

TOLERANCE AND FIT REGISTER — PROJECT RULE: ZERO PART INTERFERENCE. EVERY MATING PAIR IS A CLEARANCE FIT, VERIFIED AT BOTH TOLERANCE EXTREMES.

REF	PART / JOINT	NOMINAL	TOLERANCE / FIT	MIN / MAX CLEARANCE FROM THE LIMITS OF SIZE
\$7.1	SPHERE AND SHELL			
T01	Sphere shell	OD 2000, t 5.0	R_OUT 1000 ±3.0; local waviness ≤0.5 per 100; plate EN 10029 Class A	Single part — governs every derived clearance below
T02	Gore seams (12 + 2 caps)	—	Full-penetration butt; dressed ≤0.2 proud after weld, blended to ≤0.03 before polish (Q11); re-polished to match; 60° gloss ≥620 GU	Proud 0 - 0.2 ✓ (no mating part)
T03	Doubler collar (INTERNAL)	8 plate, 120 wide, r 242→358	Rolled to R_MID 997.5; gap ≤0.5 before welding (NO FORCED FIT-UP); edge taper 1:4 over 32 ±2; concentricity ±1.5	Gap to shell 1/5 0 - 0.5 ✓ welded before sphere closure
T04	Support skirt	Ø600 is the MEAN dia → OD 610 / ID 590, wall 10	Mean Ø600 ±0.5; roundness ≤1.0 TIR; height 446 ±1.0; flange-face perpendicularity ≤0.3 over the mean Ø600	OD 609.5 - 610.5 / ID 589.5 - 590.5 ✓ Ø600 IS NOT THE OD (REV D.1)
T05	Skirt cope to shell	Coped to bare R_OUT 1000	MATCH-MACHINED to the AS-BUILT cap from a template taken off the actual part; blue-bedding ≥70 % contact	Contact fit — replaces an absolute ≤0.5 gap, unachievable inside R ±3.0
T06	Skirt-to-doubler weld	4.5 leg fillet (a = 3.2) both sides	≥ EN 1993-1-8 minimum throat 3.0; pulsed GTAW ≤0.8 kJ/mm; 100 back-step; internal copper chill	Throat 3.2 ≥ 3.0 required ✓
T07	Skirt drain slots	8 off 60 × 40, sills 15 below the flange top	60 +1/−0 × 40 +1/−0; R10 corners; edges deburred and polished Ra ≤0.8	60.0 - 61.0 × 40.0 - 41.0; open area ≥192 cm² ✓ zero standing water
T08	Crown penetration	Ø90 hole over Ø88.9 pipe	Ø90 +1/−0	RADIAL 0.550 - 1.050 ✓
T09	Crown weir plane	ID 82.8	Machined flatness ±0.05; machined level ±0.5 + site-set level ±0.5	±1.0 TOTAL — level taken ON THE WEIR, not on the ring
T10	Riser verticality	—	≤1:500 over 2398 = 4.80 lateral at the bottom	Absorbed by the bellows T14, NOT by a gland ✓
T11	Interior breather boss	M12 × 1.5, skirt wall above the standing-water line	Desiccant / moisture-trap type, 8 N-m, bonded 316L / EPDM seal	6g in 6H ✓ replaceable from the chamber
T12	Interior low-point drain	Ø20 CRC-V seal-welded boss + plug	Accessible from the chamber; weep telltale to the chamber	Plug 6g in 6H ✓
\$7.2	RISER AND CONNECTIONS			
T13	Riser pipe	DN80 sch10S, OD 88.9 × 3.05, ID 82.8, L 2398.1	One piece; crown end machined to a spherical R1000 dish, flush ±0.3	Flush −0.3 to +0.3 to the shell O/S ✓
T14	Bottom-pole bellows	DN80 316L single-ply, free length ≈120	Axial ±5.0 (vs a 0.58 thermal demand); lateral ±2.0; rate ≤60 N/mm; full seal weld both ends	Boss Ø110 +1/−0 over Ø88.9 → RADIAL 10.550 - 11.050 ✓
T15	Stay rods	Ø10 316L, 3 levels (z 600/1200/1800) × 3 at 120°	Shell tab slots 9.0 × 18.0 (±5 adjust); rod length ±2. WELDED GUSSETS PROHIBITED	Axial compliance 85 N/mm retained (34 N at 0.40 slip) ✓
T16	Crown conditioner cartridge	Ø82.0 f8 in a Ø82.8 H9 bore	f8 −0.036/−0.090; H9 +0.087/0 (machined spool bore); FKM O-ring 2.62 in 3.6 × 1.55 groove; rests on Ø78 shoulder — REV G	RADIAL 0.418 - 0.489 ✓ O-RING SEALED — note 5
T17	Chamber flexible connector	DN80 TIED / control-rod, PN10	Axial capacity ≥±10; tie rods set for ±10 free travel; face-to-face ±3	MUST BE TIED — untied imposes 1702 N of surge thrust on the sphere
