THERNESS

Fusion for Energy (F4E)

Weld process monitoring for critical joints

Capability statement for F4E-OPE-1405 (JT-60SA divertor)

Document type	Capability statement
Client	Fusion for Energy (F4E)
Object / scope	Weld process monitoring of divertor and diagnostic components
Equipment / method	HeatCam IR-C, Therness PoolDrop, WeldTrace, HeatCore software
Records / evidence	Company data and product specifications, October 2026; SAW application report, 2026
Author	Therness S.r.l.
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Reference	TR-F4E-WELD-MONITORING-2026-11-10
Revision	Rev01
Status	For customer discussion
Confidentiality	Customer documentation

Document note

This statement describes the monitoring capability only. Commercial terms are not part of this document and are confirmed separately in writing.

1 Summary

Therness builds weld process monitoring systems for critical joints: thermal and visible cameras on the welding head, edge AI that flags process anomalies while the pass is made, and a per-joint record usable as inspection documentation. Everything runs on the edge, without cloud dependency. This statement describes what we measure, what the record contains, the evidence behind the figures and the limits that apply.

2 Who we are

Therness S.r.l. is an Italian SME in Turin, spin-off and innovative start-up of the Politecnico di Torino (since 2025, incubated at I3P). Seven years of R&D on thermography for welding; the monitoring chain is shipped as a product — camera, acquisition, models, record.

2,000+
welds monitored in production

16 km+
of weld seam monitored in production

230 h+
of welding monitored in production

3,000+
welds recorded in thermography in 2026

15+
systems, cameras and licences shipped

7
industrial sectors served

7 yrs
of R&D on thermography for welding

15+
peer-reviewed papers by the founding team

Company data as of October 2026.

3 What we measure

Thermal imaging shows how the weld behaved; the electrical channels show what the machine delivered. Both sit on one time axis, so every joint keeps a single, replayable record.

Sensor	What it adds to the record	Key figures
HeatCam IR-C (thermal)	Weld pool and trailing bead, radiometric frames in °C; pool area, width, height, position and thermal drift measured on every frame.	384 × 240 px; −20 to 900 °C (1500 °C optional); 60 mK NETD; PoE
Therness PoolDrop (visible)	Wire, droplet and pool, arc by arc; high-speed visual frames usable as visual-testing evidence.	Up to 480 frames/s; Class 1 laser-safe light; USB 3.0
WeldTrace (electrical)	Voltage, current, wire feed and gas flow measured at the welding equipment and recorded with the thermal stream.	Voltage ±100 V (0.01 V); current ±500 A continuous / ±700 A peak (0.1 A); wire feed ±25 m/min (0.021 m/min); gas 10 Hz; sampling up to 25 kHz

Specifications: Therness product pages, October 2026. Sampling rate adjustable per channel.

4 What the per-joint record contains

- **Thermal metrics per frame:** peak intensity, thermal width, centreline position, left-right asymmetry, cooling behaviour, local hot or cold discontinuities, segment-level stability score.
- **Thermal C-scan map of the whole weld:** one image line per frame, stacked over the weld length, so a long seam is reviewed as a compact process map instead of frame by frame.
- **Alarms and qualification data:** out-of-spec voltage or current, wire-slip detection, gas-flow logging, WPS/PQR records, WAAM traceability.
- **Evidence pack:** thermal video, CSV metrics, raw frames, quality report, timestamped audit log; REST API (OpenAPI 3.1), WebSocket, RTSP, CSV export; PLC integration on project.

5 Reference applications and measured evidence

- **Production line, since August 2026:** over 2,000 welds and 16 km of seam recorded in thermography on an industrial welding line, one record per weld.

- **Submerged arc welding:** application report for thick-section, long-seam SAW — trailing-view thermal monitoring, alignment view, thermal C-scan and a four-step shadow-mode pilot path.
- **Robotic arc-wire cell (CMT / MIG-MAG), our laboratory:** 30 hard geometries, 10 layers, one run, 360 of 360 arcs recorded; a +5 mm stickout step seen by the torch-mounted camera on 6 walls out of 6.
- **Three-sensor dataset and program recognition:** thermal 25 fps, visible 480 fps and current/voltage up to 25 kHz on the same bead; welding program recognised from one second of current (97 and 64 takes against a shuffled-label control, p = 0.0099 and p = 0.029).

6 Where it fits in a welding procedure

Alignment view. Joint reference, wire reference, thermal centreline and a tolerance band in one operator display: when the thermal centreline leaves the band the segment is flagged and the evidence kept, so lateral drift is caught before it becomes a long non-conforming section. **Workflow.** Head alignment, baseline per WPS, material, thickness and travel speed, monitoring of lateral position, thermal width and asymmetry during the weld, review of flagged segments against NDT and repair logs.

7 Evidence for the standards you work to

Standard	Asks for	We record
ISO 3834	Controlled, documented welding	A record per weld
ISO 17637	Visual testing	High-speed visual frames
ISO 17635	General NDT rules	Thermal data alongside NDT
ISO 5817	Imperfection quality levels	Data against your limits
EN 1090-2	Steel structure execution	Traceable weld records

8 Scope and limits

- **Measurement, not approval.** Conformity assessment and qualification stay with the welding coordinator, examiner or notified body; Therness provides measured evidence.
- **No parameter control.** WeldTrace does not change welding parameters; only the optional gas-saving module regulates gas flow.
- **Documented reference cell.** Arc-wire (CMT / MIG-MAG) with thermal and visible imaging. We do not claim wire-laser or DED experience.
- **Submerged arc welding.** Arc and pool are partly hidden by flux: the stable window is just behind the welding point, on the deposited bead and the base metal on both sides, with a rigid mount on the carriage or head support and a protected optical path (window, air knife).

9 How an engagement starts

1 Line survey and installation design (station, mounting point, protection, field of view, data access, weld-ID traceability), **2 Data collection** on representative welds, including normal variation and any defect or repair evidence, **3 Offline model calibration** (accepted process window, flagged segments compared with quality outcomes), **4 Shadow-mode validation**: the system runs beside production without changing acceptance decisions, with response rules agreed with your quality team.

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