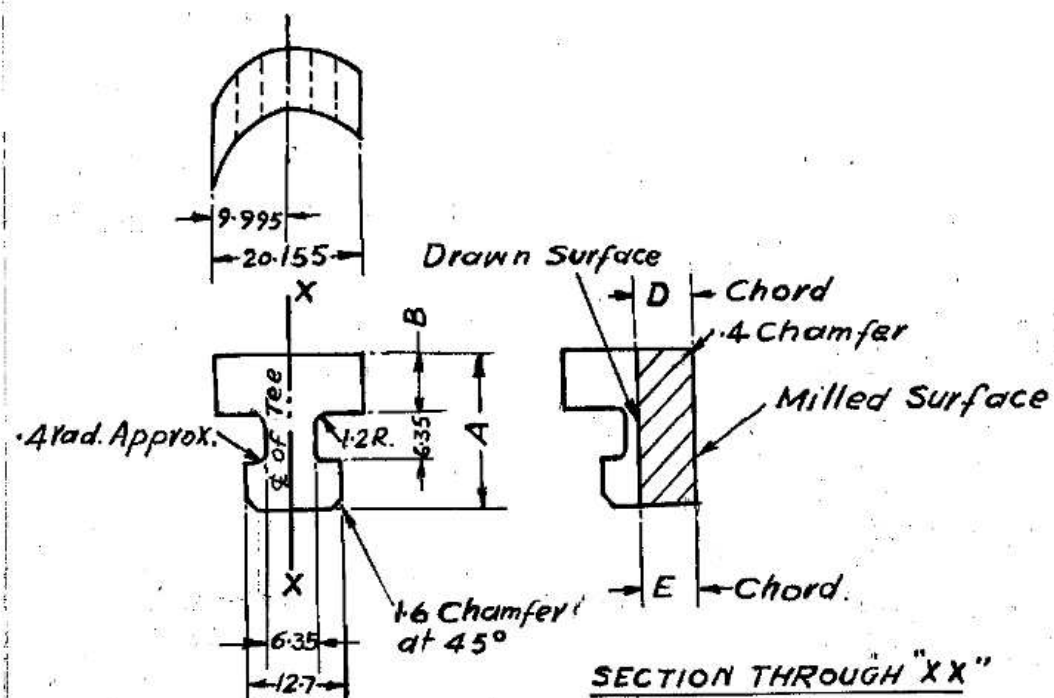


DINE, D

ENCLOSURE

COL.	ITEM NO.	DESCRIPTION, SIZE, OR WEIGHT	GOVERNMENT ORIGIN	COUNTRY OF ORIGIN	REMARKS



Note:- 1. For process tool list see drg DP5151337Mv  
2. For details of blade see drg E.2760100  
3. For details of form see drg D.2820122

### TABLE OF DIMENSIONS

WHEEL NO.	DIMENSION A	DIMENSION B	CHORD D	CHORD E	PACKERS PER WHEEL	MEAN DIAMETER
2	18.75	6.05	6.355	5.959	298	915.162
3	19.51	6.81	6.345	5.939	302	927.862
4	18.54	5.84	6.330	5.951	306	940.562
5	19.18	6.43	6.322	5.961	310	956.437
6	18.62	5.92	6.317	5.949	316	972.312
7	19.05	6.35	6.274	5.903	322	988.187
8	18.75	6.05	6.276	5.913	326	1004.062

Machining tolerances  $\pm$  mm.  
Unless shown otherwise  
Non-machining tolerances  $\pm$  mm.

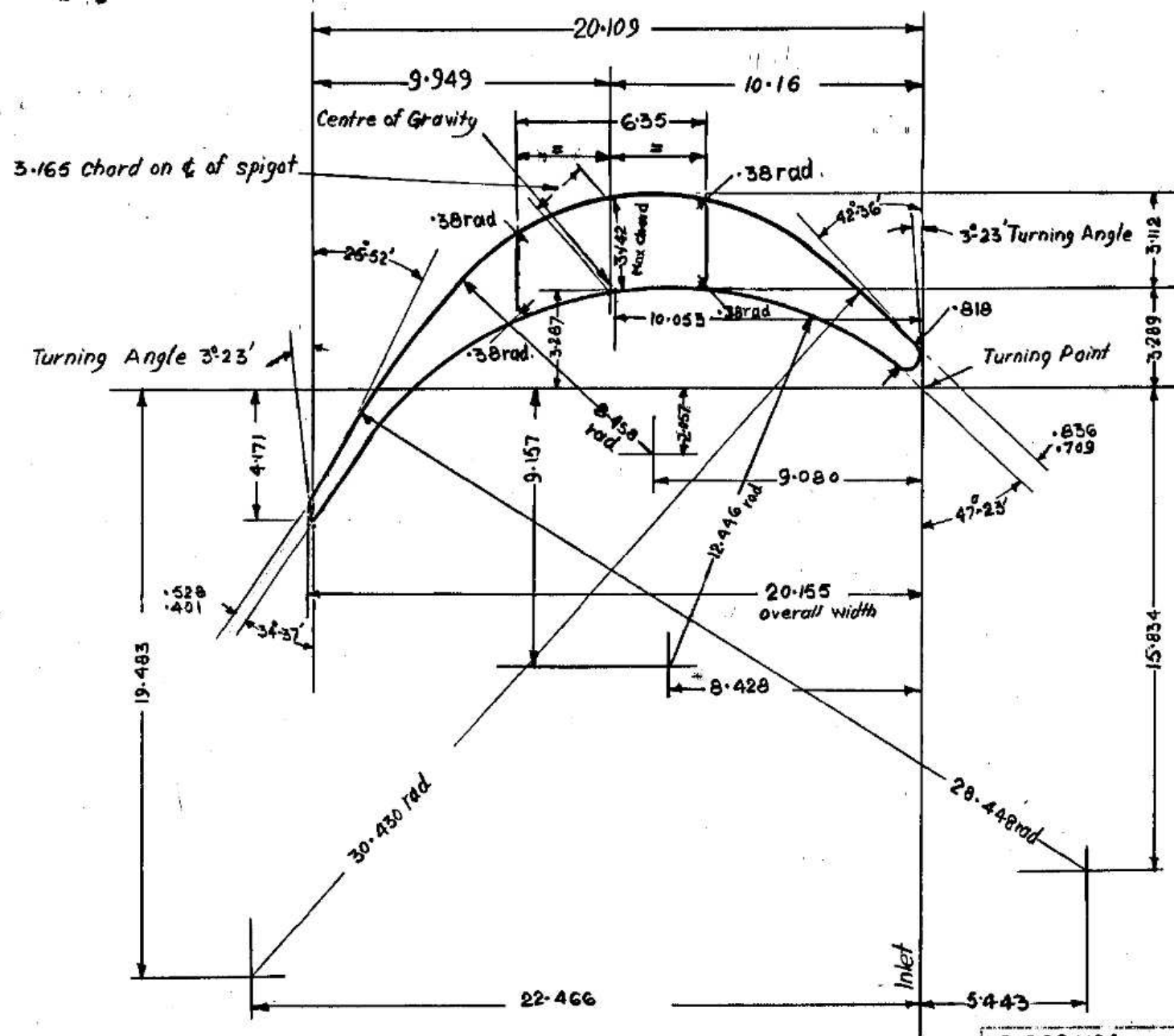


M.O. 1910001/1

REF.D5/51337/2 (M.V.)

1	DATE 27-3-65 APPROVED <i>S. Swick</i>	DRG. NO. E.2760/100 Was D.2820/169 M.O.191000111	DRG. NO. 8-84 APPROVED <i>S. Swick</i> 1-9-64 D.S. 2-9-64 ACT <i>[Signature]</i>	PRINTING ISSUED BY <b>Steam Turbine D.O.</b> PRINTS TO Office copy 1 PRX 1 STM 3 TGX 1	HEAVY ELECTRICALS (INDIA) LTD. MADRAS <b>PACKING PIECE</b> SECTION 3706P/MV SCALE 1:1 THIRU ANNAI ENGINEERING
---	--	--	---	--	--

ALL DIMENSIONS ARE IN MM  
UNLESS OTHERWISE SPECIFIED



TOOL LIST		
ITEM	TOOL	DESCRIPTION
	1426340	Slide Gauge
	1426341	Draw Die

## NOTE:-

1. Important:- Inlet Edge to be fully rounded by drawfiling
2. This blade is produced by turning section No. 3528 R at 3°23' to give an outlet concave angle of 34°37' instead of 38°

Machining tolerances  $\pm$   
unless shown otherwise  
Non-machining tolerances  $\pm$  mm.

D 2820124

## DRAWING REFERENCE

REF. D 263705/3 (M.V)

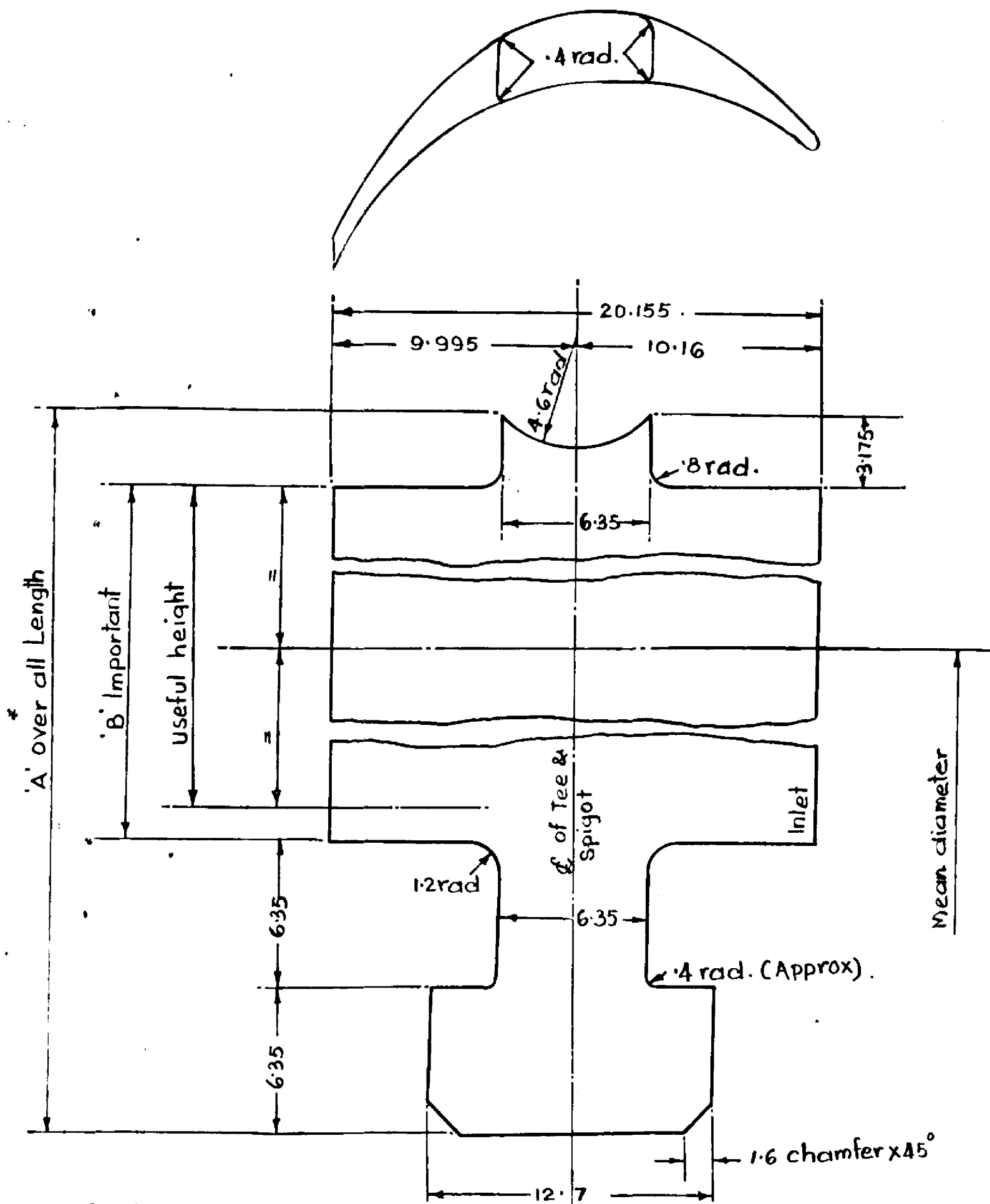
DRAWING ISSUED BY		HEAVY ELECTRICALS (INDIA) LIMITED	
STEAM-TURBINE D.O.		BHOPAL	
PRINTS TO:-		MOVING BLADE SECTION NO 3705 R	
O.C.	1	USED WITH PACKER SECTION No 3706 P	
S.T.M.	2	SCALE - 1:15 N.T.S.	
PRX	1	THIRD ANGLE PROJECTION	
TGX	1	D 2820164	

M. Q. 19/0001/1

DATE	APPD.	REVISIONS
28-9-64		1. <i>Design</i>
5-9-64		2. <i>Appd.</i>
6-10-64		3. <i>Appd.</i>
7-10-64		4. <i>Appd.</i>

2

E 2760100



E 2760100

3 12.11.78 2 17.8.78 1 24.5.75  
 over all length 'A' dimension was excluding 'T' Head. Shroud punching & strip ref. drg. added & process tool list ref. drg. deleted. Retraced original missing from Drg. vault.

