Improving Safety and Reliability

of Boiling Water Reactor Core Isolation Cooling Pump Systems

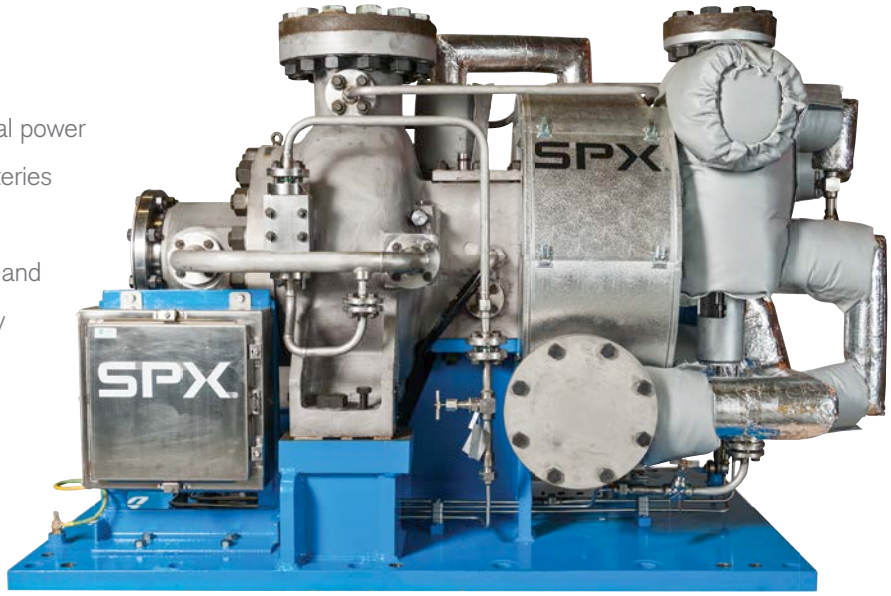
TWL Combined Turbine/Pump Upgrade Package

Continued, reliable operation of reactor core isolation cooling (RCIC) pumps is vital to nuclear plant safety during a station blackout (SBO). The Turbine Water Lubricated (TWL) Pump is a combined centrifugal pump and turbine designed specifically for nuclear safety applications. It requires no external power or additional support systems to provide continued, remote operation during prolonged periods of power outage. It provides reliable pumping of water for decay heat removal and, subject to net positive suction head (NPSH) availability, can also be used to pump high-temperature suppression pool water during pool boiling events.

The TWL is manufactured as a single shaft in a monoblock casing. It is approximately half the size of traditional pump/turbine arrangements and provides a compact, light pumping solution that is easy to retrofit and more easily accessible for simplified maintenance. It has fewer parts than systems that use separate turbines, pumps, and couplings, and has a design that should offer improved reliability, better performance, and easier maintenance. With no need for any electrical power, it is designed to extend SBO coping duration beyond the capabilities of existing turbine-driven pump sets in nuclear power plants.

Benefits of upgrading to a TWL Pump

- Extended SBO RCIC operation—no electrical power required, so is not dependent on station batteries or manual operation
- Easier maintenance with fewer components and compact design, enabling easier accessibility
- Proven, reliable operation
- Reduced fire risk due to no oil requirement
- Discharge head, flow rates, and required steam conditions meet or exceed existing boiling water reactor (BWR) installation requirements






Designed for reliable operation in extreme conditions

- Completely self-contained solution—no lubricating oil, cooling water, electrical, pneumatic, or other external services required
- Can run and start-up under completely flooded conditions
- Designed to withstand seismic events
- No drive couplings and no alignment issues
- Eliminates failure modes such as those identified in NUREG reports:
  - Water lubricated bearings ensure reliable operation without the need for oil systems
  - Self-contained governor and controls require no external services
- No potential leak paths as the shaft does not penetrate the casing and there are no mechanical seals between pumped fluid and the atmosphere
- Rapid hot or cold start-up
- No overshoot beyond running speed
- Accommodates water slugs both at start-up and during normal operation with no detrimental impact to equipment
- Compact design

How does the TWL operate?

The TWL is designed for simple, reliable operation without the need for any electrical power. On demand, the mechanical governor arrangement quickly accelerates the TWL to operational speed without the need for any additional supporting services such as oil systems, pneumatics, etc.

The TWL employs a venturi in the pump discharge branch to measure pressure that is proportional to the pump flow. This pressure acts across the piston of the governor, providing a mechanical action that throttles the steam flow to the turbine. At start-up, the throttle is fully open, allowing rapid acceleration. As the speed increases, the duty flow and pressure are met and the governor moves to control the steam. The mechanism is fully mechanical and requires no external signals or controls.

Proven, accredited, tested

SPX ClydeUnion Pumps manufactures Class 1, Class 2, and Class 3 pumps for nuclear power plants and has ASME, 10CFR50 Appendix B Program, RCC-M, RCC-MX, HAF604, and 'N' stamp accreditation. It has proven capability with pumps installed in a majority of operational nuclear power plants and more than 50 years of experience in supplying nuclear pumping solutions. The TWL Pump/Turbine set has full nuclear quality assurance and has been approved by the U.S. Nuclear Regulatory Commission for use in RCIC system on advanced BWR (ABWR) plants. It has been installed in nuclear power plants throughout Europe, China, South Korea, and Taiwan, with more than 30 years of successful operating history as a safety related pump.

Submergence tested for complete peace of mind

The TWL has a single casing design with no shaft protrusions, enabling it to start and operate while fully submerged. Extensive testing at ClydeUnion Pumps' Glasgow facility has shown that it will maintain safety performance and continue to operate with no adverse effects or detrimental changes to performance for a minimum of eight hours. During this time, the pump can be started and stopped, again with no detriment to its performance.

SPX®

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