T18	Chamber elbow anchor	LR elbow, CL radius 114.3	Bracket designed for 2.5 × 1828 = 4.6 kN along the bend bisector	Design action 1828 N vs 4600 N capacity = 0.40 ✓
\$7.3	BASE FLANGE, EMBED AND ANCHORAGE			
T19	Base flange	CRC-V 1.4529, 25 plate, OD 940 / ID 500	OD / ID ±1.5; FLATNESS ≤1.0 over Ø940 MEASURED POST-WELD; level ±2.0 (fine level by the jacks)	Out-of-flatness absorbed by the 25 epoxy bed T28 ✓ see note 1
T20	SKIRT SOFFIT TO FLANGE TOP	WELDED JOINT — NO BORE	The skirt lands ON the flange annulus (r 250-470), welded both sides with a continuous 4.5 leg fillet (cadChange 6, SH04); fit-up gap ≤0.5 before welding	NO MATING BORE EXISTS — the \$7 Ø604 bore is SPURIOUS AND IS STRUCK. FLANGE_ID 500 is the riser / bellows access hole ✓
T21	Anchor slots in flange	6 off, radial slot 24 × 30, Ø800 PCD, 60° (REV G)	Slot 24 +0.2/0 × 30 +0.3/0; CRC-V plate washer Ø45 × 6; the slot spans r 385 → 415; foam grout stop in the slot annulus	TANGENTIAL 4.000 - 4.100 per side; RADIAL 7.000 - 7.150 ✓ EDGE TO OD = 470 - 415 = 55, NOT 90 (RFI-02)
T22	Cast-in studs	6 × M16 × 400 CRC-V, h_ef 250, head Ø40 × 12	Position ±1.5 (template from the flange CAD file); plumb ≤1:200; PROJECTION 150 above the embed top (−450); TRIM after final torque to leave 60-100 clear	Stack ±2.9 worst case vs ±4.0 tangential (slot 24, REV G) — margin 1.1
T23	Guide dowels	2 × Ø16 h9 duplex, Ø720 PCD, 180°, 200 long	One round bush Ø16.5 +0.2/0; one radially slotted 16.5 +0.2/0 × 20 long; 30° lead over 12	ROUND: RADIAL 0.250 - 0.372 ✓ slotted allows 0.096 growth at ΔT 20 K — note 5
T24	Cast-in embed ring	Duplex 1.4462, 20, OD 940 / ID 560	Top face level ±3.0 over Ø940; plan position ±5.0; NOT tied to carbon rebar — NYLON TIES ONLY	Jacks give ±15 and grout ±12 → both relaxations fully covered ✓ note 2
T25	Jacking screws	3 × M20 × 2.5 × 60 duplex, Ø700 PCD, 120°	6g in a 6H boss; range ±15; 17 mm hex socket drive	45 mm clear radius from the skirt OD at r = 305 ✓ 1/8 turn = 25 µm at the weir
T26	Jacking pads	3 × hardened CRC-V, 25 × 25 × 6, welded to the embed ring	Ø700 PCD, ±1.0	Screw tip lands inside the 25 × 25 pad at ±1.0 + ±1.5 = ±2.5 ✓
T27	Lifting bosses	4 × M20 × 30 deep BLIND, Ø800 PCD, AZ 35/125/215/305°	6H thread; sealed after the lift with CRC-V plugs + epoxy; cradle arms follow the bosses — 90° pitch, square, indexed 35°	CLEAR OF ALL SIX ANCHOR SLOTS at 25/85/./325° ✓ the 30° INDEXING is WITHDRAWN; the pitch stays 90°. RFI-03 CLOSED
T28	Epoxy grout bed	25 nominal	22.5 ±12 (product window 10-250); bond-breaker film to the flange underside; 4 × Ø12 ports, vents at the ID	10.5 - 34.5 inside the 10-250 window ✓ bearing 0.38 MPa vs ≥80 MPa = 0.5 %
T29	Levelling shims	316L / CRC-V only, packs 0.5 / 1.0 / 2.0 / 3.0	±0.05; left permanently in place. CARBON STEEL, PTFE AND FILLED NYLON PROHIBITED	Per-shim ±0.05; a 4-shim stack ±0.20 within the jack range ±15 ✓
T30	Bonding boss	M8 CRC-V stud-welded, skirt above the grout line	Conductor 6 mm² Cu in conduit to an accessible, testable point	Continuity <0.05 Ω recorded BEFORE the paving closes; Cu transition OUTSIDE the wet zone
\$7.4	CIVIL, COLLECTION AND ACCESS			
T31	RC pad	1800 × 1800 × 400, top −450	Plan ±20; embed-ring seating level ±5 (fine setting by the jacks); cover 55 nominal	Seating ±5 inside the jack range ±15 ✓
T32	Collector chamber wall (REV D.1)	150 thick, ID 2100 / OD 2400, −450 to −70	Cover 55; internal face steel-float; falls 1:100 to the DN110 outlet; 60 × 15 BEARING REBATE in the wall top, face −85, carries the r1050 tray edge	Rebate 3 CLEAR all round; with chamber ±1 → 2.0 - 4.0 ✓ the Rev D r950-1050 rebate is DELETED
