CONTROL PLAN

Doc. No. - F/01/23
Issue Date - 01 , 01.07.2020
Rev. no. - 02 , 08.10.2019

Prototype Prelaunch Production	Key Contact/Phone: DEVEN BHATIA / VINOD KUNTAL	CONTROL PLAN NO. :- 4475_480_053/ZF/06	Drg Rev. and Date : None
Part Name / Description: PLANETARY GEAR	Core Team : CHANDAN JANGID , LOKESH JANGID , AMIT SHARMA,BIRESH KUMAR,SATISH KUMAR,DEEPAK	Date (Orig.) : 05.11.22	Control Plan Rev no. and Date : - 05/27.06.2024
Part No.: 4475_480_053_DES001 Part Rev. No. :- None (....)	Supplier / Plant Approval / Date :	Customer Engineering Approval/Date (If Req.):	
Drawing No./ Change Level : 4475_480_053_DES001/None	Other Approval (If Req.) Date :	Customer Quality Approval/Date(If Req.):	
Customer Name : ZF Brazil Supplier Code : 1749024	Supplier / Plant Approval / Date :	Other Approval (If Req.) :	

OPN. NO.	DESCRIPTION OF OPERATION	MACHINE TOOLS & FIXTURE	CHARACTERISTICS				METHODS						CONTROL Method		REACTION PLAN
								MEASUREMENT TECHNIQUE	SAMPLE						
									Inspector		Quality Eng.				
			Sr NO.	Product	PROCESS	SPECIAL CHAR.	PROD./ PROC SPEC. / TOOL	Inspector	Quality Eng.	Size	Freq.	Size	Freq.	Prevention	Detection	
10	Raw Material Reciept	Crane for Unloading	1	Raw Material	RM STORAGE		ZF 7B	_	MILL TC	_		1	Per Heat	Recorded by Raw Material Incharge	Incomming Inspection Report (R.M) F/05/01	If Any Issue Found Inform RM Supplier And Take Action Accordingly
		_	2	Supplier TC Verification	To be controlled by steel supplier		As Specified	_	Visual	_		1	Per Heat			
		_	3	Reduction Ratio			6;1 Minimum As per ZF 7B ZF7B ISSUE 2021-07	_	Mill TC and also as per calculation of Bloom Size vs final size ratio.	_		1	Per Heat			
		_	4	Sticker , Heat No, & Color code painting for Matrial grade			Sticker at bar End, Heat No	_	Visual	_		100%	Per Heat			
					Colour Code		(Red + Yellow)	_		_		100%	Per Heat			
		_	5	Visual Inspection			Materail Should be Free from Bars Band/Straight , Gas Cutting at both end , Surface Crack , Dents , Melt & Notch	_	Visual	_		50%	Per Heat			
		_	6	Dimensions	AS PER IS-3739 GRADE		Dia 65 + 1.2 mm		Vernier Caliper	_		50%	Per Heat			
		_	7				Length 5.5 - 6 Meter	_	Scale Tape	_		50%	Per Heat			
	Raw Material Chemical Analysis	Spectrometer	6	Chemistry in %	To be controlled by steel supplier	PR | 3	ZF 7B As per ZF 7B std. ZF7B ISSUE 2021-07	_	Specro Analysis By Outsourcing NABL Approved Source	_		1 NOS	PER HEAT	Recorded by Raw Material Incharge	Incomming Inspection Report (R.M) F/05/01	If Any Issue Found Inform RM Supplier And Take Action Accordingly
			a	C			0.14-0.19									
			b	Mn			1.2-1.5									
			c	Si			0.300 max									
			d	Cr			1.1-1.4									
			e	P			0.025 max									
			f	S			0.010-0.025									
			g	Al			0.020-0.050									
			h	B			0.001-0.003									
			i	Sn			0.03 max									
			j	Ti			0.005 Max.									
			k	Sb			0.005 Max.									
			l	Ni			0.300 max									
			m	Cu			0.300 max									
	Gas Content (PPM) Max (Controlled By Steel Supplier)	_	m	Ca			30 ppm max	_	Verfiied Supplier TC	_		1 NOS	PER HEAT	As per Supplier TC		
			n	H2			--									
			o	O2			25 ppm max									
			p	N2			90 ppm min.									
	radioactivity	_	7	radioactivity			Steel Mill Certified the material is from radioactivity		Verfiied Supplier TC	_		Each Heat		As per Supplier TC		
	Raw Material Inspection	Microscopy	8	Inclusion as per std ASTM E45-18 ISO 4967	To be controlled by steel supplier		THIN THICK Type A ≤ ≤ Type B ≤2.0 ≤1.0 Type C ≤0.5 ≤0.5 Type D ≤1.0 ≤1.0	_	Microscope	_		1No. From two differnt bars.	PER HEAT	Recorded by Raw Material Incharge	Incomming Inspection Report (R.M) F/05/01 Tensile Test Report	If Any Issue Found Inform RM Supplier And Take Action Accordingly
	Macro	-----	9	Internal Soundness , Randum & Surface Defect	To be controlled by steel supplier		C2,R2 ,S2, Max. No harmful Dendrites		Visual under Magnifying Glass	_		1 NOS	PER HEAT	Recorded by Raw Material Incharge	Incomming Inspection Report (R.M) F/05/01 Tensile Test	If Any Issue Found Inform RM Supplier And Take Action Accordingly
	Grain Size	Microscopy	10	Grain size	To be controled by steel supplier		5 & finer As per ZFN 5016 (ZF 15-53)		Microscope			1 Nos. From two diffeent bars.	PER HEAT	Recorded by Raw Material Incharge	Incomming Inspection Report (R.M) F/05/01 Tensile Test	If Any Issue Found Inform RM Supplier And Take Action Accordingly
		Ultrasonic Testing M/C (Controlled by Still supplier)	11	Internal Cracks			100% Inspection ASTM A388	_	Ultrasonic Tester (Controlled by Still supplier)	_		100%	Each Heat	As per Supplier TC		If Any Issue Found Inform RM Supplier And Take Action Accordingly
	Raw Material Inspection continue	Jominy Appretus	12	Jominy Hardenability band As per ZF15-53			mm Hrc min Hrc max 5 39 - 44 10 35 - 40 25 27 - 32 50 24 min.	_	Hardness Testing Machine	_		1 NOS	PER HEAT	Recorded by Raw Material Incharge	Incomming Inspection Report (R.M) F/05/01 Tensile Test Report	If Any Issue Found Inform RM Supplier And Take Action Accordingly
			1	Billet Weight	-		2290±10 grm	_	Weighing machine	_		n = 2	Per Hour		Recorded in 1st	

