

Table 1 — CSR - TDE-Vacuum™ (RH) Implementation Levels

TDE-Vacuum™ (RH) can be deployed at three progressive implementation levels, depending on the customer’s objectives, available data and desired degree of plant integration.

Integration level:

- Full live integration
- ◐ Partial / advisory integration
- No live plant connection required

Version	Main purpose	Typical use	Plant integration	Expected output
Offline Simulator	Process study and scenario evaluation	What-if analysis, vacuum treatment studies, degassing assessment, thermal evaluation, training, benchmarking	— No live plant connection required	Simulated treatment trends, thermal and metallurgical analysis, comparison of operating strategies
DSS / Advisory Mode	Decision support during RH treatment	Operator guidance, degassing assessment, treatment review, temperature and chemistry adjustment support, deviation interpretation	◐ Historical, exported or semi-live plant data	Recommendations, warnings, process interpretation, support for treatment decisions
Online Digital Twin	Real-time synchronized process representation	Live monitoring, predictive supervision, vacuum treatment tracking, digital twin deployment	● Integrated with live plant signals and automation architecture	Real-time tracking, predicted process evolution, dynamic advisory output, synchronized digital process view

Each level corresponds to a different operational scope, from offline engineering analysis to real-time synchronized process intelligence.