TABLE OF DIMENSIONS							
WHEEL NO.	DIMENSION 'A'	DIMENSION 'B'	USEFUL HEIGHT	PITCH OF HOLES IN SHROUDING	MEAN DIAMETER	BLADES PER WHEEL	PITCH ON MEAN DIAMETER
2	39.19	23.32	17.27	9.830	915.16	298	9.647
3	41.60	25.73	18.92	9.848	927.86	302	9.650
4	42.55	26.670	20.83	9.870	940.56	306	9.657
5	45.16	29.29	22.86	9.924	956.44	310	9.693
6	45.67	29.79	23.88	9.903	972.31	316	9.667
7	48.39	32.51	26.16	9.896	988.19	322	9.642
8	51.89	36.02	29.97	9.964	1004.06	326	9.675

NOTE :- Master Section is 3528R When turned to 3705 R & Used with 3706P instead of 3529P. reduce axial width from 20.320 to 20.155.

FOR DETAILS OF FORM SEE DRG. D 2820164

FOR DETAILS OF PACKER SEE DRG. D 2820124

~~FOR PROCESS TOOL LIST SEE D.P. 5151336/MV~~

FOR DETAILS OF SHROUD PUNCHING SEE DRG. G 2612175 & FOR SHROUDING STRIP SEE DRG. D 2821210

G 2612166

D 5151336/2-MV

Steam Turbine

V.N. Singh 11.8.64

S.G. Khanna 26.8.64

S. Singh 26.8.64

K.K. John 26.8.64

MOVING BLADE SECTION

3705R/MV.

O.C.  
 S.T.M.  
 PRX.  
 TGX (D.O.)

SCALE: 5:1

M.O. 1910001/1

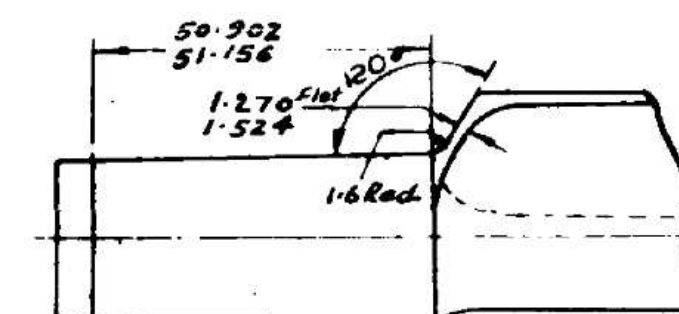
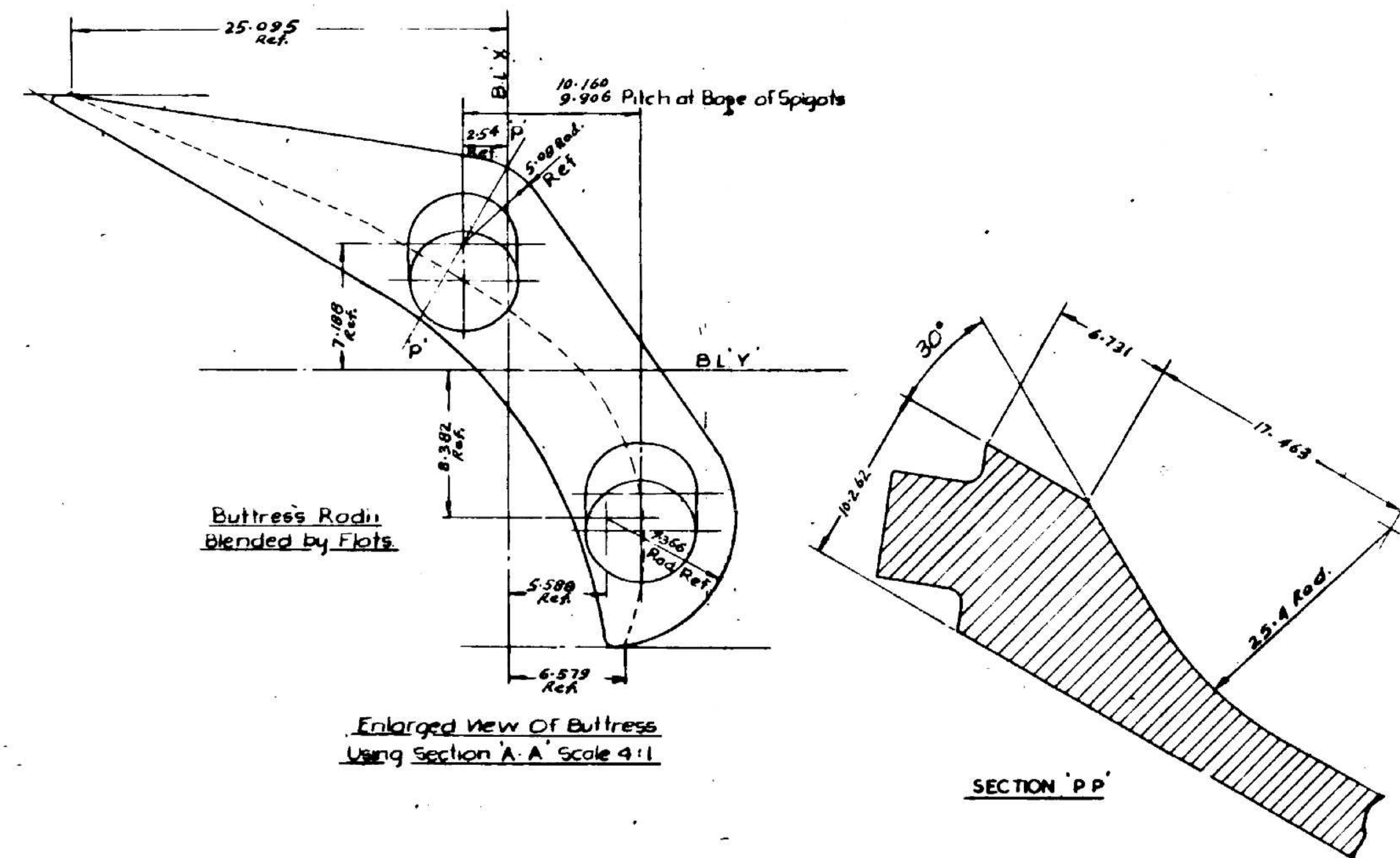
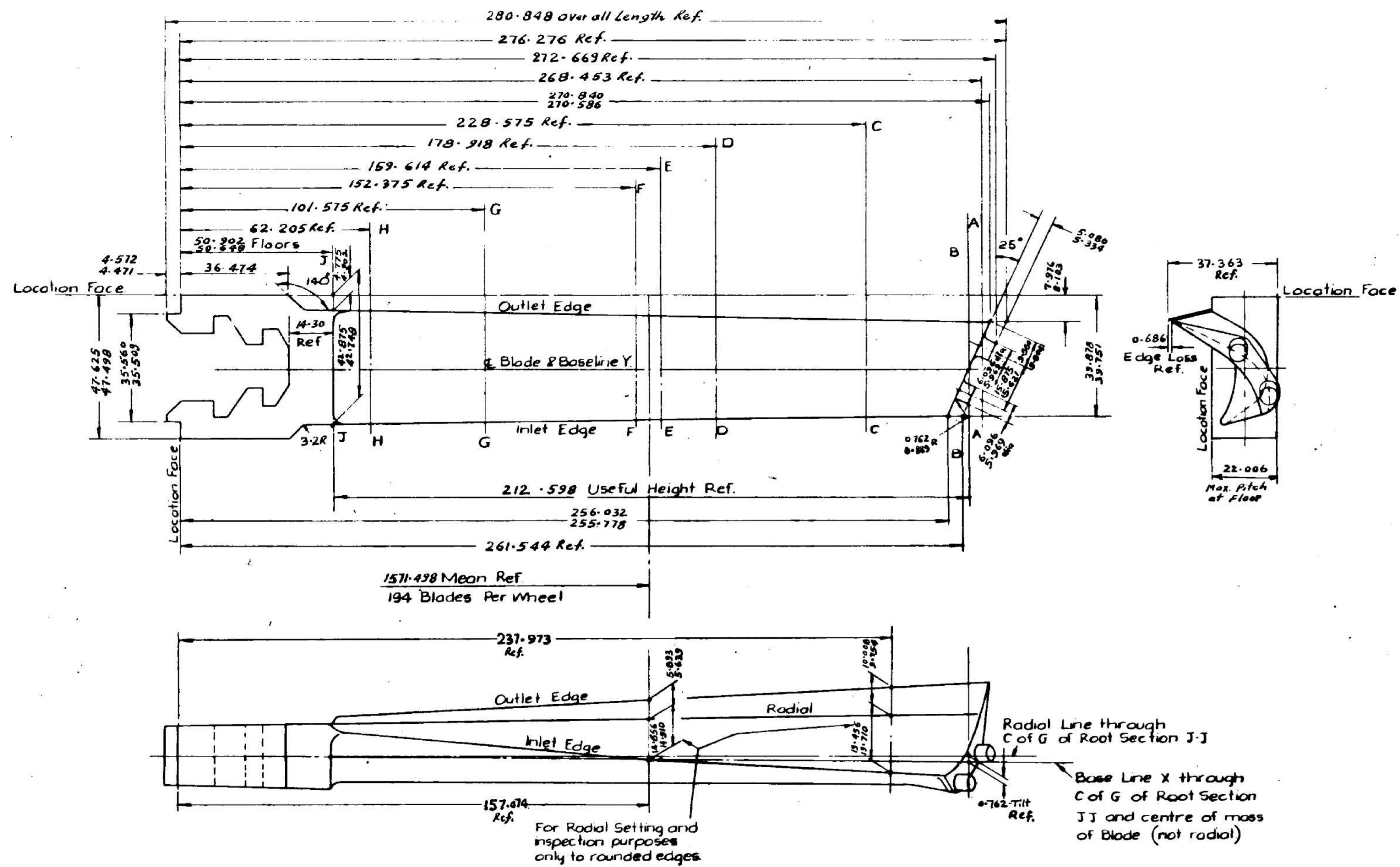
E 2760100



File No. HEP-CMMOASC(28)/15/2026-HEP-STE4000 (Computer No. 300879)  
Generated from *Office of Sanjayan Kumar Savana* ENGINEER/SCS/ASC/34200/HEP ENGINEER HEP/HEAVY ELECTRICALS PLANT (HEP) on 14/05/2026 09:43 ar