20	Billet Cutting	Circular Cutting Saw	2	Billet Length			86.5 ± 0.5 mm	_	Vernier Caliper	_		n = 2	Per Hour	Recorded by Quality Inspector Through Set Up approval & Patroling Inspection	Five piece Inspection Report- F/09/02 , PQCS /Process Quality check sheet - F/09/03	Over Weight-Rework If More / Less Bar Dia found Inform RM Incharge and take action Accordingly Less weight - Reject
			3	Bar Dia.			Dia 65 + 1.2 mm	_	Vernier Caliper	_		n = 2	Per Bundal			
			4	Visual Inspection	-		Materail Should be Free from Surface Crack , Dents , Notch , Chips , end pieces	_	Visual	100%		n = 2	Per Hour			
30	Induction Heating	350 KW Induction Heater (Bar Heater)	1	Bar Temp.	_		1200°C to 1250°C	_	Infrared Pyrometer	_		100%	-	Recorded by Line Supervisor Through Set Up approval & Patroling Inspection	Recorded in 1st Five piece Inspection Report- F/09/02 , PQCS /Process Quality check sheet - F/09/03 Flapper mechanism available to shorting under heat/overheat billets	Over Heating - Reject Under heating - Reheat 1 times
			2	_	Pyrometer accuracy		Duly Calibrated & Certified	_	Calibration	_		1time	1year	Calibration Certificate		
				_			Verification by Hand Pyrometer Gun.		Hand Pyrometer Gun (Must be calibrated by Certifed External	_		Daily	Every Shift	Calibration Certificate		
40	Forging	Forging Press Narendra 1000 ton	1	OD			Ø104.40±0.5 mm	_	Vernier Calipers	_	_	n=2	Per Hour	Recorded by Line Supervisor Through Set Up approval & Patroling Inspection	Recorded in 1st Five piece Inspection Report- F/09/02 PQCS /Process Quality check sheet - F/09/03	Stop machine Take Action accordingly ,Segregate the matl, send reject pcs to scrap yard.
			2	Bore			Ø68.80±0.5 mm	_	Vernier Calipers	_	_	n=2	Per Hour			
			3	Total Height			48.00±0.5 mm	_	Vernier Calipers	_	_	n=2	Per Hour	One point lesson for parts handling after forging		
			4	Die temp.			200º C - 250º C	_	Hand Pyrometer Gun	_	_	n=1	Per shift (During setting)			
			5	Material Handling After forging			After forging part Should be cool down independently up to reach 400º / 500º C	By Visually (shift the part in large bins after color changing from Red Hot to Black)	Hand Pyrometer Gun	100%		n=2	Per Shift	WI for 4M Chages- QSP-01-03 Poke Yoke Flapper system added		
			6	Grain size			5 & finer As per ZFN 5016 (ZF 15-53)	_	Microscope	_	_	n=1	Per lot	Recorded by Line Lab. Supervisor	Grain Size Report F/05/37	
			7	Grain Flow			ASTM A983	_	Visual	_	_	n=1	NPD / Die design change	Recorded by Line Lab. Supervisor	Grain Flow report F/05/16	
50	ISO thermal Annealing AS PER ZF 15-93 B1):2021-05	COUNTINOUS PUSHER TYPE FURNACE (Electricle)	1	Heating	zone-1		800°c ± 10°		Visual / SCADA			1 TIME	PER HOUR	Temperature controller Availabe	INPROCESS QUALITY CHECK SHEET Heat Treatment Process Quality Inspection report F/05/05	Rework / Reject
					zone-2		955°c ± 05°	_	Visual / SCADA	_	_	1 TIME	PER HOUR			
					zone-3		955°c ± 05°	_	Visual / SCADA	_	_	1 TIME	PER HOUR			
			2	Tray Push Time			18 Min.	_	Visual / SCADA	_	_	1 TIME	PER HOUR			
			3	Pre Heating	5 Trays		90 Min.	_	Visual / SCADA	_	_	1 TIME	PER HOUR			
			4	Soaking Time	6 Trays		108 Min. ± 06 Min.	_	Visual / SCADA	_	_	1 TIME	PER HOUR			
			5	Fast cooling	by Air		Nil	_	Visual / SCADA	_	_	1 TIME	PER HOUR			
			6	ISO Zone	cooling cycle		630°C ± 10°	_	Visual / SCADA	_	_	1 TIME	PER HOUR			
				Isothermal	17 Trays		308 Minuts	_	Visual / SCADA	_	_	1 TIME	PER HOUR			
			7	_	Load Size		35 nos	_	MANUALY	100%	Every tray				PUSHER FURNACE DAILY PRODUCTION REPORT	
			8	Hardness	_		146-178 HBW	_	Hardness Testing M/C BRINNEL HARDNESS Tester	_	_	n=1	Approx. 100 pcs.		INPROCESS QUALITY CHECK SHEET Heat Treatment Process Quality Inspection report F/05/05	
			9	MicroStructure	_		Ferrite-pearlite (black white), no bainite or martensite	_	Microscope 200X	_	_	n = 1	Approx. 1000 pcs.			
			10	Grain size	_		5 & finer As per ZFN 5016 (ZF 15-53)	_	Microscope	_	_	n=1	Per lot	Gain size will be checked after every stage as per ZFN5016 A. RM stage B. After forging C. After ISO annealing		
60	Shot blasting	Automatic Loader Tumbler Type	1	Scales	_		Free From Scale	Visual	_	100%	every lot	_	_	Recorded By Supervisor	Recorded IN- SHOT BLAST PRODUCTION REPORT -F/05/40 SOP of shot blast F/05/38	Rework
			2	_	Shot Grade		Steel Shot Grade S - 0.550	_	_	100%	every lot	_	_			
			3	_	Shot Size		Ø1.40 mm	_	_	_	_	_	_			
			4	_	Cycle Time		300 Sec.	Wall Clock / Auto Cut	–	every Batch	–	–	–			
			5	_	Qty per Batch		As per SOP	Counting	_	every Batch	_	_	_			
			1	OD			Ø102.40±0.2 mm	Dial Comp.	Varnier caliper	Every 1 Hrs.		n=2	Every 2 Hrs			

