

Tender 1501700009 - Item List

Sl.No.	Material Description	Qty (Mtrs)	WT (MT)
1	TUBE OD 31.8 X 6 X 6000 - SA213TP347H	1,860.00	7.68
2	TUBE OD 63.5 X 3.99 X 10000- SA213TP347H	6,000.00	38.46
3	TUBE OD 63.5 X 3.99 X 8500- SA213TP347H	3,825.00	24.52
4	TUBE OD 63.5 X 3.99 X 9000- SA213TP347H	8,100.00	51.92
5	TUBE OD 76.2 X 5.08 X 10000 - SA213TP347H	1,500.00	14.63
6	TUBE OD 44.45 X 8.13 X 10000 -SA213TP347H	8,700.00	68.59
7	TUBE OD 44.45 X 8.6 X 10000 -SA213TP347H	3,060.00	24.48
8	TUBE OD 76.2 X 4.57 X 8500 - SUP304CODE2328	450.50	3.98
9	TUBE OD 63.5 X 3.81 X 8500 - SUP304CODE2328	5,525.00	33.93
10	TUBE OD 50.8 X 8.13 X 11000 - SUP304CODE2328	3,333.00	30.95
11	TUBE OD 44.45 X 7.11 X 11000 - SUP304CODE2328	40,271.00	278.35
12	TUBE 44.45 X 8.1 X 10000 - SUP304CODE2328	55,500.00	424.46
13	TUBE 44.45 X 8.10 X 12150 - SUP304CODE23	44,104.50	337.31
14	TUBE OD 44.45 X 7.6 X 10000 - SUP304CODE2328	36,790.00	267.94
15	TUBE OD 44.45 X 7.6 X 12400 - SUP304CODE2328	7,514.40	54.73
16	TUBE OD 44.45 X 7.6 X 7500 - SUP304CODE2328	1,485.00	10.82
17	TUBE OD 44.45 X 7.6 X 9000 - SUP304CODE2328	1,503.00	10.95
18	TUBE OD 50.8 X 9.14 X 10000 - SUP304CODE2328	900.00	8.90
19	TUBE OD 50.8 X 9.14 X 10500 - SUP304CODE2328	6,237.00	61.70
20	TUBE OD 50.8 X 9.14 X 11500 - SUP304CODE2328	10,453.50	103.42
21	TUBE OD 50.8 X 14 X 5000 - SUP304CODE2328	460.00	6.09
22	TUBE OD 54 X 8.64 X 12800 - SUP304CODE2328	1,344.00	13.71
23	TUBE OD 54 X 8.64 X 13500 - SUP304CODE2328	1,417.50	14.46
24	TUBE OD 54 X 9.27 X 6500 - SUP304CODE2328	1,326.00	14.30
25	TUBE OD 54 X 12.7 X 10000 - SUP304CODE2328	360.00	4.88
	Total		1,911.15



Product: SEAMLESS STEEL TUBES (for BOILERS)

Revision record:

Rev 08: 21.09.04: UT as per BS EN 10246-7, in lieu of ASTM E 213
Rev 09: 31/12/05: Cl 5.0 - mention of shape and size of tensile test specimen on TC introduces
Rev 10: 29/12/07: Cl 1.0, 3.0, 6.0, 7.0, 11.0 and 12.0 modified.
Rev 11: 19/05/09: Cl 8.0 – Modified. Cl 9.0 – Marking details included in line with material specification.
Rev 12: 08/06/11: Cl 1.0- SA 213 T12, T92 and T23 removed from this TDC. Cl 2.0 Process of Manufacture – Clarified. Cl 9.0- Stenciling and colour coding modified. Cl 12.0- Modified.
Rev 13: 04/07/11: Cl 6.0: Modified, Cl 9.0 – Marking: Correction made in the “Details to be identified”
Rev 14: 26/10/12: Cl 2.0, 6.0 and 12.0 modified
Rev 15: 19/02/2016: TDC: 0:124 requirements merged in this TDC. And Cl 1 modified; Cl 2 modified to include polygonization requirements; Cl 4– heat treatment temperature added for Gr 91; Cl 5– lot size for mechanical tests defined & additional requirements of Gr 23, 91 & 92 added; Cl 6, 7, 9 – modified; Cl 10 –Preservation requirements modified; Cl 11 – modified; Cl 12-changed as per latest IBR including MAWP requirements.