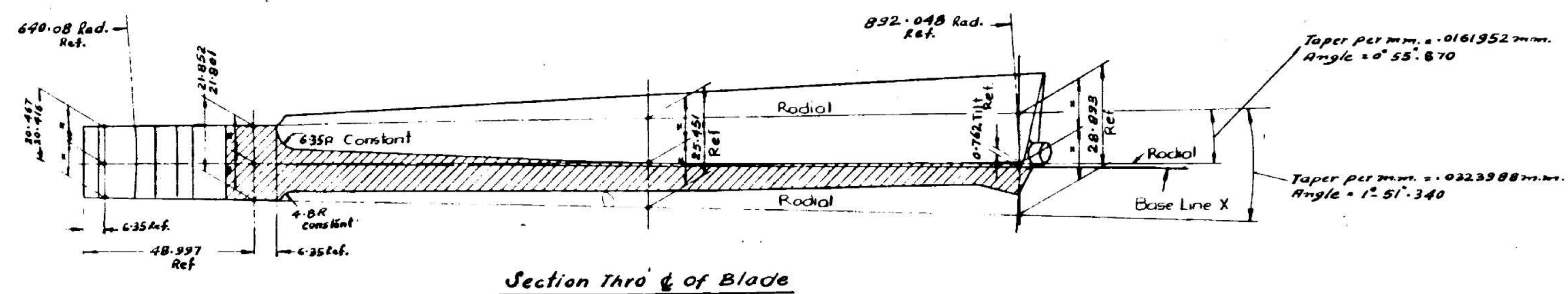


ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED

[illegible]

Scrap View On Outlet Edge

Note:- Shroud Spigots to be free from flats and so positioned that the radius at junction of Spigot and Blade tip is maintained fully around periphery. Blade form and inlet edge radius to be finish machined to  $\sqrt{}$  all other surfaces to finished to  $\sqrt{}$ .



Section Thro'  $\phi$  of Blade

*Note:- For details of closing Blade see drg. G2612 090  
Inlet edge to be fully rounded by drawfiling.  
For method of development and blade  
section see drawing G2612134.  
Make from 44.45 x 50.8 Rectangular Bar.  
For detail of Blade fastening See drg. F2700170*

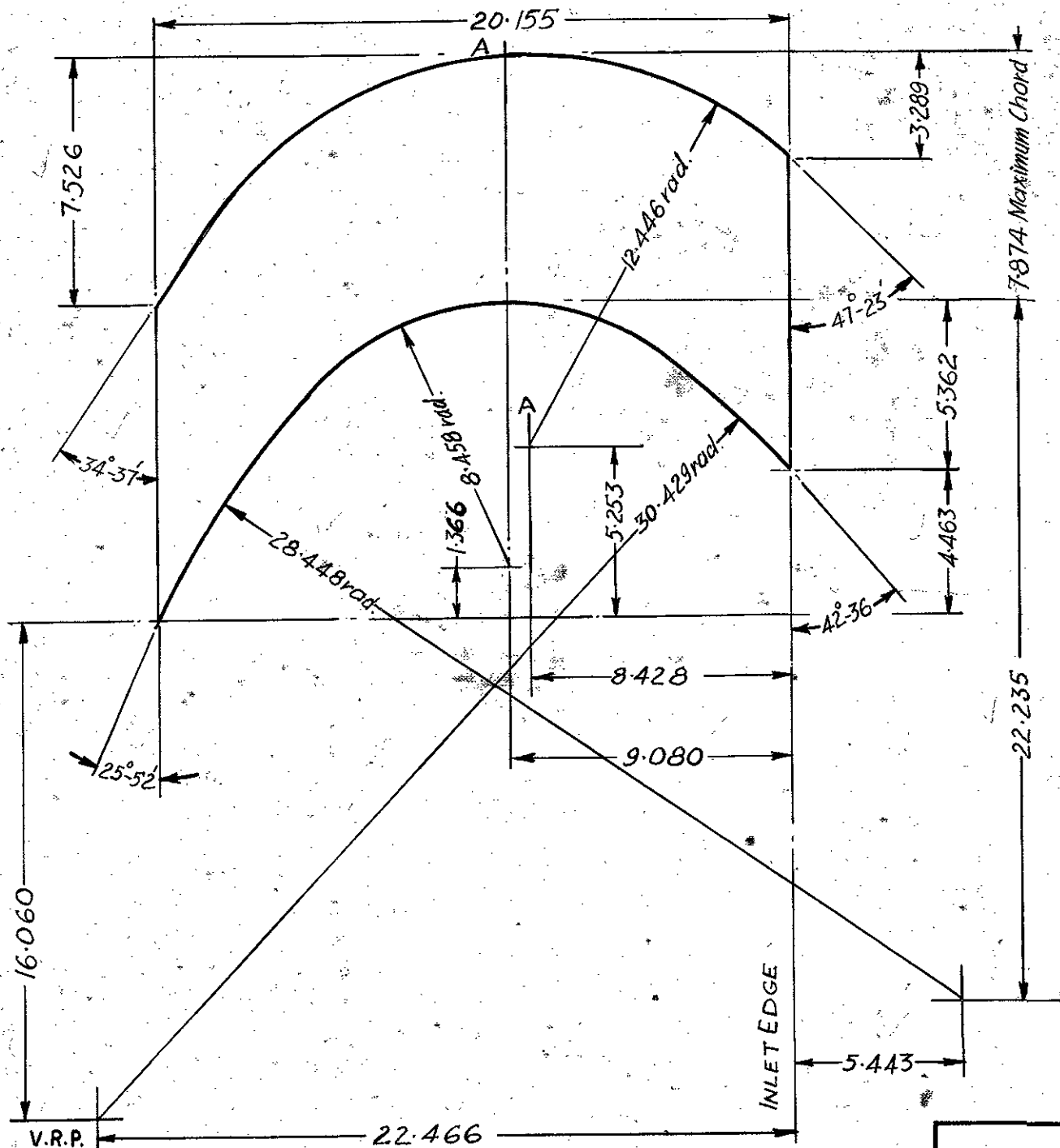
**G 2612121**

	DATE	DATE	DATE	DATE	DATE
	CKD.	CKD.	CKD.	CKD.	CKD.
	APPD.	APPD.	APPD.	APPD.	APPD.
					Drawing Revised as per A.E.1 Rev. D.

Dimensions with limits to be made to gauges Machining tolerances $\pm .25$ mm. unless shown otherwise Non-machining tolerances $\pm$ mm.	G26/2166	
	DRAWING REFERENCE	
	REF. A2296328/BM.V.	
	BHARAT HEAVY ELECTRICALS LIMITED BHOPAL	
DRAWING ISSUED BY:-	D. O.	
STEAM TURBINE		
DRN.		
CRD. P. G. Joshi	22-9-69	
DRG. APPD. S. Singh	7-10-69	
DES. APPD. K. A. JOHN	7-10-69	
PRINTS TO:-		
QZ	4	
STM.	4	
DR.	1	
TGR(O)	1	
SCALE :- 1:16 N.T.S.		M.O. 1910001/1
		G 2612121

ALL DIMENSIONS ARE IN MM.  
UNLESS OTHERWISE STATED.

D2820122



TOOL LIST		
ITEM	TOOL	DESCRIPTION
1	1426349	Draw Die
1	1426350	Slide Gauge
1	1426351	Special Form Gauge For Draw Bench.

Note :-  
Position AA is micrometer gauging  
Point for use by inspection dept.  
For rolled packer material  
see drg. D263676/MV

Machining tolerances  
unless shown otherwise  
Nom-machining tolerances  $\pm$  mm.

M.O. NO. 1910001/1

DRAWING REFERENCE	
REF. D263706/2 M.V.	
DRAWING ISSUED BY:	HEAVY ELECTRICALS (INDIA) LIMITED.
STEAM TURBINE D.O.	BHOPAL
PRINTS TO :-	PACKING PIECE SECTION No. 3706 P/MV
O.C.	USED WITH BLADE SECTION No. 3705 R/MV
S.T.M	SCALE: - N.T.S.
P.R.X.	THIRD ANGLE PROJECTION
Tool & Gauge	D2820122

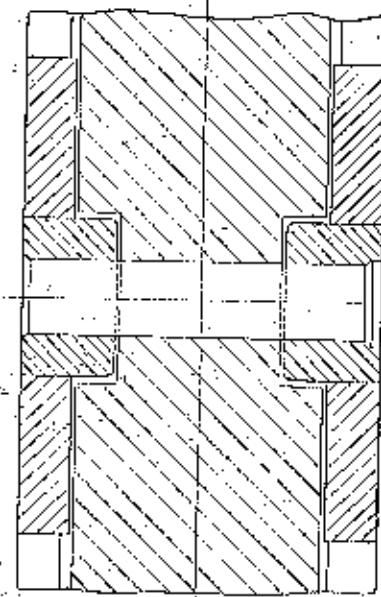
REVISIONS	DATE	DRN.
	APPD.	CKD. S.S. Datta 31.8.64
	6	DRG. APPD. 1.1.64
	M.C.	DESN. APPD. 1.9



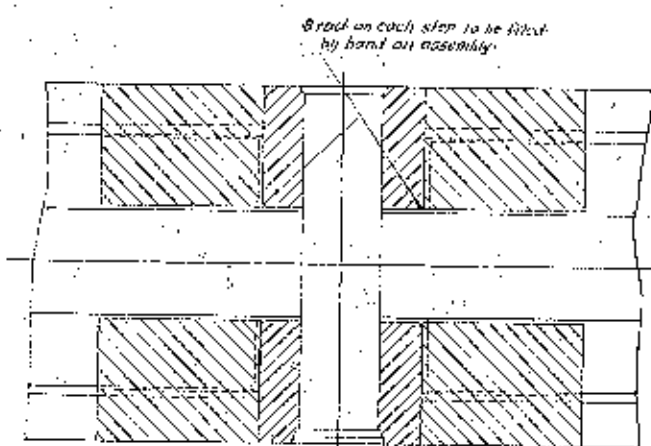
THIRD ANGLE PROJECTION

ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE STATED  
F2700073

TOOL LIST		
ITEM	TOOL	DESCRIPTION
1427167	And Mill for gate fitting	
1427163	For gate drill	
1426529	Endurance Rocker	
1426504	Endurance Cutter	
1426529	Depth Gauge 10-15	



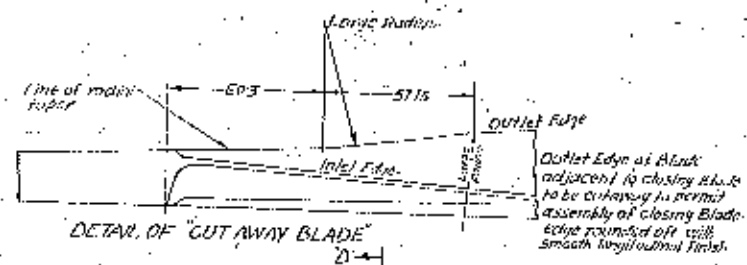
SECTION OF ASSEMBLY 'C' C'



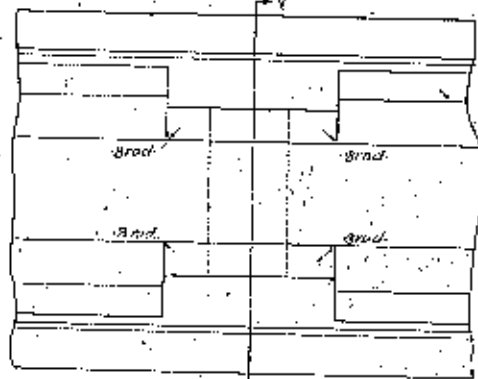
SECTION OF ASSEMBLY 'B' B'