70	Pre-Machine	Lath Mchine	2	BORE			Ø70.80±0.2 mm	Dial Comp.	Varnier caliper	Every 1 Hrs.		n=2	Every 2 Hrs	Recorded By Supervisor	Recorded IN-PROCESS QUALITY CHECK SHEET - PRE M/C -F/09/48	If any NG piece found inform Incharge and take action accordingly
			3	TOTAL HEIGHT			46.00±0.2 mm	Dial Comp.	Varnier caliper	Every 1 Hrs.		n=2	Every 2 Hrs			
				_	CUTTING FEED		Manual	Visual	Visual	_	_					
				_	SPINDLE RPM		720 RPM	Visual	Visual	_	_					
80	CNC MACHINING 1ST SET UP		1	OD			Ø101.4 -0.1mm	Dial Comp.	1. CMM 2. Micrometer 3. Micrometer/CMM	100%		1. SLP 6# & Production 5# 2. n = 1 3. n=1 4 n = 1	1. First Piece Inspection Report 2. **Every 1 HRS (Approx. - 28 pcs.)** 3. Last piece inspection 4. Insert / Tool Change	Recorded by Quality Inspector Through First piece inspection & Patroling Inspection WI of CNC machine operator - WI/04/01 WI for 4M Chages- QSP-01-03 Poke Yoke Tool Life Monitoring added Every Insert/Tool change respective characteristics to be verified = (n=1, to be check by Quality Eng.)	First Piece Inspection Report - F/09/05 PQCS /Process Quality check sheet - F/09/06 Last Piece Inspection Report - F/09/49	Stop machine inform to supervisor,Segregate the matl,rework pcs and send reject pcs to scrap yard. scrap the part
				OD Taper			20 micron	Dial Comp.	CMM	Every 10th Pcs.		1. SLP 6# & Production 5# 2. n = 2 3. n=1 4 n= 1	1. First Piece Inspection Report 2. Per shift 3. Last piece inspection 4. Insert / Tool Change			
			9	OD Chamfer			K0.6 +1.0	_	Contracer	_		1.n=5 2. n=1 3. n=1 4 n = 1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			14	ID Chamfer angle			45°±5°	_	Contracer	_		1.n=5 2. n=1 3. n=1 4 n = 1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			17	ID Chamfer width			3.0 +0.5mm	_	Contracer	_		1.n=5 2. n=1 3. n=1 4 n = 1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			29	Unspecified chamfer			K0.3 max	_	N/A	_		N/A	N/A			
			30	Unspecified radius			R0.3 max	_	N/A	_		N/A	N/A			
				Rough Bore			71.3 ± 0.05	Dial Comp.	DVC	Every 10th Pieces		n=1	Every 2 HRS			
		OD TNMG 0.8/1.2 BORE **TNMG 0.8**		_	CUTTING FEED		180-300mm/min.	_	Visually Check In M/c programme	_		Once During setting approval				
				_	RPM		1800-2200									
				_	FEED		0.05-0.3mm/rev.									
				_	DEPTH OF CUT		0.2-1.0 mm									
				_	CLAMPING PRESSURE		5-25 KG (ACE MICROMATIC) 50-300 MPI/Psi (MAZAK)									
				_	SPINDLE RUNOUT		0.01 (max.)									
			1	OD			Ø101.4 -0.1mm	Dial Comp.	1. CMM 2. Micrometer 3. Micrometer/CMM	100%		1. SLP 6# & Production 5# 2. n =1 3. n=1 4. n= 1	1. First Piece Inspection Report 2. **Every 1 HRS (Approx. - 28 pcs.)** 3. Last piece inspection 4. Insert / Tool Change	Recorded by Quality Inspector Through First piece inspection report & Patroling Inspection WI of CNC machine operator - WI/04/01 WI for 4M Chages- QSP-01-03 Poke Yoke Tool Life Monitoring added		
				OD Taper			20 micron	Dial Comp.	CMM	Every 10th Pcs.		1. SLP 6# & Production 5# 2. n = 2 3. n=1 4. n= 1	1. First Piece Inspection Report 2. Per shift 3. Last piece inspection 4. Insert / Tool Change			
			2	Radial Runout			0.03	Bench Center + Taper Manderal + Collet	CMM	n=1	Every 1 HRS (Approx. - 28 pcs.)	1. SLP 6# & Production 5# 2. n = 1 3. n=1 4. n= 1	1. First Piece Inspection Report **2. Per Shift (Approx. 141 Pcs.)** 3. Last piece inspection 4. Insert / Tool Change			
			3	ID			Ø72.3±0.05mm	Dial Comp.	CMM	100%		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			4	ID Chamfer angle			45°±5°	_	Contracer	_		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			5	Height			8.0 max	_	Contracer	_		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			6	Total Height			45.0 -0.4mm	Dial Comp.	Height Gauge	100%		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Every 2 Hrs. 3. Last Piece inspection 4. Insert / Tool Change			

