Question 4: Does your refinery/company adopt a time-based rather than inspection-based replacement strategy for FCC reactor and regenerator hardware such as feed nozzles, air distributor, cyclones, cyclone support systems, and flue gas expansion joint bellows? If so, what is the planned service life for this equipment?

THOMPSON (Chevron)

It depends. I had to throw that in there. FCC folks always say that. Service life of each component is highly dependent on the application and varies from unit to unit. We have generally found that inspection-based replacement frequency is used as opposed to time-based. We use the results of the last unit inspection, coupled with a run history, to determine whether we need to replace a particular component.

Unit monitoring is extremely important and we do not want any surprises when we open up the unit. As an example, we would try to use cyclone erosion predictions to determine whether we are going to have an issue with cyclone wear when they get inside. We have adopted an upgrade strategy for high-wear, low-reliability components. We generally plan for at least a five-year run. And if we have components that will not make that run, then we try to address those selectively. We have developed Best Practices for most of those components.

Our expectations for typical service life of some of these components would be feed nozzles—five to 10 years; air distributor—15 to 20 years; reactor and regenerator cyclones—15 to 20 years; cyclone support systems—15 to 20 years; and, flue gas expansion bellows—15 to 20 years. Again, this service life is highly dependent on the severity of the unit and the particular configuration.

Obviously, operating conditions and run history have a big effect on the service life. The other thing that we found that is a big impact is the number of shutdowns. If you have a lot of emergency shutdowns or the unit is unstable a lot of the time, that is going to greatly affect the service life.

WARDINSKY (ConocoPhillips)

We use a combination of inspection-based and time-based replacement schedules for converter section internals; for example, feed nozzles, depending on the particular licenser nozzles used. It is not uncommon to replace feed nozzle tips on each turnaround. We generally recommend that everyone have a spare set of nozzle tips or nozzles around ready for replacement on turnaround.

We would typically start looking at replacing regenerator internals, such as cyclone systems and air distributors, after 15 to 20 years of service or if significant sigma phase embrittlement is evident from

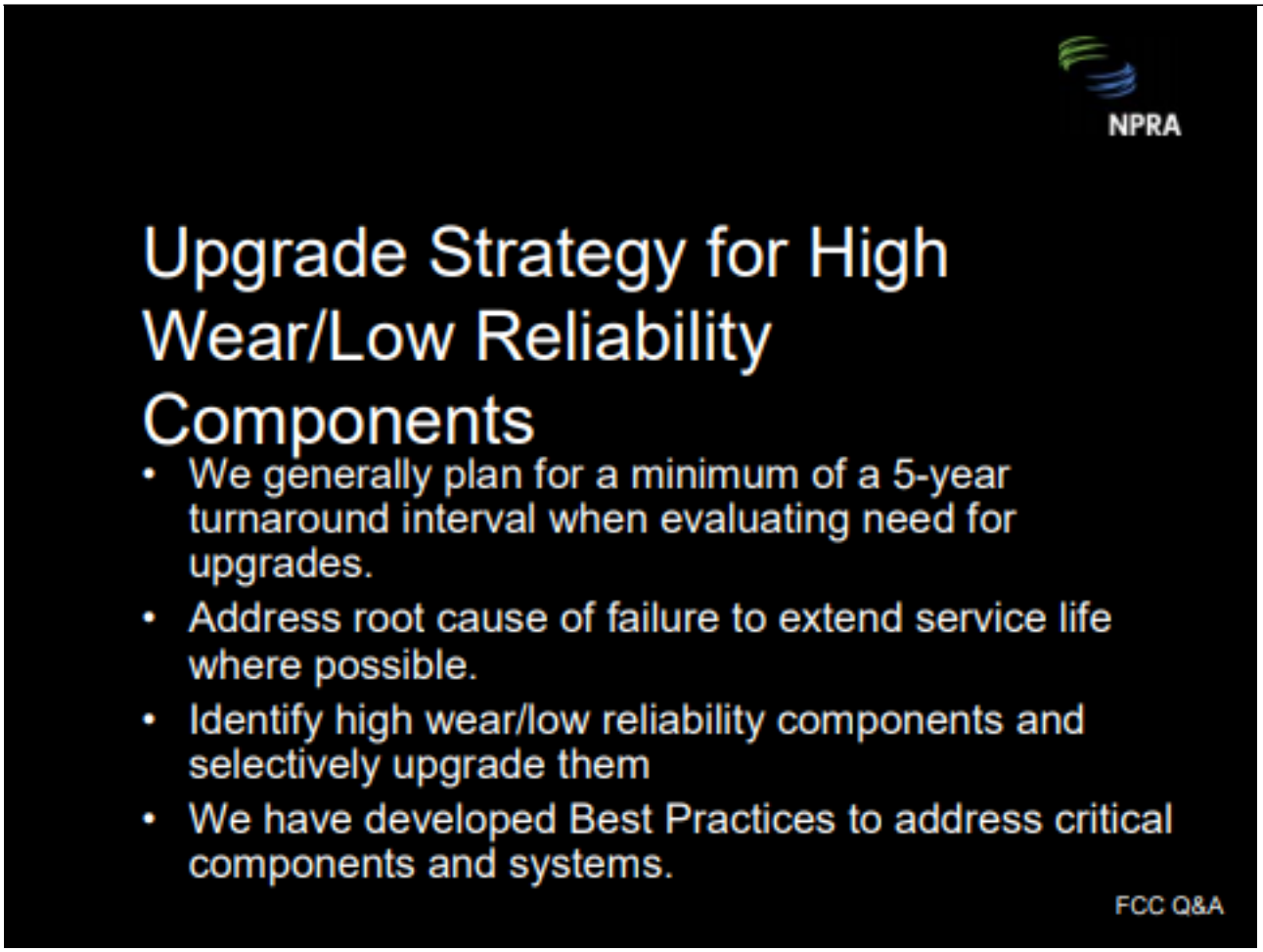
metallurgical analysis. Reactor disengager and cyclone systems can last longer—25 years or so is not uncommon—before metallurgical changes, such as carbide formation, start to limit welding repairs. This assumes that these equipment items are not replaced sooner during capacity expansions. Flue gas expansion joint bellows replacement is completely based on inspection criteria, except for bellows upstream of flue gas expanders, which typically are replaced every turnaround.

