QUALITY ASSURANCE PLAN FOR FLOW FORMED OF SHELL

LIST OF CONTENTS

RECORD OF AMENDEMENT (QAP)

Sl. No	Amendment No& Date	Brief of Amendment	Page No/ Para no	Sign / Date

QUALITY ASSURANCE PLAN FOR FLOW FORMED SHELLS

1.0	**SCOPE**		
	This document describes the Quality Assurance requirements in respect of Dimension inspection/NDT Testing during realization of flow formed shells.		
2.0	**GENERAL QUALITY REQUIREMENTS**		
2.1	VSSC/ISRO /Inspection Agency reserves the right to depute its representative to oversee the inspection at any stage of fabrication and cross check the inspection records. The inspection stages are given in the **Annexure-QR1.**		
2.2	Parts shall be submitted for inspection to Inspection Agency for further clearance at specified stages.		
2.3	Any variation in procedure/specification shall be treated as a deviation and shall be reported to by inspection agency for analysis and decision in the format enclosed to this document as **Annexure-QR2.**		
2.4	**Heat Treatment shall be carried out ISRO approved party only.**		
2.5	Calibration of metrological instruments shall be ensured.		
2.6	The decision on final acceptance of the item rests with/Inspection agency and a Final Acceptance Report (Green card) will be issued on satisfactory compliance of all the requirements of QA plan and drawing. The items will be accepted in the stores along with Green card only. Green card format is enclosed as **Annexure-QR3.**		
2.8	Fabricator shall submit the 'Manufacturing Process Document' and obtain approval from ANSP/ISRO before proceeding with the fabrication and assembly. However, the fabricator shall be responsible for sufficiency or suitability of the process to meet technical requirements specified.		
2.9	The fabricator shall obtain approval of all Fixtures and any other tooling planned for manufacturing and testing.		
3.0	**BILL OF MATERIAL:**		
Sl.No	**Description**	**Drawing No**	**Material**
1	Shell of 2.4 mm thickness		15CDV6
2	Shell of 1.6 mm thickness		15CDV6
	Note: Above drawing numbers are for reference only. However the manufacturing drawings shall be as per scope of work		
4.0	**APPLICABLE STANDARDS**		
	As per Annexure -1		
	These standards are for the reference of manufactures / heat treatment agency/ testing agency/ plating agency only (as applicable). The same have been taken as guidance only while specifying the QA requirements of these products and the QA requirements to be ensured by the QA agency have been mentioned in this QAP various stages of manufacturing.		

5.0	**MACHINING OF PERFORM**
5.1	All the proof machines forgings/Bars (performs) shall be subjected to machining keeping the material adequately for forming to realize the component as per drawings.
5.2	Raw material identification number shall be transferred to components.
6.0	**MANDREL INSPECTION**
6.1	**Visual Inspection:** Mandrel shall be visually inspected for burrs, tool marks and any other defects
6.2	**Dimensional Inspection:** Run out of the mandrel shall be checked throughout the length and circumference. Run out shall be checked by the dial gauge and it should be within 0.05mm.
6.3	Mandrel shall be applied by grease before loading the perform.
7.0	**FLOW FORMING**
7.0.1	Lubricant shall be applied on mandrel before loading the perform
7.0.2	Vendor shall establish flow forming process parameter using trial performs. All the performs shall be flow formed to the required thickness. All the flow formed shells shall be parted off to the required length as per drawing (long shell and short shell). Note: Fine tuning of Flow forming process parameter may require to take care heat batch/lot of lot variation.
7.1	**Visual Inspection:** Flow shell shall be visually inspected for burns, mandrel scratch marks, uniformity of flow forming roller feed marks, dents, pitting and any other defects on both Inside and outside diameter of the tube.
7.2	**Dimensional Inspection**
	Dimensional Inspection: All the flow formed shall be subjected to 100 % dimensional inspection by the vendor and shall confirm to the drawing. Note: Thickness mapping shall and Ovality checking shall be done at 100mm interval along the length at minimum of ‘4’ orientation along the circumference.

