

		Heat Exchanger Group				QUALITY ASSURANCE PLAN (QAP)				QAP No.		CDE-09-2703
BHEL - Bhopal		Components & Operations		Characteristics		ITEM		Non Ferrous U-Bend W.W. Tubes for Hydro Coolers		Revision No.		04
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S.No.	Components & Operations	Characteristics	Class	Type of Check	Quantum of check	Reference Document	Acceptance Norms	Format of Records	Agency			Remarks
1	2	3	4	5	6	7	8	9	1	2	3	
1.0	Material											
		Chemical composition analysis	Major	T	1 No. at random per Heat Lot.	AA12130 Rev.06 (SB111 C70600)	AA12130 Rev.06 (SB111 C70600)	TC	W	W	-	See Note-1
		Mechanical test including Elongation, Hardness, Flattening, Expansion	Major	T	2 Nos. at random per mfg. Lot	---	---	TC	W	W	-	- Hardness Vickers HV 5 : 110 (Max). - See Note-1
		Eddy current test	Major	I + Visual	100%	CL. 13.1.1 of SB-111 (E243)	CL. 13.1.1 of SB-111 (E243)	IR	W	W	-	- See Note-02 & 05 100% "W" by Tube Supplier & 10% (at random) "W" by BHEL-IA.
		Hydraulic test	Critical	I + Visual	100%	---	---	IR	W	W	-	- At 70kg/cm²(g) - See Note-05 & 06. 100% "W" by Tube Supplier & 10% (at random) "W" by BHEL-IA.
1.1	Base Tube (90-10 Cu/Ni)	Heat Treatment Bright Annealed	Critical	Visual	100%	AA12130 Rev.06 (SB111 C70600)	AA12130 Rev.06 (SB111 C70600)	HT data / Chart	W	R	-	- Annealed (O61) temper - See Note-3
		Mercurous nitrate or Ammonia Vapor cracking test	Major	T	1 No. at random per mfg. Lot	ASTM B-154 / B-858	ASTM B-154 / B-858	TC	W	W	-	See Note-1
		Microscopical examination				As specified in SB-111	As specified in SB-111					
		Dim check (i.e. OD, TK & Length) with respect to tolerance and straightness	Minor	I + Visual	100%	---	---	IR	W	W	-	100% "W" by Tube Supplier & 10% (at random) "W" by BHEL-IA. - See Note-18 & 19.
		Surface finish										
		Correlation of Material with TC & IR.	Major	Visual	100%	---	---	IR	P	W	-	- See Note-20 for marking on Base Tube. - Use calibrated "go", "no go" ring gauge for OD check.
LEGEND: 1: Base / Fin Tube Supplier, 2: BHEL-IA, 3: Customer, P-Perform, W-Witness, R-Record review, IR/TC: Inspection Report/Test Certificate, IA : Inspection Agency, T : Testing lab to be used for check, I : Instrument used to check.												
Manufacturing Lot Size : 600 Tubes or 4500KG (total weight of tubes) from same heat lot – whichever constitute greater weight.												

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[Signature]

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1	2	3	4	5	6	7	8	9	10	11		
1.2	Fin (Copper Wire)	Conductivity	Major	Visual	1 Sample (selected at random) per each lot.	IS-191	97% (Mir)	TC	W*	-	-	See Note-21
		Purity	Major	Visual		IS-191	IS-191 (Cu-ETP)	TC	W*	-	-	(*) Either of these 02 need to be "W" by BHEL-IA. Rest will be "R".
1.3	Solder Wire	Wire Diameter	Major	Visual		BHEL Drg.	BHEL Drg.	IR	W	W	-	
		Chemical composition analysis	Major	Visual		As per spec.	As per spec.	TC	W	R	-	See Note-21
2.0 In Process Inspection : At Fin Tube Manufacturer's end.												
2.1	Finning & Bending of Finned Tubes	Co-relation of Base Tube & Copper Wire with actual items received.	Major	Visual	100%	TC & IR as detailed at Para-1.1 & 1.2 above.	--	IR	P	W	-	Hold Point for BHEL-IA Marking on base tube need to be checked with TC & IR for co-relation.
		Finning	Major	Visual	100%	Mfr's std.	Mfr's std.	IR	P	-	-	Mfr's standard need to be approved from BHEL before start of manufacturing.
		U-Bending	Major	Visual	100%	Mfr's std.	Mfr's std.	IR	P	-	-	
2.2	Surface Cleanliness	Cleaning of Tubes (Inside & Outside)	Minor	Visual	100%	Mfr's standard	Mfr's standard	IR	P	-	-	Compressed air / Pressurized Potable water (max 30PPM Chloride content) to be used for cleaning followed by drying completely. See Note-18 & 29
2.3	Non Destructive Examination	Liquid Penetration test at bend	Minor	Visual	100%	Appendix-8 of ASME Sec. VIII Div.1	Appendix-8 of ASME Sec. VIII Div.1	IR	P	W	-	10% at random witnessed by BHEL IA. See Note-2
2.4	Leak Proofness	Hydraulic test	Critical	I + Visual	100%	BHEL Drg.	BHEL Drg.	IR	P	W	-	Hold point for BHEL-IA. See Note-6 At 20.0 kg/cm2(g) for 10 sec (min). 10% at random "W" by BHEL IA
2.5	Destructive Examination	Hardness at bend	Major	Visual + I	2 Nos. at random per mfg. Lot	AA12130 Rev.06 (SB111 C70600)	AA12130 Rev.06 (SB111 C70600)	TC	P	W	-	Hardness Vickers HV 5 : 110 (Max) Randomly selected by BHEL-IA (*)
2.6	Cut straight end of tubes	Dimensional matching	Minor	Visual + I	100%	BHEL Drg.	BHF ¹ Drg.	IR	P	-	-	See Note-19

