician 2: …….. If CME computer crashes during cable run do not stop the run.	

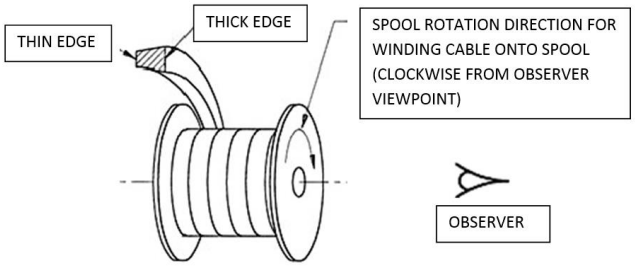
III.1.2	Locate LARP/AUP-approved reels with a minimum hub diameter of 12 inches. Install the pick-up reel so that the spool flanges are vertical (axis is horizontal).	

III.1.3	Turn on the core detector and the wire detector.	

III.1.4	Make 1-2 metres of cable. Before cutting the cable make sure the final length of the cable is greater than the required minimum.	

III.1.5	Measure the 2 m sample cable width, thickness and keystone angle using the CME machine. Measurement performed every 6”.	

III.1.6	For reference, the dimension specifications are:: Width: **18.15** mm ± 50 µm Thickness: **1.525** mm ± 10 µm Keystone angle: **0.40°** ± 0.10° Cable lay direction: **Left** Cable lay pitch: **109** mm ± 3 mm	
III.1.7	For each production unit, ask the scientist/engineer if the following tests are required. Perform the tests according to US HiLumi Doc 74 and the appropriate procedures. • Metallographic sample check (≤15% sheared triplet subelements) • Ten-stack measurements (within 8 µm agreement with CME) • Cable residual twist test (≤ 150°/m) • Cable surface inspection (clean and free from chips, roughness, sharp edges or burrs, surface uniform to 25% of a single wire diameter, no broken wires or crossovers)	
III.1.8	Adjust, if necessary, the cabling machine parameters in consultation with the Scientist/Engineer and repeat the steps above. Record any modifications made to the cabling machine parameters in the Excel File "QXF Template".	
ATPP	When the cable dimensions are within specification: Stop work and obtain authorization before proceeding. Scientist/Engineer's name + signature and date: ……..	

III.1.9	Resume machine operation and begin production run. CME every 3 m. Wind the cable such that there are no crossovers. Filler cord may be used at the reel flanges so the cable will lie flat. Cable spooling direction is specified as follows:  Note the length fabricated during steady state production ……..metres At the end of the run, wrap cling film to protect the cable surface. Label the spool.	
ATPP	Are samples to be taken? YES NO If the answer is YES, the Scientist/Engineer needs to indicate the number of pieces and the length of each piece here: (Note: US HiLumi Doc 74 requires a 3 m long sample ("Cable Test Specimen") from one end of every production run and an archival sample, minimum of 3 m, adjacent to the Cable Test Specimen.) Scientist/Engineer's name + signature and date: …….. Label all the samples appropriately, including identifying/labelling the strands for extracted measurements if required.	

IV. After a Cable Run

IV.1 Verification of the wire tension

IV.1.1	Re-measure the wire tension due to the Spool+Capstan brakes. Record the values ('Total Tension after Cable Run") in the Excel File "Respool Log".	

NP	Send the Excel File "Respool Log" and report any discrepancy of more than 0.5 kg before/after the cable run to the Scientist/Engineer.	

IV.2 Labelling of cable, stainless steel core, and strands

This part may be carried out later if instructed by the Scientist/Engineer.

IV.2.1	Add label to the cable spool and enter into inventory.	
IV.2.2	Print a barcode label with an increased use count from the Master Database for the stainless steel core. Archive usable leftover stainless steel core appropriate and discard unusable stainless steel core.	
IV.2.3	Print barcode labels for cable samples from the Master Database. Where appropriate, in the cable sample for extracted strands, mark the major edge with black ink, then open up about 2 pitch lengths and label all the strands with barcode labels.	
IV.2.4	Print barcode labels for leftover strands from the Master Database. Label. Record the tension and length in the respool log, and archive the leftover strands.	

IV.3 Stow away parts such as mandrel (with cover) if applicable

V. Documentation

V.1 Update the Master Database

This part may be carried out by the Scientist/Engineer.

V.1.1	In the sheet 'Wire Inventory' in the Master Database • Update the use of the strands that went into the cable • Update the storage location of any remaining strands from re-spooling.	
V.1.2	In the sheet 'Cable Inventory' in the Master Database • Update the cabling parameters and all other relevant information according to the working Excel File "QXF Template". • Update all the NP information, including the Rolls, the Mandrel, and the stainless steel core. • Update the storage location and use of all the cable sections.	
V.1.3	In the sheets 'SS Core Delivered', 'Mandrel Log', and 'Spool Log' in the Master Database • Update the relevant data from the NP reports.	
V.1.4	In the sheet 'Spool Map' in the Master Database • Copy the data from the sheet 'Bay Position Map' in the Excel File "Respool Log" and 'paste value' to a new line.	

V.1.5	In the Excel File “Al Spools and Brakes Log” • Update the Al spools, spool brakes, and Capstan brakes information if necessary.	

V.2 Producing the Summary Report

V.2.1	Open the Excel File “QXF Template”.	
V.2.2	If the strands were annealed, import the annealing chart and relevant details from the HT Scheduler to the sheet ‘Annealing Data’ in the Excel File “QXF Template”.	
V.2.3	Import the CME data to the sheet ‘CME Data’ in the Excel File “QXF Template”.	
V.2.4	Validate data and complete any missing information in the sheet ‘Summary’ in the Excel File “QXF Template”.	
V.2.5	Save the Excel File “QXF Template” and export in the appropriate format (PDF or printing) according to requirements from the Scientist/Engineer for review and approval.	

VI. Final Control Point

VI.1.1	Complete the following information Date of cable fabrication completion (YYYY-MM-DD): ……..……. Cabling run performed by (name, signature, and date): …….. Document Reviewed by (name, signature, and date): ……	

VI.1.2	Scan a copy of every page of this procedure after VI.1.1 is completed, email the PDF file to the Scientist/Engineer, the person responsible for uploading the file to the DCC server, and the Cable Task Leader (if not the same person).	

End of document.