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## **Question 25: Coke drum integrity can be compromised due to the use of feed side entry devices. What is your experience with drum roundness upon inspection?**

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Coke drum integrity is typically dominated by low cycle fatigue. Imposed stresses due to thermal gradients during drum warming, water quenching and the contraction of the drum while full of coke can result in stresses higher than the yield stress of the coke drum metal. This can result in an out of roundness of the coke drum regardless of the type of feed entry. There are many factors that contribute to the stresses in the coke drum metal. These include the initial quench water rate injected to quench the coke bed and the drum temperature before switching feed into the drum. Side entry introduces a momentum component to contribute to the thermal gradients in the coke drum even with a bottom feed configuration. While the ASME code allows a 1% of the internal diameter out of roundness for new pressure vessels, coke drums are typically manufactured to a 0.5% out of roundness specification. Roundness is important, particularly for protection against vacuum conditions. It is not the most important parameter to consider for mechanical integrity. Sharp bulges are the areas that typically develop cracks. These bulges typically develop near circumferential welds. The extent of the bulge and the sharpness are factors in crack generation and crack propagation.

For coke drums constructed from 1 1/4 Chrome steel base metal, which is a very common material for coke drums, radial growth has been measured as much as 2.5% of the internal diameter of the drum. Radial growth of 1% to 1.5% is more common for drums constructed of this material.

Drums with single side entry and with no internal refractory or insulation to mitigate the thermal gradient at the feed location have been in service for more than 10 years and have given good service. There have been cases where single side entry has been replaced with dual side entry or a center feed device to limit the thermal gradients and that has proven beneficial. It would make sense that reducing the thermal gradients would reduce the imposed stresses and prolong drum life. The benefit of switching to these alternate feed configurations will likely require study on a case-by-case basis depending on how severe the drum operation is with a single side entry and the momentum of the feed as it enters the drum and the type of coke produced.

Routine laser scanning of the coke drums to determine the drum shape and the extent of any bulges is the key to managing coke drum integrity. A laser scans every 3 years is appropriate from drums that do not show any significant bulges. As the bulges develop and begin to grow, annual scans are appropriate and as the drum begins to reach the end of its life, laser scans every 6 months are reasonable. A high-definition video scan can be done at the same time and can provide some insight into the drum condition.

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## Year

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