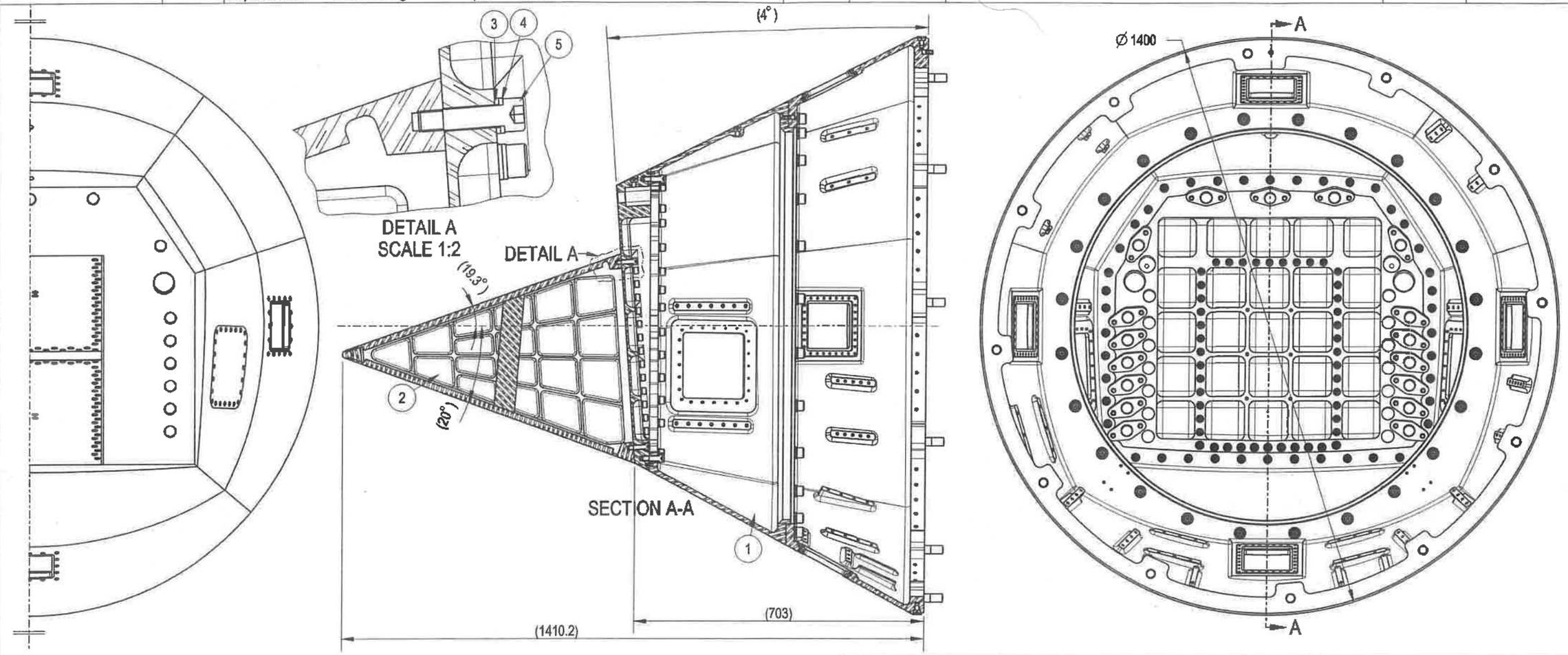
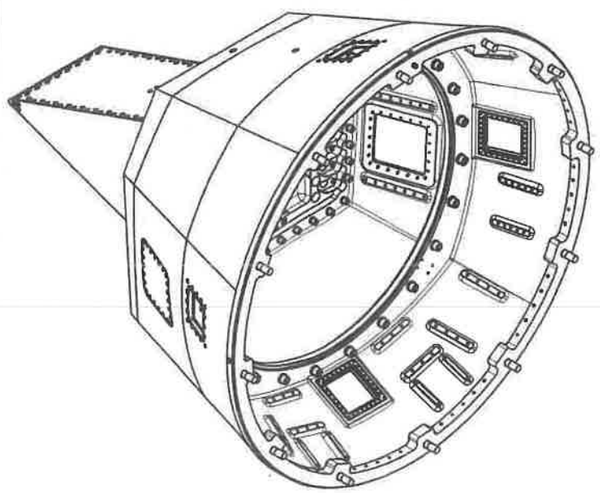
Part No.	---NA---
Drg. No.	636 23 03 03 00 00

Unless otherwise specified -: Break all sharp edges by 0.5x45°. All internal radii to be R0.2 Max
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE





Sl.No	Nomenclature	Drg No / Spec	Rev No	Qty	Material
5	Hex. Soc. Head Cap Screw	ISO 4762 M10 x 40 - 10.9		46	Steel
4	Spring Lock Washer	A10 - IS 3063 Phosphate Coated		46	Steel
3	Washer	ISO 7092 - 10 - 200 HV		46	Steel
2	Ramp Assembly - HS03	636 23 03 03 02 00	0	1	---
1	Adapter Assembly - HS03	636 23 03 03 01 00	0	1	---

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Drawn to Spec. IS:10714-Part 1 (R 2006), IS : 10714 (Part 20) : 2001, IS : 10714 (Part 21) : 2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specifiec

Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-Apr-21
564.065 kg	---	---	Scale 1:10	Surface Texture ---		

Comp / Assy Name	Ramp-Adapter Assembly - HS03			Part No.	---NA---		
Assy Drg. No.	---	Drg. No.	636 23 03 03 00 00	Rev. No.	0	Sht. 1	of 1

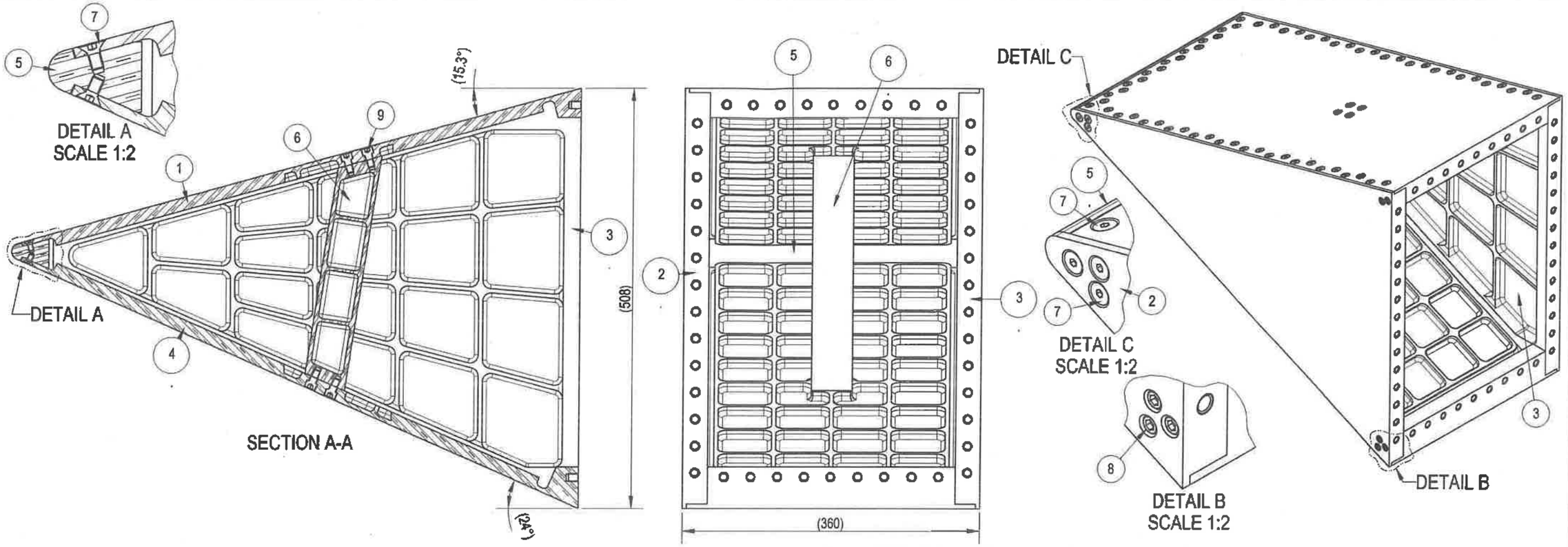
QA Doc No.:

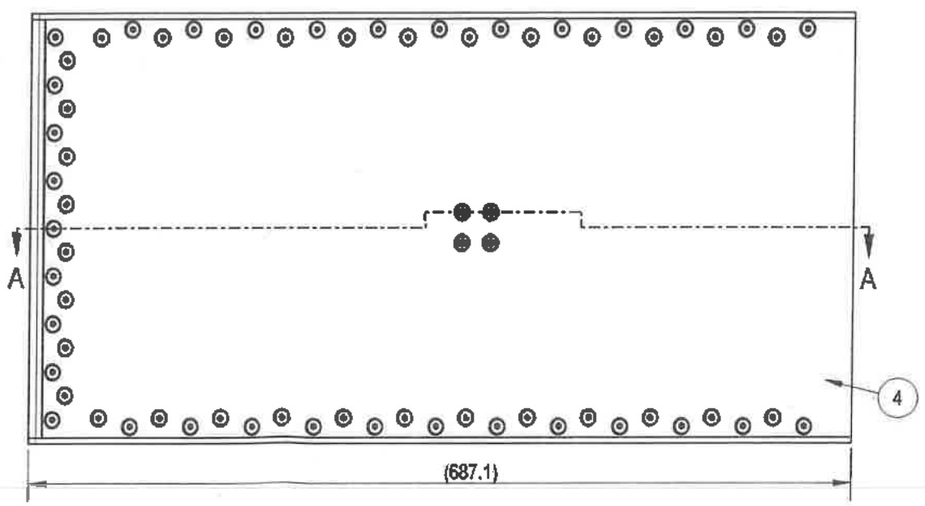
APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Arun Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

Part No.	---NA---
Drg. No.	636 23 03 03 02 00

Unless otherwise specified -: Break all sharp edges by 0.5x45°. All internal radii to be R0.2 Max
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE





Sl.No	Nomenclature	Drg No / Spec	Rev No	Qty	Material
9	Hex. Soc. Head Cap Screw	ISO 4762 M8 x 15 - 10.9	---	8	Steel
8	Hex. Soc. Head Cap Screw	ISO 4762 M6 x 30 - 10.9	---	10	Steel
7	Hex. Soc. CSK Head Screw	ISO 10642 M6 x 12 - 10.9	---	134	Steel
6	Ramp Stiffener - HS03	636 23 03 03 02 06	0	1	Steel 15CDV6 as per AIR 9160C
5	Ramp LE - HS03	636 23 03 03 02 05	0	1	Steel 15CDV6 as per AIR 9160C
4	Ramp BP - HS03	636 23 03 03 02 04	0	1	Steel 15CDV6 as per AIR 9160C
3	Ramp SPR - HS03	636 23 03 03 02 03	0	1	Steel 15CDV6 as per AIR 9160C
2	Ramp SPL - HS03	636 23 03 03 02 02	0	1	Steel 15CDV6 as per AIR 9160C
1	Ramp TP - HS03	636 23 03 03 02 01	0	1	Steel 15CDV6 as per AIR 9160C

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Drawn to Spec. IS:10714-Part 1 (R 2006), IS : 10714 (Part 20) : 2001, IS : 10714 (Part 21) : 2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specified

Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-Apr-21
65.160 kg	---	---	Scale 1:5	Surface Texture ---		

Comp / Assy Name	Ramp Assembly - HS03			Part No.	---NA---		
Assy Drg. No.	636 23 03 03 00 00	Drg. No.	636 23 03 03 02 00	Rev. No.	0	Sht. 1	of 1

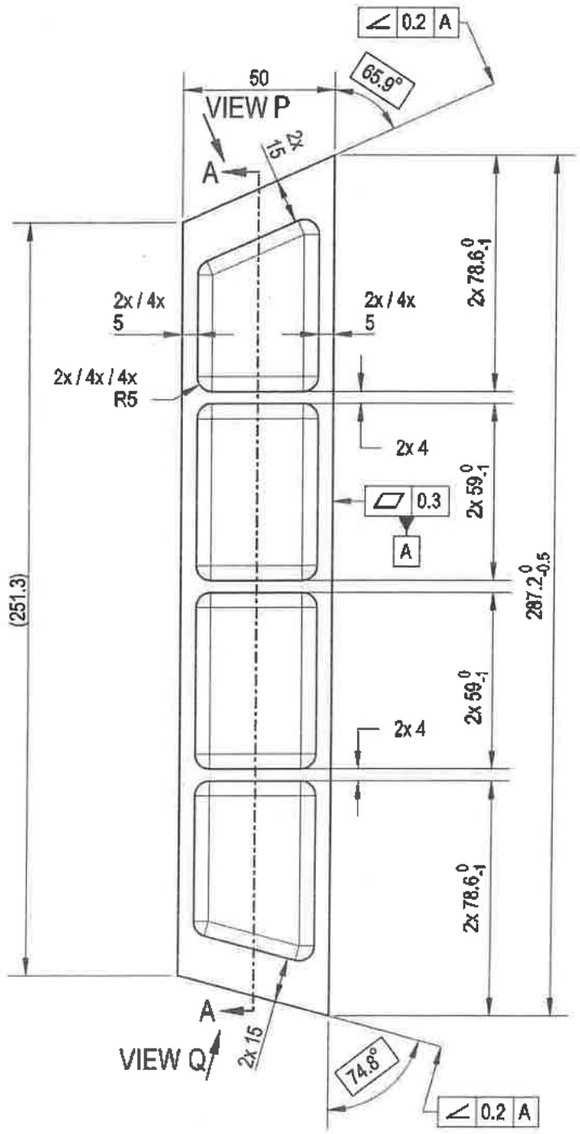
QA Doc No.:

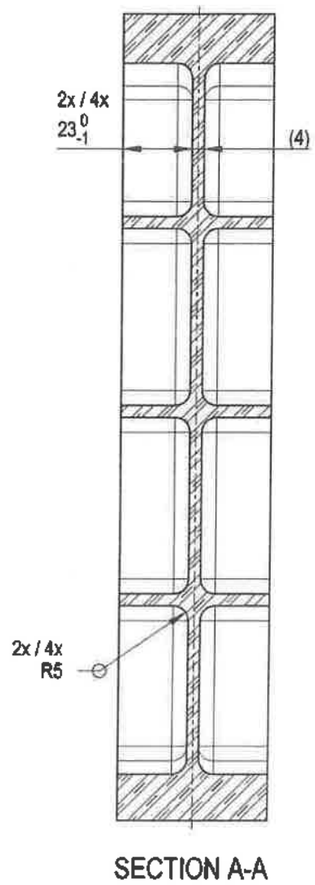
APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Arun Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

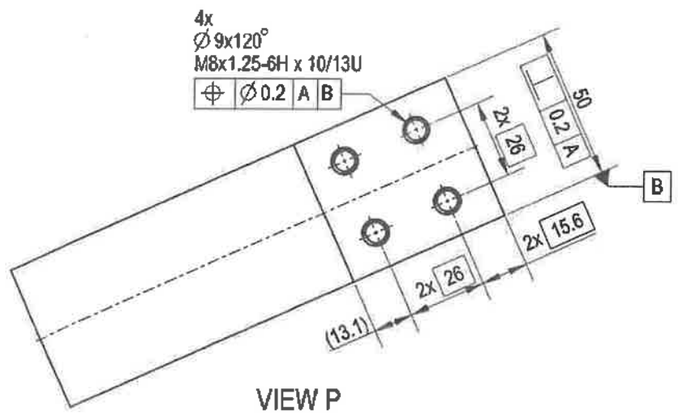
Part No.	---NA---
Drg. No.	636 23 03 03 02 06

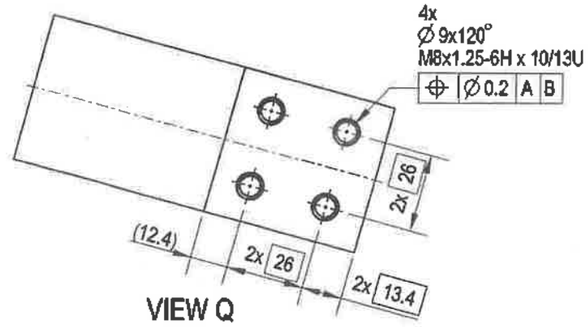
Unless otherwise specified -: Break all sharp edges by 0.5x45°. All internal radii to be R0.2 Max
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

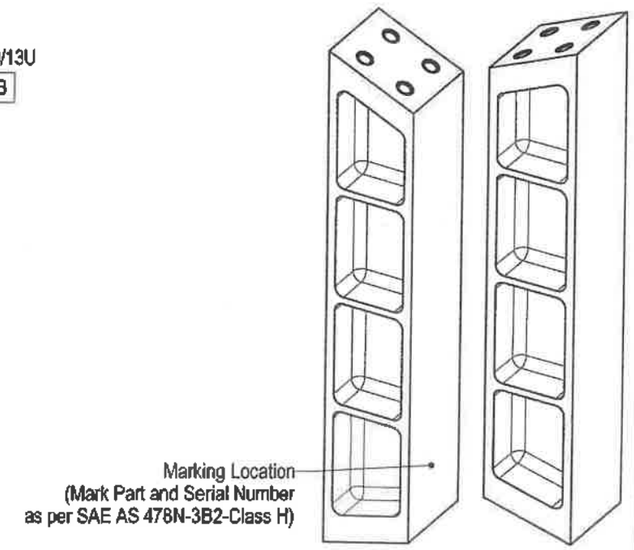
Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE











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Drawn to Spec. IS:10714-Part 1 (R 2006), IS : 10714 (Part 20) : 2001, IS : 10714 (Part 21) : 2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specified

Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-Apr-21
2.093 kg	Steel 15CDV6 as per AIR 9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:2	Surface Texture 1.6		

Comp / Assy Name	Ramp Stiffener - HS03			Part No.	---NA---		
Assy Drg. No.	636 23 03 03 02 00	Drg. No.	636 23 03 03 02 06	Rev. No.	0	Sht. 1	of 1

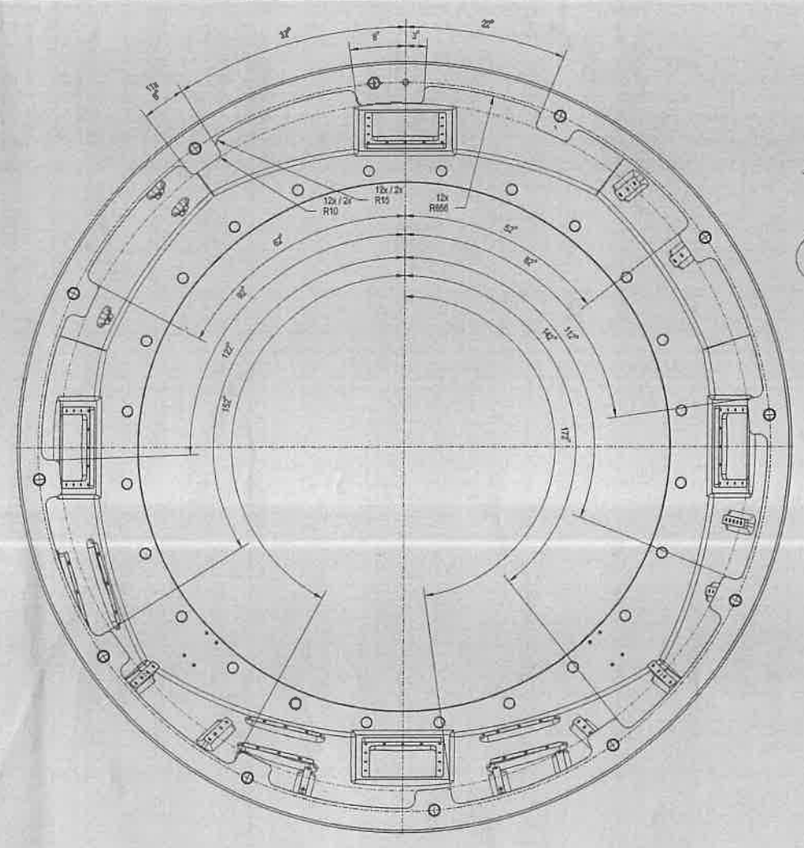
QA Doc No.:

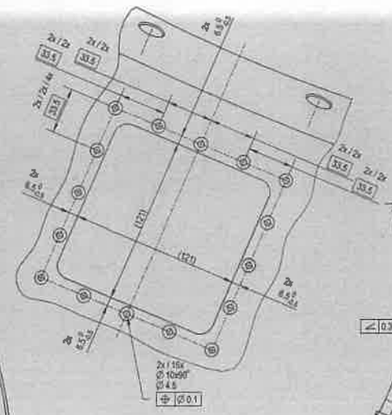
APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Arun Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

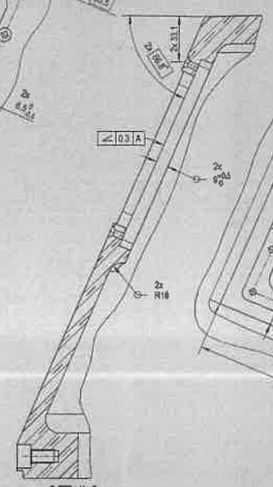
Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE

Unless otherwise specified :- Break all sharp edges by 0.2x45°
All internal radii to be R0.2 Max
Do not change Production Sequence without written permission

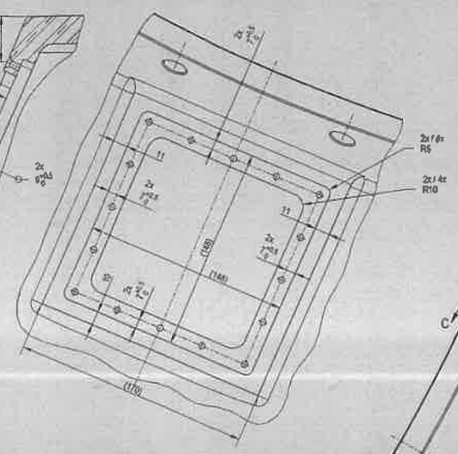
Drg. No. 636 23 03 03 01 03
Part No. NA

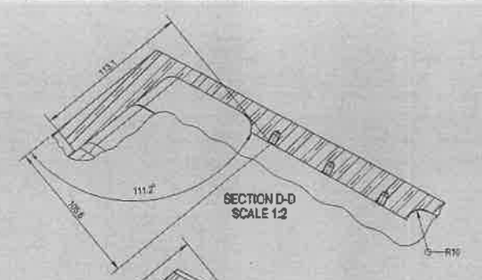




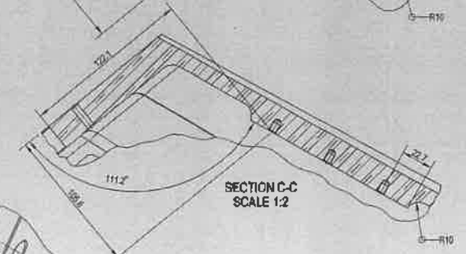


DETAIL B
SCALE 1:2





SECTION D-D
SCALE 1:2



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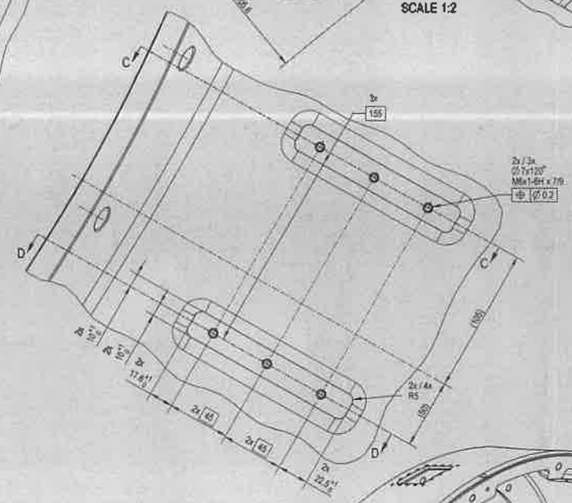
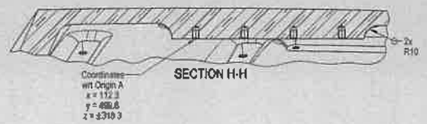
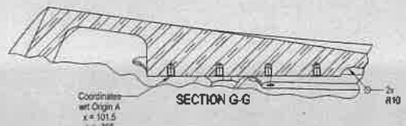
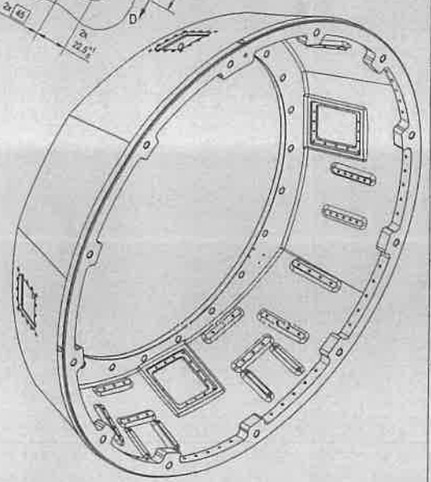


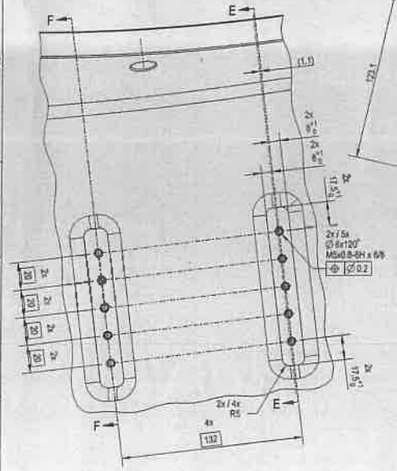


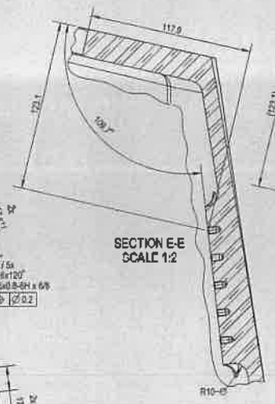
SECTION H-H



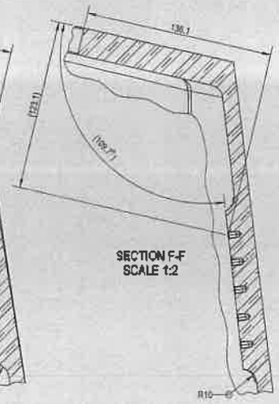
SECTION G-G



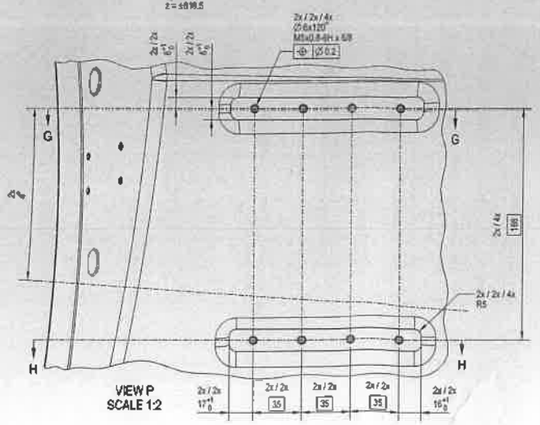




SECTION E-E
SCALE 1:2



SECTION F-F
SCALE 1:2



VIEW P
SCALE 1:2

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Drawn to Spec. IS 10714 (Part 1):2006, IS 10714 (Part 20):2001, IS 10714 (Part 21):2001 & DRDL Note Sheet 1 & 2

Deviation for UnToleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993				All Dimensions are in mm unless otherwise specified			
Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-Apr-21	
208.533 kg	Steel 15CDV6 as per AIR9180C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:5	Surface Texture 1.6			
Comp / Assy Name	Adapter Ring 2 - HS03			Part No.	NA		
Assy Drg. No.	636 23 03 03 01 00	Drg. No.	636 23 03 03 01 03	Rev. No.	0	Sht. 2	of 4

QA Doc No.:

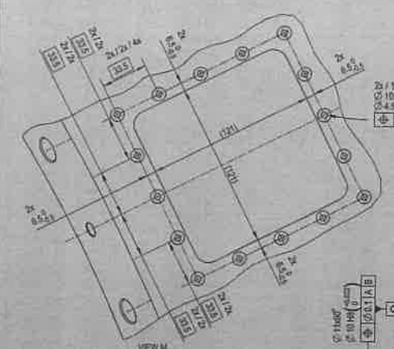
APPROVED (DESIGN)	APPROVED (DRAWING)	APPROVED (R&QA)	APPROVED (PROJECT)
R. Gnanamuthu Sc F	G Yoganand Sc F	(NA Anja Sc F)	(DK Tripathi Sc E)

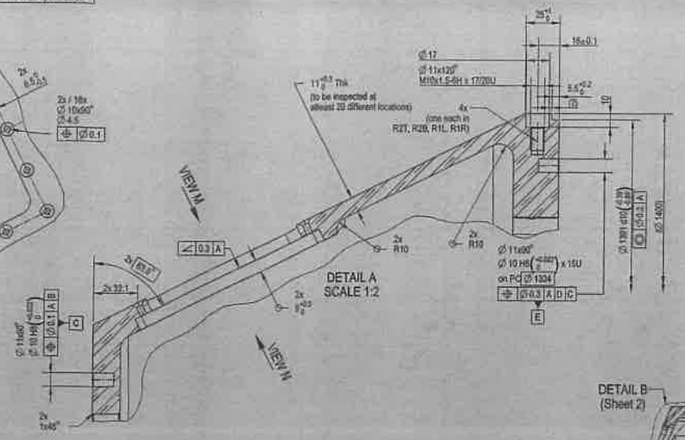
A1

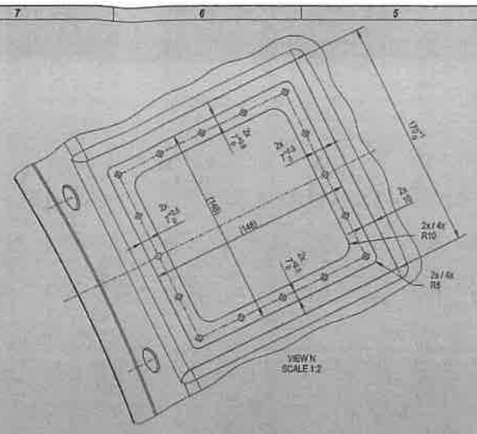
Dwg. No.	636 23 03 03 01 03
Part No.	NA

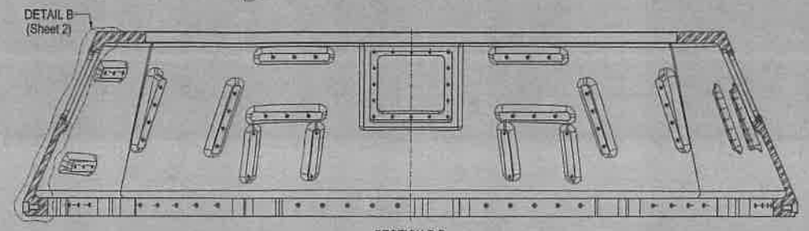
Unless otherwise specified : Break all sharp edges by 0.2x45°
All internal radii to be R0.2 Max
Do not change Production Sequence without written permission

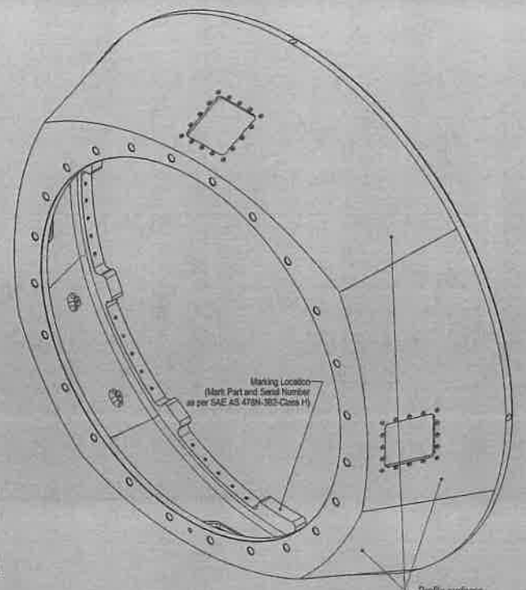
Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE

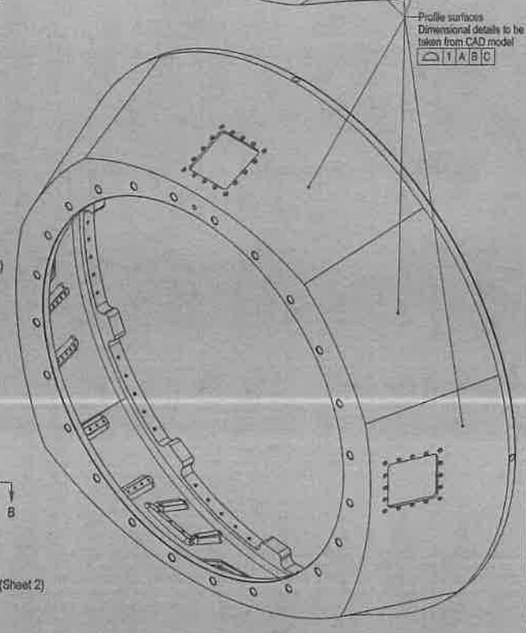


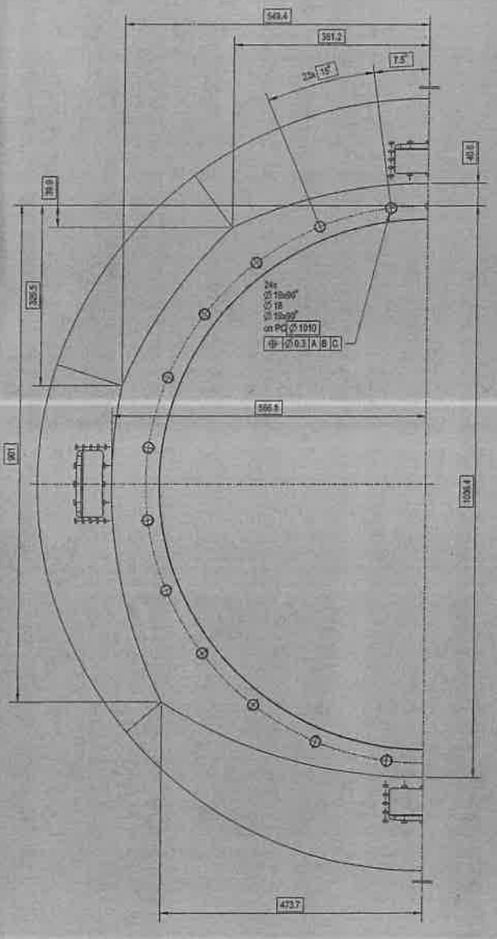


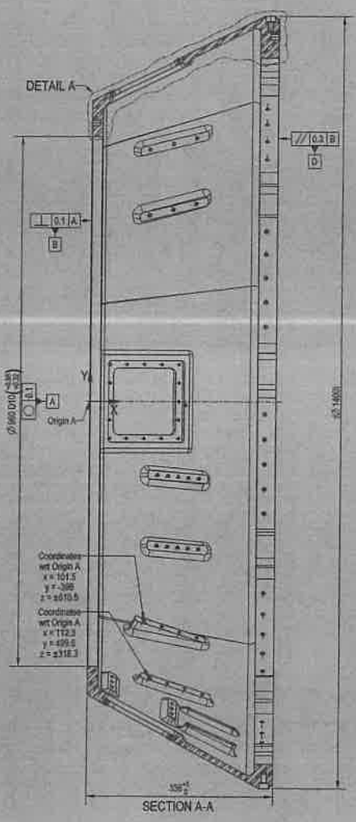


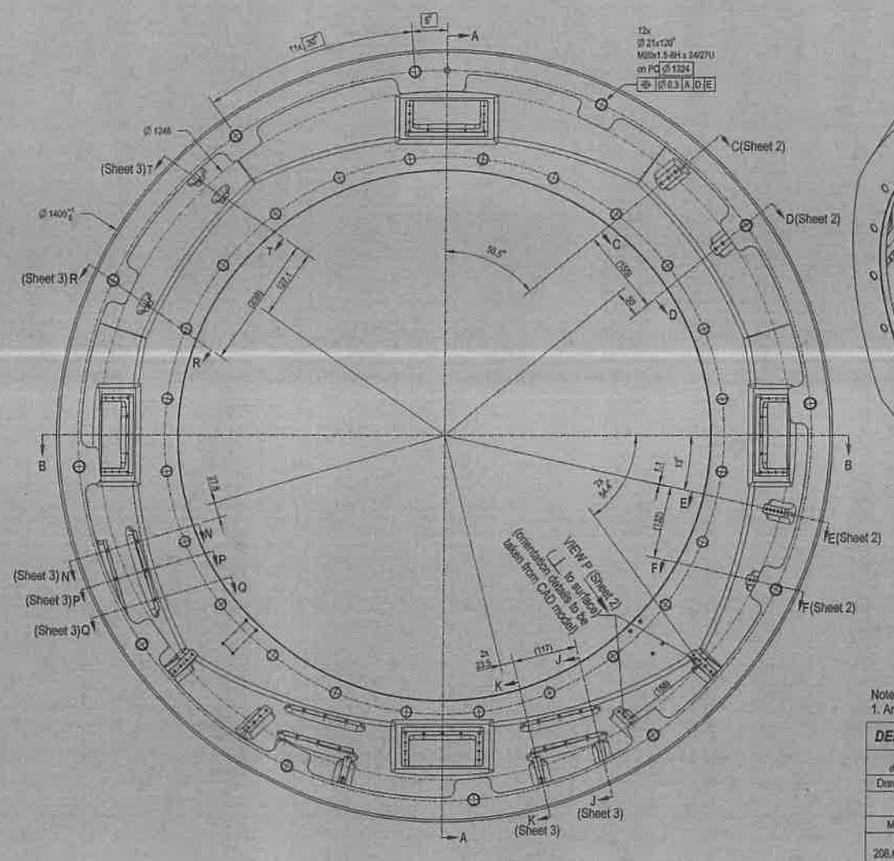












Note:
1. Any other missing details and dimensions to be taken from CAD model.