90	CNC MACHINING 2ND SET UP		7	Face Runout		PR | 1	0.02	Bench Center + Taper Manderal + Collet	CMM	n=1	Every 1 HRS (Approx. - 28 pcs.)	1. SLP 6# & Production 5# 2. n = 1 3. n=1 4. n= 1	1. First Piece Inspection Report **2. Per Shift (Approx. 141 Pcs.)** 3. Last piece inspection 4. Insert / Tool Change	Process capability (SPC) + Control chart	First Piece Inspection Report - F/09/05 PQCS /Process Quality check sheet - F/09/06 Last Piece **inspection Report** - F/09/49	Stop machine inform to supervisor,Segregate the matl,rework pcs and send reject pcs to scrap yard. scrap the part
			8	Face Runout			0.04	Bench Center + Taper Manderal + Collet	CMM	n=1	Every 1 HRS (Approx. - 28 pcs.)	1. SLP 6# & Production 5# 2. n = 1 3. n=1 4. n= 1	1. First Piece Inspection Report **2. Per Shift (Approx. 141 Pcs.)** 3. Last piece inspection 4. Insert / Tool Change			
			10	OD Chamfer			K0.6 +1.0	_	Contracer	_		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			11	Groove Height			21.425±0.1mm	Groove Height Gauge	Height Gauge	100%		1. SLP 6# & Production 5# 2. n =1 3. n=1	1. First Piece Inspection Report **2. Every 1 HRS (Approx. - 28 pcs.)** 3. Last piece inspection 4. Insert / Tool Change			
			13	ID			Ø72.3±0.05mm	Dial Comp.	CMM	100%		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			15	Height			8.0 max	_	Contracer	_		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			16	Bore		PR | 2	Ø71.8 H7 (+0.030)	Air Plug Gauge	Bore Gauge	100%		1. SLP 6# & Production 5# 2. n =1 3. n=1 4. n= 1	1. First Piece Inspection Report **2. Every 1 HRS (Approx. - 28 pcs.)** 3. Last piece inspection 4. Insert / Tool Change	Process capability (SPC) + Control chart		
				Bore Taper			10 micron	Air Plug Gauge	CMM	Every 10th Pcs.		1. SLP 6# & Production 5# 2. n =1 3. n=1 4. n= 1	1. First Piece Inspection Report **2. Every 1 HRS (Approx. - 28 pcs.)** 3. Last piece inspection 4. Insert / Tool Change			
			18	ID Chamfer width			3.0 +0.5mm	_	Contracer	_		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2.. Per shift 3. Last piece inspection 4. Insert / Tool Change			
			19	Groove Dia.			Ø73.9±0.05mm	Dial Comp.	ID Groove Caliper	100%		1. SLP 6# & Production 5# 2. n = 1 3. n=1 4. n= 1	1. First Piece Inspection Report **2. Every 1 HRS (Approx. - 28 pcs.)** 3. Last piece inspection 4. Insert / Tool Change			
			20	Groove width			2.22±0.05mm	GO NOGO Gauge	Slip Gauge	100%		1. SLP 6# & Production 5# 2. n = 1 3. n=1 4. n= 1	1. First Piece Inspection Report **2. Every 1 HRS (Approx. - 28 pcs.)** 3. Last piece inspection 4. Insert / Tool Change			
			21	Angle			3° max	_	Contracer	_		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			22	Angle			3° max	_	Contracer	_		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			23	Groove chamfer			K0.35±0.1	_	Contracer	_		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			24	Groove chamfer			K0.35±0.1	_	Contracer	_		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			25	Groove radius			R0.2 max	_	Contracer	_		1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			