T33	Pebble trays (REV D.1)	316L, 24 SEGMENTS at 15°, r 310 → 1050 (3.162 m²), top −10 — REV G	12 perforated deck (35 % open, holes ≤8) + 40 retained NON-CALCAREOUS 20-30 pebble; gap 2 ±1; top −10 ±1	≈0.132 m³/seg = 23 kg FILLED (two-person) / ≈14 kg DECANTED ✓ gap 1.0 - 3.0 ✓ rebate 2.0 - 4.0 ✓ RFI-05
T34	Tray structural design	—	5.0 kN/m² UDL (EN 1991-1-1 Cat. C3) + 3 kN on 200 × 200; deflection ≤L/360; EN 1433 A15 min (C250 if a vehicle can reach)	THE TRAYS CARRY NO SPHERE LOAD — bearing is skirt / flange / pad only ✓
T35	Inner tray support ring	316L or C35/45 RC at r 330-360, pad → −10	≥25 mm clear annular gap to the skirt OD at r = 305 so the slots discharge freely	25.0 nominal; skirt +0.5 and ring ±1 → 23.5 - 26.5 ✓ NOT at r = 310
T36	Reveal collar	Two-part 316L, SITE-SCRIBED	4 ±2 mm gap to the as-built shell; lifts with the inner tray	2.0 - 6.0 — below the 8 mm EN 1176 / EN 13451 finger probe ✓
T37	Paving, r 1050 → 1500 (REV D.1)	40 thick on 30 sand bedding, graded OUTWARD 1:80	Level 0.000 ±2 at r = 1050; falls 1:80 ±1:200; regularity ±3 under a 3 m straightedge; albedo 0.25-0.35	The tray, not the paving, receives the equatorial drip band ✓
T38	Paving slip resistance	—	DIN 51097 class C (24°) within r = 1500; class B (18°) beyond; PTV ≥36 wet to B5 7976 slider 55, tested WET	Wet-tested sample approved BEFORE order; re-tested at handover ✓
T39	Paving over the anchor zone	—	SAND-SET or lifted units on adjustable pedestals — MORTAR BEDDING PROHIBITED; positive restraint against rocking	Keeps the assembly recoverable — unbolt and lift ✓
T40	Perimeter slot drain	ACO Brickslot twin 8, stainless, K100, r = 1500	Alignment ±2 over any 3 m; set 3-5 below the adjacent paving; access units ≤6 m centres	Slot 8.0 each, throat 22 ✓ to soakaway / stormwater, NOT the reservoir
T41	Reservoir	Internal 1800 × 1400 × 1380; walls / base / roof 250	Crack width w_k ≤0.15; cover 55; external tanking to the OUTER face; internal WRAS / NSF-61 epoxy lining	B5 EN 1992-3 Tightness Class 1, tightened from 0.20 for XS exposure ✓
T42	Reservoir access cover (REV D.1)	4-LEAF, 900 × 900 clear, 316 recessed infill, EN 124 B125	Frame-to-chamber +7 mm; frame seats in an 1100 × 1100 × 90 DEEP REBATE, slab locally 340; sealed EPDM gasket	≤40 kg PER LEAF filled ✓ 2 leaves gave ≈72 kg each and the 70 mm recess had ZERO depth for the tray X
T43	Safety grille under the cover	316L, load-rated, hinged, retained	≤100 mm aperture; independent of the removable cover	Aperture 0 - 100 ✓ the opening is never an unguarded 900 × 900 drop
T44	Reservoir vent	DN50 316L swan-neck, ≥+300 above paving AND above the DFL	≤1 mm stainless insect mesh; removable coarse salt / dust filter; TERMINATED OFF THE BAREFOOT SURFACE	0.25 m/s at the 1380 L/h fill, 1.65 m/s at drain-back inrush, <1 mm w.g. ✓
T45	Make-up (REV D.1)	DN20, Type AB air gap over a ≥250 L break tank	≥20 mm OR 2 × bore, whichever is GREATER; 500 µm Y-strainer; FIXED RESTRICTOR 23 L/min downstream of the solenoid	AIR GAP 40 mm MIN ✓ FLOAT BACKSTOP −585 = 25 mm ABOVE the −610 setpoint (was 25 BELOW X)
T46	Bleed / backwash / drain-down	DN25 / DN75 / DN50 (backwash upsized at REV D.1)	Air gap ≥2 × pipe ID (min 50) at a surface tundish; socket weld clearance 0.2-0.5 diametral, seal welded	DN25 → 50; DN50 → 100; DN75 → 150 MIN ✓ DN50 backwash failed: 53.1 vs 75.4 L/min X

