

# VCR Requirements, Quality, BOM & Vendor Summary

This markdown consolidates the VCR-specific slices requested for PDF export.

## 1. Requirements Overview

Req ID	Theme	Verification	Artifact Hook
RTM.001	All serviceable joints shall be /FS (VCR-compatible)	Visual inspection + BOM review	P&IDs, Line class sheet
RTM.002	Each /FS remake shall use a new metal gasket with batch traceability and tamper evidence.	Maintenance checklist	Maintenance log, Tamper-seal log
RTM.003	/FS orientation shall be panel-female and module-male	Field inspection	Orientation checklist
RTM.003b	Small pneumatic/solenoid pilots shall be fail-open so loss of motive air does not obstruct manual isolation flow.	Functional test	Valve FAT/SAT records
RTM.004	Leak acceptance shall meet Addendum Table 6 values using EN 13185 / ISO 20485 helium mass-spectrometer methods.	Helium MS leak test	Leak reports

Req ID	Theme	Verification	Artifact Hook
RTM.005	DBB plus eductor purge shall achieve residual air $\leq 0.05\%$ before breaking the joint.	Procedure witness	Purge log, Analyzer log
RTM.006	QINFRA.S/QRB.S shall be protected at 1.3 bar(a) with PSV capacity $\geq 200$ g/s @ 300 K routed to WCS.LP recovery.	Sizing calculations + certificates	PSV certification dossier
RTM.007	Provide BD/PSV populations and setpoints as defined above with certified orifice capacity.	Manifest review + certificates	BOM_Master.csv, Certification pack
RTM.008	Implement tamper-evident ties and scan-based remake counting for every /FS connection.	Inspection + system audit	Tamper log, Maintenance system report
RTM.009	Install dual helium analyzers (GAP.WCS and GAP.QRB) measuring H <sub>2</sub> O and N <sub>2</sub> with $\pm 1$ ppm accuracy and $\leq 1$ ppm/year drift	Calibration verification	Analyzer calibration certificates

## 2. Quality Controls Snapshot

- Hold/Witness plan: see VCR\_Quality\_Procedures.docx Section 1.
- DBB purge and helium leak test steps remain mandatory before any /FS joint return to service.
- Analyzer calibration ( $\pm 1$  ppm,  $\leq 1$  ppm/year drift) anchors acceptance for RTM.004/009.

### 3. BOM Elements Driving the VCR Envelope

Tag	Area	Description	Setpoint/Ratio	Qty	Notes
BD.QCELL	QCELL	Bursting disc	2.0 bar(a)	60	Cold users; route to recovery/tunnel vent
BD.QPLANT	WCS/HP	Bursting disc (HP)	18 bar(a)	2	Compressor discharge / ORS envelope
BD.QPLANT	QRB.D/QRB.E	Bursting disc (thermal shield)	3.5 bar(a)	3	Supply/return branches
BD.QPLANT	WCS.LP	Bursting disc (LP auxiliaries)	1.3 bar(a)	0	Use PSV per spec
PSV.QCELL	QCELL	Safety valve population	(varies)	180	Allocate per QCELL functions
PSV.QPLANT	WCS/HP	Safety valve (HP)	16 bar(a)	6	Compressor trains & headers
PSV.QPLANT	QRB.D/QRB.E	Safety valve (thermal shield)	4.0 bar(a)	6	Warm TS loops
PSV.QPLANT	WCS.LP	Safety valve (LP header)	1.3 bar(a)	4	Protect LP header
PSV.QPLANT	TA/Bus	Vacuum breaker	0.95 bar(a)	4	Thin-wall vessels
PSV.QPLANT	QINFRA.S	Safety valve (S-line header)	1.3 bar(a)	4	>=200 g/s He @300 K to WCS.LP
VAL.ONOFF	WCS/QRB	On/Off valves	PN rated	180	1" welded bodies; /FS at instrument take-offs

Tag	Area	Description	Setpoint/Ratio	Qty	Notes
FSU.GASKETALL		Metal gasket kit	n/a	>500	SS primary; Ni/Cu by temperature
GAP.WCS	WCS	Gas analyzer panel	ppm range	1	Moisture/N2 analyzer; return to WCS.LP
GAP.QRB	QRB	Gas analyzer panel	ppm range	1	Cold-box room analyzer; return to WCS.LP
EDC.QINFRAHP	Network	Venturi eductor set	?P motive	6	Dry N2 motive purge blocks
SOL.FAILOPEN	WCS/QRB	Fail-open pilot solenoids	24 VDC	60	Manual isolation assist

#### 4. Vendor Landscape (budgetary only)

Scope	Vendors	Indicative Range	Notes
/FS fittings & gaskets	Swagelok; Parker Veriflo; FITOK	Metal gaskets ~EUR 2-15; bodies/weld glands ~EUR 20-120 (finish dependent)	Catalog/distributor pricing; include cleaning premiums
Pressure safety valves	Leser; Herose; Advance Valve (stockist)	DN25-DN50 cryogenic PSV ~EUR 400-1,200	Cryogenic helium service; certification costs apply
Bursting discs	REMBE; OsecoElfab; Fike Europe	Disc EUR 250-600; holder EUR 400-900	Match holders to disc series per supplier guidance
Venturi eductors & purge hardware	SMC ZH; Piab piINLINE	Approx. EUR 20-150	Dry N2 motive supply, size orifices per purge calc

Scope	Vendors	Indicative Range	Notes
Fail-open pilot solenoids	ASCO; Buerkert	Approx. EUR 100-550	Three-way NO valves; certification/material adders
Online He purity analyzers	Michell; Edgetech/PST	Dual-channel packages mid four- to low five-figure EUR	Include sample conditioning + calibration service

## 5. Architecture & Ops Touchpoints

- ADR-001 enforces the /FS policy, purge discipline, and relief population baseline.
- OCD scenarios: maintenance outage + emergency depressurization demand live proof of purge, analyzer, and S-line capacity.
- Evidence flow: P&IDs / BOM -> RTM -> QA logs -> CIS records -> vendor cert dossiers.