

Factory Acceptance Test Protocol – LC-1000

Preconditions, test steps and acceptance criteria across visual, mechanical, controls, performance and documentation scope.

DOCUMENT ID	MQA-FAT-001	REVISION	A
DATE	September 2026	PREPARED BY	Mohammad Al-Araidah
STATUS	Issued for independent engineering study	CLASSIFICATION	Synthetic data — not for production use

Independent engineering study. This document was created to demonstrate a structured approach to manufacturing quality for mission-critical equipment. The supplier, equipment, specifications and all results are synthetic. It is not design guidance, not a compliance assessment against any standard, and must not be used on a production programme.

Equipment under test

ITEM	DETAIL
Supplier	Northstar Thermal Systems
Model	LC-1000
Description	Liquid-to-liquid coolant distribution skid, nominal 1 MW
Document set	Hypothetical — created for this study

Acceptance parameters

Each parameter below is classified by its basis. Acceptance requirements are derived from the study assumptions above them; nothing here is a product specification.

PARAMETER	VALUE	BASIS	SOURCE OR DERIVATION
Nominal thermal capacity	1 MW	Study assumption	Chosen as a representative single-skid capacity so the quality problem is concrete. Not derived from any product.
Secondary design flow	1,440 L/min (24 L/s)	Acceptance requirement	Derived: $1,000\text{ kW} \div (4.18\text{ kJ/kg}\cdot\text{K} \times 10\text{ K}) \approx 23.9\text{ kg/s} \approx 24\text{ L/s}$. Rounded to 1,440 L/min, which returns a 10.0 K rise at capacity.
Secondary differential pressure at design flow	250 kPa minimum	Acceptance requirement	The head the skid must deliver to the technology loop at design flow. Assumed for this study; on a real project it comes from the downstream loop resistance.
Circuit design pressure	1,000 kPa (10 bar)	Study assumption	Chosen to make the pressure-test acceptance value derivable rather than asserted.

PARAMETER	VALUE	BASIS	SOURCE OR DERIVATION
Hydrostatic test pressure	1,500 kPa	Acceptance requirement	Derived as $1.5 \times$ design pressure, the minimum hydrostatic leak-test pressure in ASME B31.3, subject to not exceeding the rating of any non-isolated component.

Preconditions

The test does not start until every precondition below is satisfied and recorded.

- ☐ Drawings, specifications and the control narrative issued at the revisions the skid was built to, and those revisions recorded on the test record.
- ☐ All test and process instruments within current calibration, with range and resolution adequate for the acceptance values being measured.
- ☐ As-built configuration frozen and recorded, including PLC application and instrument firmware revisions.
- ☐ Hydrostatic pressure test completed and accepted; hold point released.
- ☐ Cleanliness and flushing completed and accepted.
- ☐ Test loop configured to the design operating point, with the means to set and hold design flow.
- ☐ Nonconformance status declared: every open NCR listed with its disposition, and no open NCR affecting a characteristic under test.
- ☐ Test record templates approved before execution, so results are recorded against acceptance criteria rather than transcribed afterwards.

Test section 1 — Visual and workmanship inspection

Establish that the skid as presented matches the released documentation and can be operated and maintained.

#	TEST STEP	RESULT	RECORD REF
01	Skid nameplate data verified against the purchase order and the specification.		
02	General workmanship: supports, fasteners, pipe routing, insulation, absence of mechanical damage.		
03	Valve identification and tag numbers present and consistent with the P&ID.		
04	Instrument tagging present and consistent with the instrument index.		
05	Enclosure condition, ingress protection provisions, and cable entry workmanship.		
06	Access and maintainability: filter, strainer and pump access without removing unrelated components.		
07	Drain and vent provisions present and operable.		

Test section 2 — Mechanical verification

Confirm the pressure boundary and the rotating equipment are correct before any performance number is trusted.

