Background

In the fall of 2012, a domestic pressurized water reactor (PWR) power plant was forced to suspend core offload, and experienced an outage delay of approximately 12 hours caused by the spent-fuel-handling tool becoming stuck on a spent-fuel assembly in the fuel-handling building. While lowering the tool onto a fuel assembly, the tool had been misaligned in such a way that one of the alignment “S-pins” (S-pin #1) entered the correct hole on the fuel assembly while the other (S-pin #2) missed its hole, causing the tool head to rotate and lodge onto the fuel assembly, as shown in the photograph on page two.

Although the operators did not attempt to latch the fuel assembly, they were still unable to raise the tool off of the fuel assembly due to the gripper fingers being caught under the top nozzle springs. Workers made multiple attempts to raise, rotate, lean and mechanically agitate the tool, and were finally successful in freeing it. However, critical path of the outage was ultimately extended for more than 12 hours due to the event and the subsequent inspections. Similar events have occurred at other PWR power plants over the past 20 years where refueling machines have become lodged onto fuel assemblies in containment.
Description

In response to the event described above, Westinghouse has developed a patent-pending design for a spent-fuel-handling tool that prevents the possibility of becoming stuck on a top nozzle. For many PWR spent-fuel-handling tools, the gripper fingers remain at a fixed elevation and simply pivot between a latched and unlatched orientation. This places the gripper fingers at an elevation, which can interfere with fuel components if not properly aligned. The retractable finger (RF) spent-fuel tool incorporates fingers that both pivot and raise/lower with a single latching or unlatching operation, as illustrated on page one. When in the disengaged position, the gripper fingers are raised and shielded within the tool housing, as illustrated in the “unlatched position” on page one. This protects the tool from becoming lodged onto a fuel assembly regardless of any misalignment during the latching process. The tool is inherently fail-safe because the design requires the operator to raise the gripper fingers in order to unlatch – meaning it cannot be unlatched when a fuel assembly is suspended from the tool. Similar fuel-handling equipment built for the AP1000® power plant fleet recently passed Inspections, Tests, Analyses, and Acceptance Criteria (ITAAC) testing, in which this scenario was simulated to verify that an operator cannot unlatch a tool from an assembly while the tool is under load.

Benefits

• In the unlatched position, gripper fingers are housed within the body of the tool head to prevent any undesired interaction between gripper fingers and top nozzle springs, rod cluster control assemblies, thimble plugs, etc.
• Operation of the RF spent-fuel-handling tool is identical to current spent-fuel-handling tools in the industry. Minimal updates are required for training, operating procedures, etc.
• Incorporates all upgrades in the latest tool design implemented for the AP1000 power plant fleet including:
  - Captured and locked fasteners
  - Full-down indicator
  - Reduced head for use in high density racks
  - Chamfered lead-ins for smooth rack entry
  - Single-piece latch pin design for foreign material exclusion (FME)
  - Spring assist for reduced operating effort
  - Reduction of threaded joints
  - Optional two-piece design for ease of transportation
• Tool design can be adapted to 14x14, 15x15, or 17x17 PWR fuel types

Experience

Westinghouse has been a world leader in supplying fuel-handling equipment to PWR power plants for several decades. The RF spent-fuel tool includes proven features of its existing fleet of spent fuel-handling tools, including a fail-safe latching process, full-down visual indicator and FME-proof latch pin. However, the tool also incorporates a retracting finger design proven to be reliable in the Westinghouse refuel machine grippers.