8.3	**Visible Red Dye Penetrant test After Flow Forming**
	All the tube shall be subjected to red Dye Penetrant (RDP) Testing on both side outside and inside diameter accordance with ASTM E 165 and no surface indications are permitted. RDP Test shall be carried out by qualified ASNT / ISNT personnel. **Acceptance Criteria:** No relevant indications are acceptable.
8.4	**MPT After Flow Forming**
	All the tubes shall be subjected to magnetic particle inspection on both outside and Inside diameter in accordance with ASTM E1444 and no indications are permissible. MPT shall be carried out by qualified ASNT/ISNT personnel. **Acceptance Criteria:** No relevant indications are acceptable.
9.0	**HEAT TREATMENT REQUIREMENTS (15CDV6) for only First off flow formed Shell**
	First off flow formed shells shall be subjected to heat treatment as per cycle given below with extra length (100mm) or additional shell for making tensile test specimen to evaluate the mechanical properties.

	HT Operation	Temp. ^{0}C	Soaking Time in Minutes	Quenching Media(Quench delay)	Loading temperature & (Rate of heating)
	Hardening	975±10	20	Forced Air(30 second)	≤600 (100degC/hour Max)
	Tempering	640±5	30	Forced Air (30 second)	≤500 (100degC/hour Max)
9.0.1	Non uniformity of the furnace shall be maintained as follows: a) Temperature up to 750^{0}C, Non uniformity ± 5^{0}C b) Temperature from 750^{0}C to 127^{0}C, Non uniformity ± 10^{0}C				
9.1	**Pre-Heat treatment Checks:** Following shall be ensured prior to heat treatment .				
9.1.1	The Flow formed Shell and the test coupons shall be thoroughly cleaned with acetone (technical grade)				
9.1.2	The Flow formed shell and test coupons are to be loaded in furnace such that they do not touch each other.				
9.2	Suitable fixture shall be employed for minimizing distortion during heat treatment				
9.2.1	Furnace shall be connected to a recorder where Time and Temperature during the process of heat treatment shall be recorded.				
9.2.2	Soaking time shall be as per the requirement.				
9.2.3	Quench medium shall be available at right place to minimize delays in quenching.				
9.2.4	Proper quench medium temperature shall be maintained.				
9.2.5	Quench delay shall be recorded and shall not exceed 30 seconds.				
	Note: Quench delay is the time elapsed from the point when the furnace door starts opening to the point when the job is completely immersed in the quenching medium.				
9.2.6	**Quenching of Flow Formed Shell** Flow formed shell shall be quenched vertically i.e. axis of the shell shall be perpendicular to the surface of the quenching medium. Care to be taken to avoid shaking of fixture during quenching.				
9.2.7	Tempering Treatment shall be carried out within 2 hrs of Hardening.				
9.3	**Sand blasting after heat Treatment** First off Flow formed shall be subjected to sand blasting.				
9.4	**Post Heat Treatment Checks:**				
	Following shall be ensured, after heat treatment.				
9.4.1	Visual inspection shall be carried out on heat treated semi-finished components and test coupons and they shall be free from abnormal distortion.				
9.4.2	Time Temperature chart shall be kept in records and submit to Inspection Agency for review.				
10.0	**EVALUATION OF MECHANICAL PROPERTIES**				
10.1	After heat treatment, Mechanical Testing shall be carried out on the parted off shells or additional shell from each tube and results shall conform to the respective QA plans. **Note: Tensile specimens should be made by wire cut process.**				
	Direction	UTS (Mpa)	YS (Mpa)	% Elongation	