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Drawn to Spec. IS 10714 (Part 1):2006, IS 10714 (Part 20):2001, IS 10714 (Part 21):2001 & DRDL Note Sheet 1 & 2

Deviation for Untolerenced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993 — All Dimensions are in mm unless otherwise specified

Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-Apr-21
208.633 kg	Steel 15CDV6 as per AIR9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:5	Surface Texture 1.6		
Comp / Assy Name	Adapter Ring 2 - HS03		Part No.	NA		
Assy Drg. No.	636 23 03 03 01 00	Drg. No. 636 23 03 03 01 03	Rev. No. 0	Sht. 1 of 3		

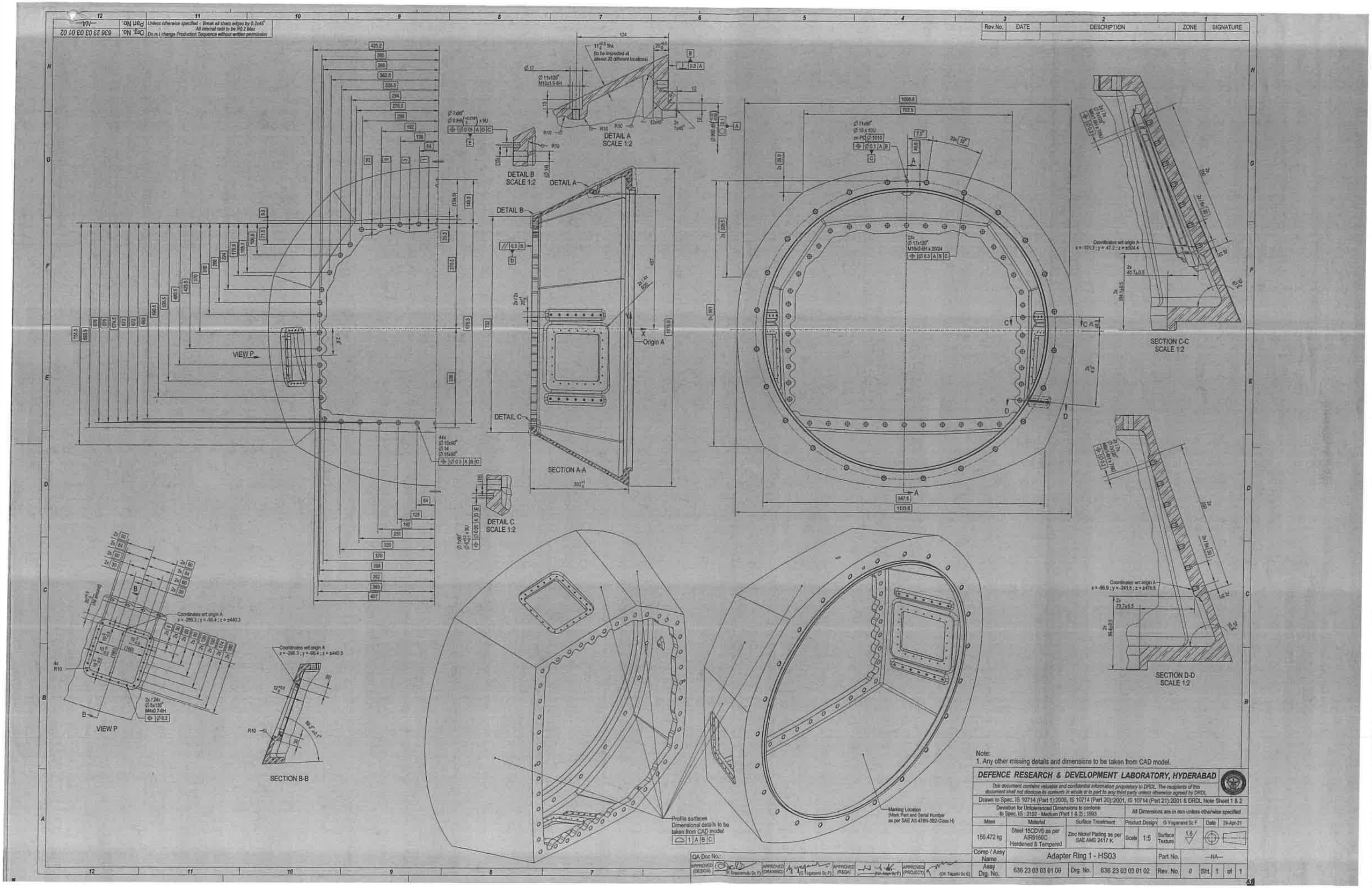
QA Doc No.:

APPROVED (DESIGN)	N. Sreenivasulu Sc F	APPROVED (DRAWING)	G Yoganand Sc F	APPROVED (R&D)	RVA Arun Sc G	APPROVED (PROJECT)	OK Tripathi Sc E

Part No.	—NA—
Dwg. No.	636 23 03 01 02

Unless otherwise specified :- Break all sharp edges by 0.2x45°
All internal radii to be R0.2 Max
Do not change Production Sequence without written permission

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE



Note:
1. Any other missing details and dimensions to be taken from CAD model.

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Drawn to Spec. IS 10714 (Part 1):2006, IS 10714 (Part 20):2001, IS 10714 (Part 21):2001 & DRDL Note Sheet 1 & 2

Deviation for Unplearanced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993 — All Dimensions are in mm unless otherwise specified

Mass	Material	Surface Treatment	Product Design	G Yogananda Sc F	Date	24-Apr-21
156.472 kg	Steel 15CDV6 as per AIR9166C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:5	Surface Texture 1.6		

Comp / Assy Name	Adapter Ring 1 - HS03			Part No.	—NA—		
Assy Drg. No.	636 23 03 03 01 00	Drg. No.	636 23 03 03 01 02	Rev. No.	0	Sht. 1 of 1	

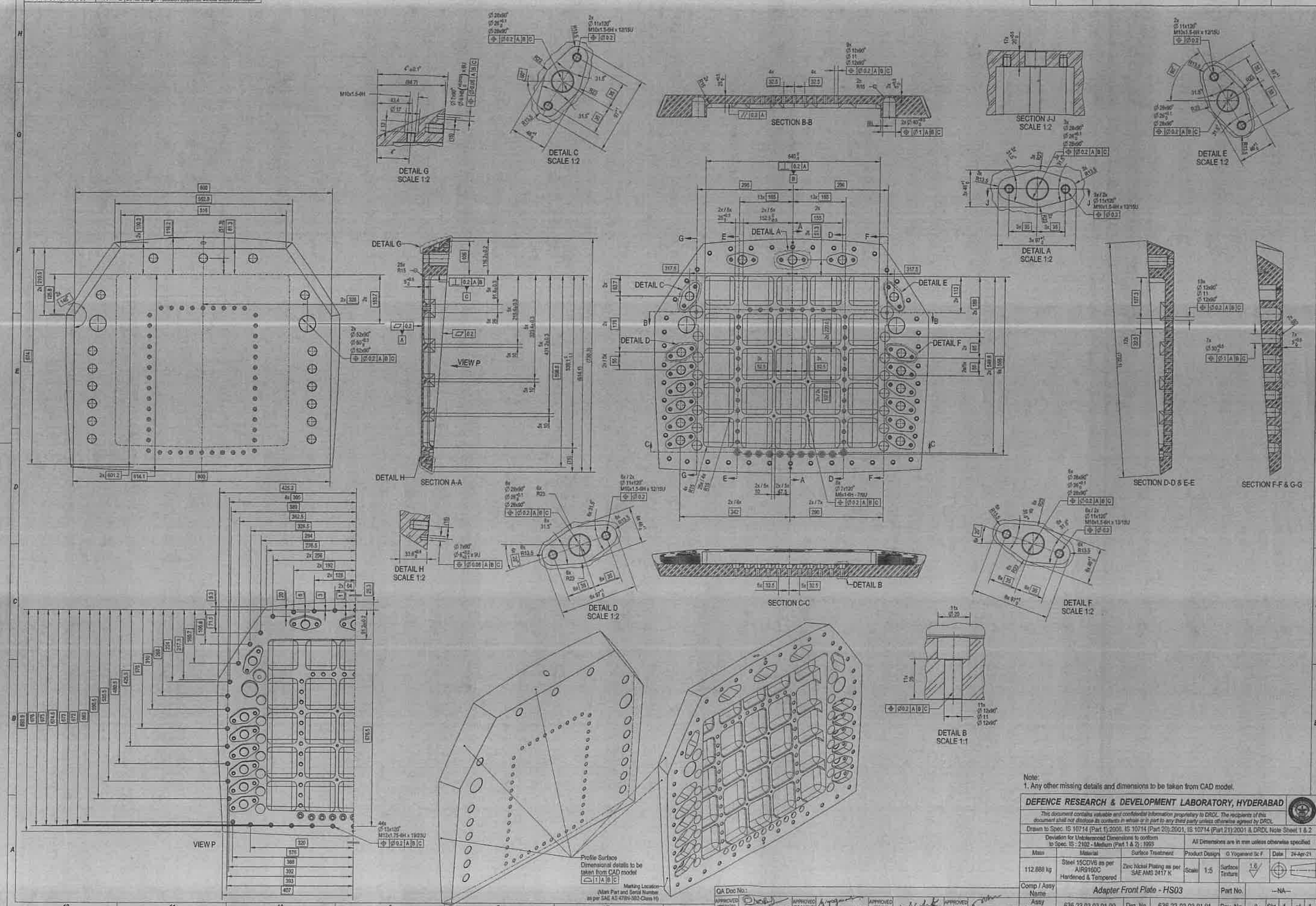
QA Doc No.:

APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yogananda Sc F)	APPROVED (R&DA)	(NA Alam Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

Part No.	---NA---
Dwg. No.	636 23 03 03 01 01

Unless otherwise specified - Break all sharp edges by 0.2x45°
All internal radii to be R0.2 Max
Do not change Production Sequence without written permission

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE



Note:
1. Any other missing details and dimensions to be taken from CAD model.

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Drawn to Spec. IS 10714 (Part 1):2009, IS 10714 (Part 20):2001, IS 10714 (Part 21):2001 & DRDL Note Sheet 1 & 2

Deviation for Unolerenced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993 — All Dimensions are in mm unless otherwise specified

Mass	Material	Surface Treatment	Product Design	G Yogenand Sc F	Date	24-Apr-21
112.888 kg	Steel 15CDV6 as per AIR9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:5	Surface Texture 1.6		

Comp / Assy Name	Adapter Front Plate - HS03		Part No.	--NA--			
Assy Drg. No.	636 23 03 03 01 00	Drg. No. 636 23 03 03 01 01	Rev. No.	0	Sht. 1	of 1	

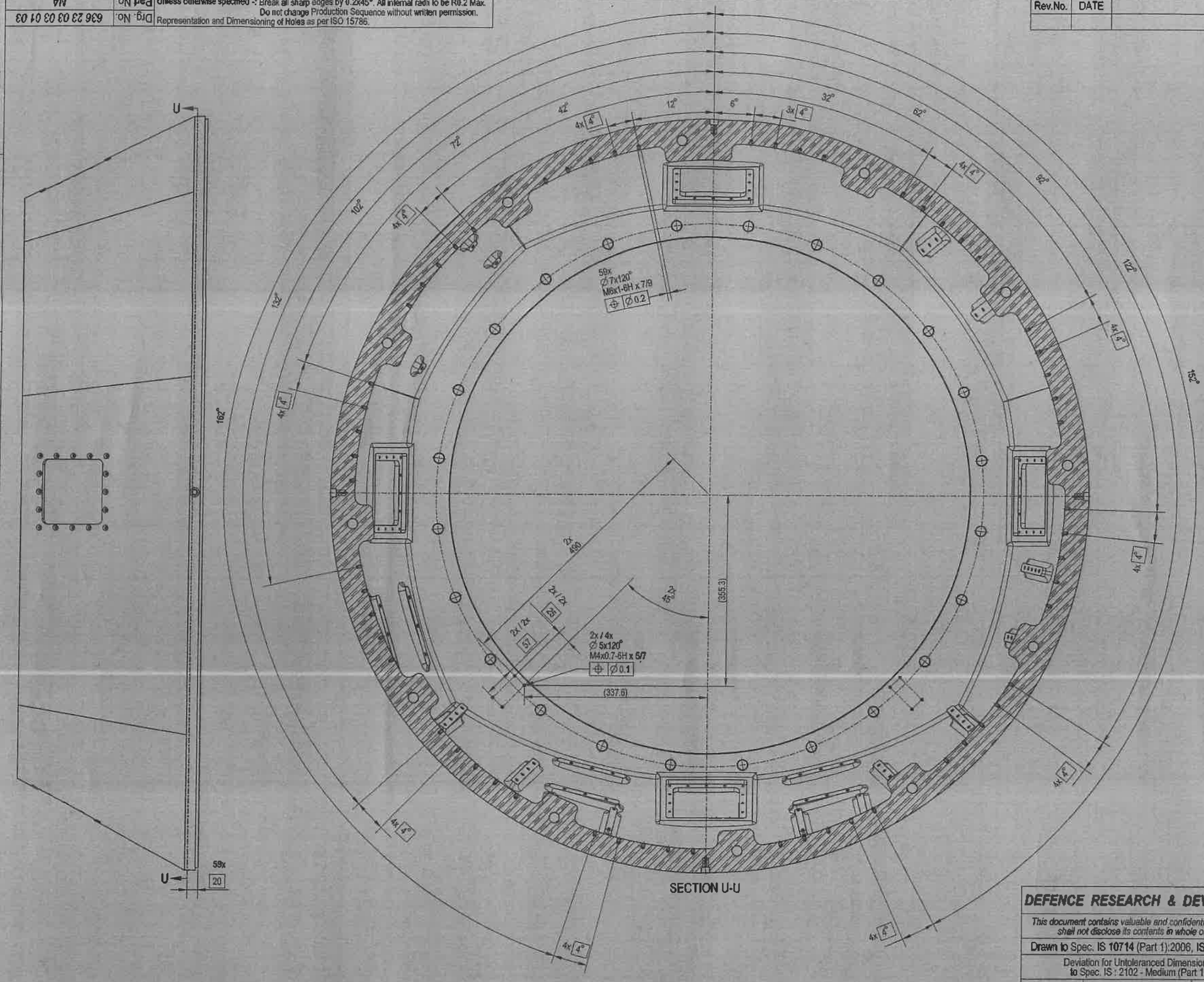
QA Doc No.:

APPROVED (DESIGN)	APPROVED (DRAWING)	APPROVED (R&QA)	APPROVED (PROJECT)
(R. Sreeramulu Sc F)	(G Yogenand Sc F)		(DK Tripathi Sc E)

Part No.	NA
Drg. No.	636 23 03 03 01 03

Unless otherwise specified -: Break all sharp edges by 0.2x45°. All internal radii to be R0.2 Max.
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE



SECTION U-U

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Drawn to Spec. IS 10714 (Part 1):2006, IS 10714 (Part 20):2001, IS 10714 (Part 21):2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specified

Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-Apr-21
208.633 kg	Steel 15CDV6 as per AIR9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:5	Surface Texture 1.6		

Comp / Assy Name	Adapter Ring 2 - HS03			Part No.	NA		
Assy Drg. No.	636 23 03 03 01 00	Drg. No.	636 23 03 03 01 03	Rev. No.	0	Sht. 4	of 4

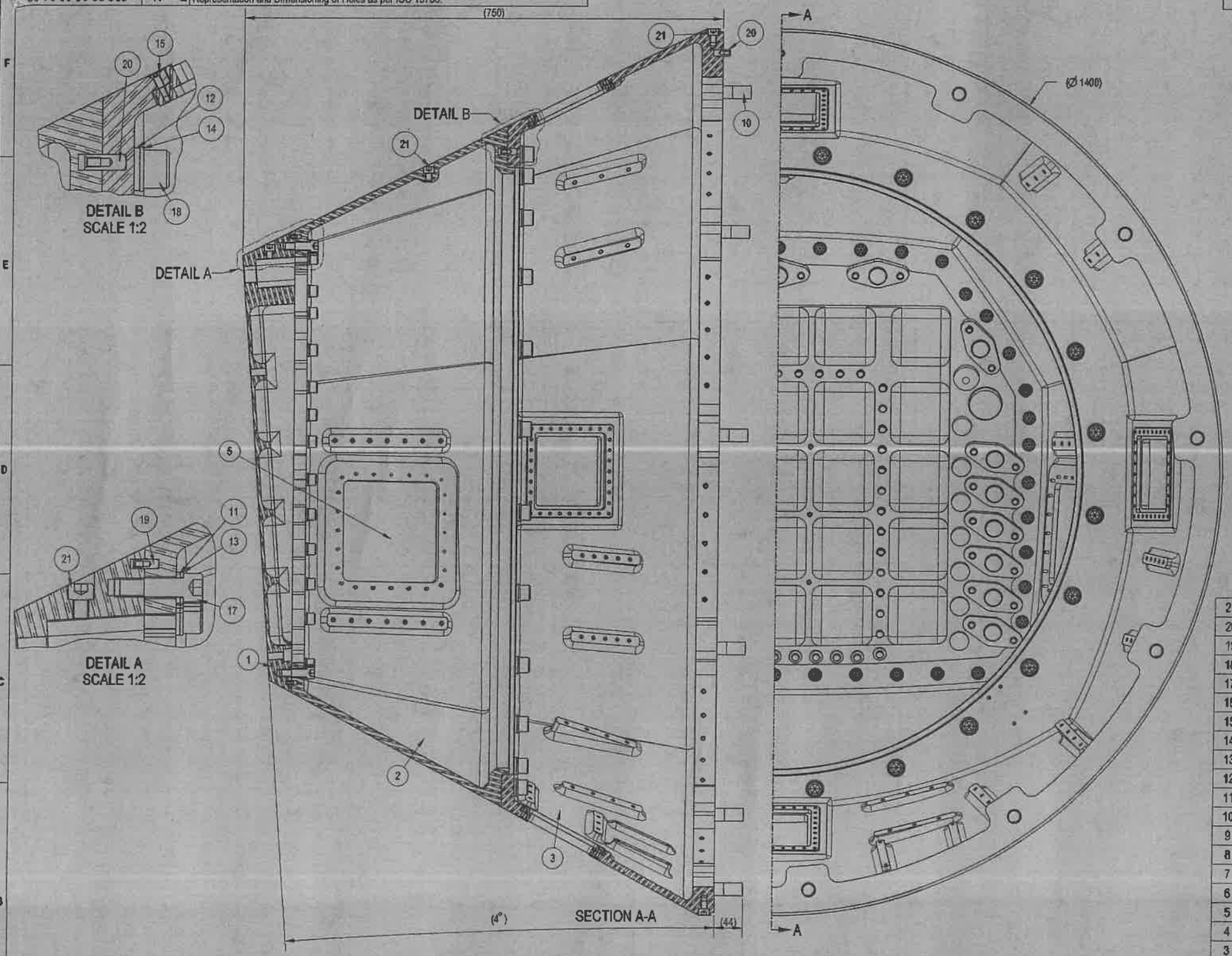
QA Doc No.:

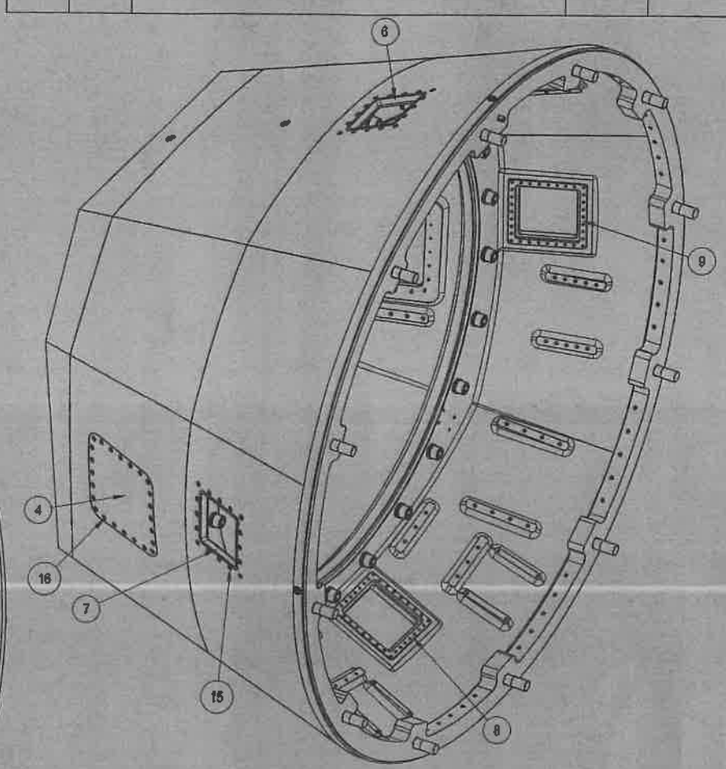
APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Arun Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

Part No.	Dtg. No.
NA	636 23 03 03 01 00

Unless otherwise specified :- Break all sharp edges by 0.2x45°. All internal radii to be R0.2 Max.
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE





Sl.No	Nomenclature	Drg No / Spec	Rev No	Qty	Material
21	Hex. Soc. Head Cap Screw	ISO 4762 M10 x 12 - 10.9		6	Steel
20	Parallel Pin	ISO 8735 - 10 x 26 - A - St		2	Steel
19	Parallel Pin	ISO 8735 - 6 x 16 - A - St		2	Steel
18	Hex. Soc. Head Cap Screw	ISO 4762 M16 x 45 - 10.9		24	Steel
17	Hex. Soc. Head Cap Screw	ISO 4762 M12 x 40 - 10.9		44	Steel
16	Hex. Soc. CSK Head Screw	ISO 10642 - M4 x 25 - 10.9		~~4~~ 8	Steel
15	Hex. Soc. CSK Head Screw	ISO 10642 - M4 x 16 - 10.9		64	Steel
14	Washer	ISO 7092 - 16 - 200 HV		24	Steel
13	Washer	ISO 7092 - 12 - 200 HV		44	Steel
12	Spring Lock Washer	A16 - IS 3063 Phosphate Coated		24	Steel
11	Spring Lock Washer	A12 - IS 3063 Phosphate Coated		44	Steel
10	Stud M20 x 45L - HS03	636 23 03 03 00 99	0	12	SAE 4340 as per SAE AMS 6414M
9	Adapter TCAB R1R - HS03	636 23 03 03 01 09	0	1	Steel 15CDV6 as per AIR 9160C
8	Adapter TCAB R2B - HS03	636 23 03 03 01 08	0	1	Steel 15CDV6 as per AIR 9160C
7	Adapter TCAB R1L - HS03	636 23 03 03 01 07	0	1	Steel 15CDV6 as per AIR 9160C
6	Adapter TCAB R2T - HS03	636 23 03 03 01 06	0	1	Steel 15CDV6 as per AIR 9160C
5	Adapter Ring 1 HCR - HS03	636 23 03 03 01 05	0	1	Steel 15CDV6 as per AIR 9160C
4	Adapter Ring 1 HCL - HS03	636 23 03 03 01 04	0	1	Steel 15CDV6 as per AIR 9160C
3	Adapter Ring 2 - HS03	636 23 03 03 01 03	0	1	Steel 15CDV6 as per AIR9160C
2	Adapter Ring 1 - HS03	636 23 03 03 01 02	0	1	Steel 15CDV6 as per AIR9160C
1	Adapter Front Plate - HS03	636 23 03 03 01 01	0	1	Steel 15CDV6 as per AIR9160C

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Drawn to Spec. IS 10714 (Part 1):2006, IS 10714 (Part 20):2001, IS 10714 (Part 21):2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specified

Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-Apr-21
496.979 kg	---	---	Scale 1:5	Surface Texture ---		

Comp / Assy Name	Adapter Assembly - HS03		Part No.	NA
Assy Drg. No.	636 23 03 03 00 00	Drg. No. 636 23 03 03 01 00	Rev. No. 0	Sht. 1 of 1

Note:
1. Use stud caps (of teflon material) to cover studs once assembled to shells, so as to avoid any damage to stud during handling.

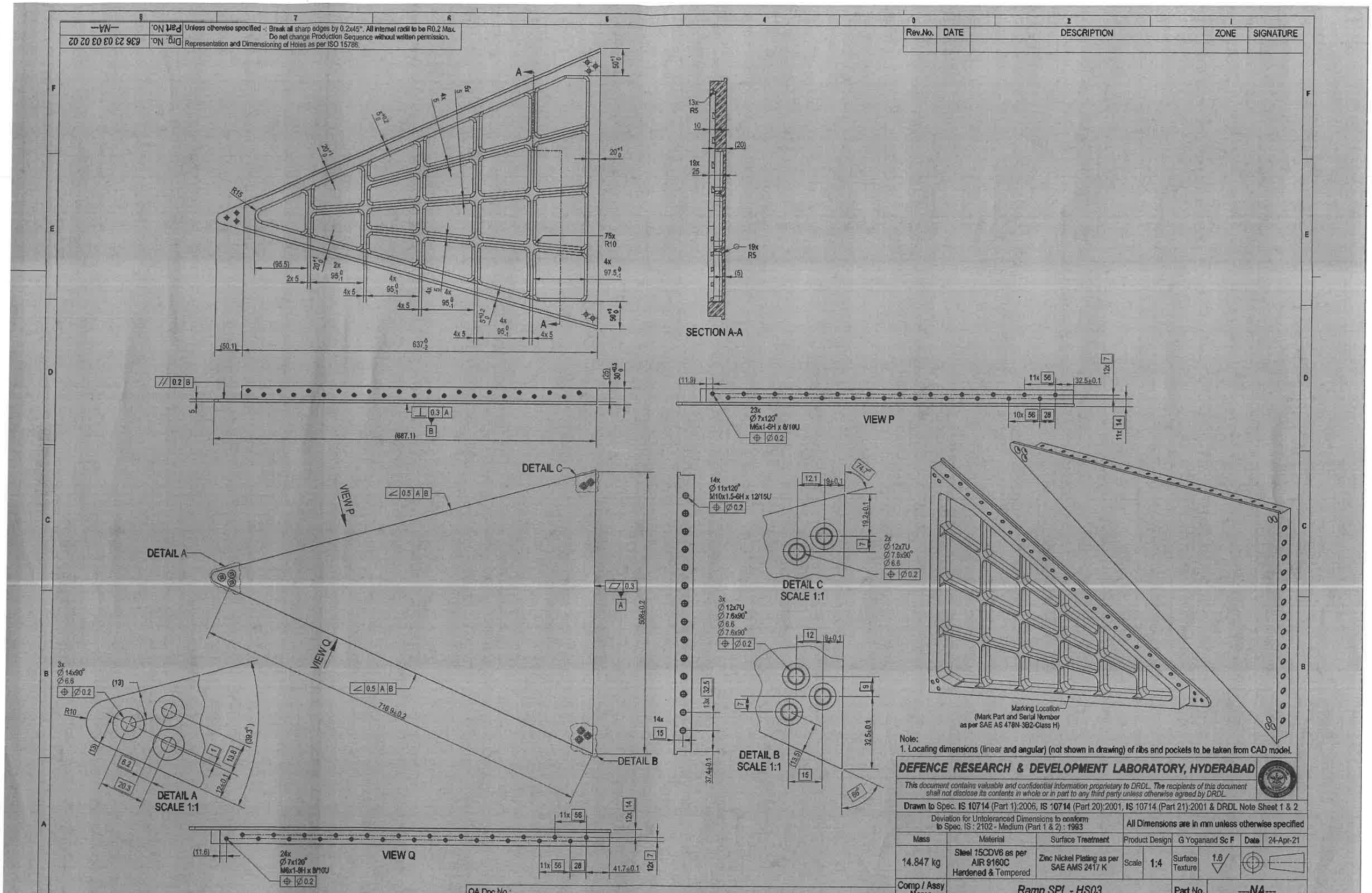
QA Doc No.:							
APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Anin Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

Format created by RSB on 01-Jan-2015

Part No.	—NA—
Dtg. No.	636 23 03 03 02 02

Unless otherwise specified :- Break all sharp edges by 0.2x45°. All internal radii to be R0.2 Max.
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE



Note:
1. Locating dimensions (linear and angular) (not shown in drawing) of ribs and pockets to be taken from CAD model.

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Drawn to Spec. IS 10714 (Part 1):2006, IS 10714 (Part 20):2001, IS 10714 (Part 21):2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specified

Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-Apr-21
14.847 kg	Steel 15CDV6 as per AIR 9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:4	Surface Texture 1.6		

Comp / Assy Name	Ramp SPL - HS03			Part No.	—NA—		
Assy Drg. No.	636 23 03 03 02 00	Drg. No.	636 23 03 03 02 02	Rev. No.	0	Sht. 1	of 1

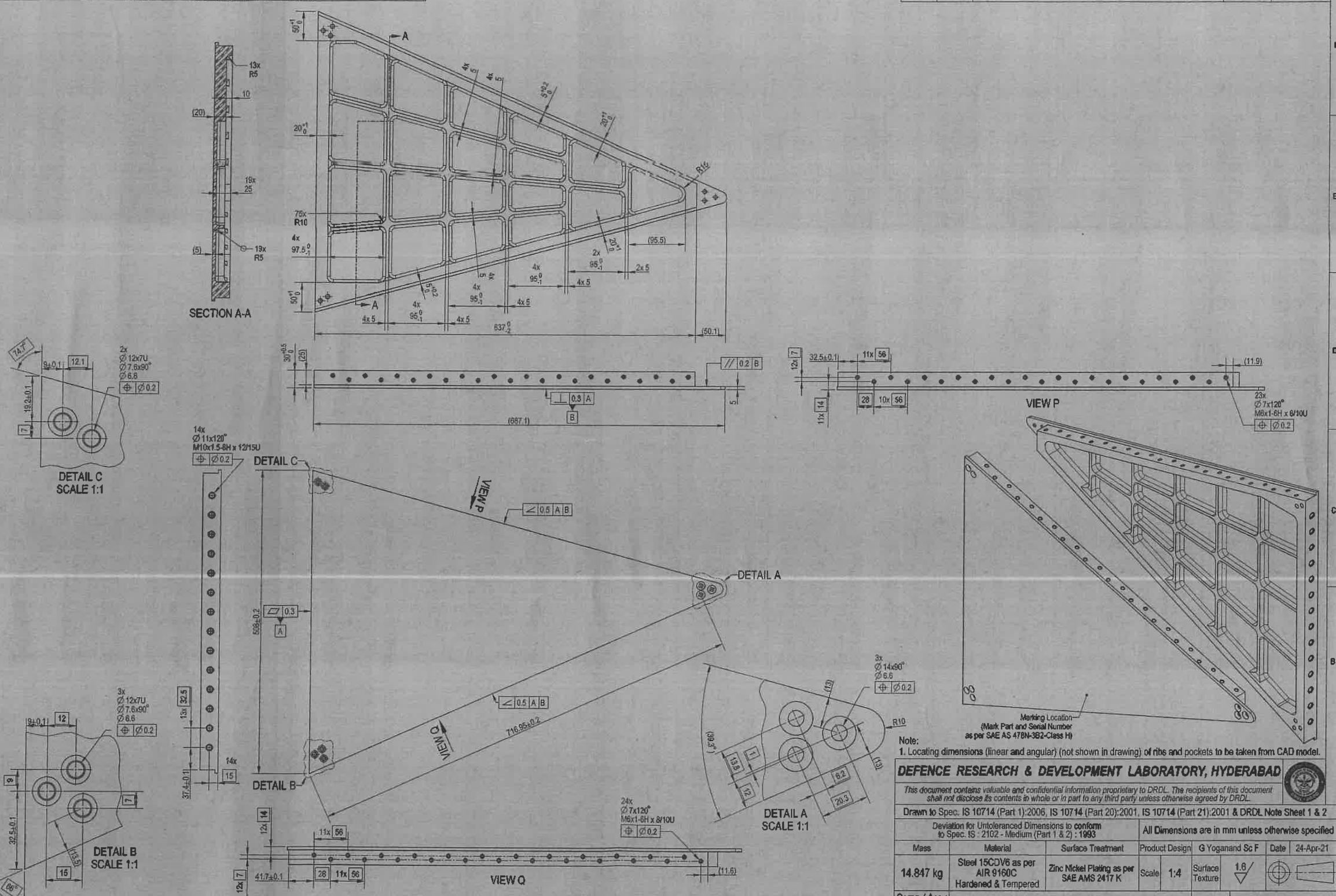
QA Doc No.:

APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Amin Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

Part No.	---NA---
Drg. No.	636 23 03 03 02 03

Unless otherwise specified -: Break all sharp edges by 0.2x45°. All internal radii to be R0.2 Max.
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE



Note:
1. Locating dimensions (linear and angular) (not shown in drawing) of ribs and pockets to be taken from CAD model.

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Drawn to Spec. IS 10714 (Part 1):2006, IS 10714 (Part 20):2001, IS 10714 (Part 21):2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specified

Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-Apr-21
14.847 kg	Steel 15CDV6 as per AIR 9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:4	Surface Texture 1.6		

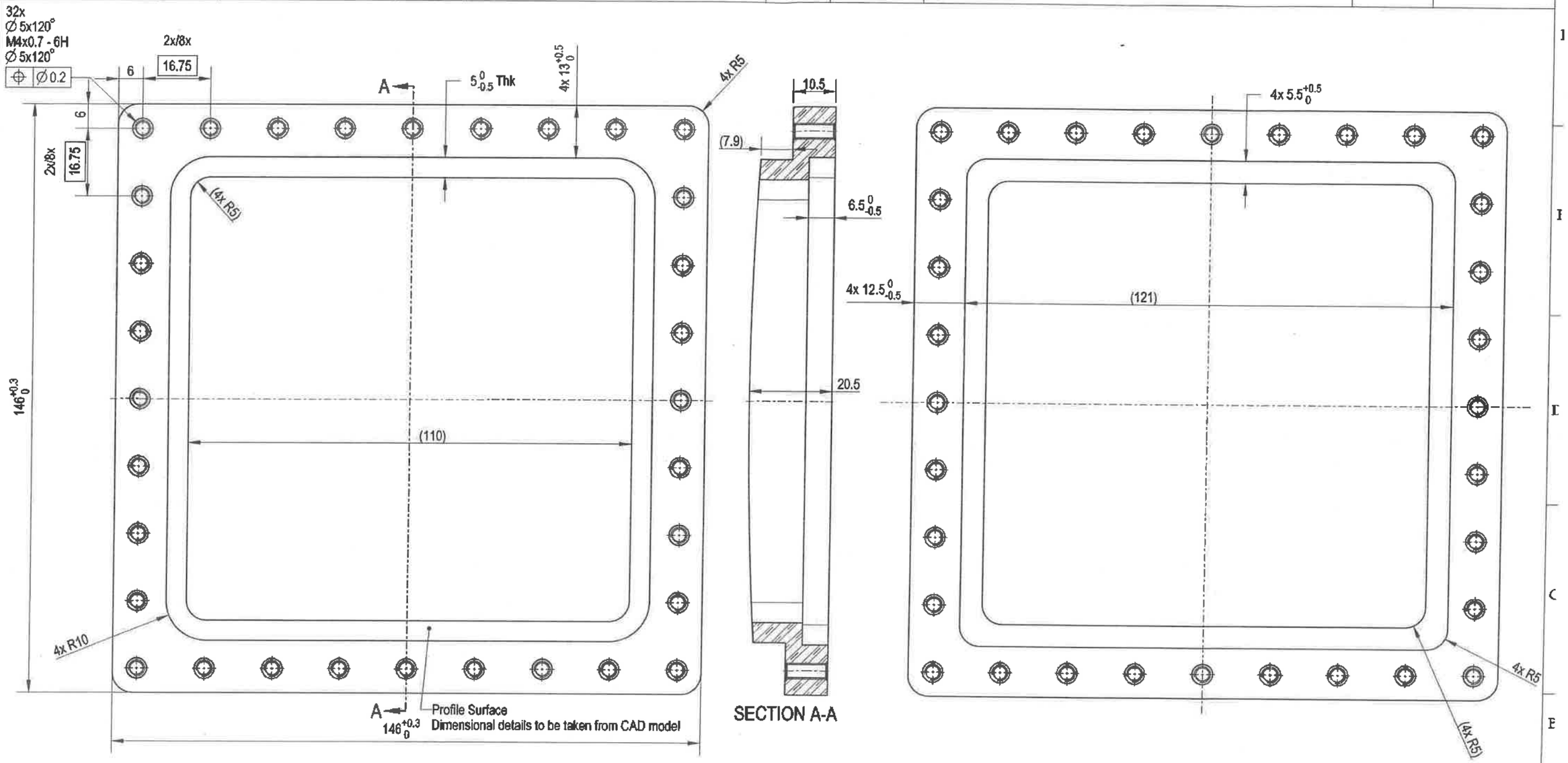
Comp / Assy Name	Ramp SPR - HS03			Part No.	---NA---		
Assy Drg. No.	636 23 03 03 02 00	Drg. No.	636 23 03 03 02 03	Rev. No.	0	Sht. 1	of 1

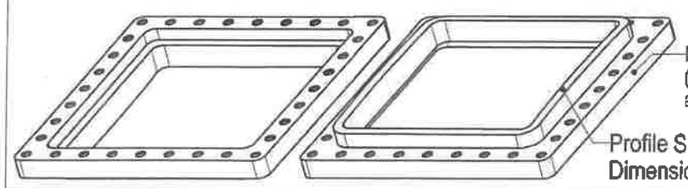
QA Doc No.:							
APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Ahmed Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE

Unless otherwise specified -: Break all sharp edges by 0.5x45°. All internal radii to be R0.2 Max
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

Drg. No. 636 23 03 03 01 09
Part No. ---NA---





QA Doc No.:

APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Arun Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

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Drawn to Spec. IS:10714-Part 1 (R 2006), IS : 10714 (Part 20) : 2001, IS : 10714 (Part 21) : 2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specified