1. MATERIALS

Specification: ASME (Latest as on the date of Enquiry/PO, whichever is earlier):

Carbon Steel (CS) : SA 192; SA 210 Gr. A1 & Gr. C

Alloy Steel (AS) : SA 209 Gr.T1, SA 213 Gr. T11, T12, T22, T23 (Code case: 2199), T91 and T92 (Code Case: 2179).

Stainless Steel (SS) : SA 213 TP 304H, 316, 321, 321H, 347H; UNS No: S30432 (Code Case: 2328, Super 304).

Additional Requirement : As listed below (Supplementary to above material specifications)

Size and Quantity : As per Purchase order

2. CHEMICAL COMPOSITION AND PROCESS OF MANUFACTURE

a) **Carbon Steel & Alloy Steel:** Tubes shall be seamless and made by processes specified below:

1. All tubes shall be cold formed in case of “t/D” ratios > 0.15, where “t” is the specified nominal wall thickness and “D” is the specified nominal OD of the tube.
2. Tubes may be cold formed or hot formed in case of “t/D” ratios upto and including 0.15.
3. The degree of polygonization (P), measured as indicated in Fig.1 & calculated using the below formula, shall not exceed 15% in both the above cases:

$$P = \{ [\sum t_B - \sum t_A] / [0.135 * (3D - \sum t_A)] \} * 100$$

where, P is the degree of polygonization in %

D is the specified nominal OD of the tube

$\sum t_B$ is the sum of maximum tube wall thicknesses measured at 6 locations 60 degrees apart and

$\sum t_A$ is the sum of minimum tube wall thicknesses measured at 6 locations 60 degrees apart.

Wall thickness shall be measured using profile projector/shadowgraph/digital scanner/any other suitable instrument meant for this purpose.

Definition of the measure points:

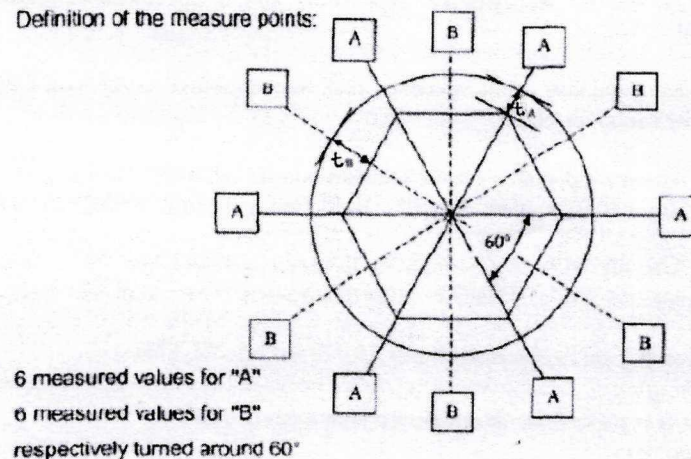


Fig. 1

	BHEL – Tiruchirappalli - 620014, India. Quality Assurance Department TECHNICAL DELIVERY CONDITIONS	DOC No: TDC:0:102 Rev: 15 Effective Date: 19/02/2016 Page: 2 of 4
Product: SEAMLESS STEEL TUBES (for BOILERS)		

Stainless Steel: Tubes shall be seamless and cold finished. All raw materials used in steel making including incoming scrap shall be checked by supplier to ensure freedom from radioactivity (Applicable for SS materials only).

b) Ladle & Product analysis is required for all steels. Chemistry shall be controlled as given below for below specified grades and for all other grades, it shall be as per applicable material specifications:

- i. Carbon Steel: Max. Carbon: SA 210 Gr.A1: 0.25%, SA 210 Gr.C: 0.30%
- ii. For SA 213 T12: Aluminum: 0.025% max; Silicon: 0.20% min. on product analysis and the values shall be reported in the test certificate.
- iii. Stainless Steel (SS): Boron: 0.01% max., Vanadium: 0.10% max.

3. DIMENSIONAL TOLERANCES

- a) For Cold finished tubes: CS: as per SA 450; for AS & SS shall be as per SA 1016.
Tolerance on thickness shall be: For OD $\leq$ 38.1 mm: -0% to +20% and For OD > 38.1 mm: -0% to +22%
- b) For hot finished tubes the tolerance shall be as follows:
For Outside Diameter: $\pm$ 0.4mm.
For Thickness: -0% to +22% $t >$ 4.5 mm
-0% to +24% t between 3.6 and 4.5 mm (both inclusive)
-0% to +28% $t <$ 3.6mm

4. HEAT TREATMENT

CS Hot finished: No Heat Treatment required.

