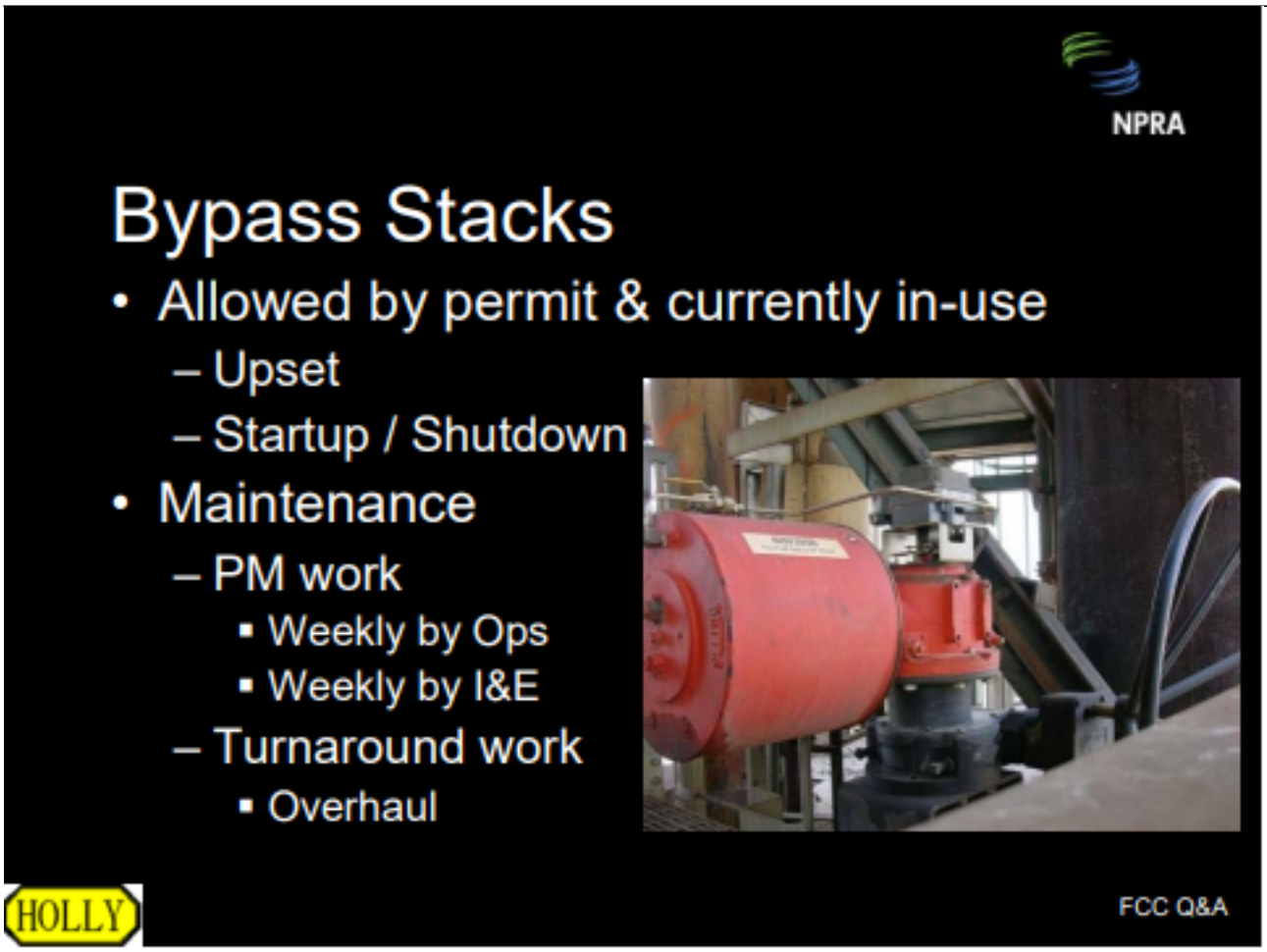
Question 6: Some CO and waste heat boilers operate with bypass stacks separated by seal pots or isolation valves. Maintenance of these seal systems can be expensive and these seal systems can be sources of poor reliability. What design upgrades and operating practices have enabled you to eliminate these bypass systems?

HOWELL (Holly Refining)