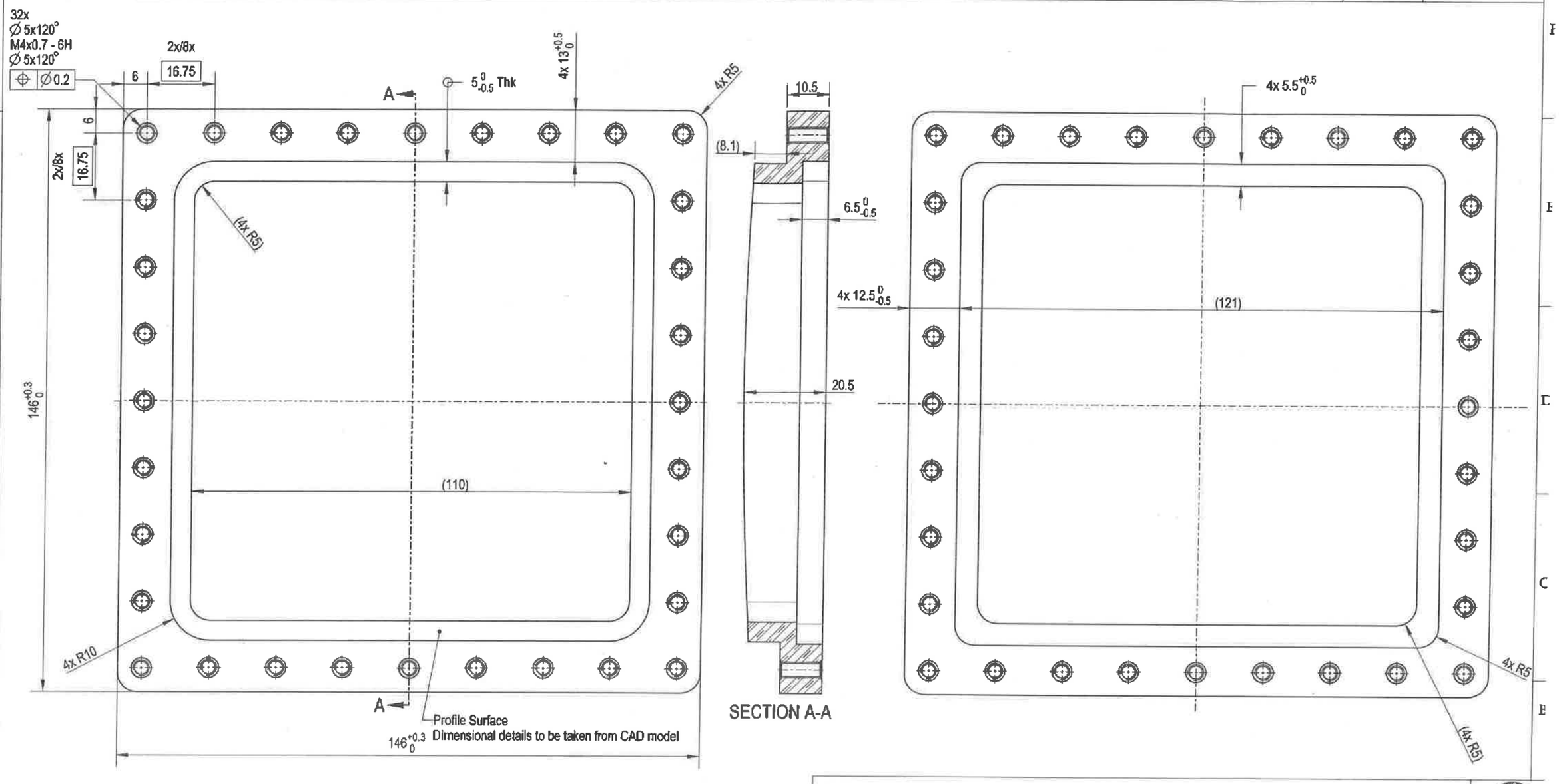
Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-May-21
0.760 kg	Steel 15CDV6 as per AIR 9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:1	Surface Texture 1.6		

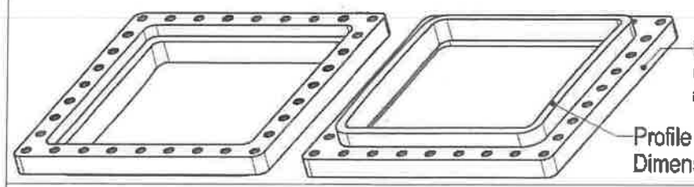
Comp / Assy Name	Adapter TCAB R1R - HS03			Part No.	---NA---			
Assy Drg. No.	636 23 03 03 01 00	Drg. No.	636 23 03 03 01 09	Rev. No.	0	Sht. 1	of	1

Part No.	---NA---
Drg. No.	636 23 03 03 01 08

Unless otherwise specified -: Break all sharp edges by 0.5x45°. All internal radii to be R0.2 Max
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE





QA Doc No.:

APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Arun Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

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Drawn to Spec. IS:10714-Part 1 (R 2006), IS : 10714 (Part 20) : 2001, IS : 10714 (Part 21) : 2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specified

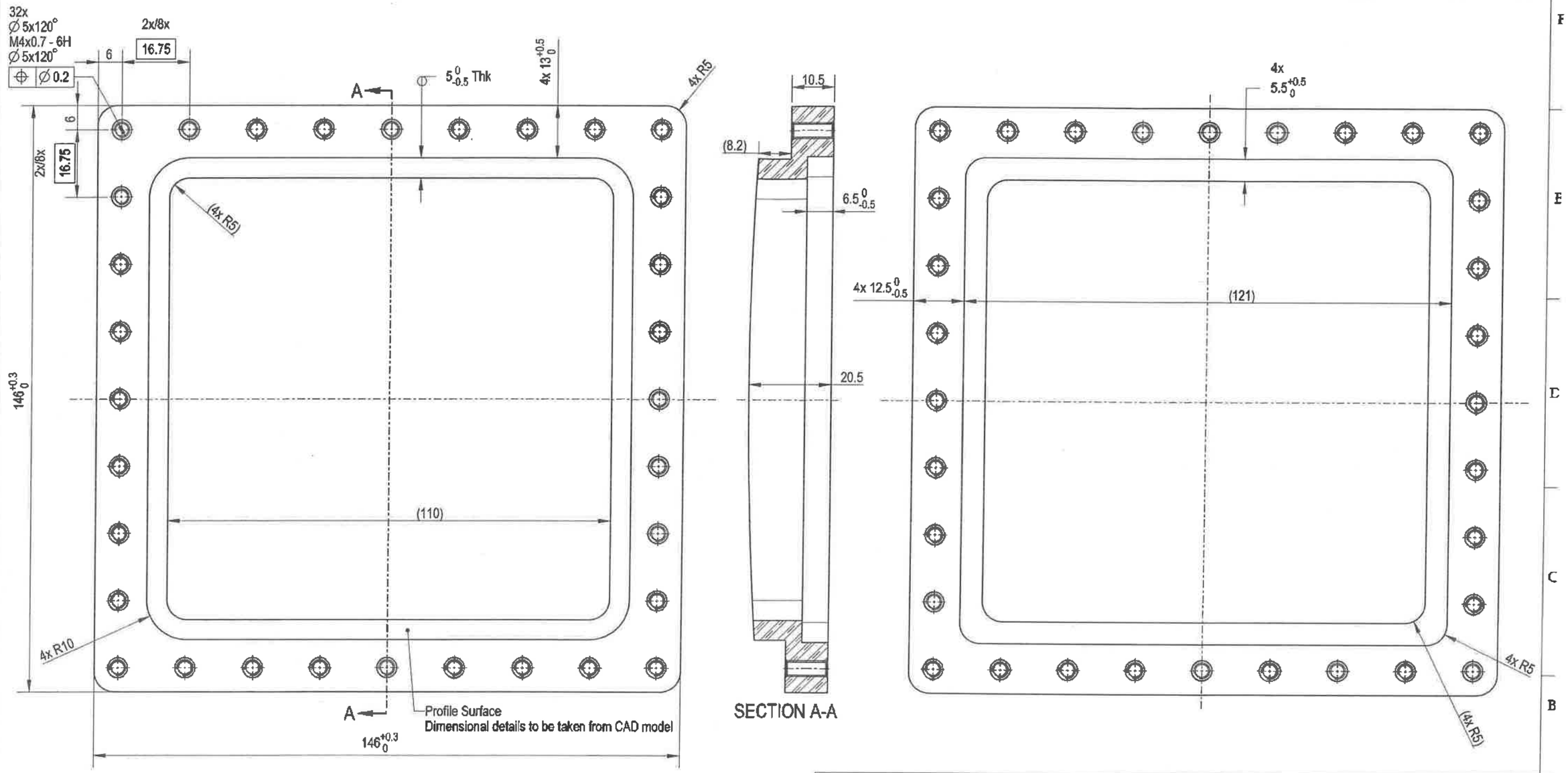
Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-May-21
0.761 kg	Steel 15CDV6 as per AIR 9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:1	Surface Texture 1.6		

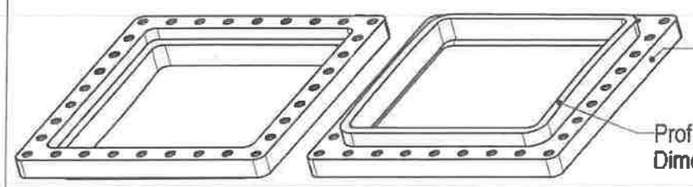
Comp / Assy Name	Adapter TCAB R2B - HS03			Part No.	---NA---		
Assy Drg. No.	636 23 03 03 01 00	Drg. No.	636 23 03 03 01 08	Rev. No.	0	Sht. 1	of 1

Part No.	---NA---
Drg. No.	636 23 03 03 01 07

Unless otherwise specified -: Break all sharp edges by 0.5x45°. All internal radii to be R0.2 Max
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE





QA Doc No.:

APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Arun Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

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Drawn to Spec. IS:10714-Part 1 (R 2006), IS : 10714 (Part 20) : 2001, IS : 10714 (Part 21) : 2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specified

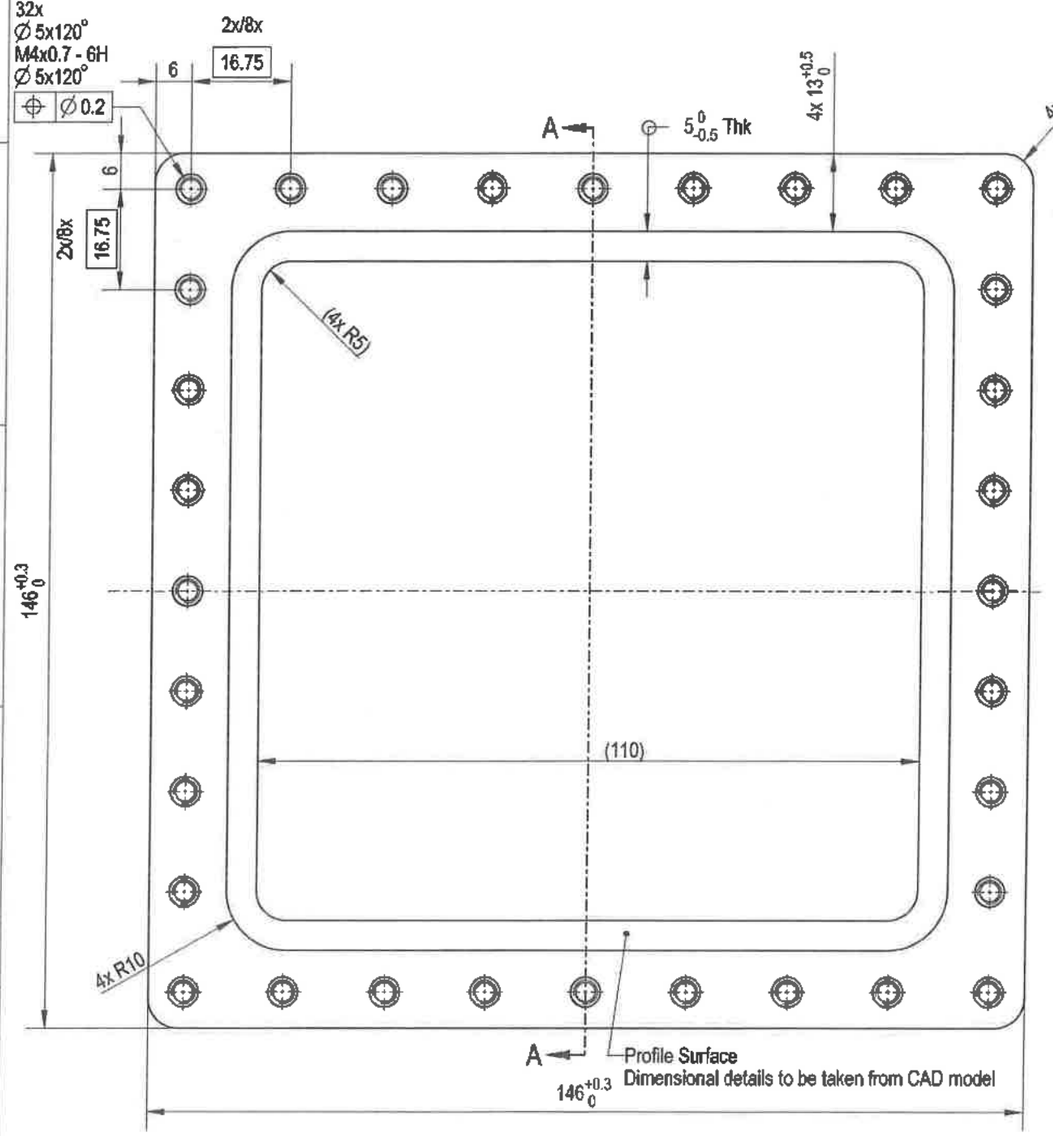
Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-May-21
0.760 kg	Steel 15CDV6 as per AIR 9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:1	Surface Texture 1.6		

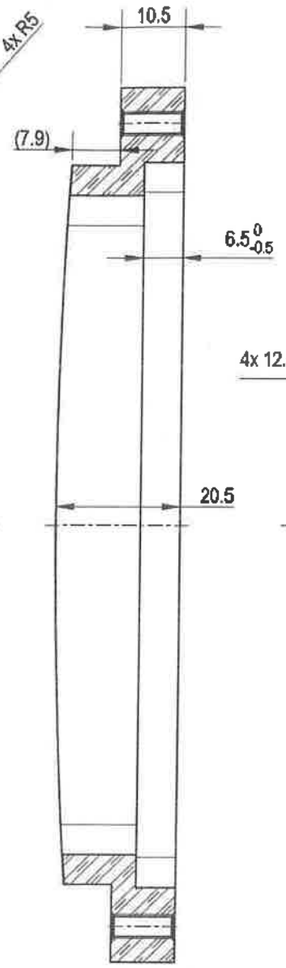
Comp / Assy Name	Adapter TCAB R1L - HS03			Part No.	---NA---			
Assy Drg. No.	636 23 03 03 01 00	Drg. No.	636 23 03 03 01 07	Rev. No.	0	Sht. 1	of	1

Part No.	---NA---
Drg. No.	636 23 03 03 01 06

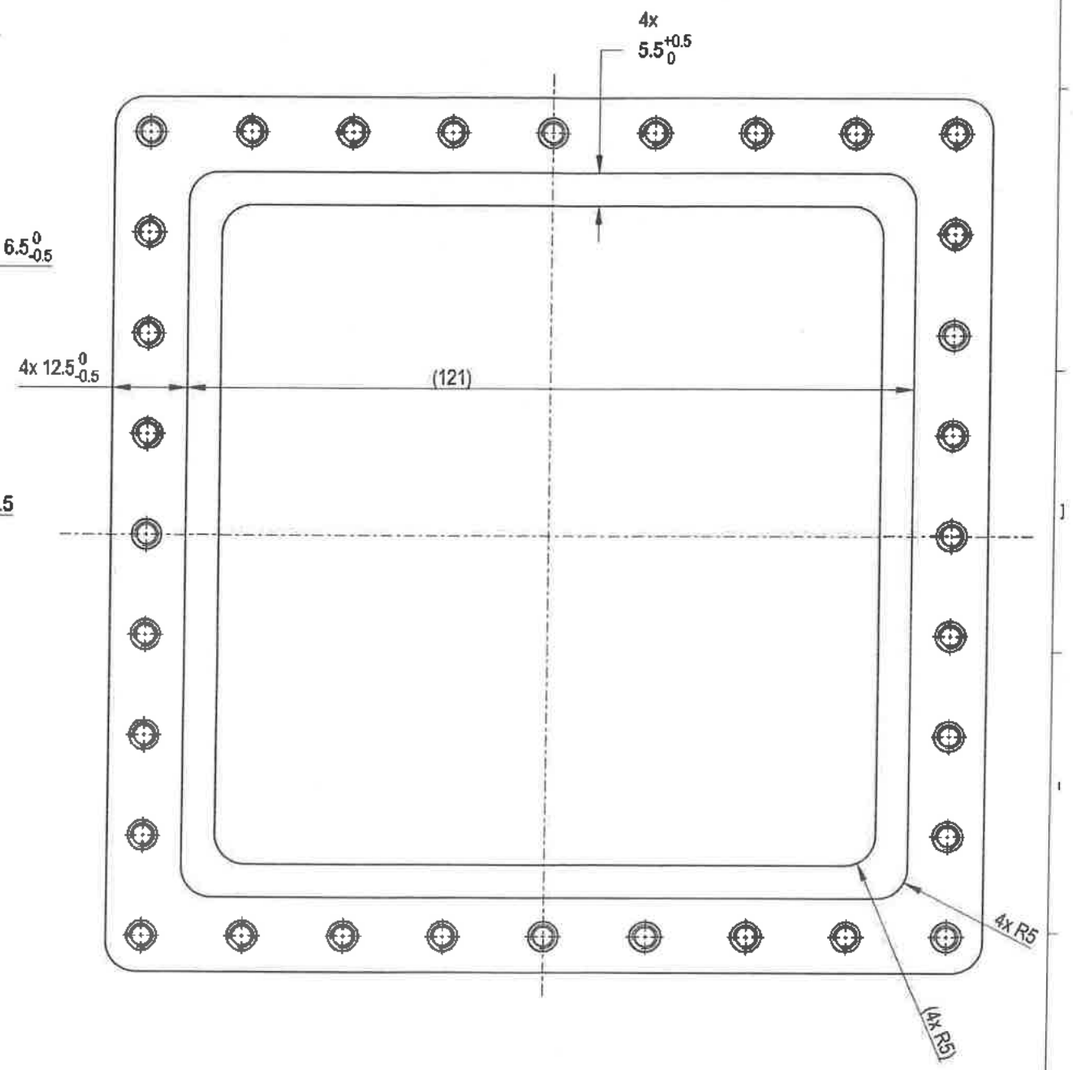
Unless otherwise specified -: Break all sharp edges by 0.5x45°. All internal radii to be R0.2 Max
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

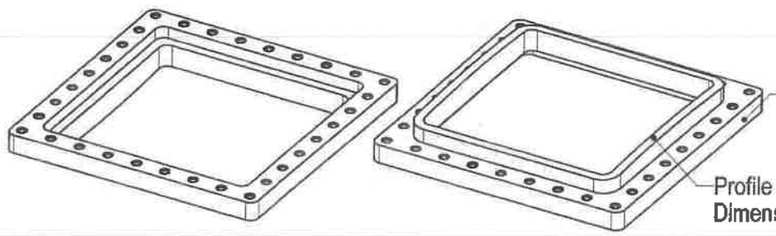
Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE





