

# Auxiliary Feedwater System and Turbine/Pump Upgrades for Pressurized Water Reactors

## Background

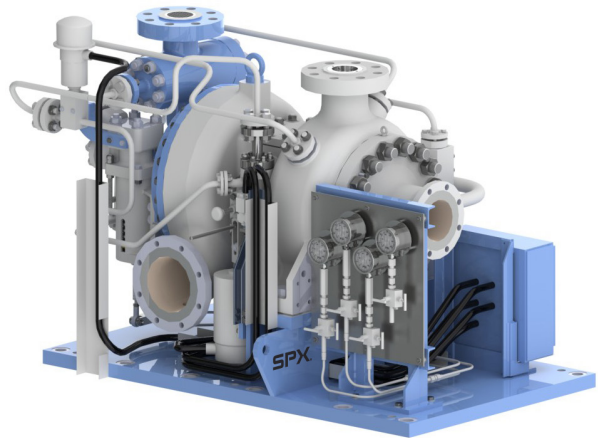
Nuclear industry plant owners, operators, original equipment manufacturer (OEM) designers, and regulators are acutely aware of potential plant vulnerabilities that can lead to a complete loss of a unit's electrical power. That loss, called station blackout (SBO), has been the subject of active investigation for decades. Current industry awareness of this event recognizes that natural phenomena, terrorist/security challenges and even random equipment failure can initiate it. The most safety-significant systems in the case of an SBO in a nuclear power plant are the reactor core isolation cooling (RCIC) system for boiling water reactors (BWRs) and the auxiliary feedwater (AFW) system for pressurized water reactors (PWRs). The steam-driven water pump in these systems is typically the frontline component that addresses SBO and provides core heat removal.

Proper operation of the AFW system in a PWR traditionally requires DC power from a station battery, steam from the steam generators and an adequate supply of secondary plant water. The total amount of current draw on the station battery can be a limiting factor in determining the duration of SBO coping.

## Description

Westinghouse, together with ClydeUnion Pumps, an SPX Brand, is offering a system and application engineering modification to incorporate a proven turbine/pump set that provides an improved plant AFW system that addresses many of the concerns related to conventional component support in an extended SBO event.

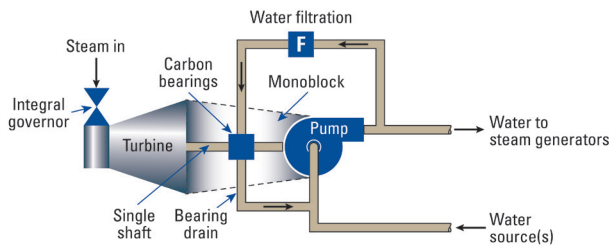
The ClydeUnion Pumps turbine/pump set is simpler and more compact than the contemporary component arrangement, with fewer moving parts. It is also capable of extended local, power-free manual operation.



ClydeUnion Pumps Turbine Water Lubricated (TWL) turbine/pump set

Westinghouse and ClydeUnion Pumps are working together to customize their existing, proven TWL turbine/pump set in order to extend SBO coping duration beyond current capabilities. This turbine/pump set can be retrofitted or can completely replace existing turbine-driven pump sets in nuclear power plants worldwide. Westinghouse provides customized system integration to make the AFW system operations fully independent of AC and DC power; performs hardware procurement and qualifications; generates needed analyses, design change packages, and design operating and emergency procedure revisions; and organizes qualified field labor forces for installation and startup testing.

The ClydeUnion Pumps TWL turbine/pump set is a monoblock design with an integral two-speed governor, a smaller footprint, a single shaft, no essential support dependencies and no lubricating oil to present a fire hazard. It is available with full nuclear quality assurance in accordance with American Society of Mechanical Engineers (ASME) and RCC-M requirements. The U.S. Nuclear Regulatory Commission approved the ClydeUnion Pumps TWL as the specific turbine-driven pump of the RCIC design (the BWR equivalent of the AFW) in the Toshiba Advanced BWR (ABWR) standard operating license application in the United States. The TWL pump provides required performance pertaining to discharge head, flow rates and required steam conditions, meeting or exceeding existing PWR installation requirements (1,200 psig and 900+ gpm), and the set is extendable for power uprates.



Generalized auxiliary feedwater cooling schematic

## Benefits

The Westinghouse extended coping package replaces the existing AFW turbine/pump set with a ClydeUnion Pumps TWL unit and adds instrumentation and customized system integration, resulting in the following significant normal operation and emergency operation benefits:

- Part of an extended SBO coping strategy in which the AFW system can operate without supporting services (AC/DC not required)
- Reduced room fire loading (no lubricating oil used)
- Fewer system components that require maintenance and surveillance
- Smaller system footprint
- Excellent transient response
- Self-governing for duty control

Westinghouse can provide full implementation, from event transient analysis simulations to design change packages, field labor, and startup testing and procedures.

Westinghouse can also deliver all services related to procurement, design, analysis, licensing and installation to extend plant coping.

## Experience

Westinghouse has proven system design and application experience operating nuclear power plants worldwide.

The ClydeUnion Pumps TWL turbine/pump set has an impressive 40-year operating history, including use in both nuclear and non-nuclear installations worldwide. Of the more than 70 nuclear plant applications in place since 1971, most support an RCIC function, although a TWL pump/turbine set is installed as an AFW pump in a contemporary Westinghouse PWR in the United Kingdom and three PWRs in Sweden.