CS Cold finished: Subcritical annealed (temperature $\geq$ 650°C), fully annealed or normalized.

AS: Normalized and Tempered. For SA213 T23, T91 & T92: Normalizing: 1050-1080°C & Tempering: 750-780°C. (The total thickness of the decarburized material (Both on ID & OD of the tube together) shall be measured once per Heat treatment lot. The measurement shall be determined from a representative sample that has been sectioned, polished, etched and examined at 100X. The total decarburization thickness shall not exceed 7% of the specified minimum wall thickness and shall be reported in the test certificate.)

SS: Solution Annealed condition as per material specification.

5. MECHANICAL TESTS

- a) As per specification. Quantum of test: As per specification – For each nominal size per heat per heat treatment batch (Minimum 2 tubes for first 100 tubes and 1 per 100 or part thereof for tubes over 100 numbers, as per IBR).
- b) Tension test required for SA 192. **Acceptance:** explanatory note in Specification. Hardness for SA 192: 120 HBW (max).
- c) For tension tests the shape and size of the specimen shall be mentioned on the Test Certificate (viz., Full tube tensile or strip tensile or round tensile).
- d) Additionally, the material supplied shall meet the requirements as below:
T91-Tensile strength: Min: 630MPa, Max: 850MPa; Yield Strength: Min: 450MPa; Hardness (HBW): Min: 195/Max: 250
T92-Tensile strength: Min: 620 MPa, Max: 850 MPa; Hardness (HBW): Min: 190 / Max:250
T23-Tensile strength: Min: 510 MPa, Max: 730 MPa; Hardness (HBW): Min: 150 / Max:220
- e) **Charpy Impact V-Notch Test at the mill as per SA 370 for SA 213 T23:**
 - **Impact testing frequency** - minimum of two tubes per each heat treatment lot produced.
 - **V-Notch Impact test procedure & specimen size** as per ASME SA 370.
 - **Test temperature:** 20°C.
 - **Acceptance:** All specimens shall absorb energies at or above 40 ft-lb (55Joules) for a full size specimen (10mm thickness). The energy requirement is proportionally reduced for sub-size specimens as specified in ASME SA 370, Table 9.

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- The fracture surfaces on all specimens must exhibit 100% ductile appearance regardless of the absorbed energy values obtained.
- Any specimen exhibiting an absorbed energy less than 40 ft-lb (55Joules) or less than 100% ductile behavior shall constitute permanent rejection of the entire lot of tubing.

6. NON DESTRUCTIVE TEST (In-house Automated Online Testing Only)

- Each tube shall be examined full section over its entire length.
Ultrasonic Testing: For thickness ≥ 3.6 mm to be conducted as per ASTM E213. Calibration: 2 axial 50mm long notches, one in outer surface and the other in inside surface. For OD < 30 mm, one notch in outer surface only. Notch depth: 5% of wall thickness (Min. 0.3 mm, Max: 1.5 mm). Scanning: clockwise & anti-clockwise.
Eddy current Test: For thickness < 3.6 mm, as per ASTM E309 /E426 as applicable, Calibration: Longitudinal notch depth: 5% of wall thickness (Min. of 0.3 mm) or drilled hole as per SA 106.
- SS: Finished tubes shall be checked for radioactive contamination and reported. Survey meter shall be used to measure at 5cm near the surface. **Acceptance limits:** Shall be less than 0.1 milli Rontgen (mR) per hour or 1 micro Sievert per hour.
- The residual magnetism in all finished tubes, measured with field indicator, shall be limited to 5 gauss maximum.

7. HYDROSTATIC TEST

Extent of test: On all tubes of thickness < 3.6 mm as per SA 450 Cl 22.3 with S=80% of specified min. yield strength at room temperature. For others if specified in Purchase Order. Acceptance: No leak shall be permitted.

8. FINISH AND REPAIR

Inside and outside surfaces are shall be free from scales and defects like laps, seams, folds, cracks, pitting etc. Repairs by welding are prohibited. Surface defects can be removed mechanically, ensuring smooth curved surface and maintaining specified minimum thickness without affecting the workmanlike finish.