			26	Groove radius			R0.2 max	_	Contracer	_	1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			27	Roughness			Rz 25	_	Roughness Tester	_	1.n=5 2. n=1 3. n=1 4. n=1	1. First Piece Inspection Report 2. Per Shift 3. Last Piece inspection 4. Insert / Tool Change			
			29	Unspecified chamfer			K0.3 max	_	N/A	_	N/A	N/A			
			30	Unspecified radius			R0.3 max	_	N/A	_	N/A	N/A			
		ODTNMG R0.8/1.2 Bore VNMG 0.8 Groove 2mm (0.1)		_	CUTTING FEED		180-300 mm/min.	_	Visually Check In M/c programme	_	During setting approval				
				_	RPM		1800-2200								
				_	FEED		0.05-0.3mm/rev.								
				_	DEPTH OF CUT		0.2-1.0 mm								
				_	CLAMPING PRESSURE		5-25 KG (ACE MICROMATIC) 50-300 MPI/Psi (MAZAK)								
				_	SPINDLE RUNOUT		0.01 (max.)								
100	Marking	Marking M/C	1	Marking Details	_		ZF 4475.319.317 ZBR HEAT CODE YEAR AND WEEK (As per ZFN2011-1)	Visual	1. Visual 2. Visual	100%	1. n= 1 2. n = 1 3. n-1	1. First Piece Inspection Report 2. Every 1 HRS (Approx. - 28 pcs.) 3. Last piece inspection	Recorded by Marking Incharge	First Piece Inspection Report - F/09/16 Process Inspection report - F/09/17 Last Piece Inspection Report -	If Any NG Part Found Stop machine and take action accordingly
			2	Appearance			No wrong letter, wrong sequence, damage letter,	Visual	1. Visual 2. Visual	100%	1. n= 1 2. n = 1 3. n-1	1. First Piece Inspection Report 2. Every 1 HRS (Approx. - 28 pcs.) 3. Last piece inspection			
			3	Marking spec./Area	_		Ø 85.0 (Marking should be on Runout 0.04 side (F2)		DVC	_	n=2	Per Shift			
110	MPI (Crack Detection Magnetic Particle Inspection)	MPI machine (3 Phase DC Machine)	1	Cracks, Laps, Folds	_		Free form Cracks, Laps, Folds (As per ZFN 5024)	MPI method visual check under UV light		100%	n=10 (OK Parts) & All NG parts	Every Shift End	Recorded in Daily Check Sheet	Daily MPI Inspection Sheet & Check sheet SOP of MPI SOP/05/01 Calibration Certificate No. 01 Calibration Certificate No. 02 Operator minimum qualification level should be NDT Level 01.	If Any NG Part Found Store separately in bins and scrap after verify the MPI in-charge and take action accordingly
			2	-	Florescent material		MI-GLOW 810	Visual		Once During the Start of Shift	_	_			
			3	-	Bath concentration		(0.20~0.40)ml	Conical flask			_	_			
			4	-	UV light intensity		Min 1000µW/cm2	Lux meter			_	_			
			5	-	Pie gauge check		Sub surface cracks should appear on the surface	Visual			_	_			
			6	-	Current		500 Amp./inch as per OD size According to ASTM E1444 (As per SOP)	Cracks on the shims should be clearly visible			_	_			
			7	-	Demagnetize		2 Gauss (max.)	Gauss meter (Must be calibrated)		100% / Lot	_	_			
			8	-	Machine calibration frequency		Yearly	As on Due date of calibration		_	_	_			
120	Final Inspection	_	1	OD	_		Ø101.4 -0.1mm	Dial Comp.	_	100%	_	Every Lot	Recorded by Quality inspector	Recorded in F.I Data F/09/44	If Any NG Part Found Recheck the 100% Dim. Insp. & Visual Insp. And Sagrigate the material for Rework or Reject
			2	Radial Runout			0.03	Bench Center + Taper Manderal +	_	Every 20th Piece	_	Every Lot			
			6	Total Height			45.0 -0.4mm	Dial Comp.	_	100%	_	Every Lot			
			7	Face Runout		PR I 1	0.02	Bench Center + Taper Manderal +	_	Every 20th Piece	_	Every Lot			
			8	Face Runout			0.04	Bench Center + Taper Manderal +	_	Every 20th Piece	_	Every Lot			
			11	Groove Height			21.425±0.1mm	Groove Height Gauge	_	**100%**	_	Every Lot			
			13	ID			Ø72.3±0.05mm	Dial Comp.	_	100%	_	Every Lot			
			16	Bore		PR I 2	Ø71.8 H7 (+0.030)	Air Plug Gauge	_	100%	_	Every Lot			
			19	Groove Dia.			Ø73.9±0.05mm	Dial Comp.	_	100%	_	Every Lot			
			20	Groove width			2.22±0.05mm	GO NOGO Gauge	_	100%	_	Every Lot			
			28	Marking			Symbol ZF, 4475.319.317, ZBR, RACE CODE(YEAR AND WEEK CODE) (As per ZFN2011-1)	Visual	_	100%	_	Every Lot			
130	Visual Inspection	_	1	Visual Inspection	-		Part Should be free from cracks, sharp edges, chatters, nicks, surface defects etc.	Visual	Visual	100%	n=2	Every 2 Hrs	Recorded by Visual Inspection incharge As per Visual Matrix	Daily Inspection sheet	If Any NG Part Found take action accordingly
	Apply Rust		1	Rust Preventive oil	_		Castrol Rustilo DWX-30	Visually	Visually	n=1	Per Day	n=1	Per Day	Monitored by	Re- Oiling

