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mPower

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U.S. Nuclear Regulatory Commission (NRC)
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11555 Rockville Pike
Rockville, MD 20852-2738

Subject: Project No. PROJ0776
Generation mPower LLC (GmP)
Update on Patent Information Related to the B&W mPower™ Reactor Design
Ltr. No. LTR-13-0084

On October 17, 2013, several non-provisional filings of patent application publications for aspects of the B&W mPower Reactor design were released to the public. These publications contained certain design information that had been previously determined by GmP and B&W to be commercial confidential information (CCI) or Proprietary Information and withheld from public disclosure. Additionally, several other patent application publications and one patent had been released earlier that also contained information previously withheld from public disclosure. Therefore, GmP is notifying the NRC staff of the change in public availability of design information which has been previously withheld.

To facilitate release of the remaining mPower Design Specific Review Standard (DSRS) sections, GmP is providing the following listing of outstanding (un-published) DSRS sections, their titles, and the patent application publication numbers that include design information that can be considered for use in each DSRS sections being processed for public release.

DSRS Section	Title	Patent Application Publication Number
5.2.2	Overpressure Protection	US Patent Publication US 2012/0243651 A1 US Patent Publication US 2012/0321030 A1
6.3	Emergency Core Cooling System	US Patent Publication US 2013/0301782 A1 US Patent Publication US 2012/0243651 A1 US Patent Publication US 2012/0321030 A1 US Patent Publication US 2013/0051511 A1
9.3.6	Reactor Coolant Inventory and Purification System (RCI)	US Patent Publication US 2013/0301782 A1 US Patent Publication US 2012/0243651 A1 US Patent Publication US 2012/0321030 A1 US Patent Publication US 2012/0294405 A1 US Patent Publication US 2013/0272473 A1
5.4	Reactor Coolant System	US Patent Publication US 2012/0294405 A1 US Patent Publication US 2013/0272478 A1
5.4.11	Pressurizer Relief Tank	US Patent Publication US 2012/0294405 A1 US Patent Publication US 2012/0243651 A1

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DSRS Section	Title	Patent Application Publication Number
5.4.14	Auxiliary Condenser (CNX)	US Patent Publication US 2012/0243651 A1 US Patent Publication US 2013/0301782 A1 US Patent Publication US 2013/0272473 A1
15.1.1-1.4	Decrease in Feedwater Temperature, Increase in Feedwater Flow, Increase in Steam Flow, and Inadvertent Opening of a Steam Generator Relief or Safety Valve	US Patent Number US D691,085 S

Enclosure 1 to this letter provides reference and subject matter information regarding each patent action listed above. Enclosure 2 includes descriptions of key design information for use by the NRC technical staff to evaluate the remaining DSRS section content for public release.

GmP has also identified several mPower submittals to NRC that contained information previously withheld as CCI or proprietary that is now publically available with these released patent applications. Those NRC submittals and associated NRC Withholding Proprietary Letters (identified by ML number) are provided in Enclosure 3 for your information.

If you have any questions or need any additional information, please contact me at your convenience at (980) 365-2071 or at pshastings@generationmpower.com.

Danielle Gardner
for
Peter S. Hastings
Director of Licensing
Generation mPower, LLC

Enclosures:
1. B&W mPower Reactor Design Patent Information
2. B&W mPower Reactor Design Information Subject to Public Release
3. B&W Submittals to NRC that Contained CCI

cc: J. L. Starefos, NRC, TWFN 9-F-27
S. L. Magruder, Jr, NRC, TWFN 9-F-27

Enclosure 1
B&W mPower™ Reactor Design Patent Information

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- US Patent Application 13/864,053 filed April 16, 2013, and published as US 2013/0301782 A1 titled "Defense in Depth Safety Paradigm for Nuclear Reactors" – this application covers: the emergency core cooling (ECC), reactor coolant inventory and purification (RCI), auxiliary condenser (CNX), how these systems are connected to the reactor vessel, and the order in which the systems are utilized in different scenarios. US Patent Application 13/161,078 filed June 15, 2011 and published as US 2012/0321030 A1 on December 20, 2012, titled "Integrated Emergency Core Cooling System Condenser for Pressurized Water Reactor" – this application relates to an early evolution of the ECC System and describes the optional use of boron.

- US Patent Application 13/069,657 filed March 23, 2011, published as US 2012/0243651 A1 on September 27, 2012, entitled "Emergency Core Cooling System for Pressurized Water Reactor," contains an additional ECC concept and identifies the boron tank/injection function.

- US Patent Application 13/217,941 filed August 25, 2011 and published as US 2013/0051511 A1 on Feb 28, 2013, entitled "Pressurized Water Reactor with Compact Passive Safety Systems," which covers the ultimate heat sink (UHS) concept (Passive Containment Cooling Tank (PCCT)).