9. MARKING: (in English only)

- Details to be identified:** Tubes shall be marked repeatedly & continuously along its entire length with the following details as indicated below:
(1) PO Number, (2) Maker's emblem/code, (3) Specification & grade, (4) Code case (if applicable), (5) Heat number, (6) Size (OD x Thickness x Length, in mm), (7) No. of tubes, (8) Inspector's seal, (9) Condition: Hot finished or Cold Finished, (10) Tube Minimum Wall Thickness Designation (For SA 213 Spec only).
 - Below OD 31.8mm. (Excl.) – SI Nos:1 to 10 to be stamped on metal/plastic tag attached to bundle.
 - OD 31.8-76.1mm. (Incl.) - SI Nos: 1 to 6, 9 and 10 to be paint stenciled, repeatedly through the entire length each tube. Also SI.No:1 to 10 to be stamped on Metal/Plastic tag attached to bundle.
 - OD>76.1 mm- SI Nos: 2 to 6 & 8 to be hard stamped with round edge stamp at 100mm from both ends and SI No:1 to 6, 9 and 10 to be paint stenciled on each tube.
- Colour Coding:** Continuous longitudinal colour coding shall be done on the entire length of all tubes, without masking stenciling. If more than one color is to be applied on the tubes then, colour bands shall be adjacent. Colour coding scheme as per Procedure SIP: PP: 21 (latest).

10. PRESERVATION:

All tubes, except SS, shall have Rust Preventive Fluid (RPF) coating on the external surface as follows: The Tubes shall be coated with suitable RPF with minimum DFT of 50 microns. RPF coated steel surfaces shall be capable of withstanding salt spray corrosion test for minimum 1000 hours. The RPF coating should be sea worthy, ensuing freedom from corrosion when transported through sea voyage. The RPF coating shall get dried and shall be a transparent coating, so that it is possible to see the tube surface clearly as well as read any stenciled matter on tube surface. The inside surface of the tube shall be protected with volatile corrosive rust inhibitor. Rust preventive coating shall withstand at least one year storage at open yard from receipt of materials. The supplier shall stand guarantee for this. SS tubes to be surface treated as per ASTM A380 both inside and outside. Tube ends shall be closed with push type plastic end caps/plugs secured tightly to avoid entry of water during transportation and storage.

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11. PACKING:

Tubes of thickness $\leq 2.5\text{mm}$, shall be packed in boxes and others in bundles. Tubes of thickness $\geq 6.5\text{ mm}$ and OD ≥ 88.9 can be shipped loose. Bundles to be ≤ 4 tons of equal no. of tubes, fastened with galvanized strap (1x25mm.min.) or annealed wire for CS & AS and by Nylon strap for SS at both ends & at 1m interval in between. Wooden pallets/cardboard to cover tubes are not permitted.

12. INSPECTION AND CERTIFICATION:

12.1 Products shall be inspected at works and the applicable IBR Form must be Countersigned by the Inspecting Authority as indicated below:

Imported Items: Inspecting Authority approved by IBR for the Country of origin (To be concurred by BHEL before placing PO.)

Indigenously Supply: Director of Boilers/Chief Inspector of Boilers/Inspecting Authority approved by IBR, for the respective state.

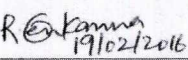
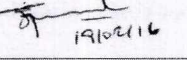
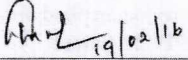
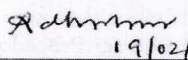
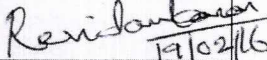
12.2 Certification in IBR Form III-B for finished tubes from "IBR-Well Known Tube Maker" or "Inspecting Authority", as applicable, shall be submitted. Refer to BHEL Engineering Drawing: 4-03-000-0006 1(Latest Rev) for MAWP values for various material grades & sizes at various temperatures.

12.3 **Additionally, Manufacturer's Test certificate(MTC)** (ORIGINAL in ENGLISH) with following details shall be submitted:

- Purchase Order No. (BHEL), TDC No and its Rev No, Test certificate No., Size and Quantity-Melt wise.
- Specification and Grade with year of code, Code case number (if applicable), Heat Number, Steel & Tube making process, chemistry including incidental elements-Ladle and product Analysis.
- Heat Treatment details with actual temperature and soaking time
- Mechanical test results
- Detailed NDE report with reference norms, acceptance standards and test results.
- Grain size, as applicable.
- Decarburization layer thickness
- Certification for compliance to residual magnetism
- Certification for minimum DFT of rust preventive coating

In the MTC a clause for Certificate of Compliance (as per SA 1016) shall be added stating that: All materials/components supplied to Purchase Order meet all requirements contained in the PO, this Technical delivery conditions and applicable ASME specifications.

