ArevaEPRDCPEm Resource

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Sent: Thursday, July 08, 2010 3:09 PM
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Subject: DRAFT Response to U.S. EPR Design Certification Application RAI No. 337, FSAR Ch. 9, Supplement 6
Attachments: RAI 337 Supplement 6 Response US EPR DC - DRAFT.pdf

Getachew,

Attached is a draft response for RAI 337 Supplement 6. Earlier today, AREVA submitted Supplement 5 that provided a date for the final response as August 17, 2010. This question has been previously discussed with the staff. Let us know if you have any further questions or we can submit as final.

Sincerely,

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Response to

Request for Additional Information No. 337, Supplement 6

12/15/2009

U.S. EPR Standard Design Certification
AREVA NP Inc.
Docket No. 52-020
SRP Section: 09.01.04 - Light Load Handling System (Related to Refueling)
SRP Section: 09.02.02 - Reactor Auxiliary Cooling Water Systems
SRP Section: 09.05.01 - Fire Protection Program

Application Section: FSAR Chapter 9

QUESTIONS for Balance of Plant Branch 1 (AP1000/EPR Projects) (SBPA)

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Question 09.01.04-14:

Applicants for standard design certifications are required by 10 CFR 52.47(a)(22) to address operating experience insights. Inspection and Enforcement (IE) Bulletin 84-03, "Refueling Cavity Water Seal," was issued to address the potential failure of refueling cavity seals to assure that fuel uncovery during refueling remains an unlikely event. The bulletin required licensees to evaluate the potential for and consequences of a refueling cavity water seal failure. Additional information concerning refueling cavity seal failures was provided by Information Notice (IN) 84-93, Potential for Loss of Water from the Refueling Cavity." IN 84-93 also noted that refueling cavities can be drained due to failures associated with other seals and as a consequence of valve misalignments. Therefore, in order to adequately address operating experience considerations and in accordance with the requirement specified by 10 CFR 52.47(a)(22), the following additional information is required:

a. Describe the design and installation of the refueling cavity seal and any other seals that will be used and whose failure could cause the refueling cavity to drain.

b. For each of the seals identified in (a), describe measures that will be implemented to ensure that the seals remain intact and do not become degraded over time.

c. For each of the seals identified in (a), evaluate the potential for and consequences of seal failure. These evaluations should address the following considerations:

    1. seal failure modes (including impact by dropped fuel bundles and weld failures) and the maximum leak rate that can occur;

    2. the refueling cavity makeup capability that is assured by Technical Specifications while in Mode 6;

    3. operator actions that are credited, including indication and alarms that are available to alert operators of the problem, and the time needed for operators to complete the required actions assuming that actions are not initiated until ten minutes after an alarm is sounded;

    4. the impact on stored fuel, fuel in transit or otherwise located in the refueling cavity for other reasons, and fuel in the reactor vessel, including the minimum height of water that will remain above the fuel and the basis for this determination; and

    5. the capability to isolate the fuel transfer tube with the maximum radiation level and flow rate of water through the transfer tube that are anticipated as a result of the seal failure.

d. Other than the seals that are referred to in (a), identify all of the paths that are capable of inadvertently draining the refueling cavity, describe controls that will be established to prevent inadvertently draining the refueling cavity through these paths, and evaluate the potential for and consequences of the refueling cavity to drain through these paths (similar to the evaluation referred to in (c).

e. Describe actions that must be taken to restore containment integrity when in Mode 6, the time required to complete these actions, the capability to implement these actions during and/or following situations that cause the refueling cavity to drain, and controls that will be established to ensure that containment integrity can be restored as described.

Revise the Final Safety Analysis Report (FSAR) to adequately describe the licensing basis for the certified plant design with respect to the above considerations. Establish inspections, tests, analyses, and acceptance criteria (ITAAC), interface requirements, and combined license (COL) action items as appropriate for design features, procedures and controls that are important to ensure that occupational exposures and the release of radioactive material will not exceed NRC requirements as a consequence of inadvertently draining the refueling cavity.