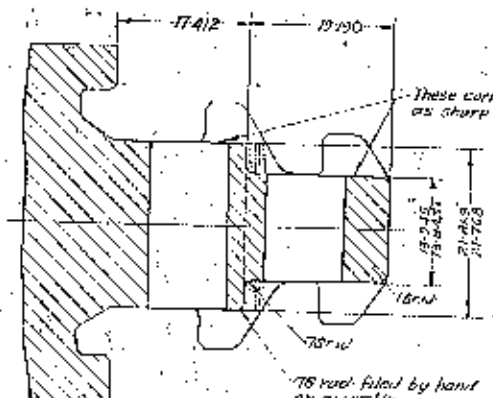
FULL SIZE VIEWS



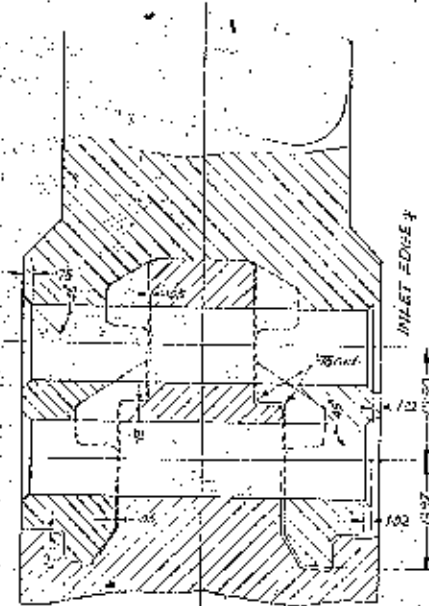
DETAIL OF 'CUT AWAY BLADE'



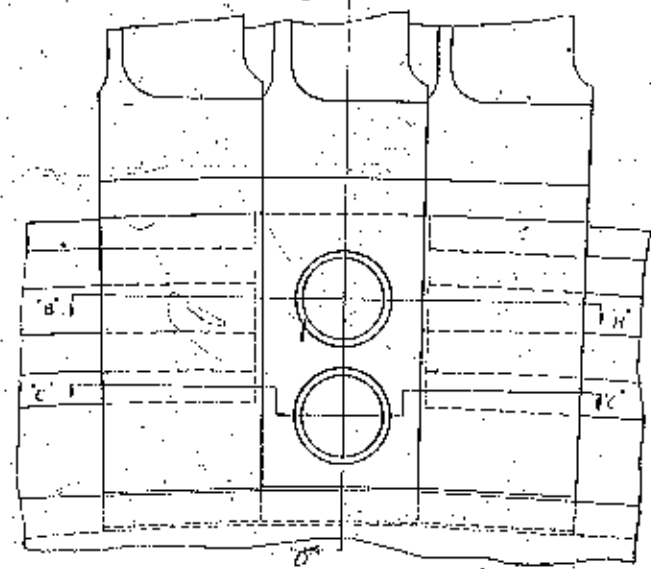
SECTION ON 'Y' Y'



- NOTE: 1. Outlet slot to be drilled 8 counter sunk after assembly.  
2. Inlet side drilled counter bore before assembly.  
3. For details of closing blade see Dry F2700190.  
4. For details of nominal blade fitting see Dry F2700170.  
5. Closing blade to be located as near central as possible in gate-trivet hole in closing blade is drilled on inlet side before assembly the hole in window outlet side of blade drilled & rounded after assembly. Rate of 22.86(0.9) that wheel rim allows a float of blade approximately 18(0.7) each way. 2 gages per wheel are to be fitted diametrically opposite.



SECTION OF ASSEMBLY 'D' D'



DETAILS OF WHEEL GATE

Demonstrations with limits to be made to gauges.	
Machining tolerances ±	mm
Unless shown otherwise.	
Non machining tolerances ±	mm
DRAWING ISSUED BY: Design Engineer	
DRN.	26.10.2024
CKD.	26.10.2024
DES.APPD.	26.10.2024
DES.APPD.	26.10.2024

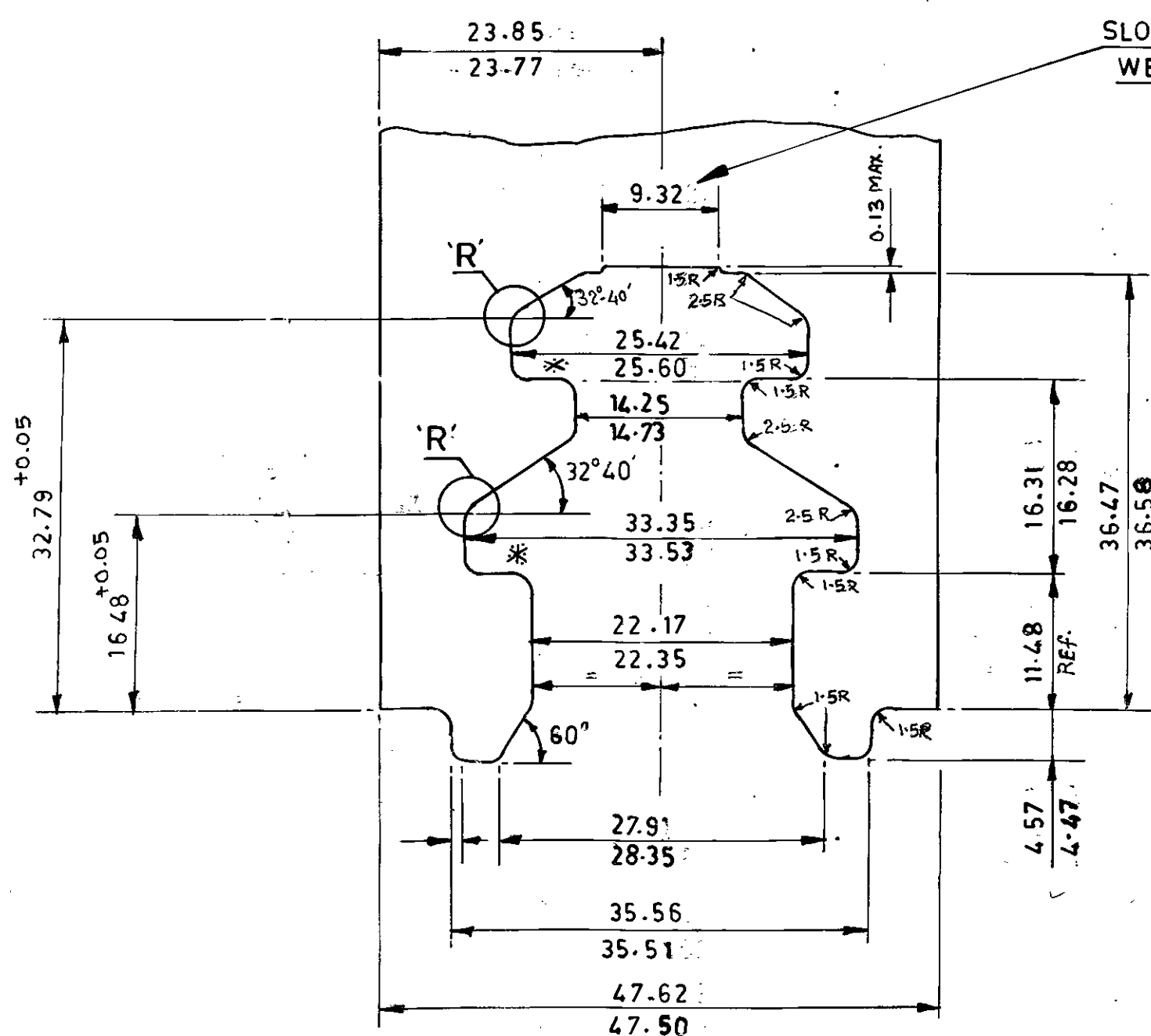
DRAWING REFERENCE		
REF. B 323278/1 (N.V)		
HEAVY ELECTRICALS (INDIA) LIMITED BHOPAL		
DETAIL OF GATE & ASSEMBLY OF CLOSING BLADE FOR 47625(1875) WIDE ROOT. 1		
SECTION 7529R		
SCALE: 1/100	M.O. 191000/11	F2700073

DATE	DATE	DATE	DATE	DATE
CHKD.	CHKD.	CHKD.	CHKD.	CHKD.
APPD.	APPD.	APPD.	APPD.	APPD.
7				1
				Total Nos. 1426326/1426324 1426321 deleted. and: Total Nos. 1427167 & 1427163 added in the Total list as per figure No. 6

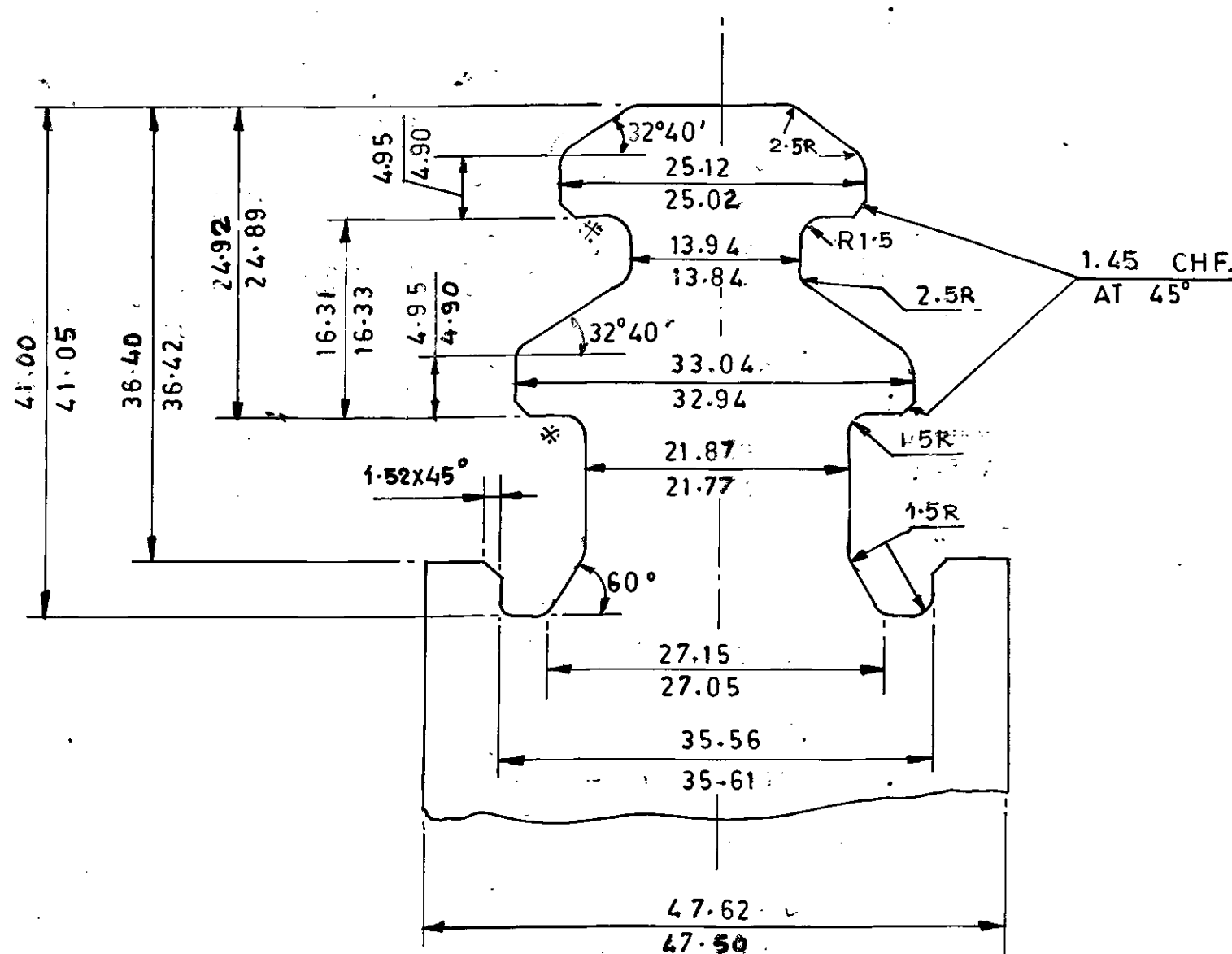
DRG. NO. F 2700170

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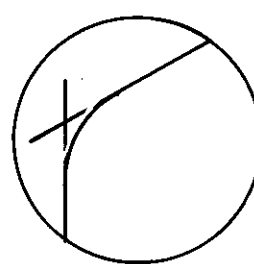
INVENTORY NO.	SIGN. & DATE	B 3103804/8 AET
		REF. DRG. NO.