12.4 For SS: Measured Radioactivity levels shall be reported in the Mill Test Certificate and shall be submitted to BHEL.

 19/02/2016	 19/02/16	 19/02/16	 19/02/16	 19/02/16
Venkanna Rupani	G. Panneer Selvam	M. Nadanakumar	R. Dharmar	U. Revisankaran
Sr.Engineer/QA	DGM/QA	AGM/MM	AGM/QC	AGM/QA&BE
Prepared By		Reviewed By		Approved By

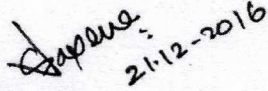
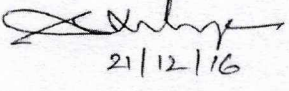
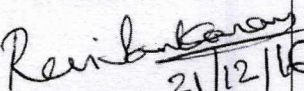
**BHARAT HEAVY ELECTRICALS LIMITED
TIRUCHIRAPALLI 620 014**

QUALITY ASSURANCE

SIP: PP: 21 Rev. 07

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**COLOUR CODES FOR TUBES AND PIPES
(FOR BOILERS, PRESSURE VESSELS & HEAT EXCHANGERS)**

REVISION	DATE	PREPARED	REVIEWED	APPROVED
01	05-02-1999	R. Sasikumar	A. R. Reddy	K. Rengachari
02	22-07-2004	K. Ganesan	U. Revisankaran	C. R. Raju
03	20-01-2009	V. Kalyanaraman	S.Selvarajan	U. Revisankaran
04	13-05-2011	C. Haritha	V. Kalyanaraman	S. Selvarajan
05	27-05-2015	Vaibhav Saxena	S. Selvarajan	U. Revisankaran
06	28-10-2015	Vaibhav Saxena	Manu Shankar. H	S. Selvarajan
07	21-12-2016	 21-12-2016 Vaibhav Saxena	 21/12/16 S. Selvarajan	 21/12/16 U. Revisankaran

RECORD OF REVISIONS

Rev. No	Clause No.	Details of Revision	Remarks
01		New Specifications included based on TDC revision.	--
02		Amendment A1 dt. 26.04.01 issued for Rev. 01 incorporated. Colour code for SA 213 Gr. T23 added.	--
03		1) Colour code for SA 213 Gr. T92, P23, P92, SA178 Gr. D added. 2) Colour code for SA 210 Gr. C modified to BLUE only.(From BLUE & GREEN)	--
04		Colour code for super 304H added	--
05		1) First para modified for clarity for colour codes containing more than one colours. 2) UNS number for Super 304H added.	--
06		Colour code for super 304H corrected in line with Revision 04.	--
07		1) First paragraph modified to include Instructions for sequence for colour code bands. 2) Sl. No. column added in table. 3) Colour code for SA 312 Gr. TP 304H added.	--

Following Colour codes are to be applied as longitudinal bands (if not specified in other documents) on tubes & pipes to identify them to specification during receipt, storage, issue and processing. For heat exchanger tubes circumferential colour code can be provided at both ends of tubes (300 mm away from end). If the Colour code contains more than one Colour then bands of Colours shall be applied adjacent to each other without any overlap. ***In case of multiple colour bands, the sequence shall be maintained as indicated in the table.***