#	TEST STEP	RESULT	RECORD REF
01	Hydrostatic test record reviewed: test pressure at or above $1.5 \times$ design pressure, hold time achieved, calibrated gauge identified.		
02	No visible leakage at any joint under operating pressure after filling.		
03	Pump rotation direction verified.		
04	Pump alignment record reviewed against the manufacturer tolerance.		
05	Vibration measured at each pump at design duty and compared against the agreed limit.		
06	Filter and strainer elements confirmed installed to the specified rating.		
07	Expansion tank pre-charge verified and low-level alarm function confirmed.		

Test section 3 — Controls verification

Prove that the protective functions work, including on failure — the section most often reduced to a demonstration rather than a test.

#	TEST STEP	RESULT	RECORD REF
01	Instrument loop check: applied input versus indication at the HMI and over the BMS interface, across the instrument range.		
02	Differential-pressure transmitter scaling verified against an applied reference at two points spanning the operating range.		
03	Every alarm induced and its annunciation verified, at the HMI and at the BMS.		
04	Every interlock induced and its action verified, including the resulting equipment state.		
05	Emergency stop operated and the resulting state verified.		
06	BMS interface point list verified end to end; behaviour on loss of communication verified against the narrative.		
07	Fail-safe state verified on loss of power and on loss of control signal.		
08	Parameter security verified: setpoints cannot be altered without the defined authorization.		

Test section 4 — Performance verification

Demonstrate the skid meets its hydraulic, thermal and redundancy requirements at the design operating point.

#	TEST STEP	RESULT	RECORD REF
01	Design flow established on the secondary circuit and held for the defined period.		
02	Differential pressure recorded at design flow and compared against the specified minimum.		
03	Pump speed and absorbed power recorded at the design operating point.		

#	TEST STEP	RESULT	RECORD REF
04	Thermal performance recorded at design conditions; supply temperature compared against the setpoint band.		
05	Control response to a step change in load recorded; stability assessed for sustained oscillation.		
06	Pump redundancy changeover tested in both directions, with time to re-establish design flow recorded.		
07	Leak detection tested at every zone with the fail-safe action verified.		
08	Test repeated for confirmation where a result falls within the measurement uncertainty of the acceptance limit.		

Test section 5 — Documentation verification

Confirm the record the owner will actually receive is complete and traceable, before the skid leaves.

#	TEST STEP	RESULT	RECORD REF
01	As-built drawings issued at the revision matching the skid.		
02	Material certificates present and traceable to the skid serial number.		
03	Weld records present by joint identifier, welder and WPS; NDE reports attached where required.		
04	Calibration certificates for every instrument used in acceptance measurements.		
05	Pressure test, flushing, alignment and electrical test records present.		
06	Completed FAT record with results recorded against each acceptance criterion.		
07	Punch list issued with severity, owner and required closure evidence for each item.		
08	Operation and maintenance documentation and spare parts list provided.		

Disposition definitions

VERDICT	DEFINITION	CONSEQUENCE
PASS	Every acceptance criterion met, with results recorded. Punch list contains no item affecting a tested characteristic.	Proceed to documentation turnover and shipment release.
PASS WITH DEVIATION	All criteria met except one or more where an approved engineering deviation exists, granted before the test on a stated technical basis — not a result renegotiated afterwards.	Proceed with the deviation recorded in the release package and carried into the site records, so the as-accepted condition is known for the life of the equipment.
FAIL / HOLD	One or more acceptance criteria not met with no approved deviation, or the evidence required to judge a criterion is unavailable.	Shipment placed on hold. Nonconformance raised, root cause established, corrective action verified, and the affected tests repeated before the disposition is revisited.

Measurement uncertainty. Where a measured value falls within the measurement uncertainty of an acceptance limit, the criterion is not met by default. The test is repeated, and if the result remains within uncertainty the disposition is escalated to engineering

rather than resolved by rounding.

Disposition

ENGINEERING DECISION

FAT disposition: ☐ PASS ☐ PASS WITH DEVIATION ☐ FAIL / HOLD

Basis: _____

Open nonconformances at disposition: _____

Approved deviations referenced: _____

Supplier quality — name, signature, date

Supplier engineering — name, signature, date

Owner quality engineering — name, signature,
date