Table 2 — Customer Data Requirements for CSR - TDE-Vacuum™ (RH)

What information is required from the customer?

The implementation level depends on the quality, depth and availability of plant data. The matrix below shows what is typically needed for each TDE-Vacuum™ (RH) deployment level.

Legend:

● Required ◐ Recommended ○ Optional — Not required

Required input from customer	Offline Simulator	DSS / Advisory Mode	Online Digital Twin
Basic RH plant data (vessel type, ladle capacity, vacuum vessel arrangement, circulation system, main equipment)	●	●	●
General RH process description (treatment philosophy, vacuum practice, circulation logic, alloying and trimming practice)	●	●	●
Typical operating values (arrival temperature, target temperature, treatment duration, vacuum level, gas flow practice, alloy additions)	●	●	●
Standard recipes / operating practice	●	●	●
Historical treatment results (final temperature, final chemistry, treatment time, vacuum performance, alloy consumption)	◐	●	●
Heat-by-heat / treatment-by-treatment production data	○	●	●
Time-stamped process sequence (vacuum start/end, circulation phases, gas injection, alloy additions, sampling events, temperature measurements)	○	◐	●
Actual process measurements during operation	○	●	●
Vacuum pressure data	○	●	●
Gas flow data (argon or other treatment gases, if applicable)	○	◐	●
Temperature measurement data	◐	●	●
Chemistry and sampling data	◐	●	●
Circulation / recirculation related process data (if available)	○	◐	●
Alloy addition and trimming data	○	●	●

Required input from customer	Offline Simulator	DSS / Advisory Mode	Online Digital Twin
Treatment timing and sequence logic	○	◐	●
List of available data sources (Excel, CSV, historian, database, Level 2, etc.)	◐	●	●
Live signal availability	—	○	●
PLC / Level 1 / Level 2 tag list	—	○	●
Tag description and engineering units	—	○	●
Data communication architecture (OPC-UA, database, API, historian, network constraints)	—	◐	●
Automation sequence and phase logic	—	○	●
IT / OT environment and deployment constraints	—	○	●
Customer expectations and project objectives	●	●	●

TDE-Vacuum™ (RH) can start as an Offline Simulator and progressively evolve into DSS / Advisory Mode and a fully integrated Online Digital Twin as plant data availability increases.

Note on data quality and consistency

The quality of TDE™ outputs depends on the accuracy, completeness, time alignment and engineering consistency of the data provided by the customer. Whenever available, data should be supplied with clear units, time stamps, signal descriptions, process phase references and indication of measurement source. Inaccurate, incomplete or non-synchronized data may still allow a preliminary implementation, but with reduced predictive strength and advisory precision.