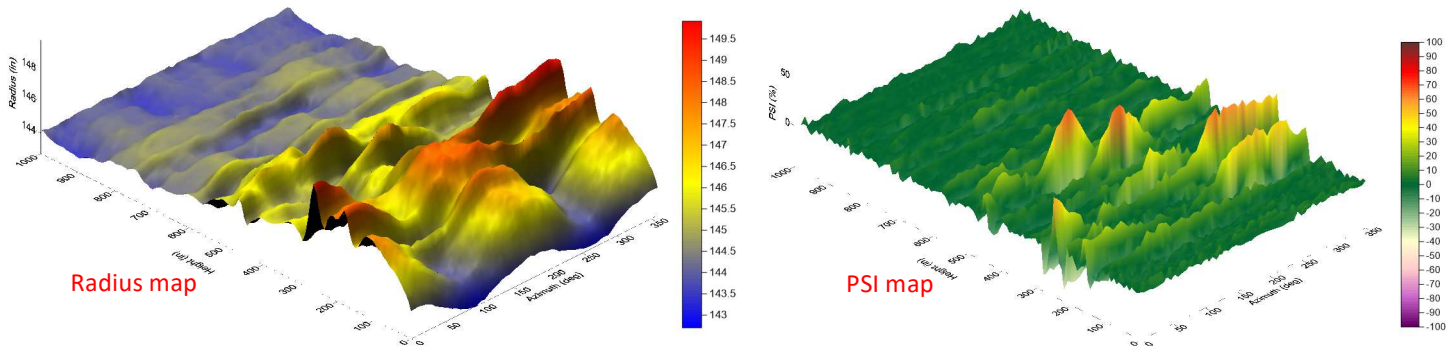


## The Plastic Strain Index (PSI)<sup>TM</sup>

Coke drums are unique in the frequency and severity of the in-service damage they experience. The shell section experiences severe distortions and cracks unlike any other process vessel. Assessment of this damage type is challenging because the cyclic thermo-mechanical loads that the shell experiences during operations cannot be defined or predicted with any useful accuracy.

The Plastic Strain Index (PSI)<sup>TM</sup> is a proprietary methodology that was developed by HES specifically for assessing the severity of bulging in coke drums. The strain-based technique identifies and ranks the areas that are most susceptible to failure on the inside and outside surfaces of drum wall using API 579/ ASME FFS failure limits that were calibrated using a database of internal and external bulging-induced cracks. Bulging severity at each point on the drum is classified to be within “Design”, “Concern”, “Danger”, or “Failure” levels. PSI results are used to make decisions regarding future inspections, repairs, and replacement. When more than one scan is analyzed for a given drum, a historical severity trend can be established and used to make timely repairs and avoid unplanned shutdowns.



As of 2021, more than 350 bulging assessments have been performed using this state-of-the-art technique for refineries and upgraders all over the world. When bulging severity reaches unacceptably high levels, PSI results are used to design effective long-term repairs such as weld overlay reinforcements. The accuracy of failure predictions made by PSI and the effectiveness of long-term bulge repairs that were implemented based on PSI results have been widely published by operating companies. To obtain copies of these publications, please visit HES website or submit requests via email.

The following table compares PSI to other bulging assessment methods.

Comparison of Bulging Assessment Methods	Geometric Features (magnitude, derivatives, sharpness, etc.)	Stress Concentration	Full API 579 Procedure	Pattern Recognition	PSI
Based on laws of solid mechanics	NO	YES	YES	NO	YES
Uses API 579 industry standard limits	NO	NO	YES	NO	YES
Uses realistic thermomechanical loads	N/A *	NO	NO	N/A *	N/A *
Calibrated using database of both external and internal failures	NO	NO	NO	YES	YES
Assessment specifies external versus internal failure initiation	NO	YES	YES	YES	YES
Correlation to observed failures published by operating companies	NO	NO	NO	YES	YES
Effectiveness of bulge repairs published by operating companies	NO	NO	NO	YES	YES

\* N/A: Not Applicable