ASDOURIAN (Sunoco Inc.)

Sunoco relies on an inspection-based replacement strategy. The inspection-based strategy for the listed items will vary by component. Many factors come into play when making these determinations. Note that the inspection for all but one of the components—that being the flue gas expansion joint bellows—must be done when the unit is down. And even on the bellows, a complete visual inspection cannot be performed on the expansion unit when the unit is running. Therefore, these two must be looked at when the unit is down.

The inspections are performed using guidance and knowledge provided by these documents: API-RP571—Damage Mechanisms Affecting Fixed Equipment, API-RP579— Fitness for Service, and API-RP936—Inspection and Testing Monolithic Refractory Linings and Materials. These are the documents our Inspection and Reliability folks utilize.

The listed components, and others, are subjected to a document review as early as 24 months prior to the turnaround. The historical inspection records are reviewed by the team and a determination is made of the likely condition of the components. These are reviewed by the business team during the Turnaround Preparation meetings. An inspection work scope is then generated and assigned to each of the components. Upon gaining access to the equipment, a condition assessment occurs utilizing all of the documents. The conditions are noted in the inspection report and items that revealed excess wear and damage will be noted in recommendations for future repair or replacement.



JIM WEITH (Mustang Engineering)

One thing I did not hear addressed was the flue gas piping, as I said I worked on some time ago. We learned from the metallurgical folks—who can explain this better—that apparently things migrate in stainless piping. This was a hot-wall pipe. After 12 to 14 years, it starts cracking. We did have that experience. Every time we had a thermal cycle, we would come up and find a crack in our flue gas piping. Then, we would have to schedule in time to get that fixed. And of course, it was always at some out-of-the-way place that was nearly impossible to get to. So ultimately, we bit the bullet and replaced the flue gas piping in its entirety.

WALKER (UOP)

I agree with that. What we do is with the entire flue gas is cold-wall for a new unit. That includes the line, the orifice chamber, and the slide valve.

WARDINSKY (ConocoPhillips)

The only place nowadays where you expect to see a hot-wall system would be upstream of the expander and those areas do require special attention from the mechanical folks to make sure the metallurgy that exists there is still in good shape.

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