DETAIL OF BLADE



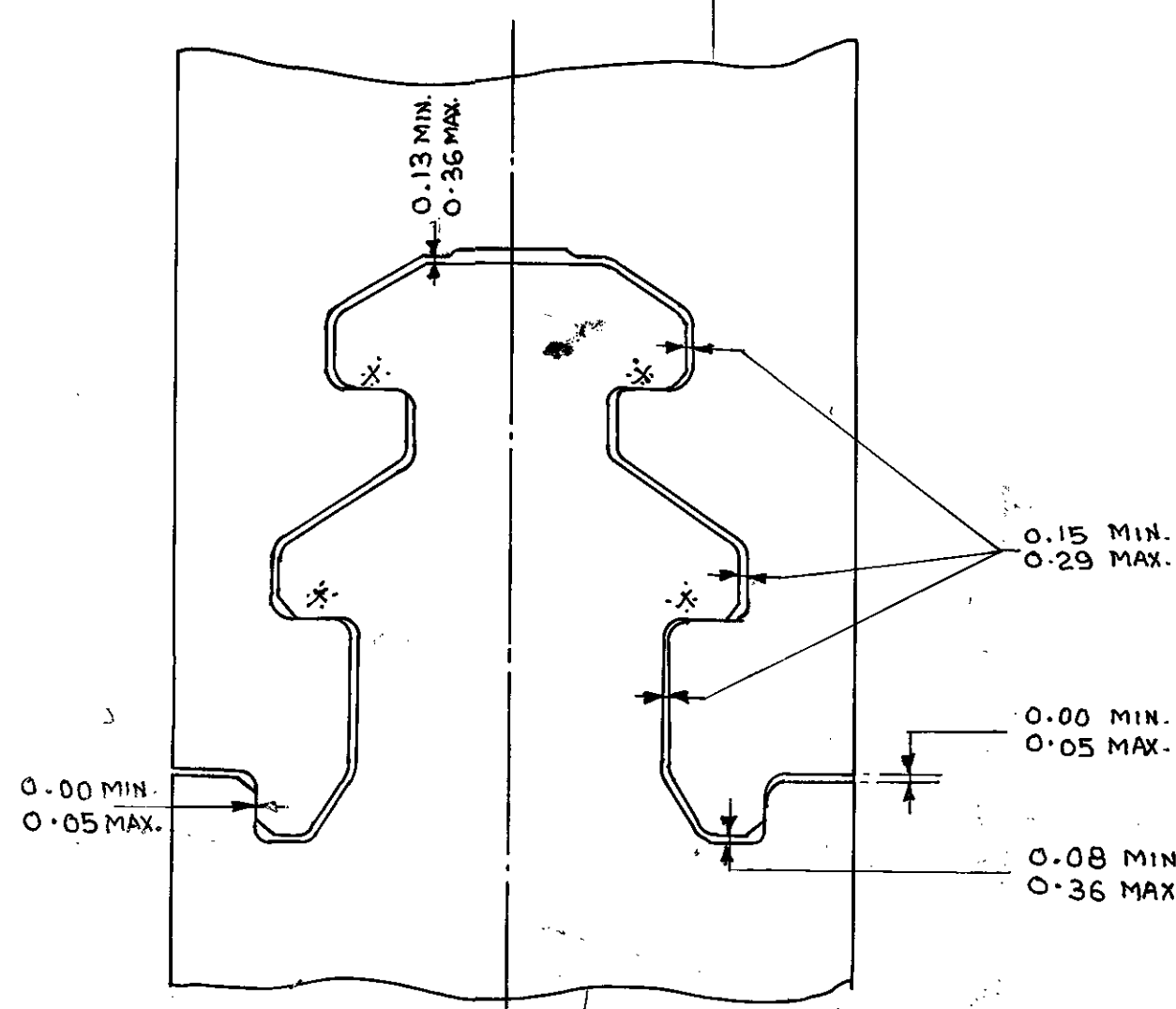
DETAIL OF WHEEL




ENLARGED VIEW OF  
DETAIL- R

TOOL LIST		
ITEM No.	TOOL No.	DESCRIPTION
	1427 977	2.54 RAD. GAUGE (M)
	1427 978	2.54 RAD. GAUGE (TOP)
	1427 979	2.54 RAD. GAUGE (SIDE)
	1427995	1.448 45° CHF. GAUGE
	1427996	1.524 45° CHF. GAUGE
	1427 997	DEEP FRAME MICROMETER
	1428008	CARBIDE TIPPED CHF. TOOL
	1428006	CARBIDE TIPPED CHF. TOOL
	1428007	CARBIDE TIPPED
	1428011	FINAL CHECKING SLIDING FIR TREE GAUGE.
	1427 980	152 RAD GAUGE (M)
	1427116	FIR TREE GAUGE
	1427117	FIR TREE TOOL.
	1427115	SEQUENCE OF OPERATION DRG.
	1428011	SHUTTER GAUGE
	1427160	TOOL HOLDER

1. ALL SURFACES TO BE FREE FROM BURRS AND MACHINED TO  $3.2/\sqrt{\Delta}$  EXCEPT BEARING AREA AND BLEND RADIUS WHICH SHOULD BE  $1.6/\sqrt{\Delta}$
2. DIMENSIONS ABOUT THE  $\phi$  MUST BE SPACED EQUIDISTANT ABOUT THE  $\phi$  WITHIN  $\pm 0.04$ .
3. BEARING SURFACE MARKED THUS ~~X~~ ON BLADE & WHEEL ARE CIRCULAR AND EACH PAIR MUST NOT BE MORE THAN 0.02 OUT OF LINE WITH EACH OTHER.



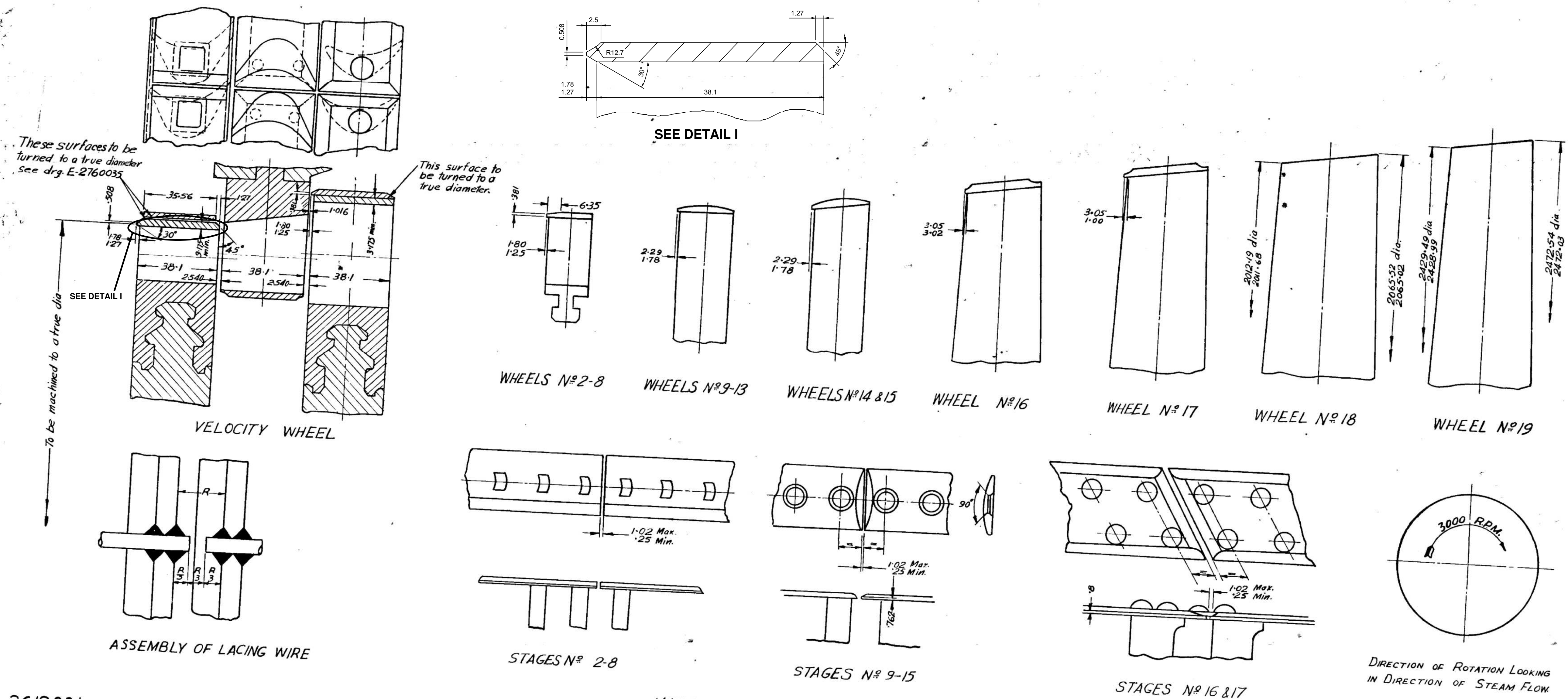
### ASSEMBLY OF FASTENING ON BLADE AND WHEEL SHOWING CLEARANCES

VAR.OO		REMARKS		VAR. NO.		ITEM NO.		DESCRIPTION		DRAWING NO.		MATL. CODE		MATL. SPQN.		UNIT WT.		QTY.		ZONE	
28 → CARD TYPE-3				28 → CARD TYPE-1								28 → CARD TYPE-2									
ADDITIONAL INFORMATION										STEAM TURBINE											
STATUS OF DRAWING										TYPE OF PRODUCT OR NAME OF CUSTOMER/PROJECT											
DISTRIBUTION OF PRINTS STE 1 STM 4 TCX (STM) 1										 भारत हेवी इलेक्ट्रिकल्स लिमिटेड भोपाल BHARAT HEAVY ELECTRICALS LTD. BHOPAL											
REV. DATE ALTERED 10 15-4-95 CHECKED [Signature] 15-4-95 APPROVED [Signature]										ग्राहक का संकेत REF. TO ASSY. DRG. 83103804/B											
ZONE Drg. retraced in Line With A=1 Rev.No.08										ड्राइंग नं./DRAWING NO. F 2700170											
श्रीकेश/TITLE 47.6 (1875)/2 P FIR TREE ROOT FOR STAGE 16&17										कुल शीट सं./NO. OF SHT. 1											