RELAXATIONS AND WHY

1. FLANGE FLATNESS RELAXED FROM 0.3 TO 1.0 mm, MEASURED POST-WELD. Holding 0.3 over Ø940 AFTER an 8 mm double fillet around Ø600 AND a weld to a 695 kg sphere means mounting a mirror sphere on a vertical borer; post-weld distortion of 1-3 mm is normal. It is also pointless — the entire function of the 25 mm epoxy bed (T28) is to accommodate baseplate out-of-flatness. FABRICATION SEQUENCE: machine the flange soffit flat → weld flange to skirt → RE-MACHINE the soffit flat → weld to the loose bottom cap with the internal chill → close the sphere last with full argon back-purge → grind and polish.
2. EMBED RING LEVEL ±3.0 AND PLAN POSITION ±5.0. The three jacking screws give ±15 mm of level and the epoxy bed accommodates ±12 mm, so tighter values buy nothing and are not achievable in a wet cast-in placement. A tolerance a Maldivian contractor can actually hit is worth more than one quietly abandoned in week one.
3. SKIRT COPE MATCH-MACHINED TO THE AS-BUILT CAP WITH ≥70 % blue-bedding contact, replacing an absolute ≤0.5 mm gap which is unachievable inside R1000 ±3.0.
4. ZERO INTERFERENCE IS CONFIRMED AT EVERY MATING PAIR ABOVE, WITH NO EXCEPTIONS (REV D.1). The one apparent exception — the Ø604 skirt bore at T20 — was a DOCUMENT ERROR, not a geometric one: there is no bore. Confirmed against the Fusion model: zero interference across the whole steel assembly.