140	Preventive	Oil Tank	2	Rust Preventive oil Condition	–		Rust Preventive oil Condition Should be Dirt free	Visually	Visually	n=5	Per Day	n=1	Per Day	Packing Incharge	Supervisor	Change the Oil
150	Packaging	-	1	-	Packing Condition		As per Packing Standard	Visual	Visual	100%	Every Lot	n=5	per lot	As Per W.I.	Supervisor	Stop the process. Inform shift incharge
		-	2	-	NOS Pieces in one BOX											
160	PDI (Pre-Delivery Inspection)	–	1	OD	–		Ø101.4 -0.1mm	–	SLP:- CMM/ Micrometer + Dial Comp. Production:- CMM/ Micrometer	–		SLP:- n= 5+5 Production:- n=5	Every Lot	Recorded by Quality inspector	Recorded in PDI Report F/09/08	If Any NG Part Found Recheck the 100% Dim. Insp. & Visual Insp. And Sagrigate the material for Rework or Reject
			2	Radial Runout			0.03	–	SLP:- CMM + Bench Center and Taper Mandrel Production:- CMM	–		SLP:- n= 5+5 Production:- n=5	Every Lot			
			3	ID			Ø72.3±0.05mm	–	CMM	–		n=5	Every Lot			
			4	ID Chamfer angle			45°±5°	–	Contracer	–		n=1	Every Lot			
			5	Height			8.0 max	–	Contracer	–		n=1	Every Lot			
			6	Total Height			45.0 -0.4mm	–	Height Gauge	–		n=5	Every Lot			
			7	Face Runout		PR | 1	0.02	–	SLP:- CMM + Bench Center and Taper Mandrel Production:- CMM	–		SLP:- n= 5+5 Production:- n=5	Every Lot			
			8	Face Runout			0.04	–	SLP:- CMM + Bench Center and Taper Mandrel Production:- CMM	–		SLP:- n= 5+5 Production:- n=5	Every Lot			
			9	OD Chamfer			K0.6 +1.0	–	Contracer	–		n=1	Every Lot			
			10	OD Chamfer			K0.6 +1.0	–	Contracer	–		n=1	Every Lot			
			11	Groove Height			21.425±0.1mm	–	SLP:- DHG+Groove height GO NOGO Production:- DHG	–		SLP:- n= 5+5 Production:- n=5	Every Lot			
			12	Marking			Ø85.0	–	DVC	–		n=5	Every Lot			
			13	ID			Ø72.3±0.05mm	–	CMM	–		n=5	Every Lot			
			14	ID Chamfer angle			45°±5°	–	Contracer	–		n=1	Every Lot			
			15	Height			8.0 max	–	Contracer	–		n=1	Every Lot			
			16	Bore		PR | 2	Ø71.8 H7 (+0.030)	–	SLP:- CMM/ Bore Gauge + Air Plug Gauge Production:- CMM/ Bore Gauge	–		SLP:- n= 5+5 Production:- n=5	Every Lot			
			17	ID Chamfer width			3.0 +0.5mm	–	Contracer	–		n=1	Every Lot			
			18	ID Chamfer width			3.0 +0.5mm	–	Contracer	–		n=1	Every Lot			
			19	Groove Dia.			Ø73.9±0.05mm	–	ID Groove Caliper	–		n=5	Every Lot			
			20	Groove width			2.22±0.05mm	–	SLP:- Slip Gauge + Width Gauge Production:- Slip Gauge	–		SLP:- n= 5+5 Production:- n=5	Every Lot			
			21	Angle			3° max	–	Contracer	–		n=1	Every Lot			
			22	Angle			3° max	–	Contracer	–		n=1	Every Lot			
			23	Groove chamfer			K0.35±0.1	–	Contracer	–		n=1	Every Lot			
			24	Groove chamfer			K0.35±0.1	–	Contracer	–		n=1	Every Lot			
			25	Groove radius			R0.2 max	–	Contracer	–		n=1	Every Lot			
			26	Groove radius			R0.2 max	–	Contracer	–		n=1	Every Lot			
			27	Roughness			Rz 25	–	Roughness Tester	–		n=5	Every Lot			
			28	Marking			Symbol ZF, 4475.319.317, ZBR, RACE CODE(YEAR AND WEEK CODE) (As per ZFN2011-1) (Marking should be on Runout 0.04 side (F2))	–	SLP:- Visual Production:- Visual	–		SLP:- n= 5+5 Production:- n=5	Every Lot			
			29	Unspecified chamfer			K0.3 max	–	N/A	–		N/A	N/A			
			30	Unspecified radius			R0.3 max	–	N/A	–		N/A	N/A			