Sl. No.	Specification	Colour 1	Colour 2	Colour 3
1.	12 X 1 MØ	RED	YELLOW	
2.	13 Cr Mo 44	ALUMINIUM	BLACK	
3.	A 200 Gr. T5	ALUMINIUM	RED	YELLOW
4.	A 200 Gr. T9	ALUMINIUM	GREEN	YELLOW
5.	AISI 602	WHITE	YELLOW	
6.	API 5L Gr. B	ALUMINIUM		
7.	BS 3059 PART2 CDS/HFS 360	ALUMINIUM	BLACK	BROWN
8.	BS 3059 P2 S2 440	ALUMINIUM	BLACK	RED
9.	BS 3059 P2 S2 622 Gr. 490	ALUMINIUM	BLACK	GREEN
10.	BS 3602 PART1 CDS 360	ALUMINIUM	BLACK	BLUE
11.	NFA49-213 42C	ALUMINIUM	BLUE	BROWN
12.	NFA49-213 TU 10CD9.10	ALUMINIUM	BLUE	RED
13.	NFA49-213 TU 15CD2.05	ALUMINIUM	BLUE	GREEN
14.	NFA49-213 TU Z10CD9	ALUMINIUM	BLUE	YELLOW
15.	NFA49-213 TU Z10CDVNB09.01	ALUMINIUM	GREEN	RED
16.	SA 106 Gr. B	RED		
17.	SA 106 Gr. C	BLUE		
18.	SA 178 Gr. D	ORANGE		
19.	SA 179	BLACK	BLUE	GREEN
20.	SA 192	WHITE		
21.	SA 199 T5	BLUE	BROWN	RED
22.	SA 209 Gr. T1	ALUMINIUM	RED	
23.	SA 210 Gr. A1	YELLOW		
24.	SA 210 Gr. C	BLUE		
25.	SA 213 Gr. T11	ALUMINIUM	YELLOW	
26.	SA 213 Gr. T12	BROWN	YELLOW	
27.	SA 213 Gr. T2	BROWN	GREEN	
28.	SA 213 Gr. T22	GREEN	RED	
29.	SA 213 Gr. T23	RED	WHITE	
30.	SA 213 Gr. T5	BLACK	BROWN	GREEN
31.	SA 213 Gr. T9	BROWN	WHITE	
32.	SA 213 Gr. T91	GREEN	YELLOW	
33.	SA 213 Gr. T92	BROWN	BLUE	
34.	SA 213 Gr. TP 304	BLUE	GREEN	YELLOW
35.	SA 213 Gr. TP 304H	BLACK	BLUE	YELLOW
36.	SA 213 Gr. TP 304L	BLUE	WHITE	YELLOW
37.	SA 213 Gr. TP 309H	BLACK	BROWN	YELLOW
38.	SA 213 Gr. TP 316	BROWN		
39.	SA 213 Gr. TP 316 Ti	BLACK	BLUE	
40.	SA 213 Gr. TP 316L	BLUE	BROWN	YELLOW
41.	SA 213 Gr. TP 321	BLUE	WHITE	
42.	SA 213 Gr. TP 321H	BLACK	WHITE	
43.	SA 213 Gr. TP 347H	BLACK	YELLOW	

Sl. No.	Specification	Colour 1	Colour 2	Colour 3
44.	SA 268 Gr. TP 405	ALUMINIUM	GREEN	
45.	SA 268 Gr. TP 410	BROWN	RED	YELLOW
46.	SA 268 Gr. TP 443	BLUE	GREEN	WHITE
47.	SA 269 TP 316	GREEN	RED	YELLOW
48.	SA 312 Gr. TP 304	BLUE	YELLOW	
49.	SA 312 Gr. TP 304L	BLUE	RED	YELLOW
50.	SA 312 Gr. TP 304H	BLACK	BLUE	YELLOW
51.	SA 312 Gr. TP 316	BLACK	GREEN	
52.	SA 312 Gr. TP 316L	BLACK	BLUE	BROWN
53.	SA 312 Gr. TP 321	BLUE	BROWN	
54.	SA 312 Gr. TP 347	BLUE	RED	WHITE
55.	SA 333 Gr. 1	BLACK	BROWN	RED
56.	SA 333 Gr. 3	BLACK	GREEN	RED
57.	SA 333 Gr. 6	BLUE	GREEN	RED
58.	SA 334 Gr. 1	BROWN	GREEN	RED
59.	SA 334 Gr. 3	BLACK	RED	YELLOW
60.	SA 334 Gr. 6	BLACK	BLUE	RED
61.	SA 335 Gr. P1	BROWN	GREEN	YELLOW
62.	SA 335 Gr. P11	GREEN	WHITE	
63.	SA 335 Gr. P12	BLACK	RED	
64.	SA 335 Gr. P2	BLUE	BROWN	GREEN
65.	SA 335 Gr. P22	BLUE	RED	
66.	SA 335 Gr. P23	RED	WHITE	
67.	SA 335 Gr. P5	BLACK	BROWN	
68.	SA 335 Gr. P9	ALUMINIUM	BROWN	
69.	SA 335 Gr. P91	BROWN	RED	
70.	SA 335 Gr. P92	BROWN	BLUE	
71.	SB 163 Inconel	BLACK	GREEN	YELLOW
72.	ST 35.4	ALUMINIUM	BLUE	
73.	Steel 20	GREEN		
74.	Structural Tubes & Pipes	BLUE	BROWN	WHITE
75.	X20 Cr Mo V 121	BLACK		
76.	SA 213 UNS S30432(Super 304)	BLACK	RED	GREEN

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