Response to Question 09.01.04-14:

IE Bulletin 84-03, "Refueling Cavity Water Seal," was issued on August 24, 1984 to address an incident where the refueling cavity water seal failed and rapidly drained the refueling cavity. The bulletin requested evaluations of the potential for and consequences of a refueling cavity seal failure to establish that fuel uncovery during refueling remains an unlikely event. The 1984 incident involved the gross failure of a pneumatic seal that resulted in the loss of approximately 200,000 gallons of water from the refueling cavity within 20 minutes. If the fuel was in transfer, it could have been partially or completely uncovered. If the fuel transfer tube was open, the spent fuel pool (SFP) could have drained to a level that would have uncovered the top of the fuel.

IN 84-93, "Potential for Loss of Water from the Refueling Cavity," was issued on December 17, 1984 and identified additional failure modes for the refueling cavity seal and noted that refueling cavities can be drained due to other seal failures and as a consequence of valve misalignments.

a. The U.S. EPR design includes features to address the risks identified in IE Bulletin 84-03 and IN 84-93. As stated in U.S. EPR FSAR Tier 2, Section 3.8.3.1.1, the reactor vessel (RV) cavity ring is a permanently installed stainless steel assembly welded to the RV and the refueling cavity liner to prevent water leakage from the refueling cavity. This seal is designed to accommodate the expansion and contraction of the reactor pressure vessel (RPV) during heatup and cooldown. The cavity seal is designed to Seismic Category I requirements meets the stress limits of ASME BPVC, Section III, Subsection ND. Seal and structural welds are made in accordance with ASME BPVC, Section IX and are examined in accordance with ASME BPVC, Section V. The cavity seal does not rely on inflated seals, gaskets, o-rings, or other active components. The cavity seal is designed to withstand the impact of one fuel assembly with resultant leakage less than the capacity of the makeup flow to the refueling cavity. Rapid drain down through the reactor cavity ring resulting in fuel uncovery during refueling is not a credible event. The additional cavity seal failure modes identified in IN 84-93 (i.e., variations in cavity gap dimensions and seal punctures during installation) are not applicable to the permanently installed steel cavity ring. US. EPR FSAR Tier 2, Section 3.8.3.1.1, Table 3.2.2-1—Classification Summary, and Table 3.10-1—List of Seismically and Dynamically Qualified Mechanical and Electrical Equipment will be revised to include this information.

   IE Bulletin 84-03 states that during the 1984 cavity seal failure event, if the fuel transfer tube had been open, it could have drained the SFP to a level which would have uncovered the top of the fuel. The U.S. EPR SFP design includes weirs that prevent drainage of the SFP below the top of the stored fuel assemblies. A weir is located between the refueling cavity and the Reactor Building (RB) transfer pit (refer to U.S. EPR FSAR Tier 2, Figure 3.8-13—Reactor Building Section C-C). Above these weirs are leaktight gates that are closed to further mitigate a loss of pool water. The pool gates do not rely on pneumatic seals for leak tightness.

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The three preventive measures identified by Generic Safety Issue 137, Refueling Cavity Seal Failure, to resolve the issue of cavity seal failure leading to refueling cavity drainage, are addressed by the U.S. EPR design:

1) Installation of improved-design seals at plants with single inflatable seals: The U.S. EPR design uses a Seismic Category I permanent steel cavity ring, which is an improved design compared to single inflatable seals.

2) Replacement of double inflatable seals with permanent steel seals: The U.S. EPR design uses a permanent steel cavity ring.

3) Installation of a coffer dam to prevent SFP draining through the refueling cavity at plants where this is possible: The U.S. EPR pool design includes weirs that prevent drainage of the SFP below the top of the stored fuel assemblies.

Seals for other penetrations through the refueling cavity liner do not rely on active components and are not susceptible to gross failure. Large openings through the liner are closed using sealing doors with double gaskets. Locking mechanisms and hydrostatic pressure of the refueling water maintain the leaktight door seals. Even if gasket leakage occurs, the leakage rate between the door and the pool liner results in a slow decrease in water level given the volume of water in the refueling cavity. Damage to penetrations in the refueling cavity is prevented by administrative disposition for heavy load handling. These seals do not pose a risk for rapid cavity draining. In addition to the SFP level, indication of refueling water level is provided for each of the flooded RB compartments in the control room (refer to U.S. EPR FSAR Tier 2, Figure 9.1.3-2—Fuel Pool Purification System).