			31	Material		PR | 3	ZF 7B: 2021-07	_	Spectro Analysis (NABL Lab _ Out Sourced)	_		n=1 (During Incoming Inspection of Raw Material)	Every Heat				
			31A	Chemical composition			Sn ≤ 0,03 Ti ≤ 0,005 Ca ≤ 0,003 Sb ≤ 0,005 O ≤ 0,0025ZF 7B: 2021-07 DIN EN EN 10020	AS PER LAB REPORT										
			31B	Quenching Grain Size			ZF7B 2021-07 : Section no. 3 (grain size factor 5 and finer after final case hardening)ZFN 5016: 2022-09 ZF 15-53: 2019-10	AS PER LAB REPORT										
			31C	Cleanliness	ISO 4967 Methode A [1] / Method A [1] A: Fein Fine, Dick Thick; B: Fein Fine, Dick Thick; C: Fein Fine, Dick Thick; D: Fein Fine, Dick Thick; D9 n. s. [2] | n. s. [2] | 2 | 1 | 0,5 | 0,5 | 1 | 1 | 2	Section 4.1 : Free of blowholes, cracks, macro slags, porosities, and flakes Section 4.2 (ISO 4967), Table 2 For dia. 35 < d ≤ 70 : K4 ≤ 10	AS PER LAB REPORT										
			31D	Hardenability			ZF7B 2021-07 ZF 15-53: 2019-10 Distance Hardness Spec. 5 (in MM) 39 - 44(In HRC) 10 (in MM) 35- 40(In HRC) 25 (in MM) 27- 32(In HRC)	AS PER LAB REPORT										
			31E	Reduction ration			at least 6. folld from casting cross section to semi-finished product	AS PER LAB REPORT										
			31F	Inspection certificate			DIN EN EN 10204-3.1	AS PER LAB REPORT										
			32	Heat Treatment			Iso Annealing (ZF 15-93 B1):2021-05	AS PER LAB REPORT				n=2	Every Heat					
			32 A	Hardness			146 - 178 HBW	AS PER LAB REPORT				n=2	Every Heat					
			32 B	Microstructure			Ferrite-pearlite (black white), no bainite or martensite	AS PER LAB REPORT				n=2	Every Heat					
			33	Delivery Conditions			ZF 7B: 2021-07	AS PER LAB REPORT										
			34	Tolerance of untoleranced dimension for clearance and blind			>Ø 1 ≤Ø 30 0.2 -0.1	_										
			35	Depth Tolerance of Blind **Holes**			+2	_										
			36	Size			ISO 14405	AS PER FORGING DRG.										
			37	Tolerance			ISO 8015 ZFN 16	_										
			38	Tolerance			ZFN 89-2	_										
			39	Forging Tolerances			Acc. to EN 10243	_										
			40	Draft Angle			3°Max	_										
			41	The Resting of face F1 must necessary be in opposite position to face F2 with Engraving			Runout For F1 - 0.02 Runout For F2 - 0.04	AS PER PDI / DIMENSION REPORT										
170	Dispatch	Proper Transport	1	_	Material loading		Handle With Carefully	_	_	100%	Yes	_	_	Invoice /Challan Paper	Supervisor	Stop the process Inform incharge		