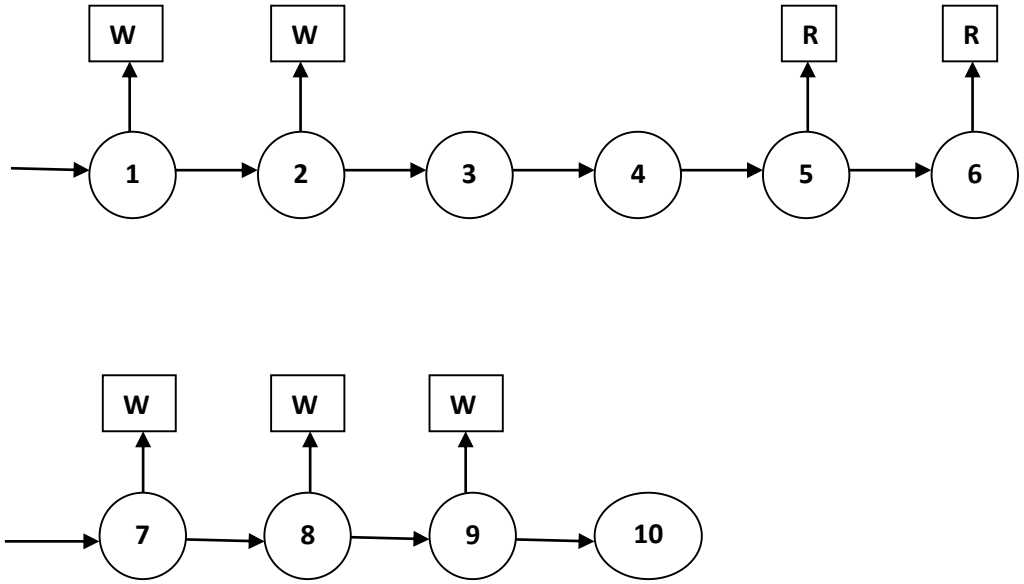
	Longitudinal	980 Min.	835 Min.	10 Min. at gauge length of 5.65 $\sqrt{A}$
11.0	**NON-DESTRUCTIVE REQUIREMENTS**			
11.1	**Red Due Penetrant test after Flow Forming**			
	All the tubes shall be subjected to Red Dye Penetrant (RDP) Testing on both outside and inside diameter in accordance with ASTM E165 and no surface indications are permitted. RDP test shall be carried out by qualified ASNT / INST personnel. **Acceptance Criteria:** No relevant indications are acceptable.			
12.0	**FINAL INSPECTION**			
12.1	**Visual and Dimensional inspection**			
12.1.1	**Visual inspection:** all the flow formed shells shall be visually inspected for burns, mandrel scratch marks, dents, pitting, quench cracks and any other defects on both Inside and Outside diameter of the tube.			
12.2	**Dimensional inspection:** All the flow formed shall be subjected to 100% dimensional inspection by the vendor and shall confirm to the drawing. Note: Thickness mapping shall and Ovality checking shall be done at 100mm interval along the length at minimum of '4' orientation along the circumference.			
12.3	A pre-inspection report to this effect shall be submitted to QA Agency to depute its representative for final clearance of the components.			
12.4	All the critical dimensions given in the drawings shall be checked again in presence of QA Agency representative.			
12.5	Dimensions which cannot be checked conventional instruments shall be checked by CMM.			
13.0	**MARKING & IDENTIFICATION ON MOTORS AND OTHER COMPONENTS**			
	Each shell shall be marked with ID No and PO No: and Year of manufacture for easy identification and traceability, ID number shall be engraved at the edge of the shell.			
14.0	**SURFACE PROTECTION FOR FLOW FORMED SHELL**			
	All the Shells shall be applied with suitable paints from inside and outside to avoid rust formation which will be finalized after mutual discussion			
	Visual inspection after Coating			
	All the Flow Shells shall be visually inspected for burns, mandrel scratch marks, dents, pitting, uniformity of coating and any other defects on both Inside and outside diameter of the tube.			
15.0	**DESPATCH CLEARANCE & GREEN CARD:**			
	Vendor has to duly fill the GREEN CARD and obtain the VSSC / Inspection Agency signature before the dispatch of the item. Vendor has to note that, without Green Card Consignment cannot be accepted at VSSC Stores. Model Green Card is enclosed as **Annexure-QR3**			
16.0	**PACKING AND TRANSPORTATTON OF SHELLS:**			
16.1	Vendor has to provide vacuum bag packing for each shell. Vacuum bag Shells have to be packed properly in wooden boxes along with their respective short shell to avoid any damage during transportation.			
16.2	Fabricator should also arrange for cushioning pads for absorbing the shocks and arresting all degrees of freedom of the motor hardware with respect to the container during the transportation.			