(*) Instrument data collected by NADI personnel cannot be traceable to NADI need to be used only.

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1	2	3	4	5	6	7	8	9	10			11			
		Thickness at bend	Critical	Visual + I	2 Nos. at random per Lot	BHEL Drg.	BHEL Drg.	IR	P	W	-	• Minimum thickness at bend = 0.915 (for 1.016 Nom TK), 0.823 (for 0.914 Nom TK).			
		Ovality at bend	Critical	Visual + I	2 Nos. at random per Lot	BHEL Drg.	BHEL Drg.	IR	P	W	-	• Major Dia = 13.3mm (max) for 12.7 O/D Tube, 10.0mm (max) for 9.5 O/D Tube.			
		TK at straight portion	Major	Visual + I	100%	BHEL Drg.	BHEL Drg.	IR	P	W	-	• See Note-7 & 12			
		OD at straight portion	Minor	Visual + I	100%	BHEL Drg.	BHEL Drg.	IR	P	W	-	• $[= 1.016 / 0.914 \pm 0.11]$: As applicable.			
												• 10% at random witnessed by BHEL IA.			
												• $[= 12.7 / 9.5 \pm 0.064]$			
												• Use calibrated "go", "no go" ring gauge.			
												• 10% at random witnessed by BHEL IA.			
												• 10% at random witnessed by BHEL IA.			
												• Use template to ensure bend radius.			
												• See Note-13			
												• 10% at random witnessed by BHEL IA.			
												• 10% at random witnessed by BHEL IA.			
												• Tolerance = ± 1.0 mm			
												• 10% at random witnessed by BHEL IA.			
												• Tolerance : 0.25 mm (max).			
												• 10% at random witnessed by BHEL IA.			
												• 10% at random witnessed by BHEL IA.			
												Randomly selected by BHEL-IA.			
												See Note-11			
2.7	Dimensional Check	Bend Radius	Critical	Visual + I	100%	BHEL Drg.	BHEL Drg.	IR	P	W	-				
		Dimension – "A"	Minor	Visual + I	100%	BHEL Drg.	BHEL Drg.	IR	P	W	-				
		Dimension – "B"	Minor	Visual + I	100%	BHEL Drg.	BHEL Drg.	IR	P	W	-				
		Dimension – "C"	Critical	Visual + I	100%	BHEL Drg.	BHEL Drg.	IR	P	W	-				
		Dimension – "D"	Major	Visual + I	100%	BHEL Drg.	BHEL Drg.	IR	P	W	-				
		Dimension – "E"	Major	Visual + I	100%	BHEL Drg.	BHEL Drg.	IR	P	W	-				
		Winding Formula (e.g. wire gauge, dia over loop, loops per inch, coils per ft run, etc.)	Major	Visual + I	100%	BHEL Drg.	BHEL Drg.	IR	P	W	-				
		Squareness of cut	Major	Visual + I	100%	AA12130 Rev.06 (SB111 C70600)	AA12130 Rev.06 (SB111 C70600)	IR	P	W	-				
2.8	Checking of surface	See Note-19 & 20.	Minor	Visual	100%	BHEL Drg.	BHEL Drg.	IR	P	W	-				
2.9	Fin adhesion check	To ensure fin adhesion	Minor	Visual + I	1 No. per lot at random	Mfg. Std. duly approved by BHEL	Mfg. Std. duly approved by BHEL	IR	P	W	-				
3.0	Final documentation.	Verification of all TCs & IRs for completeness	Major	Visual	100%	PO. Specn, drg & QAP	BHEL Spec., Drg	IR	P	R	-				