Annual revalidation

100% all drawing specified characteristics including material tests shall be measured & recorded at SSB once in year. Reports shall be shared with ZF based on request.

Layout Inspection performed as per
LAYOUT PLAN
APRIL 2023 TO MARCH 2024 , D.C. NO.-F/01/17

Legends:				PR	Special / Important/Significant Characteristics as per Drawings			*	Major Charatcteristices as per process

Prepared By :
Mr. Sonu jangid

Checked By:-

RM Supervisor Mr.Amit Sharma	Forging Dept. Mr. Ram / Mr. Satveer	CNC Dept. Mr.Satish Kumar	Dispatch Dept. Mr.Pradeep Kumar	Heat treatment Mr. Lokesh jangid	QA Mr. Chandan jangid

APPROVED BY:-
Mr. Deven Bhatia / Mr. Vinod Kuntal

Amendment History

Rev. No.	Rev. Date	Process Revised	Revision Description
1	22.08.2023 / 14.12.23	50 & 40	1. Grain Size Checking frequency revised, Increase the temp. of austenite furnace from 940°C to 955°±5 during ISO annealing against issue received in initial lot related to grain size. 2. Improved the method of part handling/storage after forging , part will be store separately for natural and independently cooling i.e. cooldown the parts independently upto reach 400º / 500º C after forging.
2	03.05.2024	All	Revised against ZF observation (Mr. Chockklingam)
3	14.05.2024	Multiple	SPC with Control charts added for Special Characteristics in process, PDI checking frequency changed for SLP- PCM Specifications , FI and PDI process Seperated
4	3.06.2024	Multiple	Colour code in RM added, Rust preventive used name mentioned, SOP and Wis mentioned.
5	27.06.2024	All	MPI Process shifted after marking

Lessons Learnt

S.No.	Problem	Corrective Action / ActionTaken	Corrective Action / ActionTaken	Lessons Learnt	Department
1	Grain Size not Observed as per ZFN5016 (Not up to Mark 5 & finer)	Occurrence 1. Improved the method of part handling/storage after forging , part will be store separately for natural and independently cooling i.e. cooldown the parts independently upto reach 400º / 500º C after forging. 2. During ISO annealing Increase the temp. of austenite furnace from 940°C to 955°±5°c	Detection - developed the inhouse facility to Sample preparation and measuring of Grain size. Gain size will be checked after every stage as per zfn5016 A. RM stage B. After forging C. After ISO annealing	Grain Size inspection was a new topic for SSB , No in-house facility available to check the same , For inspection the grain size SSB was depended on RM Supplier , its a time taking process also SSB Was not 100% confident about the result provided by them. Now SSB developed the inhouse facility and team for Sample preparation and measurement of Grain size.	Met Lab.