16.3	All the boxes should have corresponding Serial Number identification, which can be seen Very clearly.
17.0	**INSPECTION REPORTS**
	The vendor shall furnish three copies of consolidated inspection reports (spiral bound) from Raw material stage to final finished product showing the conformance to all the requirements mentioned in this QA plan and Appendices.
	List of Contents
	Green card
	List of deviations
	Raw material Test Certificates for department supplied Preforms
	Dimensional Inspection report for all flow formed shells
	NDT reports
	Furnace calibration certificate
	Heat Treatment cycle schedules with Time Temperature records
	First off flow formed shell, mechanical properties with dimensional and NDT report
18.0	**DELIVERY**
	Delivery of Components shall be made at Bonded stores of Project.

Appendix 'A'

Annexure – QR – 1

QUALITY MONITORING FLOW CHART FOR FLOW FORMED SHELLS



LEGEND

○	▭	R	W
Operation	**Inspection**	**Review**	**Witness**

QUALITY MONITORING STAGES FOR FIRST OFF FLOW FORMED SHELL

No.	Operations	Inspection Stages	
		Firm QC	VSSC/Inspection Stages
1	Proof Machining for preform	**Perform**	**-----**
2	Flow Forming	**Perform**	**-----**
3	Flow Formed shell Inspection DP, MPI, Visual Inspection, Dimensional Inspection	**Perform**	**Review**
4	Heat Treatment	**Perform**	**Review**
5	Evaluation of Mechanical Properties	**Perform**	**Review**
6	MPI & DP on Final components	**Perform**	**Witness**
7	Dimensional inspection	**Perform**	**Witness**
8	Surface Protection for Flow Formed shell	**Perform**	**Review**
9	Final Inspection & Green Card	**Perform**	**Witness**
10	Packing & Dispatch	**Perform**	**-----**

QUALITY MONITORING STAGES FOR REMAINING FLOW FORMED SHELLS

No.	Operations	Inspection Stages	
		Firm QC	VSSC/Inspection Stages
1	Proof Machining for preform	**Perform**	**-----**
2	Flow Forming	**Perform**	**-----**
3	Flow Formed shell Inspection DP, MPI, Visual Inspection, Dimensional Inspection	**Perform**	**Review**
4	Surface Protection for Flow Formed shell	**Perform**	**Review**
5	Final Inspection & Green Card	**Perform**	**Witness**
6	Packing & Dispatch	**Perform**	**-----**

Annexure –QR-2

DEVIATION/NON-CONFORMANCE REPORT

Date:

P.O.No : **Supplier:**

Nomenclature:

Drg No. : **Id.No/Sl.No.:**

Sl. No	Drawing Dimension	Drg Zone	Observed	Reasons for Deviations by Manufacturer	Justification for Acceptance/Rejection by indenter /	Remarks by Inspection Agency	Decision by Waiver Board

Supplier QC

Annexure - QR3

No:

GREEN CARD
(Batch / Group / Individual)

Date:

FINAL ACCEPTANCE REPORT

*1. Supply Order No:
* 2. Firm Name:
* 3. Supply Order Nomenclature:
* 4. Quantity on Order:
* 5. Quantity offered for acceptance:
* 6. Quantity Per Set:
* 7. PDC:
8. Inspection Report (Nos):
9. Other Supporting Documents:
10. Waiver (if any, report no):
*11. Packing instruction (if any):

Following items are accepted and cleared for dispatch to Department

Sl. No.	Item Nomenclature	Drawing No.	Identification No's of the Components	Quantity Offered

Firm QC SSQAG

NOTE:
1 Critical Parameters Report on Overleaf

SPECIAL - INSTRUCTIONS:

1 Packing & Transportation: Refer QAP
2 Inwards Goods inspection: Yes

CRITICAL PARAMETERS REPORT

Nomenclature: **Drawing No:**

No	DESCRIPTION	INSPECTION REPORT NO	REMARKS
1	Preform FIM TC		
2	First off shell HEAT TREATMENT REPORT TIME TEMPERATURE CHART		
3	First off MECHANICAL PROPERTIES		
4	DIMENSIONAL INSPECTION REPORT OF all flow formed shells		
5	NDT REPORT for all flow formed shells		