MOVING BLADES						PACKER OR CLOSING BLADE				SHROUDING STRIP				RIVETS		
WHEEL Nº	DRAWING Nº	SECTION Nº	Nº PER WHEEL	USEFUL HEIGHT	OVERALL LENGTH	DRAWING Nº	SECTION Nº	Nº PER WHEEL	OVERALL LENGTH	DRAWING Nº	SECTION Nº	Nº OF SEGMENTS	APPROX LENG OF EACH SEG OR LENG OF DRAWING	Nº OF BLADES PER SEGMENT	DRAWING Nº	Nº REGO
1st ROW	F-2700166	4625 R	124	23-40	78-07	E-2760081	4625 R	1	78-09	F-2700146	1830 1835-56	12	288-06	11	B-2920012	4
2nd ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
3rd ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
4th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
5th ROW	F-2700166	4626 R	64	33-56	91-03	"	"	"	"	"	"	"	"	"	"	"
6th ROW	F-2700166	7727 R	137	40-26	100-30	F-2700120	7727 R	1	100-30.5	F-2700146	5 C	Cut To Suit	2134	DRILL TO SUIT	"	"
7th ROW	F-2700166	"	1	"	"	"	"	"	"	"	5 B	"	2134	21-00	B-2920012	4
8th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
9th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
10th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
11th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
12th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
13th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
14th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
15th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
16th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
17th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
18th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
19th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
20th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
21st ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
22nd ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
23rd ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
24th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
25th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
26th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
27th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
28th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
29th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
30th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
31st ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
32nd ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
33rd ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
34th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
35th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
36th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
37th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
38th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
39th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
40th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
41st ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
42nd ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
43rd ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
44th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
45th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
46th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
47th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
48th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
49th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
50th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
51st ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
52nd ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
53rd ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
54th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
55th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
56th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
57th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
58th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
59th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
60th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
61st ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
62nd ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
63rd ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
64th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
65th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
66th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
67th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
68th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
69th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
70th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
71st ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
72nd ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
73rd ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
74th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
75th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
76th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
77th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
78th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
79th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
80th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
81st ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
82nd ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
83rd ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
84th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
85th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
86th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
87th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
88th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
89th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
90th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
91st ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
92nd ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
93rd ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
94th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
95th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
96th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
97th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
98th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
99th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
100th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
101st ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
102nd ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
103rd ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
104th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
105th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
106th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
107th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
108th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
109th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
110th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
111th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
112th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
113th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
114th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
115th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
116th ROW	F-2700166	"	6	"	"	"	"	"	"	"	"	"	"	"	"	"
117th ROW	F-2700166	"	1	"	"	"	"	"	"	"	"	"	"	"	"	"
118th ROW																

MOVING BLADES										PACKER OR CLOSING BLADE						
DRAWING N.P.	MANFG. NO OF BLADES	MATERIAL MILLED ROLLED OR FORGED	APPROX. NO. MILLED SECTION NO. INCLUDING ALLOWANCE	MATERIAL SECTION NO. OF RECT. BAR	P. D. SPEC. NO.	MATERIAL	APPROX. MILL SECTION NO. IN 36 IN.	BLADE FORGING DRAWING N.P.	DRAWING N.P.	MANUFACTURING NO. OF PACKERS	MATERIAL MILLED OR DRAWN	APPROX. NO. MILL REGR. INCLUDING ALLOWANCE	MATERIAL SECTION NO.	MATERIAL	P.D. SPEC. NO.	WHEEL NO.
F2700166	131	Milled	11-60	44-45X30-8	1245	Stainless Steel			E2760081	1	Milled	15	44-45X30-8	Stainless Steel	1245	Int. Row
NOT LISTED	1	"	15	"	"	"										Int. Row
NOT LISTED	6	"	61	"	"	"										Int. Row
F2700169	68	"	50	"	"	"			F2700120	1	Milled	15	34-9X42-6	Stainless Steel	1245	Int. Row
F2700169	142	"	16-05	34-9X42-6	"	"										Int. Row
F2700169	1	"	15	"	"	"										Int. Row
F2700169	1	"	15	"	"	"										Int. Row
F2700169	6	"	91	"	"	"										Int. Row
F2700169	304	Roll'd	13-85	332@ R	1495	"			D2820104	304	Drawn	8-23	3706 P	Low Carbon Steel	1466	Int. Row
"	308	"	16-76	"	"	"				308	"	8-54	"	"	"	Int. Row
"	312	"	17-37	"	"	"				312	"	8-54	"	"	"	Int. Row
"	316	"	18-29	"	"	"				316	"	8-54	"	"	"	Int. Row
"	322	"	18-90	"	"	"				322	"	8-84	"	"	"	Int. Row
"	328	"	20-12	"	"	"				328	"	9-15	"	"	"	Int. Row
"	332	"	24-95	"	"	"				332	"	9-15	"	"	"	Int. Row
E2700086	203	Milled	18-90	28-60X22-9	1245	"			F2760053	2	Milled	"	28-60X20-3	Stainless Steel	1245	Int. Row
F2700164	210	"	20-73	"	"	"			F2760047	2	"	"	"	"	"	Int. Row
F2700164	210	"	22-86	"	"	"			F2760043	2	"	"	"	"	"	Int. Row
E2760005	212	"	24-18	"	"	"			F2760067	2	"	"	"	"	"	Int. Row
F2700165	214	"	27-43	28-60X25-4	"	"			F2700165	2	"	"	"	"	"	Int. Row
E2760085	266	"	35-05	"	"	"			F2700165	2	"	"	"	"	"	Int. Row
E2760064	266	"	42-67	"	"	"			F2700165	2	"	"	"	"	"	Int. Row
G2600128	206	"	44-50	44-45X30-8	"	"			F2700165	2	"	"	"	"	"	Int. Row
G2600127	206	"	62-18	"	"	"			F2700165	2	"	"	"	"	"	Int. Row
G2600123	166	Forged	62-18	10-60X38-10	1261	"			F2700165	2	"	"	"	"	"	Int. Row
G2600122	148	"	57-21	113-35X44-6	"	"			G2601276	2	"	"	"	"	"	Int. Row
									G2601276	2	Forged	1-22	101-64X38-1	"	1261	Int. Row



TOTAL				
SHROUding STRIP				
DRAWING NO.	SECTION	APPROX. NO. OF MAT. REQ. OF MAT. REQ.	194.6 FOR 1 STAGE	WHEEL NO.
F-27001-6A	18" to 16"	2-26	STRESSING 301	13" Low rel.
"	5 C	2-13	"	Guide.
"	5 A	4-27	"	2" Low rel.
"	1	24-38	"	2-8"
"	2	32-31	"	2-15"
"	5 C	14-63	"	16-17"

1st & 2nd Vel. Shroud to be chamfered before fitting

DRAWING NO FOR GATE 4 ASSEMBLY OF CLOSING BLADES		
1 <sup>ST</sup> ROW	7527 A	E-2700035
2 <sup>ND</sup> ROW	7597 B	F-2700038
2 - B	3703 A	G-2620267
3 - B	3703 A	F-2700030
4 - B	3703 A	F-2700057
16417	7529 B	F-2700073
18	7531 R	F-2700053
PACKING FOR BLADE ASSEMBLY		
WHEEL NO	DRAWING NO	
18	D-2820117	
15	D-2820145	
16	D-2820142	
17	D-2820155	
18	D-2820143	
19	D-2820141	

RIVETS					
DRAWING NO.	NO OF RIVETS + 5% WASTE	APPROX MT OF MISC MATERIAL	DATE	RD SPEC. NO	WHEEL INCH
D-252002	4	3/1	6-31	4060-8 1/2 5.3 Model Steel	17 1/2
"	4	3/1	"	"	2nd Vel
D-2820147	15	6/1	9-50	10441-9 1/2 11 Model Steel	2 - 8
D-2820160	10	6/1	"	10441-9 1/2 11 Model Steel	9-13
D-2520010	10	5/2	9-50	10441-9 1/2 11 Model Steel	14-15
D-2820123	9	6/1	17-45	Ch. Wn. 2nd	16-17
D-2820200	7	5/2	"	"	"
D-2820254	4-1	6-2-10	"	5060-8 1/2 5.3 Model Steel	18 19

SILVER SOLDER		
PURPOSE	QUANTITY	WHEELS
Large wire	60 Kg. Std	18(inner) & 15
"	30 Kg. v. 100 Kg. Std 100 Kg. Std	18 & 19
Shrouding	60 Kg. Std.	16 & 17
Erosion Shield	4 - 4 Kg. Std.	18 & 19

STAGE N°	N° OF CASTING ORDERED	PATTERN N°	CASING DRG. N°	DETAIL ASSEMBLY DRG. N°	I/EM N°	GRINDING DRG. N°
18	172	1226401	D-282014	G-262123	1	D-282057
19	154	1226402	D-2700072	D-2700150	1	E-270057**

LACING WIRE				
DIA	BLADES PER SEGMENT	NO OF SEG HEAD	MATERIAL	WHEEL NO
4.75	18 PHOSPHOR 2 Coverings	16	Stainless steel	15
6.35	" " "	40	"	16 (inner outer)
8-1	20 " 7	30	"	16 (outer)
12.7	" "	42	"	16 (inner outer)

Note:-

1. Blades for wheels 16, 17, 18, 19 to have static moment balancing.
2. Shrouding for wheels 16 & 17 to be silver soldered to blades.
3. When arranging banding on wheels care is to be taken to ensure that the closing blade is approximately in the centre of band segment.