The use of steam generator (SG) nozzle dams for the U.S. EPR was addressed in the Response to RAI 26, Supplement 1, Question 19-174.

b. As stated in the response to Part a, the refueling cavity seals do not pose a risk for rapid cavity draining. Seals using double gaskets have inter-gasket leakage testing capability to verify leak tightness prior to service. Leak detection capability is provided in the reactor pit by the leakage detection system. The refueling cavity seal welds are accessible for periodic inspection.

c1. As stated in the response to Part a, the refueling cavity seals do not pose a risk for rapid cavity draining. U.S. EPR FSAR Tier 2, Chapter 16, Technical Specifications, Section 3.9.6 requires a minimum water level of 23 feet above the top of the RV flange. Water level is verified every 24 hours.

c2. Because a leak in the refueling cavity is not a design basis accident, Technical Specifications do not specifically require a source of makeup water to be available during Mode 6. Makeup water to the refueling cavity can be provided by three sources. The RB purification pump can be aligned to take suction from the IRWST (in-containment refueling water storage tank) to provide makeup to the refueling cavity at 400 gpm (refer to U.S. EPR FSAR Tier 2, Table 9.1.3-1—Fuel Pool Cooling and Purification System Component Design Data). If available, the residual heat removal (RHR)/low head safety injection (LHSI) trains that are not being used for RHR can be actuated to provide makeup to the refueling cavity at greater than 2200 gpm (refer to U.S. EPR FSAR Tier 2, Table 6.3-2—Low Head Safety Injection Pumps Design and Operating Parameters). If a train of medium head safety injection (MHSI) is available, the MHSI pump can be actuated to provide makeup to the refueling cavity at over 600 gpm (refer to U.S. EPR FSAR Tier 2, Table 6.3-3—Medium Head Safety Injection Pumps Design and Operating Parameters).

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c3. In addition to the Technical Specifications surveillance requirements, a decrease in pool level can be detected visually during refueling or by level instrumentation installed in the pool (refer to U.S. EPR FSAR Tier 2, Figure 9.1.3-2—Fuel Pool Purification System). A dose rate measurement device on the refueling machine detects an excessive dose rate, indicating a reduction in water shielding above a handled fuel assembly. In the unlikely event of a leak, the operator would place the handled fuel assembly in the reactor core or in the fuel transfer facility where it could be positioned horizontally to increase water shielding and/or transferred to the Fuel Building (FB).

c4. In the reactor core, approximately 13 feet of water remains above the active fuel if the refueling cavity were drained to the RV flange level. In the fuel transfer facility, approximately 12 feet of water remains above the horizontal fuel assembly if the pool were drained to the top of the weir separating the transfer pit from the refueling cavity. U.S. EPR FSAR Tier 2, Figure 3.8-13—Reactor Building Section C-C shows the general arrangement of the refueling cavity and weir, RV, and fuel transfer facility.

c5. As stated in the response to Part a, weirs prevent drainage of the SFP through the fuel transfer tube. Isolation of the fuel transfer tube is not required in the event of a cavity seal failure to prevent drainage of the SFP below the top of the fuel assemblies.

d. The residual heat removal system (RHRS) and fuel pool cooling and purification system (FPCPS) are potential paths for inadvertently draining the refueling cavity. The RHRS can also be aligned to LHSI mode. The potential drain paths in the RHRS are formed by three valves whose alignment could revert to the LHSI mode when the system is performing its RHR function. These valves (train 4 presented) include the LHSI suction isolation valve to the IRWST (30JNG40AA001), the LHSI radial miniflow check valve (30JNG40AA003), and the LHSI tangential miniflow check valve (30JNG40AA004) (refer to U.S. EPR FSAR Tier 2, Figure 6.3-2—Safety Injection/Residual Heat Removal System Train). When a given train is aligned to RHR mode, an alarm will alert the operator to a misalignment of these valves. The FPCPS pipe exiting the bottom of the reactor cavity includes redundant isolation valves, each equipped with position indication in the main control room (MCR). An alarm alerts the operator if the RB pool suction isolation valve (30FAL10AA005) is open when the pool is flooded. The reactor cavity, the internals compartment, and the RB transfer compartment drain pipes are Seismic I, Quality Group C pipes (refer to U.S. EPR FSAR Tier 2, Figure 9.1.3-2—Fuel Pool Purification System). U.S. EPR FSAR Tier 2, Section 9.1.4.3.2 will be revised to include this information.