RFI RULINGS — ALL CLOSED AT REV E

- RFI-01 CLOSED — DOCUMENT ERROR, NOT AN INTERFERENCE. THERE IS NO SKIRT BORE IN THE FLANGE. The skirt does not pass through the flange: cadChange 6 and SH04 both weld it to the flange soffit with a continuous 4.5 mm leg fillet both sides, so the skirt lands ON the flange annulus (r 250-470), and FLANGE_ID 500 is simply the central access hole for the riser and bellows. \$7 entry T20 — the derived Ø604 bore and its 3.00 mm 'interference' — is SPURIOUS AND IS STRUCK. Confirmed in the Fusion model: zero interference across the whole steel assembly. T04 also corrected: Ø600 is the skirt MEAN diameter (OD 610 / ID 590), NOT the OD.
- RFI-02 ACCEPTED AND CORRECTED. The 90 mm slot-to-OD edge distance quoted at T21 is wrong; it derives as 470 - 415 = 55 mm. T21 now carries 55. Nothing else in this register depended on the 90.
- RFI-03 CLOSED. Lift bosses are AT AZ 35/125/215/305° on the Ø800 PCD — clear of all six anchor slots at 25/85/./325°. The 90°-pitch arrangement indexed 30°, which coincided at 120° and 300°, is withdrawn. Cradle arms follow the bosses: 90° pitch, square, indexed 35°. Issued arrangement on SH11.
- RFI-04 CLOSED. M16 × 400 at h_ef 250 projects 150 above the embed ring top (−450), i.e. crown −300 and 100 CLEAR above the flange top (−400). geo.STUD_PROJ = 150. TRIM AFTER FINAL TORQUE to leave 60-100 clear, so the ≥60 rule is met without 68 mm of naked thread. The earlier 91 (41 clear) failed the rule; the interim 110 was arbitrary.
- RFI-05 CLOSED — 24 SEGMENTS ADOPTED (REV G). The r 310 → 1050 annulus is 3.162 m²: a 12 mm 316L deck at 35 % open is 62.4 kg/m² and 40 mm of retained pebble −64 kg/m³, so the trays total ≈400 kg. At 6 segments that was 67 kg per lift — and 47 kg even at the old r900, so the 6-segment call was already wrong before the collector was widened. geo.TRAY_SEG_MIN = 24 gives 15° segments of ≈0.132 m³: ≈23 kg FILLED / ≈14 kg DECK + FRAME AFTER DECAN'T. See the SH10 note.
- NOTE 5 T16 and T23 derived maxima (1.481 and 0.372) differ from the \$7 figures (1.55 and 0.35) because the mating part's ISO grade is included in the derivation. The derived values govern; neither is an interference.
- NOTE 6 REV D.1 supersedes the Rev D level stack, pump duty and pipe sizes. T20, T21, T22, T27, T32, T33, T37, T42, T44, T45 and T46 above carry the revised values; SH09 and SH10 carry the full re-cut.
- REV E INTEGRATION SH05 now states that the skirt lands on the flange annulus and that the Ø500 central opening is an access bore — there is no skirt bore. This closes the former cross-sheet conflict.

REV	DATE	DESCRIPTION	BY
D	2026-08-05	CONCEALED SKIRT ANCHORAGE, RESERVOIR + PLANT, PEBBLE COLLECTOR	NX
E	2026-08-20	REV D.2 ALIGNMENT + VISUAL QA CORRECTIONS	NX
F	2026-09-03	LOGO ENGRAVING ADDED (SH15); SHEET COUNT 14 -> 15	NX
G	2026-09-05	AUDIT CLOSE-OUT: CART Ø82 f8, SLOT 24, 24 TRAYS, DN80	NX
G.2	2026-09-06	PART DRAWINGS SH30-38; SLOTS AZ22.5; DOUBLER R995	NX
G.3	2026-09-06	SH37 BRACKET, SH42 WELD MAP, P-16 BELLOW; IFF	NX

SPA FOUNTAIN — B7 SPA, MALDIVES

SPA-F-SH12 — TOLERANCE AND FIT REGISTER — T01 TO T46 (ZERO INTERFERENCE)

DRAWN: NaXief Eng.		CHECKED: NX 2026-09-06		APPROVED: I. NAZEEF 2026-09-06		STATUS: IFF REV G.3			
DATE: 2026-09-06		REV: G.3		UNITS: mm		SCALE: AS NOTED		A3 · SHEET 12/25	
ISSUED FOR FABRICATION — REV G.3 · HOLD POINTS PER SH42 WORK TO FIGURED DIMENSIONS · ISO 2768-mK U.O.S.									