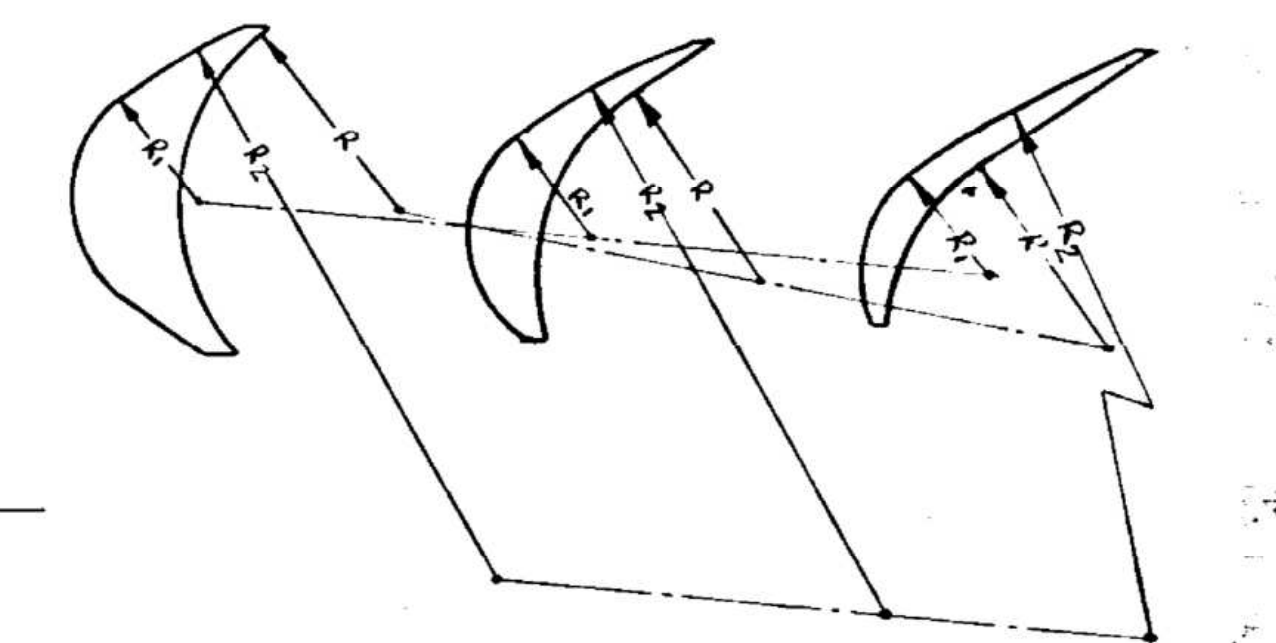
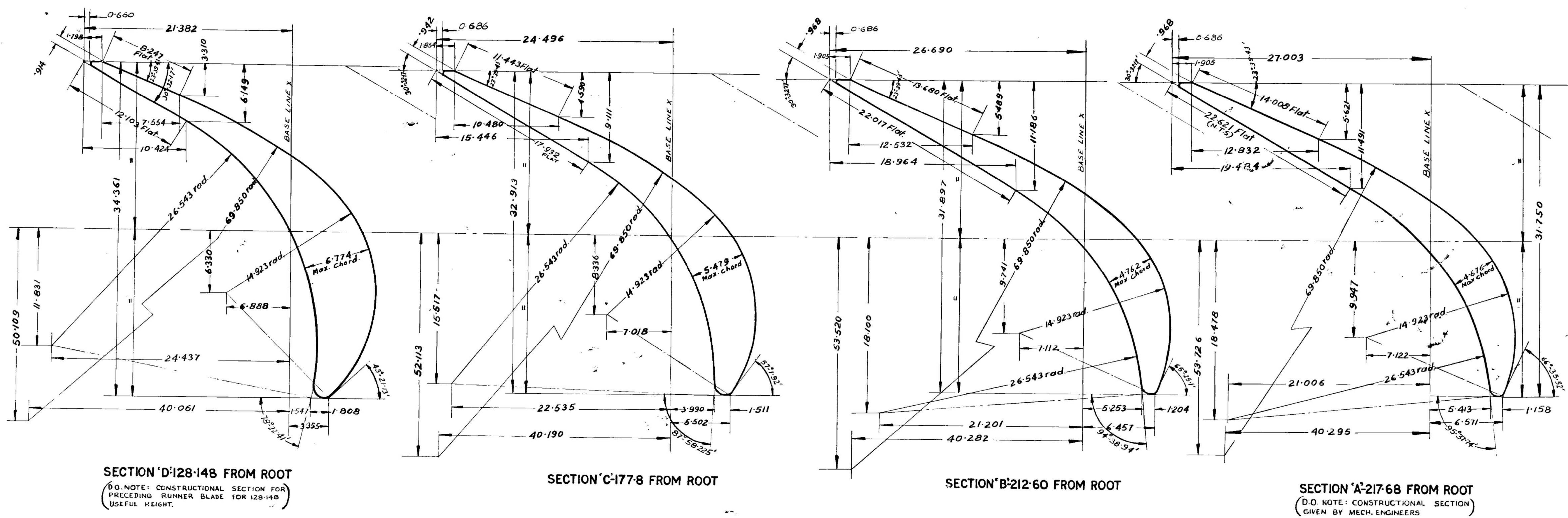
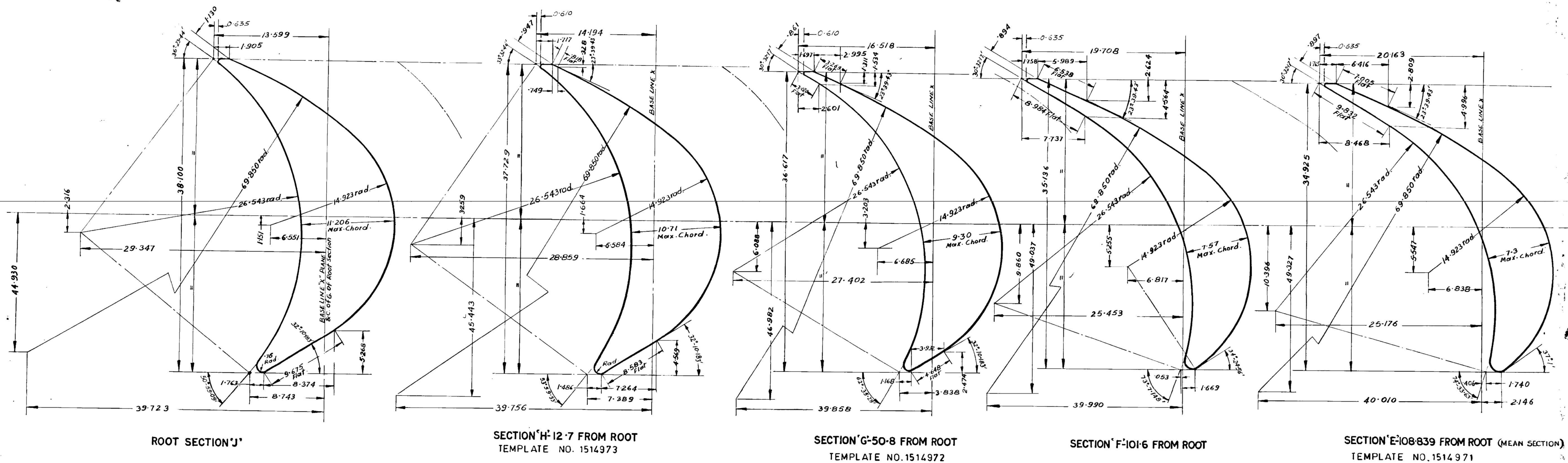
REV	DATE	CHKD BY	R.S. 27.02.23
01	27.02.23	APPROVED BY	D.C.N. 27.02.23
		DETAIL 'I' ADDED FOR VELOCITY BLADE STAGE 1 ROW 1	

Steam Turbine  
Private  
 E. E. Quinn  
 11-3-65.  
 23-3-65  
 A. Smith 8-9-65.  
 [Signature]  
 MF  
 office copy.  
 STM  
 PAX.  
 1  
 4

BLADING TABLE  
H-9 225 FRAME

1:1 1910002/1 - 26/2031





**METHOD OF DEVELOPEMENT TO DETERMINE INTERMEDIA SECTIONS OF BLADE BETWEEN 'A' & 'B' 'J'**

Inlet and outlet angles on back form & radii on both inside & outside forms are constant throughout the length of the blade, and the centres of the radii are on a straight line, as shown. Sections are normal to axis of development, but slide gauges may be applied to  $\phi$  of blade.

SECTION	DIA.	PITCH	THROAT	K
A	1794.26	29.055	11.623	.400
B	1784.00	28.890	11.580	.401
C	1714.50	27.162	11.331	.408
D	1615.19	26.154	11.008	.421
E	1576.58	25.530	10.897	.427
F	1562.10	25.296	10.856	.429
G	1460.50	23.650	10.592	.448
H	1384.30	22.416	10.384	.463
J	1358.90	22.004	10.211	.464

BASED ON — 194 BLADES PER WHEEL

A2059067/4 M.Y.

ALT. *Prank*  
CKD. PUF *8/10/55*  
APPD. *Wm*  
TEMPLATE NOS. ADDED. Edge loss dimensions FOR SECTION 'E, G' at outlet added. AND 'H'

STEAM TURBINE  
Revised by *Wm* 20.10.64  
27.10.64  
27.10.64  
30.10.64

**TURBINE BLADE**  
SECTION 752.9 R/MV  
RIGHT HAND STAGE 16

O.C. *MF*  
STM.  
PRX.





## PLANT PURCHASING SPECIFICATION BHOPAL

BP 10791

Rev. No. 04

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### 540 N/mm<sup>2</sup> 0.2 % Rp RUSTLESS STEEL BAR FOR TURBINE BLADING AND DETAILS (WITH STRESS RUPTURE CHARACTERISATION)

SUPERSEDES  
BP 10791 Rev. 03

#### 1. GENERAL:

This specification defines the requirements of 540 N/mm<sup>2</sup> 0.2% Rp, rust less steel rectangular or round bar.

#### 2. APPLICATION

For the manufacture of components, such as moving blades, moving blade pins, lacing rods, bolts and turbine details where the duty require stress rupture characterization.

#### 3. CONDITION OF DELIVERY:

Bar shall be descaled unless otherwise stated on the order and shall be straight and free from twists and harmful defects which might preclude its use for the intended application.

Material for bar where "d" is more than 25 mm (d= diameter or thickness) shall be subject to stress rupture characterization. (Refer Clause 13).

#### 4. COMPLIANCE WITH NATIONAL STANDARDS:

There is no Indian Standard covering this type of material.

#### 5. DIMENSIONS AND TOLERANCES :

Dimensions shall be as specified on the order. Unless otherwise stated on the order the cross – sectional dimension shall not vary from the specified dimension by more than the following:

Bar less than or equal to 25 mm diameter or thickness:	- 0
	+ 0.38 mm
Bar over 25 mm diameter or thickness:	- 0
	+ 1.5%

#### 6. MANUFACTURE:

##### 6.1. Melting Route:

The steel shall be manufactured by an electric furnace process or by an equivalent agreed to BHEL, Bhopal

Revision: -  
Reviewed & No Tech. Change

Issued by :   
STANDARDS AND MATERIALS GROUP  
TECHNICAL SERVICES DEPARTMENT

Date. No. 04

Date : 30.09.2019

Date of first issue: Sept. 1974



TSD 6206 A

## PLANT PURCHASING SPECIFICATION BHOPAL

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### 6.2. Technical Manufacturing Procedure (TMP):

The supplier shall work in compliance with an appropriate technical manufacturing procedure (TMP) which shall have been agreed in writing by BHEL, Bhopal prior to the commencement of manufacture.

As a minimum, the following information shall be included:

#### 6.2.1. Metallurgical Requirements :

- i) Steelmaking method and the name of the steelmaker if different from the supplier.
- ii) Ingot dimensions and weight.
- iii) Dimensions of intermediate wrought product (if applicable) and forming process.
- iv) Details of proposed heat treatment including :
  - Type of furnace (continuous or batch),
  - Heating rate,
  - Nominated holding temperature and time,
  - Cooling method,
  - Control of temperatures (surveyed furnace or contact thermocouples),
  - Location of contact thermocouples.
- v) Method of descaling.
- vi) Sequence of manufacturing operations, mechanical tests and non- destructive examination.
- vii) Standards to be used for hardness testing.

#### 6.2.2. Non-Destructive Examination Requirements :

Standards to be used for equipment and operator qualifications.

### 6.3. Rolling / forging Deformation :

Bar shall have been subject to the following deformation ratio (based on area relating to the original ingot dimensions):

more than 8:1 for moving blades, unless otherwise agreed. More than 3:1 for other applications.

- 6.4. The heat treatment shall be either conducted in a surveyed furnace or in a furnace monitored by the use of metal contact thermocouples. The temperature control equipment shall be checked at least every six months and the supplier shall retain records of these checks.





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## PLANT PURCHASING SPECIFICATION BHOPAL

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Where a surveyed furnace is used the supplier shall have demonstrated by means of a survey, a control of temperature equivalent to that achieved by the use of contact Thermocouples. Such a survey shall be performed whenever modifications to the furnace have taken place. The supplier shall retain records of surveys.

Where the temperature is measured by metal contact thermocouples these shall be Shielded and attached to, or in contact with, the bar.

### 7. HEAT TREATMENT :

#### 7.1. Hardening :

The material shall be heated to a nominated temperature within the range 990 deg.C. to 1010 deg.C and maintained at this temperature for at least 30 minutes after the whole of the material has attained this temperature. The material shall be cooled in oil or air, at the supplier's discretion, to ambient temperature.

#### 7.2. Tempering :

The material shall be tempered at a nominated temperature within the range 660 deg.C to 700 deg.C and maintained at this temperature for a minimum of 4 hours, unless otherwise agreed, after the whole of the material has attained this temperature. The material shall be cooled in air, unless otherwise agreed.

#### 7.3. Stress Relieving :

If the material is straightened after hardening and tempering, it shall subsequently be stress relieved at a nominated temperature within the range 600deg.C. The material shall be maintained at this temperature for a minimum of 2 hours followed by cooling in air.

### 8. CHEMICAL COMPOSITION :

The chemical composition of the steel, based on cast analysis, shall comply with the following requirements

Element	% Minimum	% Maximum
Carbon	0.09	0.13
Silicon	0.15	0.50
Manganese	0.30	0.70
Sulphur	-	0.015
Phosphorus	-	0.025
Nickel	-	0.60
Chromium	11.50	13.00
Molybdenum	0.40	0.80
vanadium	-	0.10

The composition shall be selected such that the delta ferrite content of the heat treated product does not exceed 15%.