- US Patent Application 13/766,693, filed on February 13, 2013 and published as US 2013/0272473 A1 on October 17, 2013, titled "Auxiliary Condenser System for Decay Heat Removal in a Nuclear Reactor System" – this application discusses reliance on CNX for beyond design basis events.

- US Patent Application 13/109,120 filed May 17, 2011, published as US 2012/0294405 A1 on Nov 22, 2012, titled "Pressurized Water Reactor with Upper Vessel Section Providing both Pressure and Flow Control" – this application provides a description of the reactor coolant system (RCS) and the reactor coolant pump (RCP) location and method of connecting to the reactor vessel.

- US Patent Application, US 13/864,466 filed April 17, 2013 entitled "Integral Vessel Isolation Valve was published on October 17, 2013 as US 2013/0272478 A1, and describes an integral isolation valve (IIV) concept.

- US Design Patent D691,085 S was issued on October 8, 2013. This patent describes the Reactor Vessel Exterior and provides general perspective and planar views of a reactor vessel evolution having external RCPs.

Enclosure 2
B&W mPower™ Reactor Design Information Subject to Public Release

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- **Reactor Coolant System (RCS)**

The RCS utilizes an integral arrangement in which the reactor core, steam generator (SG), pressurizer, control rod drive mechanisms (CRDM), and reactor coolant pumps (RCP) are combined into a common pressure vessel known as the reactor. The primary function of the RCS is to transfer the heat energy in the reactor to the steam generator by forced circulation of hot reactor coolant from the reactor to the steam generator, and the return of cooled reactor coolant from the steam generator to the reactor. The RCS, including connections to related auxiliary systems, constitutes the reactor coolant pressure boundary (RCPB). The reactor core, core support structure, and in-core instrumentation and guides are located in the lower vessel which is referred to as the reactor pressure vessel. The control rod guide frames and CRDMs are physically inside the reactor pressure vessel but are supported by a flange captured between the lower and upper vessel. The upper vessel contains a single once through steam generator (OTSG) with a central riser, and the pressurizer. The mPower RCS design minimizes the probability and consequences of a design basis accident. Key system characteristics include: a large inventory of reactor coolant water; no large loop piping connections to the reactor; minimized reactor penetration diameters; all reactor penetrations located above the reactor core; and integral isolation valves connected to the reactor to eliminate low break LOCAs.

Coolant is circulated by eight RCPs bolted to a pump support plate at the base of the pressurizer. The RCPs are canned motor pumps with axial flow, single stage hydraulics. The RCP has one vertical shaft line for the motor, and hydraulics, and radial and thrust bearings. The canned motor pump contains the motor and other rotating components inside the RC pressure boundary. The motor is cooled by primary reactor coolant circulating through the motor cavity and the integral heat exchanger, which is cooled by component cooling water. Each pump motor is driven by a variable speed drive.

- **Overpressure Protection for Reactor Vessel**

Overpressure protection for the mPower Reactor is provided primarily by redundant safety relief valves connected in parallel to the pressurizer at the top of the reactor. In addition, pressure relief of the reactor vessel is provided by two low temperature overpressure protection valves that are connected to the pressurizer at the top of the reactor. Both sets of valves are in lines that run to in-containment heat reservoirs, the Refueling Water Storage Tanks (RWSTs). The RWSTs are sealed tanks, filled with water that provide water for use during reactor refueling or maintenance operations, but also serve as a water source for the Emergency Core Cooling System (ECC) discussed below. The RWSTs are sized to have sufficient water to provide long term cooling (e.g., for at least seven days), without makeup from outside sources.

- **Emergency Core Cooling System (ECC)**

The ECC is the primary fluid safety system in the plant and ensures adequate water is available in the reactor vessel to provide core cooling. The ECC is divided into two identical, redundant trains with all components located inside containment. Each train includes two sets of high pressure and low pressure automatic depressurization valves (ADVs), an intermediate pressure injection tank (IPIT), and one of the two compartments of the refueling water storage tank (RWST). The ADVs are connected to the pressurizer region of the RCS and the IPIT and RWST are connected to the lower reactor vessel by injection lines that utilize integral isolation valves (IIVs) bolted directly to the lower vessel. The IIV design information is discussed below.

On very high pressurizer pressure or very low pressurizer level, the high pressure ADVs will open to either depressurize or accelerate the depressurization of the RCS. As the RCS depressurizes, the IPITs will inject to control minimum water level. When RCS depressurization slows, the low pressure ADVs are opened to continue depressurization until water from the RWST can drain into the reactor vessel through redundant emergency pressure regulating valves (EPRVs). The EPRVs control water flow from the RWSTs to maximize fluid quality through the ADVs and any potential pipe break. As a result, the ECC can maintain core cooling in either loss of heat sink or loss-of-coolant accidents (LOCAs) for a minimum of seven days. In all design basis accidents, the ECC provides sufficient water during depressurization to ensure that collapsed water level in the reactor vessel covers the reactor core to prevent film boiling throughout that seven day period.