Because of the design and construction of the refueling cavity seal and the design and controls of the FPCPS and RHRS, a significant leak is not considered a credible event. In the unlikely event of a leak in the refueling cavity, the leak would be diverted to the IRWST, from which both the FPCPS and RHRS can take suction to pump the water back into the refueling cavity. The RHRS and FPCPS are described in U.S. EPR FSAR Tier 2, Section 5.4.7 and Section 9.1.3, respectively.

e. Because a cavity seal failure resulting in a rapid drain down of the refueling cavity is not a credible event, the need to restore containment integrity is not considered. As specified in the U.S. EPR FSAR Tier 2, Chapter 16, Technical Specifications, containment is not required to be operable in Mode 6.

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FSAR Impact:

U.S. EPR FSAR Tier 2, Table 3.2.2-1, Section 3.8.3.1.1, Table 3.10-1 and Section 9.1.4.3.2 will be revised as described in the response and indicated on the enclosed markup.

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U.S. EPR Final Safety Analysis Report Markups

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Table 3.2.2-1—Classification Summary
Sheet 9 of 190

KKS System or Component Code	SSC Description	Safety Classification (Note 15)	Quality Group Classification	Seismic Category (Note 16)	10 CFR 50 Appendix B Program (Note 5)	Location (Note 17)	Comments/ Commercial Code
30JAA10 AA501/502	RPV High Point Vent Valves	S	A	I	Yes	UJA	ASME Class 1[1]
JAC	RPV Internals - Control Rod Drive Mechanism Adaptor Thermal Sleeves	NS-AQ	D	II	Yes	UJA	ASME Class CS[4] (Internal Structure)
30JAB	RPV Refueling Cavity Seal	NS-AQ	D	I	Yes	UJA	
JAC	RPV Internals - Handling Studs and Inserts	NS-AQ	D	II	Yes	UJA	ASME Class CS[4] (Internal Structure)
JAC	RPV Internals - Head and Vessel Alignment Pins	NS-AQ	D	II	Yes	UJA	ASME Class CS[4] (Internal Structure)
JAC	RPV Internals - Hold Down Spring	S	B	I	Yes	UJA	ASME Class CS[4]
JAC	RPV Internals - Radial Key Inserts	S	B	I	Yes	UJA	ASME Class CS[4]
JAC	RPV Lower Internals - Core Barrel (Flange and Shells)	S	B	I	Yes	UJA	ASME Class CS[4]
JAC	RPV Lower Internals - Dome Spray Nozzles	NS-AQ	D	II	Yes	UJA	ASME Class CS[4] (Internal Structure)

09.01.04-14

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This seal is designed to accommodate the expansion and contraction of the RPV during heatup and cooldown. The cavity seal is designed to Seismic Category I requirements and to meet the stress limits of ASME BPVC, Section III, Subsection ND. Seal and structural welds are made in accordance with ASME BPVC, Section IX and are examined in accordance with ASME BPVC, Section V. The cavity seal does not rely on inflated seals, gaskets, o-rings, or other active components. The cavity seal is also designed to withstand the impact of one fuel assembly with resultant leakage less than the capacity of the makeup flow to the refueling cavity.

The RV supports and cavity concrete wall resists normal operating loads, seismic loads, and loads induced by postulated pipe rupture events, including a LOCA (GDC 4 and GDC 5). The supports limit the movement of the RV within allowable limits under the applicable combinations of loadings, and minimize resistance to thermal movements during plant operations.

Refer to Figure 3.8-2, Figure 3.8-3, Figure 3.8-4, Figure 3.8-11, Figure 3.8-12, and Figure 3.8-13 for general arrangement layouts of the RV support structure.