SECTION A-A





QA Doc No.:

APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Arun Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

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Drawn to Spec. IS:10714-Part 1 (R 2006), IS : 10714 (Part 20) : 2001, IS : 10714 (Part 21) : 2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specifie

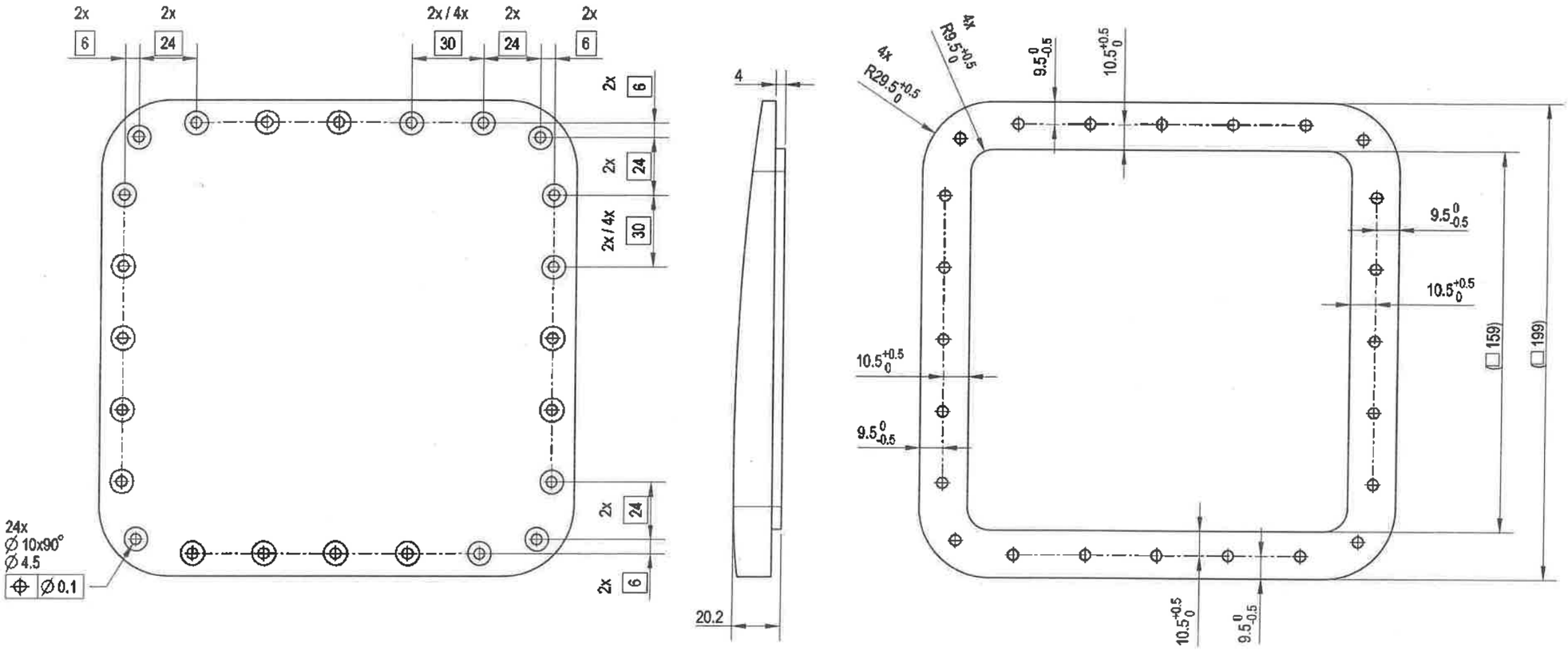
Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-May-21
0.759 kg	Steel 15CDV6 as per AIR 9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:1	Surface Texture 1.6		

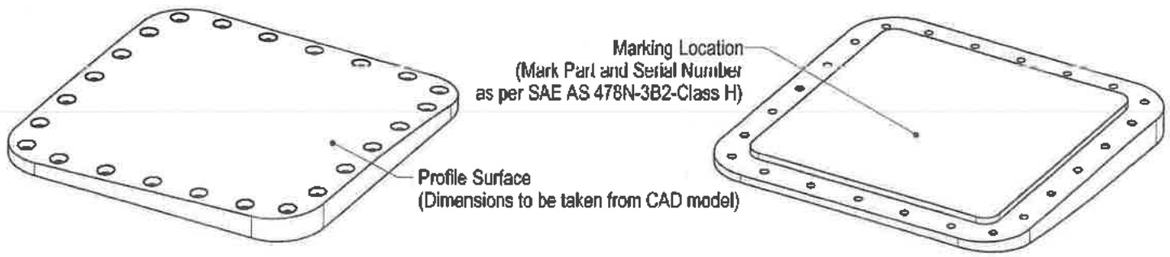
Comp / Assy Name	Adapter TCAB R2T - HS03			Part No.	---NA---		
Assy Drg. No.	636 23 03 03 01 00	Drg. No.	636 23 03 03 01 06	Rev. No.	0	Sht. 1	of 1

Part No.	---NA---
Drg. No.	636 23 03 03 01 05

Unless otherwise specified -: Break all sharp edges by 0.5x45°. All internal radii to be R0.2 Max
Do not change Production Sequence without written permission.
Representation and Dimensioning of Holes as per ISO 15786.

Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE





QA Doc No.:

APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Arun Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

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Drawn to Spec. IS:10714-Part 1 (R 2006), IS : 10714 (Part 20) : 2001, IS : 10714 (Part 21) : 2001 & DRDL Note Sheet 1 & 2

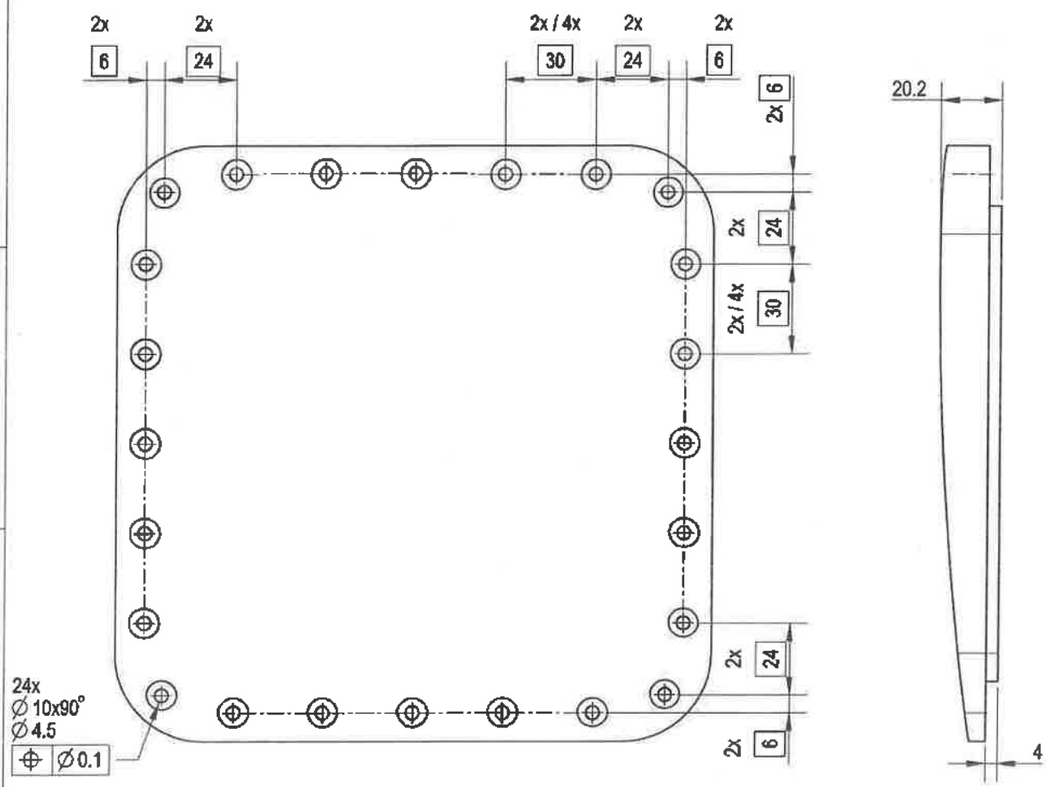
Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

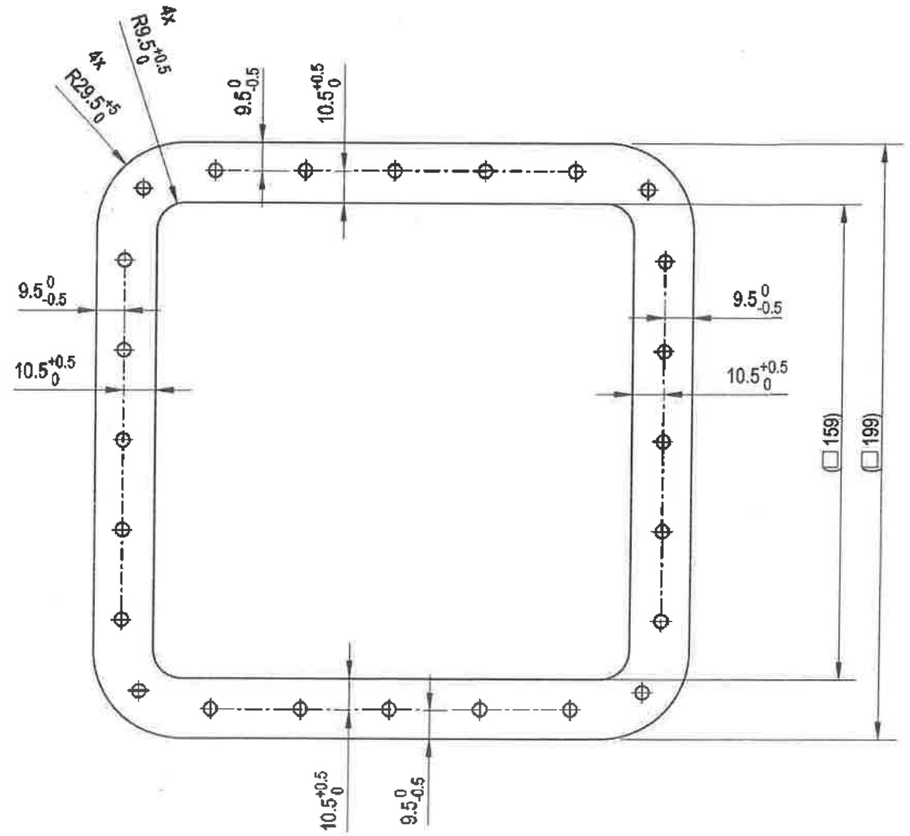
All Dimensions are in mm unless otherwise specified

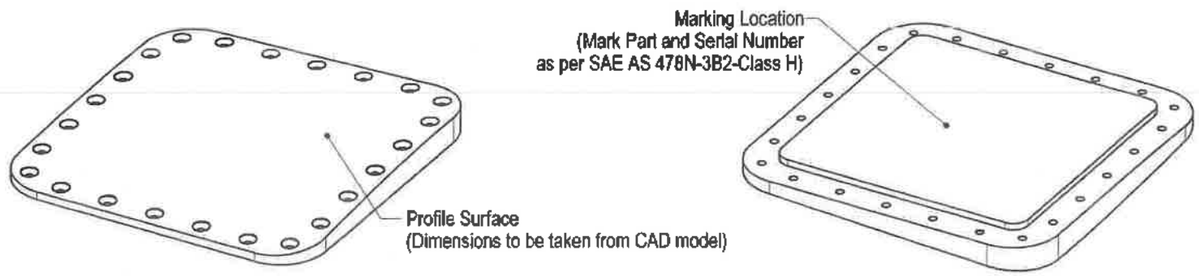
Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-Apr-21
3.870 kg	Steel 15CDV6 as per AIR 9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:2	Surface Texture 1.6		

Comp / Assy Name	Adapter Ring 1 HCR - HS03			Part No.	---NA---		
Assy Drg. No.	636 23 03 03 01 00	Drg. No.	636 23 03 03 01 05	Rev. No.	0	Sht. 1	of 1

Part No.	Unless otherwise specified -: Break all sharp edges by 0.5x45°. All internal radii to be R0.2 Max Do not change Production Sequence without written permission. Representation and Dimensioning of Holes as per ISO 15786.	Rev.No.	DATE	DESCRIPTION	ZONE	SIGNATURE
---NA---						
Drg. No.	636 23 03 03 01 04					







QA Doc No.:

APPROVED (DESIGN)	(K Sreeramulu Sc F)	APPROVED (DRAWING)	(G Yoganand Sc F)	APPROVED (R&QA)	(NA Arun Sc F)	APPROVED (PROJECT)	(DK Tripathi Sc E)

DEFENCE RESEARCH & DEVELOPMENT LABORATORY, HYDERABAD

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Drawn to Spec. IS:10714-Part 1 (R 2006), IS : 10714 (Part 20) : 2001, IS : 10714 (Part 21) : 2001 & DRDL Note Sheet 1 & 2

Deviation for Untoleranced Dimensions to conform to Spec. IS : 2102 - Medium (Part 1 & 2) : 1993

All Dimensions are in mm unless otherwise specifiec

Mass	Material	Surface Treatment	Product Design	G Yoganand Sc F	Date	24-Apr-21
3.870 kg	Steel 15CDV6 as per AIR 9160C Hardened & Tempered	Zinc Nickel Plating as per SAE AMS 2417 K	Scale 1:2	Surface Texture 1.6		

Comp / Assy Name	Adapter Ring 1 HCL - HS03			Part No.	---NA---			
Assy Drg. No.	636 23 03 03 01 00	Drg. No.	636 23 03 03 01 04	Rev. No.	0	Sht.	1	of 1

SCOPE OF WORK FOR ADAPTOR – RAMP ASSEMBLY

Introduction

HSTDV HS-03 Flight configuration requires Adaptor assembly for LV-CV attachment and separation. M20 pyro bolts will be used for joining cruise vehicle to the launch vehicle. Adaptor airframe is designed using 15CDV6 material due to high temperature, experienced during boost phase. It's a varying cross section area airframe where it connects to the circular interstage and other end 2D Cruise Vehicle rear end.

S. N.	Nomenclature	Reqd. Qty
1	Adaptor – Ramp Assembly	1 no.

Scope of Work

1. Raw material for fabrication of taper section and front plate will be supplied as FIM in annealed condition. Whereas, Ramp assembly material will be procured by the firm.
2. Fabrication of the components to be done only after the clearance of the raw material by DRDL.
3. After rough machining of the components, heat treatment as per QA plan is to be done. Heat treatment reports to be sent to DRDL for approval.
4. Intersection joining studs to be machined as per the drawings
5. Bought out items to be procured by Vendor and necessary certificates to be provided to DRDL for clearance.
6. Testing's and Inspection shall be carried out as per QA plan.
7. All the mandatory witnessed stages of R&QA, DRDL are specified in the QA Matrix.
8. All the test certificates and inspection reports shall be forwarded to the DRDL before delivering the item.

(D.K. Tripathi)
Sc 'E', HSTDV

Doc. No. DRDL/R&QA/HSTDV/373
Rev. No.00
Date: July 2021

QUALITY ASSURANCE PLAN FOR FABRICATION OF ADAPTOR-RAMP ASSEMBLY FOR HSTDV (HS04)

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QUALITY ASSURANCE PLAN FOR FABRICATION OF RAMP-ADAPTER ASSEMBLY FOR HSTDV (HS03)

1.0 SCOPE OF WORK:

This document stipulates the Quality Assurance and Quality control requirements, inspection requirements and acceptance test norms for raw materials, machining and testing of Ramp-Adapter Assembly for Project HSTDV.

The Project HSTDV/ DRDL shall Supply Free Material as Specified in this Document. The Vendor shall procure remaining material required for fabrication of the components. The Vendor shall procure, manufacture, fabricate and integrate the components. Vendor shall procure standard components necessary for the entire Adapter assembly. **Vendor shall ensure completion of all activities as per "Scope of work" document, engineering drawings and relevant engineering standards.**

2.0 QUALITY CONTROL REQUIREMENTS:

2.1 Process documents, fabrication drawings and Quality Control Plan shall be generated by Manufacturer and submitted to DRDL for approval prior to commencement of fabrication.

2.1.1 Process documents shall contain detailed process sheets mentioning various stages of operation from raw materials to the finished product.

2.1.2 Fabrication drawings shall be generated and submitted to DRDL for review and approval.

2.1.3 Quality control plan shall list various Quality Control requirements during fabrication including Inspection stages, for all the operations like machining and testing. The inspection/ testing stages where DRDL inspector's presence is mandatory shall be clearly mentioned for DRDL's review and concurrence.

2.2 DRDL reserves the right to depute its representatives to oversee the inspection at any stage of fabrication and cross check the inspection records.

2.3 Complete inspection, testing and documentation shall be carried out by the manufacturer as mentioned in this document.

2.4 All inspection reports as mentioned in the document shall be submitted to DRDL for approval.

2.5 Any variation in procedure/ specification shall be treated as a snag and shall be reported to DRDL for analysis and decision.

2.6 Calibration of testing machines at a periodicity of once in a year shall be ensured, as mentioned in ASTM E4-10.

2.7 Calibration of metrological instruments shall be ensured.

2.8 Raw material Identifications shall be carefully maintained and transferred properly at all stages of fabrication to ensure traceability.

2.9 The decision on final acceptance of the Items rests with DRDL.

3.0 LIST OF DRAWINGS AND BILL OF MATERIALS:

3.1 **List of Drawings:** Following is the list of drawings applicable for Adapter Assembly.