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Rev. No. 04

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### 9. SELECTION OF TEST ASPMPLES :

#### 9.1. General :

Mechanical tests shall be carried out after completion of all heat treatment.

The tests shall be carried out on bar selected from each batch.

#### 9.2. Batch Criteria :

A batch is defined as consisting of bar of the same or similar dimensions, manufactured from the same cast and heat treated together. Bar is considered to have similar dimensions when a following criterion is satisfied.

$\frac{d_{\max}}{d_{\min}}$  less than or equal to 1.2 for  $d_{\max}$  less than or equal to 150 mm

$\frac{d_{\max}}{d_{\min}}$  less than or equal to 1.1 for  $d_{\max}$  more than 150 mm

where d = diameter or thickness.

For bar where 'd' less than or equal to 25 mm, the batch size shall be limited to 2000 kg maximum weight. For bar where 'd' is more than 25 mm, the batch size shall be limited to 5000 kg maximum weight.

#### 9.3. Hardness Tests :

The brinell test method shall conform to the requirements of BS, NF or EN standards or to the requirements of the Supplier's National standard, with a ratio of  $F/D^2$  of 30 (where F is in kg). for bar where 'd' is less than or equal to 25mm, Brinell hardness tests shall be carried out on 20% of the bar in the batch. For bar where 'd' is more than 25mm, Brinell hardness tests shall be carried out on each bar in the batch.

Bar heat treated in a batch furnace shall each be hardness tested at one end and the mid-length. Bar heat treated in a continuous furnace shall each be tested at both ends. The position of the Brinell impression shall be more 100 mm from the bar end.

Other methods of hardness evaluation may be acceptable to BHEL, Bhopal. In such cases the supplier shall demonstrate the equivalence the equivalence of the alternative method.

#### 9.4. Selection of Test Material :

For each batch batch of bar two sets of mechanical tests shall be taken. One set of mechanical tests shall be taken from the bar end with the highest hardness and one set from the bar end with lowest hardness.

A set of mechanical tests comprises :

- One tensile test,
- One Charpy V-Notch impact test\* (which comprises 3 test piese).

- Note : This test is not applicable for rectangular second bar less than or equal to 12 mm to 12mm thickness and round bar less than or equal to 16 mm diameter.





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### 9.5. Location of Test Pieces :

Test pieces shall be prepared with their longitudinal axis parallel to the longitudinal axis Of the test bar.

The location of the test pieces in the test bar shall be in accordance with BSEN 10083 part I, except for bar where 'd' is more than 100 mm where the distance of the test pieces from the bar surface shall be increased from 12.5 mm to 25 mm.

### 9.6. Tensile Tests :

The test pieces & procedure shall be in accordance with BS EN 10002: Part 1.

A Brinell hardness test shall be carried out on each of the tensile test pieces. Any difference in excess of 20 points Brinell between the hardness value on a test piece and that on the bar from which it was taken shall be subject to enquiry and corrective action.

### 9.7. Charpy V-notch Impact Tests :

Standard Charpy V-notch test Pieces (10mm x 10mm) Shall be used and the form, dimensions and procedure shall be in accordance with the requirements of BS EN 10045: Part.1.

### 9.8. Mechanical Re-Tests :

In the event that tensile or impact properties do not meet the requirements of the material specification retests may be performed.

In this case, for whichever test has failed to meet the requirements, two retests be carried out and must comply with all specification requirements.

## 10. MECHANICAL PROPERTIES :

The room temperature mechanical properties of the material shall comply with the following requirements :

Tensile Strength	:	695-850 N/mm <sup>2</sup>
0.2% Proof Strength,	:	540 N/mm <sup>2</sup> Minimum
Elongation on 5.65 √ So , Gauge Length	:	18% Minimum.
Reduction of area,	:	50% Minimum
Hardness (Brinell)	:	207-255 HB
<u>Charpy Impact (V-Notch)</u>	:	
- Mean of three test Pieces	:	50 Joules Minimum
- On Single test piece	:	35 Joules Minimum



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- Note : This test is not applicable for Rectangular Section bar less than or equal to 12mm thickness & round bar less than or equal to 16mm diameter.

### 11. STRUCTURAL EXAMINATION :

Rectangular section high alloy martensitic steel be subject to microstructural examination for delta ferrite. The test shall be carried out on each batch, on section taken longitudinally from each tensile test piece. Unless otherwise agree by BHEL Bhopal, assessment of delta ferrite shall be by the mean linear intercept technique carried out transverse to the rolling direction, at a magnification of 100x.

### 12. NON-DESTRUCTIVE EXAMINATION :

#### 12.1. Personnel :

Non-destructive examination shall be performed by personnel qualified in compliance with one of the following systems :

- EN 473,
- SNT – TC -1A.

Equivalent systems may be accepted by BHEL, Bhopal, Steam Turbine Engg. Deptt.

Only qualified personnel shall write detailed internal procedures used by the supplier to satisfy the requirement of this specification.

BHEL, Bhopal reserves the right to reject any operator considered not to be competent for performing the required NDE

#### 12.2. Equipment :

The Supplier shall ensure that all equipment used shall be capable of meeting the requirements of this specification.

The calibration, characteristics and use of equipment's shall conform to the requirements of the EN, BS or NF standards or to the requirements of the supplier's National Standards:

#### 12.3. Procedures & Acceptance Standards :

##### 12.3.1. Ultrasonic Examination :

Ultrasonic examination of all material shall be carried out. The examination shall be of either the intermediate wrought product or of the finished bar product.

Surface finish shall be sufficient to permit the required ultrasonic examination.

##### Probes :

Probes shall have a nominal frequency of 4-5 MHz and shall have a diameter within the range 10 to 26 mm.



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### Sensitivity :

The sensitivity of the test shall be determined using a reference block to establish a Distance Amplitude Curve (DAC) or by an alternative method agreed by BHEL Bhopal.

The reference block shall be of acoustically similar material to the product being tested and shall contain at least two flat bottom holes (FBH). Holes shall be drilled to depths such that the constructed DAC is effective over the central 50% of the section thickness of the product under test.

The amplitude of the DAC at the testing distance equal to 25% of section thickness shall be set at 80% of full screen height. The sensitivity shall be adjusted such that this reference DAC represents a 2.0 mm FBH equivalent response. This shall be the scanning sensitivity.

A suitable non-corrosive couplant, such as grease, light oil or a proprietary couplant, shall be used. The same couplant shall be used for scanning.

### Scanning :

Scanning shall be carried out over the whole length of the product.

Coverage shall be from two adjacent sides at 90° using a normal compression wave probe.

Test surfaces shall be scanned 100%. Scanning overlap shall be at least 25% of the probe diameter & the scanning speed shall not exceed 150 mm/Sec.

The interference height (grass) at the scanning sensitivity shall not be greater than the 2.0 mm FBH equivalent reference DAC minus 10dB.

### Evaluation :

All indications exceeding the evaluation level, that is, the reference DAC minus 4 dB (1.6mm FBH equivalent) shall be evaluated.

When an indication is detected its length shall be measured by using the 6dB drop method.





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### Acceptance Standard :

Stage of testing	Deformation ratio after ultrasonic examination	Unacceptable indications evaluated	
Intermediate Wrought	More than or equal to 4:1	Indications Insulating from cracks	Indications more than 3.0 FBH* and Linear Indications more than 30mm
Intermediate Wrought Product	Less than 4:1		Indications more than 2.0 mm FRH*
Finished Bar	-		

- Note: FBH = Flat bottom hole equivalent response.

### 12.3.2. Magnetic Particle Examination:

The surface of each length of each bar shall be examined for longitudinal indications. The examination shall be carried out after completion of all heat treatment.

The surface of the bar shall be de-scaled and the surface finish shall be sufficient to permit the required examination.

#### Technique :

The examination technique shall conform to the requirements of the EN, BS or NF standards or to the requirements of the Supplier's National Standards.

The current flow technique shall be used. Dry powders shall not be used.

The sustained method shall be used in which the magnetic ink is applied simultaneously with magnetization and the magnetizing current is maintained for a short time after the application of the ink.

#### Magnetic Field strength :

A minimum magnetic field strength of 2,400 amperes / meter shall be attained at all positions on the surface of the bar. This shall be verified by the use of a magnetic fields strength meter, or by the use of a magnetic field strength indicator such as:

- A berthold penetrometer set at position 2,
- Those specified by NF A 09-590 or by ASME.



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The field strength shall be increased from a low level until the specified field strength is attained. The magnetic field strength shall be verified by positioning the field strength meter or the field strength indicator midway between the points of contact for magnetization.

### Acceptance Standard :

Indications less than 25 mm in length shall not be considered.

All crack-like indications (e.g. from cracks, seams or laps are unacceptable if greater than 2 mm in depth).

### 13. DOCUMENTATION :

A report of the Non-Destructive Examination as detailed below of each batch shall be produced. The report shall contain the following information:

#### 13.1. BHEL References :

Order No.  
BP 10791 – Rev.04

#### 13.2 Supplier's References:

##### 13.2.1 Ultrasonic Examination :

Stage of manufacture at which examination was made.

Ultrasonic flaw detector type and serial number including size and frequency of probes used.

Name and qualifications of the operator.

Number, size and batch serial letters of tested product.

Result of the examination

##### 13.2.2 Magnetic Particle Examination:

Name and qualifications of the operator.

Number, size and batch serial letters of the tested bars.

Result of the examination.

### 14. STRESS RUPTURE CHARACTERISATION :

Material for bar where d more than 25 mm (d=diameter or thickness) shall be subject to stress rupture characterization.

The supplier shall provide, for BHEL, Bhopal assessment, data demonstrating that the material to be supplied has acceptable stress rupture characteristics. The data may represent the same or similar material manufactured by the supplier. If, in the opinion of BHEL, Bhopal the data provided provided are acceptable are acceptable no further tests will be required. In the case, where no data are available, testing of the three casts, at three test temperatures for durations up to 8000 hours will be required, and such tests shall be agreed by BHEL, Bhopal.



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### 15. TEST CERTIFICATE :

Three copies of a test certificate shall be supplied unless otherwise specified on the order.

In addition, the supplier shall ensure to enclose one copy of the test certificate along with their dispatch documents to facilitate quick clearance of the material.

The test certificate shall bear the following information :

#### BHEL (Bhopal) References:

BP 1079, Rev. 04

Order No.

Serial Letters

#### Supplier's References:

Name of supplier

Technical Manufacturing Procedure Reference No. (TMP)

Batch Identification No.

Cast No., Including Steelmaker's Name, if different from the supplier.

#### Manufacturing Details:

Size and number of bars.

Statement of compliance with rolling/forging deformation requirements.

Statements of temperature, time at temperature, and cooling medium for each stage of heat treatment.

#### Result of Tests :

Result of the chemical analysis. All mechanical tests including the Brinell range obtained on the batch and the ferrite estimation as specified in this specification. (Clause 8 & 11). And NDT as per this specification (Cl.13).

All documentation shall be endorsed by a responsible person on behalf of the supplier.

### 16. PACKING AND MARKING:

Each bar, other than round bars up to and including 25 mm thickness, shall be stamped on one end with the number "BP 10791" and with "serial letters" identifying the heat treatment batch and cast. These serial letters will be issued by BHEL.





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Round bar, upto and including 25 mm diameter, from the same cast/heat treatment batch shall be bundled together and identified by metal tags attached at each end of bundle. In order that the delivered material can be related to its test certificate, the tags shall be stamped with the number "BP 10791" and with "serial letters" identifying the heat treatment batch and cast. The bars shall be adequately packed to prevent damage during transits. Each package shall bear the following information :

BP 10791 : 540 N/mm<sup>2</sup> 0.2% Rp Rustles Steel Bar for Turbine Blading and Details (With Stress Rupture Characterisation)

Our order No.

Supplier's Name.

Size / weight.

Heat Treatment Batch No.