



Heat Exchanger Group
BHEL- Bhopal

QUALITY ASSURANCE PLAN (QAP)

QAP No. CDE-14-3037
Revision No. 06
Date of Issue 29.04.2017
Page 1 of 4

ITEM Double Tubes for OFWF Coolers

S.No.	Components & Operations	Characteristics	Class	Type of Check	Quantum of check	Reference Document	Acceptance Norms	Format of Records	Agency			Remarks	
									1	2	3		
1	2	3	4	5	6	7	8	9	10			11	
1.0 Material													
1.1	Base Tube (both Inner & Outer Tubes)	<u>Ladle Analysis</u>	Major	T	Sample from each Ladle	See Remarks	See Remarks	TC	W	R	-	<ul style="list-style-type: none"> Inner Tubes : SB111 C70600/C71500 (as applicable) Outer Tubes : SB359 C12000/12200. See Note- 1 & 16 	
		<u>Manufacturing of tubes</u>	Major	-	-	Supplier's own mfg. standard	Supplier's own mfg. standard	-	P	-	-		
		Eddy current test for both Inner & <u>Outer</u> Tubes.	Major	I + Visual	100%	CL. 13.1.1 of SB-111/359 (E243)	CL. 13.1.1 of SB-111/359 (E243)	IR	W	W	-		• See Note-2
		Hydraulic Test before Heat Treatment	Critical	I + Visual	100%	SB-111/359 (See Remarks also)	SB-111/359 (See Remarks also)	IR	W	W	-		<ul style="list-style-type: none"> At 70kg/cm²(g) for 10 sec (min) See Note-5 20% "W" at random by BHEL IA
		Heat Treatment	Critical	Visual	100%	SB111/359 C70600 / C71500 / 12000/12200 (as applicable)	SB111/359 C70600 / C71500 / 12000/12200 (as applicable)	HT Data / Chart	W	R	-		<ul style="list-style-type: none"> Inner Tubes : Annealed (O61) temper. Outer Tubes : Light-drawn (H55) See Note-3
		Microscope Examination	Major	T	1 No. at random per mfg. Lot	SB111/359/ E-112	SB111/359/ E-112	TC	W	W	-		See Note-1
		<u>Product Analysis</u> : Chemical composition check	Major	T	1 No. at random per Heat.	See Remarks	See Remarks	TC	W	W	-		<ul style="list-style-type: none"> Inner Tubes : SB111 C70600/C71500 (as applicable) Outer Tubes : SB359 C12000/12200. Hardness Inner Tubes : Vickers HV 5 : 110 (Max). Outer Tube : To be decided by Fin & Base tube supplier meeting specification requirement & suitable for finning and grooving. See Note-1 & 16
		<u>Product Analysis</u> : Mechanical Properties Check (Tensile, Yield, Elongation, Hardness, Flattening, Expansion).	Major	T	2 Nos. at random per mfg. Lot			TC	W	W	-		

LEGEND: 1: Fin / Base Tube Supplier, 2: BHEL-IA, 3: Customer (If any); P-Perform, W-Witness, R-Record review, IR/TC: Inspection Report/Test Certificate, TCR : Test Certificate Report, IA : Inspection Agency, T : Testing lab (duly approved by NABL) to be used for check, I : Instrument used to check.

Manufacturing (mfg) Lot Size : 600 Tubes or 4500 KG (total weight of tubes) from same heat lot – whichever constitute greater weight.