Sl. No.	Nomenclature	Drawing No.	Rev. No.
I	Ramp-Adaptor Assembly –HS03	636 23 03 03 00 00	00
1	Adapter Assembly – HS03	636 23 03 03 01 00	00
1.1	Adapter Front Plate	636 23 03 03 01 01	00
1.2	Adapter Ring 1 – HS03	636 23 03 03 01 02	00
1.3	Adapter Ring 2 – HS03	636 23 03 03 01 03	00
1.4	Adapter Ring 1 HCL – HS03	636 23 03 03 01 04	00
1.5	Adapter Ring 1 HCR – HS03	636 23 03 03 01 05	00
1.6	Adapter TCAB R2T – HS03	636 23 03 03 01 06	00
1.7	Adapter TCAB R1L – HS03	636 23 03 03 01 07	00
1.8	Adapter TCAB R2B – HS03	636 23 03 03 01 08	00
1.9	Adapter TCAB R1R – HS03	636 23 03 03 01 09	00
1.10	Stud M20 x 45L – HS03	636 23 03 03 00 99	00
2	Ramp Assembly – HS03	636 23 03 03 02 00	00
2.1	Ramp TP – HS03	636 23 03 03 02 01	00
2.2	Ramp SPL – HS03	636 23 03 03 02 02	00
2.3	Ramp SPR – HS03	636 23 03 03 02 03	00
2.4	Ramp BP – HS03	636 23 03 03 02 04	00
2.5	Ramp LE – HS03	636 23 03 03 02 05	00
2.6	Ramp Stiffener – HS03	636 23 03 03 02 06	00

3.2 **BILL OF MATERIAL:**

Sl. No.	Nomenclature	Drawing No.	Qty per Set	Raw material	Component Realization method
I	**Ramp-Adaptor Assembly –HS03**	**636 23 03 03 00 00**	**1**	**--**	**Assembly**
1	Adapter Assembly – HS03	636 23 03 03 01 00	1	--	Assembly
1.1	Adapter Front Plate	636 23 03 03 01 01	1	15CDV6 Hardened and Tempered	Machining, Heat treatment and Plating
1.2	Adapter Ring 1 – HS03	636 23 03 03 01 02	1		
1.3	Adapter Ring 2 – HS03	636 23 03 03 01 03	1		
1.4	Adapter Ring 1 HCL – HS03	636 23 03 03 01 04	1		Machining and Plating
1.5	Adapter Ring 1 HCR – HS03	636 23 03 03 01 05	1		
1.6	Adapter TCAB R2T – HS03	636 23 03 03 01 06	1		
1.7	Adapter TCAB R1L – HS03	636 23 03 03 01 07	1		
1.8	Adapter TCAB R2B – HS03	636 23 03 03 01 08	1		
1.9	Adapter TCAB R1R – HS03	636 23 03 03 01 09	1		
1.10	Stud M20 x 45L – HS03	636 23 03 03 00 99	12	EN 24 or SAE 4340	Machining and Plating
1.11	Spring Lock Washer	A12 – IS 3063 Phosphate Coated	44	Steel	Not in Scope
1.12	Spring Lock Washer	A16 – IS 3063 Phosphate Coated	24	Steel	
1.13	Washer	ISO 7092 – 12 - 200HV	44	Steel	
1.14	Washer	ISO 7092 – 16 - 200HV	24	Steel	
1.15	Hex. Soc. CSK Head Screw	ISO 10642 – M4 x 16 – 10.9	64	Steel	
1.16	Hex. Soc. CSK Head Screw	ISO 10642 – M4 x 25 – 10.9	48	Steel	
1.17	Hex. Soc. Head Cap Screw	ISO 4762 - M12 x 40 – 10.9	44	Steel	

1.18	Hex. Soc. Head Cap Screw	ISO 4762 - M16 x 45 – 10.9	24	Steel	Not in Scope
1.19	Parallel Pin	ISO 8735 – 6x16 – A-St	2	Steel	
1.20	Parallel Pin	ISO 8735 – 10x26 – A-St	2	Steel	
1.21	Hex. Soc. Head Cap Screw	ISO 4762 – M10 x 12 – 10.9	6	Steel	
2	Ramp Assembly – HS03	636 23 03 03 02 00	1	--	Assembly
2.1	Ramp TP – HS03	636 23 03 03 02 01	1	15CDV6 Hardened and Tempered	Machining and Plating
2.2	Ramp SPL – HS03	636 23 03 03 02 02	1		
2.3	Ramp SPR – HS03	636 23 03 03 02 03	1		
2.4	Ramp BP – HS03	636 23 03 03 02 04	1		
2.5	Ramp LE – HS03	636 23 03 03 02 05	1		
2.6	Ramp Stiffener – HS03	636 23 03 03 02 06	1		
2.7	Hex. Soc. CSK Head Screw	ISO 10642 M6 x 12 – 10.9	134	Steel	Not in Scope
2.8	Hex. Soc. Head Cap Screw	ISO 4762 M6 x 30 – 10.9	10	Steel	
2.9	Hex. Soc. Head Cap Screw	ISO 4762 M8 x15 – 10.9	8	Steel	
3.0	Washer	ISO 7092 – 10 – 200HV	46	Steel	
4.0	Spring Lock Washer	A10 – IS 3063 Phosphate Coated	46	Steel	
5.0	Hex. Soc. Head Cap Screw	ISO 4762 M10 x 40 – 10.9	46	Steel	

4.0 RAW MATERIAL:

The following Raw material used for fabrication of Ramp-Adapter Assembly is.

Sl. No.	Raw Material	Appendix
01	QA Plan 15CVD6 steel forging in hardened and tempered condition	Appendix – 'A'
02	Quality Assurance Plan For Fabrication Of Stud M20	Appendix – 'B'

Note: **The raw material (15CDV6 in Annealed condition) for Adapter Front Plate, Adapter Ring 1 and Adapter Ring 2 shall supply as free issue material (FIM) by DRDL. The Vendor shall procure remaining material required for fabrication of Ramp-Adapter assembly.** The Vendor shall ensure the quality mentioned in this QA Plan by undertaking the tests at a NABL accredited laboratory in the presence of DRDL representatives. All test certificates shall be offered to DRDL for Scrutiny and clearance, prior to commencement of fabrication.

5.0 ROUGH MACHINING OF 15CDV6 COMPONENTS

Rough machining shall be carried out in Annealed condition as per requirements of components made of 15CDV6. After rough machining of 15CDV6 material, heat treatment shall be carried out ~~if required~~.

6.0 HEAT TREATMENT - QUALITY CONTROL

Heat treatment records shall be generated. Actual Heat treatment Cycle followed by fabricator shall be reported to DRDL.

6.1 PRE-HEAT TREATMENT CHECKS

The components shall be thoroughly cleaned with Acetone (Technical grade as per IS 170).

Furnace calibration shall be carried out as per SAE AMS 2750 / BS 2M 54/ DIN 17052 and certificate shall be made available.

Thermocouples used for monitoring the furnace temperature shall be calibrated as per ASTM E 220. The readings of thermocouples mounted near both the ends of job, shall show temperature within the permissible variation of nominal value. For this purpose the thermocouples shall be hanging in the furnace as close as possible to the job.

Test Samples which represents the Airframe shall be Co-Heat Treated with the Airframe components. Test sample shall be taken for preparing the tensile test specimen (3Nos) to know the parent material strength as mentioned in 6.4

6.2 CHECKS DURING HEAT TREATMENT

Temperature of the job shall be recorded.

Heat treatment cycle and time shall be as per the requirement i.e., Para 6.4

6.3 POST HEAT TREATMENT CHECK

Visual inspection shall be carried out and observations recorded for the Components and test samples.

Hardness shall be checked on each sample heat treated with the Component in the same cycle and the value shall conform to **290-360 BHN.**

The Tensile properties (Tested per each HT batch) shall meet the requirements mentioned in Para 6.4.

6.4 HEAT TREATMENT CYCLE HARDENED & TEMPERED OF 15CDV6 STEEL MATERIALS

(a) Components to be made of 15CDV6 steel shall be subjected to heat treatment (Hardened and Tempered) after rough machining along with Test sample as per the cycle mentioned below.

Treatment	Temperature	Cycle
Refining	1000-1020 deg C	Heating for 4 minutes per mm (90 minutes minimum) then air cooling
Hardening	960-980 deg C	Heating for 4 minutes per mm (90 minutes minimum) then oil or water quenched
Tempering	590-630 deg C	Soaking for 8 minutes per mm (120 minutes minimum) then water quenching

(b) Mechanical Properties after Heat treatment

Property	Longitudinal Value	Transverse Value (Radial and tangential)
Tensile strength (UTS) (MPa)	1080 (min)	1020 (min)
0.2% PS (MPa)	930 (min)	880 (min)
%Elongation	10% (min)	10% (min)
Hardness (Brinell)	290-360 BHN	290-360 BHN

7.0 FINAL MACHINED COMPONENTS:

All the machined components shall be subjected to the following checks before they are cleared for assembly.

(i) Raw material identification number shall be transferred to the components and Sl. No. of component shall be marked on each component.

(ii) All the dimensions (100%) mentioned in the drawing shall be inspected for each of the component and actual measured value shall be reported and the values shall conform to the dimensions and tolerances mentioned in the drawings.

(iii) Machined components shall be subjected to Dye Penetrant Test to detect the presence of surface defects. DP test shall be carried out as per IS 3658: 1999 (R 2000). **No defects are permissible.**

8.0 SURFACE PROTECTION

8.1 ZINC- NICKEL PLATING

Zn-Ni Plating as per SAE AMS 2417 J

a. All the components shall be stress relieved before plating. The suggested temperature range is 190 to 220 °C for not less than 4 hours.

b. The components shall be thoroughly cleaned to ensure satisfactory adhesion and corrosion resistance performance of the coating. The components shall be Zn-Ni plated as per SAE AMS 2417

c. The plated article shall be free from plating defects such as blisters, pits, roughness, cracks, unplated areas and shall not be stained or discolored. The finish shall be bright.

d. After plating within 3 hours, the components shall be heat treated to hydrogen de-Embrittlement. The suggested temperature range is 190 °C to 220 °C for minimum 8 hours duration as per SAE AMS 2759/9E. The suppliers shall show clear evidence that hydrogen de-Embrittlement treatment is carried out within 3 hours after plating. ***Otherwise entire batch will get rejected.***

Heat Treatment Cycle for Hydrogen Embrittlement Relief

Temperature	Duration
190 °C to 220 °C	8 hrs

Note: The supplier shall also show the clear evidence of **Log records** that hydrogen de-Embrittlement treatment is carried out within 3 hrs after plating. ***Otherwise entire batch will get rejected.***

e. **Coating Thickness Measurement Test:** By measuring the diameter of a ground finished rod (size ϕ10 mm x 50 mm long) before and after plating by a micrometer, the thickness of the plating may be established. Measurement shall be carried on the rod at the same locations before and after plating (minimum at 4 locations).

f. **Acceptance Criteria:** For the specification of 8 microns, the minimum thickness is 8 microns. In case of small parts where minimum local thickness cannot be determined, the average thickness shall be 12 microns.

9.0 ASSEMBLY INSPECTION

9.1 RAMP-ADAPTER ASSEMBLY

The assembly shall be inspected for all the dimensions and geometrical tolerances as per drawings.

a) All dimensions as per the drawing.

b) Weight of Ramp-Adapter Assembly shall be recorded.

10.0 PACKAGING

The finished Product shall be packed in wooden crates, suitable for Road and Rail Transport. Crates shall provide cushioning to the product through Felt Lining at the contact surfaces. Crates shall also be provided with appropriately positioned Dunn age to Facilitate Fork Lifting and Slinging and to provide some degree of protection from Water Logging and Impact Damage. The Wooden Crates shall carry the following information directly painted on them.

- DRDL Supply Order Number
- Manufactures Name
- Net weight

11.0 REPORTS

The following Inspection Reports shall be forwarded to DRDL in triplicate (i.e., 3 Copies). These reports are to be submitted in spiral bind form.

i) For Raw Material – as per Appendices

ii) For Machined Products

- Heat Treatment Reports
- Dimensional Inspection Reports
- Dye Penetrant Test
- Assembly Inspection report
- Non-conformance Report
- Surface Protection Reports

12. Deliverables

Adaptor Arrframe -1 No

Ramp Assembly -1 No

Appendix-'A'

QUALITY ASSURANCE PLAN FOR 15CDV6 STEEL FORGINGS IN HARDENED AND TEMPERED CONDITION

1.0 SCOPE

This QA plan gives the details of applicable documents, raw materials specifications, inspection requirements, and acceptance criteria for 15CDV6 Steel Forgings.

2.0 APPLICABLE DOCUMENTS

STANDARD NO.	DESCRIPTION
AIR 9160 C	Specification of 15CDV6 Steel
ASTM A 370 – 2017	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A 604-07	Standard Practice for Macro etch Testing of Consumable Electrode Remelted Steel Bars and Billets
ASTM E 8-15a	Standard Test Methods for Tension Testing of Metallic Materials
ASTM E 23 – 12 c	Standard Test Methods for Notched Bar Impact Testing of Metallic Materials
ASTM E 45 - 2018	Standard Test Methods for Determining the Inclusion Content of Steel
ASTM E 112 - 13	Standard Test Methods for Determining Average Grain Size
ASTM E 350 - 18	Standard Test Methods for Chemical Analysis of Carbon Steel, Low – Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
BS EN 3523-2007	Aerospace series – Steel FE-PL1505 (15CrMoV6) – Air melted – Hardened and – tempered – Bar for machining – De ≤ 100 mm -1 080 MPa ≤ Rm ≤ 1 280 MPa
SAE AMS 2630 D	Ultrasonic inspection of products over 12.5mm thick
MIL-STD-1504B	Abrasive Blasting
IS 2074 – Part 1 2015	Ready mixed paint, air drying, red oxide- Zinc chrome, priming specification

3.0 MATERIAL SUPPLY CONDITION

The steel shall be manufactured by Arc/Induction Furnace melting followed by either vacuum degassing or Electro Slag Refining (ESR Route). Ingots shall be made from not more than one melt. Blooms/ Billets shall be either hot rolled or forged from ingot with at-least 50% cross-section area reduction with respect to ingot. Forgings shall be forged from Blooms/ Billets that have been hot worked.

Material shall be furnished in Hardened & Tempered, descaled, proof machined and corrosion protected condition. Heat Treatment may be accomplished by contractor's proprietary thermal cycle. Descaling may be

accomplished by abrasive blasting in accordance with MIL-STD-1504B. Corrosion protection shall be accomplished by a removable paint.

3.1 **MANUFACTURE**

Manufacturer shall submit the process sheets and calibration reports of the equipment, sample extraction plans and test procedures to R&QA before taking up of any activity viz., forging, heat treatment, extraction of sample, testing etc.

Manufacturing process shall be recorded and preserved and details produced to inspection agency.

4.0 **CHEMICAL COMPOSITION**

The 15CDV6 material shall conform to AIR 9160C. The required chemical composition properties of 15CDV6 Steel Forging are given below. The chemical analysis shall be carried out on a sample taken out of the heat/melt manufactured under same condition, from same stock from one source offered at one time. Chemical analysis shall be carried out in accordance with ASTM E 350 and conform to values given in table-1 below.

Table-1

Element	Minimum Percent	Maximum Percent
Carbon	0.12	0.18
Manganese	0.8	1.10
Phosphorus	-	0.015
Sulphur	-	0.015
Silicon	-	0.20
Chromium	1.25	1.50
Molybdenum	0.80	1.00
Vanadium	0.20	0.30
Nickel	-	0.25
Copper	-	0.20
Others (each)	-	0.05
Others (total)	-	0.15
Iron	Remainder	
Hydrogen	-	3ppm
Oxygen	-	70ppm
Nitrogen	-	150ppm

4.1 Manganese, Silicon, Chromium, Molybdenum & Vanadium shall be analyzed using Optical Emission Spectrometer / X – Ray fluorescence spectrometer.

4.2 Carbon and sulphur shall be analysed using C & S analyzer.

4.3 Phosphorous shall be analysed using Optical Emission Spectroscopy / wet Chemical analysis / X – Ray fluorescence spectrometer.

4.4 Any other mutually agreed standard method of analysis capable of consistent and repeatable results could also be used, if necessary.

5.0 METALLOGRAPHY

5.1 MACRO STRUCTURE

Macrostructure examination shall be carried out on transverse section of billet, at suitable stage (before boring) of manufacture, from the ends corresponding to top, middle & bottom of ingot as per ASTM A604. Macrostructure shall be free from shrinkage porosity, blisters, laminations, intercrystalline cracks, segregation and flakes visible to naked eye.
The maximum occurrence of each condition shall be as stipulated in Table 2.

Table-2

Class	Condition	Severity
1	Freckles	A
2	White spots	A
3	Radial Segregation	B
4	Ring Pattern	B

5.2 GRAIN SIZE

Three samples shall be cut from each forging and subjected to metallurgical examination as per ASTM E112. There shall not be any abnormalities in the microstructure. Grain size of the samples drawn from all sizes of forgings shall be ASTM No. 5 or finer.

5.3 MICRO INCLUSION RATING

Inclusion rating shall be checked in accordance with ASTM E 45, minimum 3 samples taking one sample each from top, bottom and middle. No specimen shall exceed the limits shown in table-3 given below.

Table-3

Type	A	B	C	D
Thin	1.5	1.5	1.5	1.5
Thick	1.0	1.0	1.0	1.0

6.0 NON DESTRUCTIVE INSPECTION

6.1 ULTRASONIC INSPECTION

Forgings shall be subjected to Ultrasonic examination in accordance with SAE AMS 2630D in Normal beam as well as Angle beam inspection method so as to cover the entire volume. The acceptance criterion is Class A1 as per SAE AMS 2630D. Ultrasonic inspection shall be carried out by ASNT level II certified inspector.

6.2 LIQUID PENETRANT INSPECTION

Both inside and outside surfaces shall be subjected to liquid penetrant test as per SAE AMS 2647E and no crack/discontinuities shall be allowed.

7.0 PROPERTIES

The product shall confirm to the following requirements; Hardness and Tensile testing shall be performed in accordance with ASTM A 370. Properties shall be checked on the Forgings having least Hardness.

7.1 ANNEALING

The material shall be annealed as per the cycle given below. 'Lot' is defined as the Forgings made from same Melt Number to the same Property requirements in the same Furnace at the same Time for the same Duration.

Table-4

Treatment	Temperature	Heat Treatment Cycle	
		Soaking Time	Cooling Media
Annealing	875±10	4min/mm	Furnace Cooling at the rate of 50°C/Hr to Room Temperature.

The Heat Treatment shall be carried out in Electrical Furnace Provided with Forced Air Circulation. The furnace and Associated instruments shall be calibrated in accordance with BS 2M 54.

7.2 HARDNESS IN ANNEALED CONDITION

Hardness of Annealed forgings shall be a Maximum of 197 BHN or equivalent

7.3 HEAT TREATMENT - HARDENING & TEMPERING

The heat treatment cycle for obtaining required mechanical properties is given in table-5 below ***only for guidance.*** It should be noted that the fabricator may vary the actual cycle to achieve required properties. The onus of achieving required properties is on fabricator.

Table-5

Treatment	Temperature	Cycle
Refining	1000-1020 deg C	Heating for 4 minutes per mm (90 minutes minimum) then air cooling
Hardening	960-980 deg C	Heating for 4 minutes per mm (90 minutes minimum) then oil or water quenched
Tempering	640 deg C	Soaking for 8 minutes per mm (120 minutes minimum) then water quenching

7.4 MECHANICAL PROPERTIES AFTER HARDENING & TEMPERING

The tensile test specimens shall be prepared from test forgings. The tensile properties shall be checked at room temperature in Axial direction as per ASTM E8 or equivalent. The test samples taken from test forging of same heat treatment batch (3nos samples from Axial direction) shall be checked for mechanical properties after Hardened and tempered condition. The properties to be achieved are given in table-6 below for reference.

Table-6

Property	Axial Value
Tensile strength (UTS) (MPa)	1080 (min)
0.2% PS (MPa)	930 (min)
%Elongation	10% (min)
Hardness (Brinell)	290-360 BHN

7.4.1 Identification numbers shall be verified with those mentioned in the MILL test certificates forwarded by the raw material supplier. Copies of raw material certificate shall be submitted to DRDL inspection authority for approval.

7.5 IMPACT TOUGHNESS

Forgings for 15CDV6 material shall be subjected to 5 mm Charpy U notch impact toughness test as per ASTM E 23. The values to be achieved are given in table-7 below for reference.

Table-7

S. No.	Testing Temperature	Value (J) / Cm^2	Minimum number of samples per heat / batch
1	Room temperature	60 (min)	3 each in Tangential and Axial directions

8.0 DIMENSIONAL INSPECTION

The dimensions shall be checked for all the forgings to verify the conformance to dimensional requirements of this QA Plan.