3.8.3.1.2 Steam Generator Support Structures

The SGs are supported and restrained to resist normal operating loads, seismic loads, and loads induced by pipe rupture. The supports prevent the rupture of the primary reactor coolant pipes due to a postulated rupture in the main steam (MS) or feedwater lines. The supports minimize resistance to thermal movements during operation.

The 6 feet, 7 inches thick heavily reinforced concrete floor at elevation +4 feet, 11 inches supports the four SGs. Four steel columns with pinned joints are provided under each SG to support the vessels vertically from the concrete floor. Keyed joints at the top of the steel support columns interface with lower lateral steel supports that connect to steel embedments in the concrete cubicle walls for each SG. Section 5.4.14 describes the design of these steel component supports.

The RB internal structure concrete walls form individual cubicles for each of the SGs. These walls isolate the SGs to protect other plant SSC in the event of a pipe rupture in one of the piping reactor coolant loops (RCL). The SG cubicle outer walls also serve as secondary shield walls for protection against radiation from the reactor piping and coolant, as described in Section 3.8.3.1.6.

Steel supports within each of the cubicles, which are mounted to the concrete slab at approximately elevation +64 feet, provide upper lateral support for the SGs. Connection of the upper lateral supports to the concrete includes steel subassemblies that are embedded in the concrete slab and cubicle walls. Section 5.4.14 provides a description of the design of the SG upper lateral supports.

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Table 3.10-1—List of Seismically and Dynamically Qualified Mechanical and Electrical Equipment
Sheet 1 of 203

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Name Tag (Equipment Description)	Tag Number	Local Area KKS ID (Room Location)	EQ Environment (Note 1)	Radiation Environment Zone (Note 2)	EQ Designated Function (Note 3)	Safety Class (Note 4)	EQ Program Designation (Note 5)
FLUID SYSTEMS							
				Reactor Coolant System (RCS)			
RPV							
Reactor Pressure Vessel	30JAA10BB001	30UJA11001	H	H	SI	S	Y (5)
RPV O-ring Leakoff Vlv #1	30JAA10AA003	30UJA15005	H	H	SII	NS-AQ C/NM	Y (4) Y (5)
RPV O-ring Leakoff Vlv #2	30JAA10AA004	30UJA15005	H	H	SII	NS-AQ C/NM	Y (4) Y (5)
RPV O-ring Leakoff Drain Vlv	30JAA10AA301	30UJA15005	H	H	SII	NS-AQ C/NM	Y (4) Y (5)
RPV O-ring Leakoff Press Iso Vlv	30JAA10AA302	30UJA15005	H	H	SII	NS-AQ C/NM	Y (4) Y (5)
RPV High Point Vent Vlv #1	30JAA10AA501	30UJA18019	H	H	SI	S C/NM	Y (4) Y (5)
RPV High Point Vent Vlv #2	30JAA10AA502	30UJA18019	H	H	SI	S C/NM	Y (4) Y (5)
RPV High Point Vent Vlv #3	30JAA10AA506	30UJA18019	H	H	SII	NS-AQ C/NM	Y (4) Y (5)
RPV High Point Vent Vlv #4	30JAA10AA505	30UJA18019	H	H	SII	NS-AQ C/NM	Y (4) Y (5)
RPV High Point Vent Vlv #5	30JAA10AA507	30UJA18019	H	H	SII	NS-AQ C/NM	Y (4) Y (5)
RPV High Point Vent Vlv #6	30JAA10AA503	30UJA18019	H	H	SII	NS-AQ C/NM	Y (4) Y (5)
RPV High Point Vent Vlv #7	30JAA10AA504	30UJA18019	H	H	SII	NS-AQ C/NM	Y (4) Y (5)
Post Acc RPV High Pt Vent Vlv #1	30JAA10AA508	30UJA18019	H	H	SI	S C/NM	Y (4) Y (5)
Post Acc RPV High Pt Vent Vlv #2	30JAA10AA509	30UJA18019	H	H	SI	S C/NM	Y (4) Y (5)
Post Acc RPV High Pt Vent Vlv #3	30JAA10AA510	30UJA18019	H	H	SI	S C/NM	Y (4) Y (5)
Post Acc RPV High Pt Vent Vlv #4	30JAA10AA511	30UJA18019	H	H	SI	S C/NM	Y (4) Y (5)
Post Acc High Pt Vent Flow Restrictor	30JAA10BP001	30UJA18019	H	H	SII	NS-AQ	Y (5)
Vlv AA503 Position Sensor (M)	30JAA10CG503B	30UJA18019	H	H	SII	NS-AQ	Y (5)
Vlv AA504 Position Sensor (M)	30JAA10CG504B	30UJA18019	H	H	SII	NS-AQ	Y (5)
Vlv AA505 Position Sensor (M)	30JAA10CG505B	30UJA18019	H	H	SII	NS-AQ	Y (5)
RPV Inner O-Ring Press Sensor (PB)	30JAA10CP050	30UJA15005	H	H	SII	NS-AQ	Y (5)
RPV Inner O-Ring Temp Sensor (PB)	30JAA10CT050	30UJA15005	H	H	SII	NS-AQ	Y (5)
RPV Refueling Cavity Seal	30JAB	30UJA11001	H	H	SI	NS-AQ	Y(5)
CRDMs							
CRDM #1 Latch Mechanism	30JDA01AE	30UJA11001	H	H	SI	S	Y (5)
CRDM #1 Pressure Housing	30JDA01AE	30UJA11001	H	H	SI	S C/NM	Y (4) Y (5)
CRDM #1 Position Sensor (M)	30JDA01CG801	30UJA11001	H	H	SI	S	Y (5)
CRDM #1 Top Position Limit Sensor (M)	30JDA01CG802	30UJA11001	H	H	SII	NS-AQ	Y (5)