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Page 2 of 4

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Contd./---

1.1	Base Tube (both Inner & Outer Tubes)	Hydraulic Test after Heat Treatment	Critical	I + Visual	See Remarks	SB-111/359	SB-111/359 (No leakage & drop in pressure)	IR	W	W	-	<ul style="list-style-type: none"> At 25kg/cm²(g) for 10 sec (min) See Note-5 10 Nos. at random for total PO quantity less than 1000 Nos. and 20 Nos. at random for total PO quantity greater than equal to 1000 Nos.
		Dim check with respect to tolerance, straightness and Surface finish	Major	I + Visual	100%	---do--- & BHEL drg.	---do--- & BHEL drg.	IR (OD, TK, Length, Straightness & Surface Finish)	W	W*	-	<p>Inner Tubes OD=(+).0.0/(-).0.1, TK = (±) 0.10</p> <p>Outer Tubes OD=(+).0.0/(-).0.1, TK = (±) 0.11</p> <p>Length=(+).3.0/(-).0.0 * 20% at random by BHEL-IA</p> <p>Straightness = 0.75 mm (max) for each 900mm.</p> <p>See Note-1 & 14</p>
		<ul style="list-style-type: none"> Correlation of Material with TC & IR. Marking of tube. 	Major	Visual	100%	---do--- & BHEL drg.	---do--- & BHEL drg.	IR	W	W	-	

2.0 In Process Inspection (for Outer Tubes only)

2.1	Finning of Outer Tubes	Co-relation of base tubes	Major	Visual	100%	TC & IR as detailed at Para-1.1 above.	TC & IR as detailed at Para-1.1 above.	IR	P	W	-	<ul style="list-style-type: none"> Marking of base tube need to be checked with TC & IR for co-relation. Hold point for BHEL-IA.
		Finning	Major	Visual	100%	Mfr's std. & BHEL approved drg./ SB-359	Mfr's std. & BHEL approved drg./ SB-359	IR	P	-	-	
2.2	Spiral grooving of Outer Tubes at ID	Grooving	Major	Visual	100%	Mfr's std. & BHEL approved drg.	Mfr's std. & BHEL approved drg.	IR	P	-	-	
2.3	Surface Cleanliness	Cleaning of Tubes (Inside & Outside)	Minor	Visual	100%	Mfr's standard	Mfr's standard	IR	P	W	-	Inside & outside of Tubes shall be free from tool marks, dents, surface cracks, wrinkles, etc.

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Revision No.	06
Date of Issue	29.04.2017
Page	3 of 4

ITEM Double Tubes for OFWF Coolers

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2.4	Leak Proofness	Hydraulic test	Critical	Visual	100%	Refer remarks	Refer remarks	IR	P	W	-	<ul style="list-style-type: none"> Hold point for BHEL-IA. At 20.0 kg/cm2(g) for 10 sec (min). 20% "W" at random by BHEL IA
2.5	Dimensional Check (Outer Tubes)	Outer Side : See Note-14	Critical	I + Visual	100%	Drawing as approved by BHEL.	Drawing as approved by BHEL.	IR	P	W	-	<ul style="list-style-type: none"> All dimensions as shown in the drawing need to be ensured fully. Tolerance : Fin root dia = (±) 0.15, Dia over fin = (+)0.0/(-)0.2 Wall TK excluding groove depth = (-)0.0/(+)0.1 Internal dia = (+)0/(-)0.1 Dia at un-finned portion = (+)0/(-)0.1 Presence of internal grooves along the length to be ensured as per the approved drawing and to be certified. 10% "W" at random by BHEL IA for Outer Side and 02 Nos. at random for each mfg. lot for Inner Side by splitting the tubes. (***) See note-15. ID of outer tubes as 13.8 +0/-0.1 to be ensured and certified.
		Inner Side See Note-15	Critical	I + Visual	<ul style="list-style-type: none"> 100% to be ensured by tube supplier. See remarks 	Drawing as approved by BHEL.	Drawing as approved by BHEL.	IR	P	W	-	
		Straightness (**)	Critical	Visual	100%	Drawing as approved by BHEL.	Drawing as approved by BHEL.	IR	P	W	-	
3.0	Fitment of Inner Tube into Outer Tube. (Supplied in fitted condition identified by nos.)	Fitment check	Critical	Visual + I	100%	As per P.O.	As per P.O.	IR	P	W	-	<ul style="list-style-type: none"> Hold Point for BHEL-IA Radial clearance between inner tube and outer tube is very important. BHEL IA to ensure - fitment is not loose and also not too hard to push. 20% "W" at random by BHEL IA
4.0	Preservation, Packing, Marking and dispatch.	Marking, Packing & preservation, Dispatch	Major	Visual	100%	Para- <u>4.2&4.3</u> of BHEL Spec. <u>AA-0490002</u>	Para- <u>4.2&4.3</u> of BHEL Spec. <u>AA-0490002</u>	IR	P	R	-	<ul style="list-style-type: none"> See Note-6

(**) Straightness of tube is of utmost importance as any bend misleads of a push fit of inner tubes into outer tubes. (***) Randomly selected by BHEL-IA.