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4.0		Preservation, Packing, Marking and dispatch.		Marking		Major		Visual		100%		Para-4.2 & 4.3 of BHEL Spec. AA-0490003		Para-4.2 & 4.3 of BHEL Spec. AA-0490003		IR		P W		Plastic end caps to be provided on each tube as per Para-2.1 of spec. AA-0490003.			
				Packing & preservation		Major		Visual		100%		BHEL Spec. AA-0490003		BHEL Spec. AA-0490003		IR		P R		See Note-8.			
				Dispatch		Major		Visual		100%		BHEL Spec. AA-0490003		BHEL Spec. AA-0490003		IR		P R		10% at random witnessed by BHEL IA.			

Notes:

- Testing (mechanical & chemical – as applicable) to be carried out at NABL approved lab / BHEL TSD OR lab having in-house calibrated instruments (duly calibrated by NABL approved lab).
- NDT (ECT & Liquid penetration test) to be carried out by own in-house ISNT / ASNT NDT Level-I person under the supervision by Level-II/III person only.
- Heat Treatment to be carried out by calibrated in-house furnace / set up only. All associated thermocouples & temperature recorder need to be with valid calibration record (duly calibrated by NABL approved agency).
- Hot bending to form "U" tube shall not be permitted at all.
- Un-tested tube ends to be cut and discarded. Defective tubes area to be identified by permanent marking and shall be damaged & segregated out from the finished tube lot.
- 'Hydrostatic Testing' of tube shall be carried out using demineralized / drinking water followed by drying completely using dry compressed air.
- For thinning & ovality check: Cut two tubes (randomly selected by BHEL-IA) with minimum bend radius for each lot.
- Tubes shall be packed in sturdy packing as per BHEL Spec. AA-0490003 & shall be capable of withstanding mechanical damages during transit, handling & shipment.
- All requirements of BHEL drawing and material specification shall be complied fully.
- After receipt of items at BHEL-Bhopal, same can be checked at random to confirm all QAP requirements. Discrepancy found if any, shall be communicated to Tube Supplier for complete replacement.
- Four (04) copies of all test certificates (covering all the tests / steps as mentioned in the above QAP) duly signed by BHEL-IA (as per the approved QAP) shall be furnished along-with the final dispatch documents.

Sequence of documents shall be as per the QAP-only with proper index sheet at top.

- Neither the major nor the minor outside diameter of the tube at any cross section shall deviate from the nominal outside diameter (prior to bending) by more than 10%.
- Distance between tube legs (outside) at bend (including straight portion) should not be more than 58.5mm for 12.7mm O/D Tubes, 43.0mm for 9.5mm O/D Tubes.
- Final dimensional check and checking of surface (Cl.2.7 & 2.8 of QAP) to be done after hydro-testing only
- Completeness of other requirements (left if any in BHEL's drawing) also needs to be ensured in totality. In case of any conflict between this QAP and other document, this QAP shall govern finally.
- All instruments (used for dimension / thickness / hardness measurement) shall have proper co-related valid calibration record. Calibration shall be done by NABL approved agency only.
- Reference BHEL drawing: 2-16505-40003 & 2-16505-40219 (as applicable).
- Inside & Outside surface of tubes shall be free from tool marks, dents, surface cracks, wrinkles, etc.
- Inside of tubes to be cleaned to remove dirt, oil, carbon deposit, etc. Tube end edge to be smooth without burrs, to be protected by end caps before dispatch.
- Each base tube shall be stenciled with BHEL Order No., BHEL Spec. No., Heat No., Size of Tube and Supplier's mark for proper co-relation with TC. BHEL-IA to ensure the same at both base tube & Fin Tube supplier's end.
- Conductivity & Purity Check (Wet analysis or using spectrometer) of Copper wire and Chemical analysis of solder wire to be done at NABL approved lab or lab having in-house calibrated instruments (duly calibrated by NABL approved lab). Traceable to NABL is not allowed. BHEL-IA to ensure the same during inspection. PMI tester is not allowed.

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