09.01.04-14

The Spent Fuel Cask Transfer Facility is provided with internal and external interlocks related to:

- Operation of the handling opening.
- Operation of the cover of the loading penetration.
- Operation of the spent fuel cask transfer machine.

9.1.4.3.2 Refueling Cavity Draindown Events

Rapid draindown of the refueling cavity resulting in fuel uncovery during refueling is not a credible event. The reactor vessel cavity ring is a permanently installed stainless steel assembly welded to the reactor vessel and the refueling cavity liner to prevent water leakage from the refueling cavity. The passive cavity ring design does not rely on active components such as pneumatic seals and is not susceptible to gross failure. Seals for openings in the refueling cavity liner do not rely on active components and do not pose a risk for rapid cavity draining.

09.01.04-14

The residual heat removal system (RHRS) and fuel pool cooling and purification system (FPCPS) are potential paths for inadvertently draining the refueling cavity. The RHRS can also be aligned to low head safety injection (LHSI) mode. The potential drain paths in the RHRS are formed by three valves whose alignment could revert to the LHSI mode when the system is performing its RHR function. These valves (train 4 presented) include the LHSI Suction Isolation Valve to the IRWST (30JNG40AA001), the LHSI Radial Miniflow Check Valve (30JNG40AA003), and the LHSI Tangential Miniflow Check Valve (30JNG40AA004) (refer to Figure 6.3-2-Safety Injection/Residual Heat Removal System Train). The FPCPS pipe exiting the bottom of the reactor cavity includes redundant isolation valves each equipped with position indication in the main control room. The reactor cavity, the internals compartment, and the reactor building transfer compartment drain pipes are Seismic I, Quality Group C pipes (refer to Figure 9.1.3-2-Fuel Pool Purification System).

Inadvertent draining of the refueling cavity is addressed by plant procedures. Refer to Section 13.5 for plant procedure information.

Any credible drainage from the refueling cavity will be detected visually or by installed instrumentation in adequate time to place a handled fuel assembly, if necessary, in a safe storage location. The safe storage location is either in the reactor core or in the fuel transfer facility, where it can be positioned horizontally to increase shielding depth or can be transferred to the Fuel Building. Weirs in the Reactor Building and Fuel Building pools limit the loss of water in pool areas separated from the drain path by the weirs.

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