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5.0	Documentation	Verification of all quality documents as detailed above.	Major	Review	100%	As per P.O.	As per P.O.	IR	P	R	-	• See Note-8	
Notes:													
<ol style="list-style-type: none"> Testing (Product analysis : Both mechanical & chemical test, Ladle analysis, Microscopic Examination & Mercurous nitrate or Ammonia Vapor cracking test, etc.) to be carried out at NABL approved lab only. Sampling for testing to be done in presence of BHEL-IA. BHEL-IA to ensure proper co-relation between the TC / IR and actual tubes. Accordingly each tube to be legibly stenciled with order no., material spec. No., size of tube, heat no. and supplier's marks for proper co-relation with TC / IR. Eddy Current Testing to be carried out by own in-house ISNT / ASNT NDT Level-I person under the supervision by Level-II/III person only at base tube supplier's end using calibrated ECT set up 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 agency as approved by NABL]. Un-tested tube end to be cut and discarded. Defective tubes are 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 clean potable water. Tubes to be dried completely after hydraulic testing. Tubes shall be packed in sturdy wooden box which shall be capable of withstanding mechanical damages during transit, handling & shipment. All requirements of drawing as approved by BHEL and material specification shall be complied fully. 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 with proper index sheet at top. BHEL-IA to ensure the same during final verification of documents as mentioned at Cl.5 of QAP. In case of any conflict between this QAP and other document, same to be reported to BHEL for final disposal. All instruments (used for dimension / thickness / hardness measurement, pressure gauge, ECT Set Up, etc.) shall have proper co-related valid calibration record. BHEL-IA to ensure the same during inspection. Calibration need to be done by agency as approved by NABL. Base tubes (Inner) to be procured from BHEL approved vendors only. Sources to be mentioned during enquiry stage. Base tubes (outer) can be procured from other reputed vendors credentials for whom are required to be submitted to BHEL for acceptance during enquiry stage. In case they are not listed in BHEL-approved list, quantum of check shall be double the quantity duly witnessed by BHEL-IA. For length of outer and Inner Tubes: Refer Annexure to respective P.I./Enquiry/P.O. Same need to also be mentioned in the final dimensional report. For Outer Fins : Dia over fin, fin root dia, wall TK excluding groove depth, Fin TK, No. of fins per inch, total finned length, Un-finned length at both ends, outside dia at un-finned portion, etc. to be checked and reported in the IR. Use calibrated Go, No-Go ring gauge to ensure the dia at complete un-finned portion and both Inner and Outer base tubes and calibrated Shadow Graph machine to check the fin geometry. For Inner Fins : Dimensions need to be checked by splitting the tubes by suitable method as suggested by BHEL-IA and same to be reported in the IR. Additionally dia under fins to be ensured using calibrated TESA micrometer for at least 150 mm from both ends of each tube out of which 10 % of the offered quantity selected randomly by BHEL-IA needs to be witnessed by BHEL-IA. Same needs to be reported in IR also. 													
<ol style="list-style-type: none"> Ladle analysis report of all applicable heats need to be reviewed by BHEL-IA along-with the product analysis report. The ladle analysis reports also need to be part of dispatch documents. 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. Where less than 100% witness is there (be it NDT or other inspection), BHEL-IA to ensure availability of all offered quantities and out of that offered quantities, random selection (as specified in the respective column) to be done. Offered quantities during a single visit of BHEL-IA need to be mentioned in the IR also. For rest of the items where witness are not being done, BHEL-IA to ensure compliance of the inspection stages by manufacturer and same to be reported in the IR as "reviewed" only. 								Prepared by :  ALPA TOPPO Sr. Engineer (D) CDE		Reviewed by :  M.L. Carpenter Sr. Manager-(D) CDE		Approved by :  S.K. BISWAS Sr. DGM (D) CDE	