

Continuous Mobile Boration System (MOBIUS™)

Background

While all nuclear power plants have the capability to generate boric acid during normal plant operations, access to boric acid in emergency situations may be difficult if the current systems are not designed to withstand severe external events. To date, all emergency or augmented boric acid supply systems have relied on batch tanks because of the difficulty of dissolving boric acid crystals in water, which takes a significant amount of heat and mixing. The batching process thus limits the concentration and available amount of boric acid.

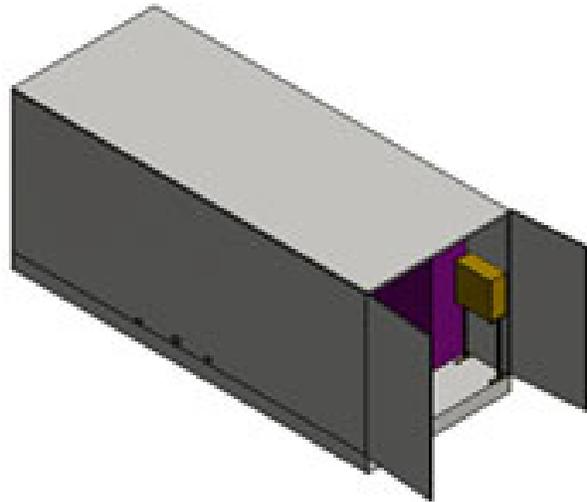
Westinghouse has designed, tested and patented a mobile boration system (MOBIUS™) that can continuously supply very highly concentrated boron at high flow rates. The system has been placed on a skid so that it is fully transportable. The skid requires minimum inputs and has been designed for efficient transport, autonomous operation and site interface flexibility. It can be used as a tool to improve normal plant operation or the diverse and flexible (FLEX) coping capability of a plant after a beyond-design-basis external event.

Description

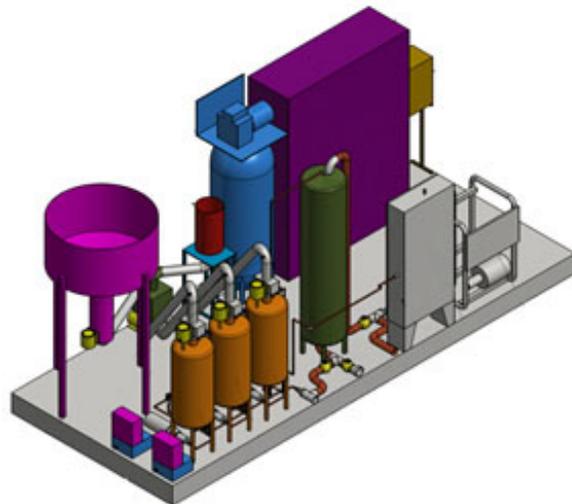
The Westinghouse MOBIUS is a portable, on-demand system that supplies the reactor coolant system (RCS) with borated coolant either during normal plant operations or as support for a plant's coping response to an extreme external event. The skid can be transported intact on a semi-trailer, making transportation, storage and deployment simple.

The system requires four main inputs: reactor-grade water (preferably), a power source, boric acid powder and a pH control agent powder. The system features a reverse osmosis unit to purify water up to an acceptable grade for the RCS in the case of a beyond-design-basis external event. From these inputs, the trailer-sized system

synthesizes a solution of the desired concentration at a specified flow rate from 2,000 ppm boron at 150 gpm to 7,000 ppm boron at 30 gpm, depending upon plant requirements. The powders are placed into hoppers and added automatically at a calculated rate via a screw conveyor.



MOBIUS skid rendition (skid arrangement)



MOBIUS skid rendition (internal view)

The operation is automated with a programmable logic controller, eliminating the need for constant operator input. The dissolution occurs in a series of three batch mixing tanks, the timing of which is staggered to contribute to steady flow out of the subsequent dilution tank prior to discharge, where the output borated coolant is supplied to the desired source without the need for an additional outlet pump.

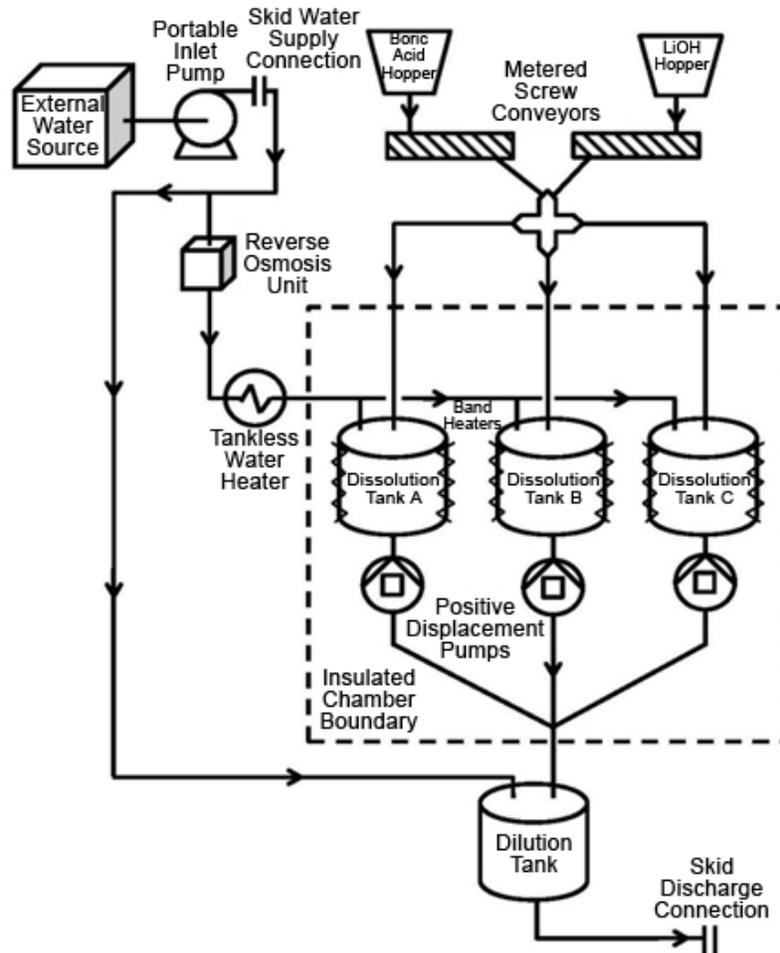
The MOBIUS can be used to:

- Fill refueling water storage tanks more easily and quickly.
- Inject coolant into the RCS during off-normal events.
- Replace or subsidize normal plant batching operations.

Benefits

The benefits of the MOBIUS include the following:

- It can quickly and efficiently supply borated coolant to the RCS during outages and potentially reduce outage time.
- It can be applied to improve post-Fukushima FLEX coping capabilities.
- It can be transported easily on a semi-trailer, allowing for transport between units and also sites.
- Flow rate and concentration can be adjusted online, making for a versatile tool for coping with planned as well as unforeseen issues and events.
- It self-regulates and processes boric acid powder at a calculated rate without operator action.



MOBIUS operation flow chart

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