



Upgrade for nuclear coolant charging pumps

Industry:	Power - nuclear
Region:	Americas
Territory:	North America
Category:	Site fault investigation
API Type:	Reciprocating pump

ClydeUnion Pumps Aftermarket Technical Services team has experience across a range of services on critical rotating and reciprocating equipment to improve operational safety, reliability and efficiency. The upgrade of the coolant charging pumps for the nuclear market is one of our success stories documented in our library of case studies. These case studies highlight the requirement from the customer, how we achieved the goal and the process we followed to deliver the improvements.

Image left: Union Pump QX300

Situation

Prior to 1990, a large number of USA Pressurised Water Reactor (PWR) nuclear power plants had experienced widespread premature failure of the coolant charging pumps (many of them were the Union Pump QX300 Triplex Pump). Reciprocating plunger pumps were the preferred choice of the original Nuclear Steam Supply System (NSSS) suppliers due to the continuous operation of these pumps at low flow and high head (specific speed considerations). These specific pumps also had a safety related function which allowed the primary loop to charge in the event of a leak. Noting a systemic problem with the existing installed reciprocating coolant charging pumps, the customer put forth a centrifugal pump solution (the RLIJ and CAM multi-stage pumps). This centrifugal pump solution was adopted by many of the USA PWR nuclear power plants. At the time, it was deemed by many of the nuclear power plants to be operationally cost effective to go forward with this costly addition of these multi-stage centrifugal pumps (cost includes plant

design changes, pump purchase and installation). From a pump selection and design point of view, the reciprocating coolant charging pump should inherently be the optimum pump type for the normal hydraulics required.

Challenge

A select few PWR operators (Indian Point 2 & 3 and Salem) broke from the pack and decided to investigate the root cause of the QX300 failures with ClydeUnion Pumps.

- Excessive leakage around packing shortly after packing replacement
- Premature valve failure - cracking (performance drop off)
- Overheating of packing
- High stress on valves and valves seats
- Gas entrainment in pumpage

Solution

The existing hydraulic design was evaluated. The root causes noted were addressed and modified resulting in over 50,000 continuous hours of operation at the Salem nuclear power plant.

The following work was undertaken and completed by ClydeUnion Pumps:

- Changed packing from UTEX to Garlock
- Dow lubricant on packing
- Changed from Nitronic 60 stuffing box to 17-4
- Valve and valve seat modifications
 - Increased thickness of valve 1/16th inch
 - Machined radii on valves edges
 - Changed materials from 17-4 to Nitronic 60 (galling considerations)
 - Increased the size of the valve to better match the seating surface (load distribution)
- Gas bleed-off on suction side tank
- Suction stabiliser vented to remove gas build-up

Benefits

- Greatly increased MTBF of reciprocating coolant charging pump
- Greatly increased MTBF of centrifugal charging pump because the centrifugal charging pump is not operating at low flow, high head on routine basis (unstable region of performance curve)
- For those PWR nuclear plants that have not changed over to centrifugal charging pumps, the costs of change-out can be avoided
- Less parasitic losses due to higher efficiency of reciprocating pump (during routine plant operation)

Financial illustration

Modification kit and field service: Approx \$200,000 per pump.

Save on operation cost over utilising centrifugal pump for the normal coolant charging service. Avoid costly pump change-out (design, pump purchase and installation) for those plants that still retain reciprocating coolant charging pumps.

Applicability

The following USA nuclear power plants have QX300s installed. These are utilised as the primary charging pump, secondary charging pump or not used at all:

- Salem - Secondary
- Diablo Canyon - Secondary (was scheduled to be replaced with centrifugal in 2005)
- Seabrook – Secondary
- McGuire – Secondary
- Comanche – Secondary
- Watts Bar – Out of service
- Indian Point 2 – Primary
- Indian Point 3 – Primary

The following USA nuclear power plants have removed the QX300s:

- | | |
|------------|-----------------|
| ▪ Callaway | ▪ Vogtle |
| ▪ Catawba | ▪ Wolf Creek |
| ▪ DC Cook | ▪ Diablo Canyon |
| ▪ Sequoyah | |



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