- **Ultimate Heat Sink (UHS)**

Internal containment pressure and temperature is controlled by water in a passive containment cooling tank (PCCT) located on the top dome of the containment. Under accident conditions, heat is removed from the hot steam and air inside containment through the containment dome structure to the water in the PCCT on the outside surface of the dome. Sufficient water is available to cool the containment atmosphere by conduction without makeup to the PCCT for a period greater than 7 days. Thus the PCCT passively removes heat from containment and transmits it to the nearby atmosphere. Through this process the nearby atmosphere becomes the ultimate heat sink (UHS) for the reactor. (In earlier design discussions, the PCCT was referred to as the ultimate heat sink.)

- **Reactor Coolant Inventory and Purification System (RCI)**

The RCI is a non-safety system that provides chemistry and primary coolant inventory control in the reactor pressure vessel. It includes a letdown line that removes primary coolant water from the vessel into the RCI and a makeup line that provides water back to the vessel after it has been purified. The RCI connection to the vessel also provides a path for injection of a soluble boron compound from a boron injection tank (in a prior design evolution, boron injection was part of the ECC, but is now part of the RCI). The RCI also serves as a means to remove heat from the reactor at both high and low pressure levels via the use of connected heat exchangers. The RCI is provided with a high pressure injection circulation pump to inject the make-up water into the reactor at high pressure without requiring depressurization of the RCS. The RCI also includes a high pressure decay heat removal component so as to provide decay heat removal at (or even above) normal operating pressure of the reactor.

- **Defense in Depth Design Strategy for the mPower Reactor**

Aspects of the reactor design include provision and reliance upon safety and non-safety response systems and methods that provide multiple layers of safety for the plant. The initial layers leverage non-safety systems and high pressure safety systems to keep the reactor within its safe operating envelope without depressurizing the reactor. Reactor depressurization is not performed unless the first level(s) of response are unable to contain the safety event. Another aspect of the defense in depth strategy is to maximize use of systems besides the safety-related RWST and, PCCT and discussed above, thereby extending the time before the PCCT is needed to mitigate an event.

Specifically the strategy is to deploy non-safety systems rated to operate effectively at high reactor pressure, so that these non-safety systems can be used to respond to an event without depressurizing the reactor and without initiating the safety ECC described above. The first line of defense is provided by the non-safety related passive auxiliary condenser (CNX) to maintain the RCS within its safe operating envelope during transients and minimizes challenges to the ECC. If this first layer of protection does not sufficiently remove heat and pressure from the reactor, then the RCI (described above) is employed.

The combination of the CNX and the RCI enable events to be controlled without needing to depressurize the reactor vessel, and without rejecting heat to the RWST, containment, PCCT, and UHS. Thus there are three layers of protection that can be engaged to keep the reactor in a safe state.

- **Integral Isolation Valves**

Another aspect of the defense in depth strategy discussed above is to provide integral isolation valves (IIVs) at the low elevation vessel penetrations. These isolation valves eliminate Type 1 low elevation LOCAs. Each IIV is composed of two valves in series bolted directly to the lower vessel on the makeup and letdown lines. The valves are actuated by either flow direction (check valves) or by an external power source. This design moves the lowest potential non-isolable pipe break location to the top of the pressurizer. There are no piping or instrumentation connections to the reactor vessel below the top of the core.

- **Auxiliary Condenser System (CNX)**

The Auxiliary Condenser System (CNX) is a non-safety-related passive system designed to protect the mPower reactor by providing high pressure decay heat removal from the RCS during loss of feedwater events (i.e., loss of normal steam generator heat removal capacity). The CNX maintains the RCS within its safe operating envelope during transients and minimizes challenges to the ECC system. The CNX is also designed to remove reactor decay heat through the steam generator during postulated station blackout (SBO) events and can establish and maintain hot standby conditions without AC power. The CNX is not normally used during plant startup or normal plant cooldown.

The CNX system consists of a forced draft air cooled condenser with fans powered by redundant, non-1E DC dedicated battery divisions, piping, containment isolation valves, and associated instrumentation. The CNX receives steam from the main steam safety valve header, condenses it and returns it to the steam generator via two dedicated nozzles on the shell.

CNX provides a containment isolation function following design basis events requiring isolation. The inlet piping up to the two containment isolation valves and the discharge piping from the outlet containment isolation valves are designed and constructed in accordance with ASME B&PV Code, Section III, Class 2.