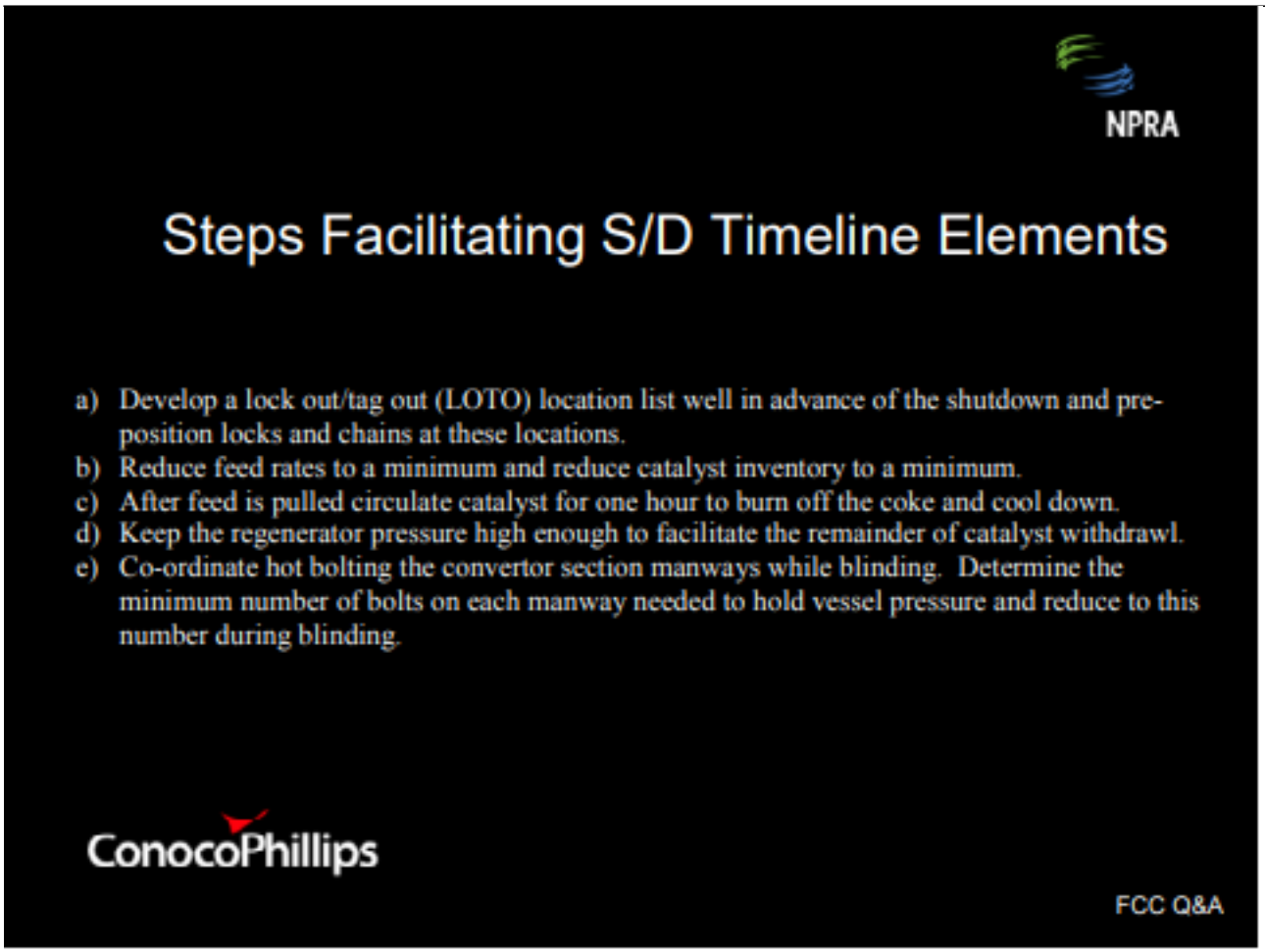
Holly Refining continues to use bypass stacks with diversion valves at both of our refineries. Those stacks and diversion valves are allowed by permit and we use them during startup/shutdown manning upset conditions. Both our Operations and Maintenance groups are assigned weekly preventative maintenance tasks to ensure operability when we do have to throw these valves. Those preventative maintenance tasks include weekly partial exercise in both the valve and the positioner. During scheduled turnarounds, valves are disassembled, inspected, and often reworked. Because we have CO boilers in both locations, we do not foresee any major design changes to these systems. Certainly at this time, we do not see any need that we might end up removing the diversion valves from our systems.



WARDINSKY (ConocoPhillips)

Flue gas heat removal equipment in FCC service has been a major source of unplanned feed outages and maintenance work. Elimination of bypass ducting around this type of equipment necessitates improved reliability off the heat removal equipment.

Steps to improve the reliability of the CO boiler and waste-heat boiler systems include those described below. I want to emphasize that if your boiler feed water is coming from another part of the plant, such as the Utility part, do not ignore it. You really need to have your unit engineers on the FCC pay attention to boiler feed water chemistry because in some cases, that chemistry has lead to failures in this type of equipment. We have also experienced failures in this equipment due to poor design of the intermittent blowdown (IBD) systems with deposits of sludge and solids inside the tubes. Obviously, make sure that you are putting enough boiler feed water to the tubes. We do not want to dry them out because that will cause them to fail. This equipment is typically hard to inspect and we do not do a good job on most turnarounds, in my opinion, of inspecting this kind of equipment. Obviously if you have had repeated failures of this equipment during a run that are not process related, then I would suggest that you look at replacing equipment with a better design.



THOMPSON (Chevron)

We would agree that CO boiler reliability has generally been poor and often does not meet the run-length requirements. This necessitates the coupling of the CO boiler from the flue gas train. Generally, we prefer to take one of two approaches. The first approach, which is preferred, is to change the operation so we operate in complete CO combustion. Often, that requires regenerator modifications. It will also necessitate increased oxygen demand and might require supplemental air or oxygen. It does have benefits in improved regeneration, high cat activity, and improved yields. Unfortunately, there are times when that is not possible, such as when you are feeding resid. We operate several units of the SSW R2R design that have twostage regeneration and those have a first-stage system that separates combusts the CO. The heat removal is non-fired and has been very reliable. The CO incinerator does have a bypass system, but we have not had to use it.

WALKER (UOP)

A field boiler is generally less reliable than most of the FCC equipment. For a grassroots unit, we would try to design for a complete combustion, if at all possible, in order to eliminate a CO boiler. For high resid

feedstocks, we would use catalyst cooling to the maximum extent. We would then use partial combustion for very high resid feedstocks. We recommend complete combustion with the cat cooler for feedstocks having up to around 3% or 5% concarbon, depending on the refiner's comfort level and partial combustion being on that level. If partial combustion is justified and a CO boiler is installed, we would recommend a bypass stack with a diverter valve.

PHIL NICCUM (KBR)

Operating in a partial combustion does offer advantages for catalyst activity maintenance for heavy feedstocks, particularly those with a lot of vanadium. On several occasions, we would design units that could be operated either in complete CO combustion or partial CO combustion and allow the refiners to change the operation as their feedstock or other requirements change.

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