9.0 CONDITION OF SURFACE:

There shall not be any cracks, folds, scabs, sand inclusions and hair-line cracks on surface of the forgings. Local defects shall be removed either by cutting or grinding. Removal of defects for forgings shall not exceed the tolerances in the given dimensions.

Negligible scratches tears from rolls, cavities and slight finishing in the depth of defects, which do not exceed half of the tolerance, may not be considered as cause of rejection.

The defects shall be rectified by finishing with a fine grained abrasive, without erosion.

10.0 CORROSION PROTECTION:

A single coat of Red oxide paint shall be applied as per IS 2074-1992.

11.0 IDENTIFICATION:

Forgings shall be punch marked at both ends with the following information:

- Alloy name and Heat Treated condition.
- Melt/Heat Number.
- Heat Treatment Batch Number.

- Unique Serial Number of each Forging
- Dimensions of each Forging.
- Weight of Forging.

12.0 WORKMANSHIP:

Forgings in Hardened & tempered, descaled and Proof machined condition shall be uniform in quality and condition, smooth and free from defects such as pits, laps, cracks, flakes, twists, seams, heat checks, slag, hard spots, porosity, slivers, scabs, rolled-in-scale, fissures, gas cavities, sponginess, segregation and nonmetallic inclusions which, owing to their nature, degree or extent will adversely affect the suitability of the parts for the service intended.

13.0 RECORDS :

13.1 PROCESS SHEETS:

Developing agency shall prepare and maintain document instructions defining the processing methods and route in the manufacturing cycle for production of the respective products.

13.2 CERTIFICATION AND REPORTS:

The manufacturer shall submit the following certificates for each batch and size of forgings. Original manufacturer's test certificate/certificates shall be obtained and submitted for the following:

- Chemical composition
- Macro Structure
- Inclusion rating
- Grain Size
- Ultrasonic Inspection & Liquid Penetrant
- Heat Treatment records
- Mechanical Properties
- Impact Toughness
- Dimensional Inspection Reports

14.0 INWARD GOODS INSPECTION (IGI):

All the Tests mentioned in Para 4.0 to 8.0 except para 5.0 which will done at Billet level shall be carried out (as part of Inward Goods Inspection) by Material Supplier at NABL accredited and DRDL approved Test Laboratories (in addition to forwarding of Material Manufacturer's Test Certificate). 100% Visual Inspection shall be carried out on the materials and Identification numbers shall be verified with those mentioned in the Test certificates.

15.0 REJECTIONS:

Product not conforming to this specification, or to modification authorized by purchaser, will be subject to rejection.

16.0 PACKING:

Forgings shall be packed in wooden box with suitable protection.

Appendix – 'B'

QUALITY ASSURANCE PLAN FOR FABRICATION OF STUD M20

1.0 INTRODUCTION

Stud M20 is to be fabricated as per drawing (636 23 03 03 00 99 Rev 00). This Quality Assurance Plan (QAP) covers the quality requirement for Raw Materials and Fabrication and Testing of Studs.

1.1 INSPECTION AGENCY

R&QA DRDL is designated QA Agency

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein.

Sl No.	Standard No.	Title
I. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)		
1	ASTM E 350	Standard Test Methods for Chemical Analysis of Carbon Steel, Low-Alloy Steel, Silicon Electrical Steel, Ingot Iron, and Wrought Iron
2	ASTM A 604	Standard Practice for Macroetch Testing of Consumable Electrode Remelted Steel Bars and Billets
3	ASTM E 45	Standard Test Methods for Determining the Inclusion Content of Steel
4	ASTM E 112	Standard Test Methods for Determining Average Grain Size
5	ASTM A 370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
6	ASTM B571	Standard Practice for Qualitative Adhesion Testing of Metallic Coatings
7	ASTM F 519	Standard Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments

Sl No.	Standard No.	Title
CIETY OF AUTOMOTIVE ENGINEERS (SAE)		
1	MS 6414L	Steel, Bars, Forgings, and Tubing 0.80Cr 1.8Ni 0.25Mo (0.38-0.43C) (SAE 4340) Vacuum Consumable Electrode Remelted
2	MS 2300L	Steel Cleanliness, Premium Aircraft-Quality Magnetic Particle Inspection Procedure
3	MS 2630C	Inspection, Ultrasonic Product Over 0.5 inch (12.7 mm) Thick

4	MS 2759/1E	Heat Treatment of Carbon and Low-Alloy Steel Parts Minimum Tensile Strength Below 220 ksi (1517 MPa)
5	SAE AMS 2759/9	Hydrogen Embrittlement Relief (Baking) of Steel Parts
III. **OTHER SPECIFICATIONS**		
1	IS 1586	Method for Rockwell Hardness Test for Metallic Material (Scales A-B-C-D-E-F-G-H-K 15N, 30N, 45N, 15T, 30T and 45T)
2	IS 11715	Rolled threads for aerospace fasteners
3	IS 1367 Part 9	Technical supply conditions for threaded steel fasteners Part 9 Surface discontinuities : Section 1 Bolts, screws and studs for general applications
4	IS 3703	Recommended Practice for Magnetic Particle Flaw Detection
5	IS 1367 Part 3	Technical Supply Conditions for Threaded Steel Fasteners - Part 3 : Mechanical Properties of Fasteners Made of Carbon Steel and Alloy Steel - Bolts, Screws and Studs
6	ISO 898-1	Mechanical properties of fasteners -- Part 1: Bolts, screws and studs

Note: ***Latest issue to be followed for the standards mentioned above.***

3.0 QA PLAN FOR SAE 4340 MATERIAL

3.1 RAW MATERIAL SPECIFICATION

(a) The Raw Material for fabrication of Stud M20 is SAE 4340 Steel Bars. The SAE 4340 Steel in annealed condition shall meet the requirements mentioned in SAE AMS 6414L. Steel shall be multiple melted using Vacuum Consumable electrode process in the re-melt cycle.

(b) Steel shall be premium aircraft-quality conforming to SAE AMS 2300L.

(c) Bars shall be hot finished and annealed having Hardness not higher than 235 HB.

(d) Bars shall be free from seams, laps, tars, and cracks. It is recommended to procure the raw material from reputed sources. The following checks are to be carried out on the raw material before starting of the fabrication.

3.2 CHEMICAL COMPOSITION

Chemical analysis shall be carried out on one bar/rod per each Heat No. / Melt No, in accordance with ASTM E 350 "Methods of Chemical Analysis". The analysis shall be done by Spectro chemical method as per ASTM E 350. The material should have the following chemical composition for acceptance.

Table -1

	SAE 4340		EN24	
ELEMENT	**MIN.**	**MAX**	**MIN**	**MAX**
Carbon	0.38	0.43	0.36	0.44
Manganese	0.65	0.90	0.45	0.70
Silicon	0.15	0.35	0.10	0.35
Phosphorus	--	0.010	--	0.025
Sulphur	--	0.010	--	0.015
Chromium	0.70	0.90	1.00	1.40
Nickel	1.65	2.00	1.30	1.70
Molybdenu	0.20	0.30	0.20	0.35
Copper	--	0.35	--	--

Chemical Check Analysis variations shall meet the applicable requirements of SAE AMS 2259E.

3.2.1 The EN24 material should also conform to the following limits as per SAE AMS 2259.

(a) O_2 = 35 ppm max.

(b) N_2 = 100 ppm max.

(c) H_2 = 3 ppm max.

3.3 MACRO STRUCTURE

Visual examination of transverse full cross-sections from Bars etched in accordance with ASTM A 604 in hot Hydrochloric acid, shall show no pipe or cracks. Porosity, segregation, inclusions, and other imperfections in product (Bars/ Rod) 144 squares inches (929 cm^2) and under in nominal cross-sectional area shall be no worse than macrographs of ASTM A 604 shown in Table below:

Table – 2: Macrostructure Limits

Class	Condition	Severity
1	Freckles	A
2	White Spots	A
3	Radial Segregation	B
4	Ring Pattern	B

3.4 MICRO INCLUSION RATING

The material accepted in the above tests shall undergo Micro Inclusion Rating test. Test procedure will be as per ASTM E 45, Method D. This test shall be conducted @ 1 sample for each Melt and Annealing Batch No.

Acceptance Criteria:

No specimen shall exceed the limits shown in the following Table, except that the length of any inclusion shall not be greater than 0.38mm.

Table – 3: Micro-Inclusion Rating Limits

	A	A	B	B	C	C	D	D
	Thin	Heavy	Thin	Heavy	Thin	Heavy	Thin	Heavy
Worst Field Severity	1.5	1.0	1.0	1.0	1.0	1.0	1.5	1.0
Worst Field Frequency maximum	a	1	a	1	a	1	3	1
Total Rateable Fields, Frequency, maximum	b	1	b	1	b	1	8	1

a – Combined A+B+C, not more than three fields.
b – Combined A+B+C, not more than eight fields.

A Rateable field is defined as one which has a type A, B, C, or D inclusion rating of at least No. 1.0 Thin or Heavy in accordance with the Jernkontoret Chart, Plate I-r, ASTM E 45.

3.5 GRAIN SIZE

Grain Size shall be ASTM No. 5 or finer, determined in accordance with ASTM E 112.

3.6 ULTRASONIC TESTING

All the Bars shall be subjected to Ultrasonic Test in accordance with (a) SAE AMS 2630D for Bars having Dia greater than 12.7mm. The acceptance level is class - A1. Ultrasonic Inspection shall be carried out by qualified ASNT/ISNT level- II personnel only. This has to be carried out on each of the Bars (100%)/Rods.

4.0 FABRICATION OF STUDS AND INSPECTION / TESTS

4.1 RODS

Rod shall be made to the required sizes from the accepted raw material, taking into consideration further machining allowances for thread tolerances and plating thickness etc., (Rods can be made even after heat treatment also).

4.2 HEAT TREATMENT OF SAE 4340

(a) Before finishing the shank and thread rolling, the Rods shall be hardened and tempered to meet the mechanical properties as per the property class 10.9 mentioned in the Drawing.

(b) Heat Treatment of SAE 4340 Bars (which are procured in annealed condition) shall be carried out so as to achieve a Hardness of 32 to 38 HRC.

(c) The following Heat Treatment details are provided for reference only from the Standard SAE AMS 2759/1E. However the manufacturer shall

establish the required heat treatment cycle to meet the specified hardness requirements:

(i) Austenitizing Temperature : 816^0 C
(ii) Soak Time : As per Table 5 of SAE AMS 2759/1E
(iii) Hardening Quenchant : Oil, Polymer
(vi) Tempering Temperature : (Refer the Table mentioned Below)

(d) Suggested Approximate Tempering Temperatures based on As-Quenched Hardness, ° C is as follows:

Table - 4

Tensile Strength (MPa)	As Quenched Hardness 33-38 HRC	As Quenched Hardness 36-38 HRC	As Quenched Hardness 40-43 HRC
1034 to 1172MPa	593 ° C	552 ° C	496 ° C

4.2.1 HEAT TREATMENT FOR EN24

Heat treatment shall be carried out in qualified furnace following the cycle as given in Table - 5 to achieve condition and to meet the corresponding mechanical properties.

TABLE - 5

TREATMENT	HEAT TREATMENT CYCLE		
	TEMP. °C	SOAKING TIME	COOLING MEDIA
Hardening	820-850 °C	2.5 min/mm	Oil
Tempering	660 °C max Note: For these steels the temperature range 280 °C to 500 °C has to be avoided.	--	Air

4.3 TESTS AFTER HEAT TREATMENT

The following tests shall be conducted on the test specimens/blanks, after heat treatment/re-heat treatment to accept the lot for further processing.

4.3.1 HARDNESS MEASUREMENT

Hardness shall be measured on the heat treated blanks on sampling basis on Rockwell hardness measuring machine in accordance with IS: 1586-1988. "Rockwell Hardness test for metallic materials. The sample size is 3 Nos., per batch of heat treatment. The hardness shall be measured at the core (Min 2 locations) and surface (Min 2 locations) of the blanks. The hardness value shall fall within the limits as given below:

Property Class	Hardness Value (HRC)
10.9	32 - 39

4.3.2 TENSILE TESTING OF SPECIMENS

A minimum of 3 Nos. of samples in the longitudinal direction shall be prepared as per ASTM A 370, from a representative Bar which had been heat treated along with the Blank and subjected to tensile test. The following Tensile Properties shall be reported in Hardened and Tempered condition:

Table – 5

Sl. No.	Mechanical properties	Specified values SAE4340	Specified values EN24
1	UTS (Min) Mpa	1034 to1172	1000 to 1150
2	0.2% Proof Stress (Min) Mpa	930	865
3	% Elongation (Min)	10	9

4.4 TESTS AFTER MACHINING

The following tests shall be conducted after thread forming.

4.4.1 VISUAL EXAMINATIONS

Studs shall be inspected visually for surface defects like cracks, bursts, shear bursts, voids, tool marks, nicks, discontinuous threads (Refer IS:1367 part 9 for details). Studs free from these defects shall be processed further.

4.4.2 PRE-PLATING GAUGING CHECK

Studs, passed through the pre-plating gauges are only acceptable for further processing (Manufacturer shall decide the size and tolerances of the gauges according to process convenience).

4.4.3 MAGNETIC PARTICLE TEST

Magnetic Particle Test shall be done on all Studs. The test shall be done in accordance with IS: 3703 "Code of Practice for magnetic particle flow detection". The magnetizing field shall be parallel to the longitudinal axis of the Studs, primarily for the indication of the transverse defects. Defects along the longitudinal axis of the Studs shall however be checked by the circular magnetization. No defects are permitted. Components without any defects only shall be processed further.

4.5 SURFACE PROTECTION

4.5.1 ZINC- NICKEL PLATING

Zn-Ni Plating as per SAE AMS 2417 J

(a) All the components shall be stress relieved before plating. The suggested temperature range is 190 to 220 °C for not less than 4 hours.

(b) The fasteners shall be thoroughly cleaned to ensure satisfactory adhesion and corrosion resistance performance of the coating. The components shall be Zn-Ni plated as per SAE AMS 2417 J

(c) The plated article shall be free from plating defects such as blisters, pits, roughness, cracks, un plated areas and shall not be stained or discolored. The finish shall be bright.

(d) After plating within 3 hours, the components shall be heat treated to hydrogen de embrittlement. The suggested temperature range is 190 °C to 220 °C for minimum 24 hours duration. The suppliers shall show clear evidence that hydrogen de embrittlement treatment is carried out within 3 hours after plating. ***Otherwise entire batch will get rejected.***

Table 1- Heat Treatment Cycle for Hydrogen Embrittlement Relief

Temperature	Duration
190 °C to 220 °C	24 hrs

Note: The supplier shall also show the clear evidence of **Log records** that hydrogen de-embrittlement treatment is carried out within 3 hrs after plating. ***Otherwise entire batch will get rejected.***

(e) **Coating Thickness Measurement Test:** By measuring the diameter of a ground finished rod (size ϕ10 mm x 50 mm long) before and after plating by a micrometer, the thickness of the plating may be established. Measurement shall be carried on the rod at the same location before and after plating minimum at 4 locations.

Acceptance Criteria: For the specification of 8 microns, the minimum thickness is 8 microns. In case of small parts and fasteners where minimum local thickness cannot be determined, the average thickness shall be 12 microns.

4.6 POST PLATING TESTS

The following tests shall be conducted on the Studs after the completion of the plating and chromate conversion coating operations.

4.6.1 VISUAL EXAMINATION

All Studs shall be inspected visually for the defects like unplated areas, blisters etc. Defective Studs shall be removed from the batch and should be destroyed immediately.

4.6.2 ADHESION TEST

Adhesion Test shall be done as per ASTM B 571-97 (2008) e1. Sample size is 3 No's per Batch.

4.6.3 ACCEPTANCE CRITERIA

If the specimen fails in any one of the Visual and Adhesion tests the batch shall be rejected. The batch of the Studs accepted in the above two tests, are called finished product.

4.7 FINAL PRODUCT TESTING

The following tests shall be conducted on the finished Studs.

4.7.1 PROOF LOAD TEST

Proof load test shall be carried out on Studs on sampling basis in accordance with IS: 1367 (Part 3) Para 8.4. The sample size is 3 Nos. per batch of finished product.

The allowable permanent extension after removing the proof load for all samples is 12.5 microns.

NOTE: The test sample Studs used for above test can be used in service if there is no permanent damage to the plating and component. However, these tested Studs are segregated and placed separated and delivered with proper marking.

4.8 DIMENSIONAL INSPECTION

After above tests, all Studs shall be inspected for the dimensions given on the drawing including their tolerance grade with thread ring gauges.

5.0 IDENTIFICATION

Each stud should have identification mark as mentioned in the drawing.

6.0 CERTIFICATES

The following reports should be submitted by the manufacturer along with product. The reports should have been duly certified by Inspection Agency before delivery.

(a) Raw material chemical composition and inclusion rating.
(b) Magnetic particle inspection.
(c) Heat Treatment.
(d) Mechanical Properties.
(e) Hardness test.
(f) Pre plating stress relieving.
(g) Plating thickness measurement.
(h) Hydrogen De-Embrittlement.
(NOTE: Time taken to carry out hydrogen De-Embrittlement after plating shall be indicated).
(i) Chromate conversion treatment.
(j) Adhesion test.
(k) Proof load test.
(l) Visual examination.
(m) Dimension inspection including post plating gauging.

Enclosure -1

QA MATRIX OF ADAPTER-RAMP ASSEMBLY FOR PROJECT HSTDV

Sl. No.	Stage / Operations	Activities / Characteristics	Type of Check	Quantum of Check	Reference Document	Form of Record	Inspection	
							Firm QC	DR&QA
1	Raw Material	Chemical Analysis	Testing	3 samples	QAP	IR	P	W
2		Heat Treatment	Inspection (Strip Chart)	--	QAP	IR	P	R
3		Ultrasonic Test	Inspection	100%	QAP	IR	P	W
4		Tensile	Testing	3 samples	QAP	IR	P	W
5		Hardness	Testing	3 samples	QAP	IR	P	W
6		Metallurgy	Testing	3 samples	QAP	IR	P	W
7	Component Stage	Rough Machining	Inspection	100%	Drg	IR	P	R
8		Heat Treatment (If any)	Inspection (Strip Chart)	--	QAP	IR	P	R
9		Final Dimensional Inspection	Inspection	100%	QAP/Drg	IR	P	W
10		DP Test	Inspection	100%	QAP	IR	P	W
11		Surface Protection	Inspection	100 %	QAP	IR	P	R
12	Assembly	Dimensional	Inspection	100%	QAP/Drg	IR	P	W
13	Studs Fabrication	Chemical Analysis	Testing	3 samples	QAP	IR	P	W
14		Ultrasonic Test	Inspection	100%	QAP	IR	P	W
15		Heat Treatment	Inspection (Strip Chart)	--	QAP	IR	P	R
16		Tensile	Testing	3 samples	QAP	IR	P	W
17		Hardness	Testing	3 samples	QAP	IR	P	W
18		Dimensional & MPT	Inspection	100%	QAP/Drg	IR	P	W
19		Surface Protection	Inspection	100 %	QAP	IR	P	R

Note: W-Witness, R- Review, P – Participate, IR- Inspection Report