Westinghouse UK
AP1000® GENERIC DESIGN ASSESSMENT
Resolution Plan for GI-AP1000-CE-04
Fuel Handling Area – Secondary Containment Leak Detection and Collection System

MAIN ASSESSMENT AREA	RELATED ASSESSMENT AREA(S)	RESOLUTION PLAN REVISION	GDA ISSUE REVISION
Civil Engineering	Control and Instrumentation Environment Agency Fault Studies Radwaste and Decommissioning	4	0

GDA ISSUE:	Justification that the civil structures which retain pool water in the fuel handling area of the auxiliary building have secondary containment which each have their own dedicated system to detect potential leakage and allow collection of that leakage. Civil pool structures that are required to contain plant water must employ multiple barriers. The numbers of barriers are dependent on the radiological hazard, but the UK Regulator expects in a modern design that at least two barriers would be provided for a spent fuel pool to achieve defence in depth. This GDA Issue is concerned with minor leakage from the pools in the fuel handling area that may be undetected for a period of time. This type of leak has the potential to damage the internal structure of the CA structural modules, but also to eventually migrate to the external environment. The main concern is that these potential leakage paths would go undetected for a long period of time (chronic leaks), and the extent of the resulting damage/contamination, if finally detected, would not be quantifiable.
ACTION: GI-AP1000-CE-04.A1	Secondary Containment Leak Detection And Collection System for Module CA20 SC Walls and HSC Floors Provide a leak detection/collection system to the secondary barrier formed by the CA steel-concrete composite construction which will: • Allow potential leaks into the structure to be detected and monitored. • Collect the potential leakage and divert it away from the significant mild steel components of

	the CA module. • Protect against migration of potential leaks into the base slab below. With agreement from the Regulator this action may be completed by alternative means.
ACTION: GI-AP1000-CE-04.A2	Secondary Containment Leak Detection And Collection System for West RC wall to Transfer Canal Provide a leak detection/collection system to the secondary barrier formed by the RC wall which is cast up against the single plate stainless steel liner to the west wall of module CA20. This should include: • Method to detect leakage through the RC wall, both above and below ground. • Collect the potential leakage, and thus protect against migration of potential leaks into the ground. With agreement from the Regulator this action may be completed by alternative means.
ACTION: GI-AP1000-CE-04.A3	Secondary containment leak detection and collection system for north wall of spent fuel pool Provide a leak detection/collection system to the secondary barrier formed by the RC wall which is cast between the north single plate stainless steel liner of the spent fuel pool and the shield building. This should include: • Method to detect leakage through/into the wall. • Collect the potential leakage, and thus protect against migration of potential leaks into the ground. With agreement from the Regulator this action may be completed by alternative means.
ACTION: GI-AP1000-CE-04.A4	Evaluate the effect of borated water from potential leakage from spent fuel pool on mild steel components within CA20. The water within the spent fuel pool and surrounding pools will be more highly borated than standard fuel pools. Corrosion of the mild steel reinforcing bar inside concrete walls and slabs is therefore of concern. Although actions A2 and A3 are aimed at detecting leakage through the secondary barriers comprising RC construction, the effect on the structural integrity must also be evaluated. Westinghouse should provide the following: • A best estimate evaluation on the potential

	corrosion rates of mild steel reinforcing bars within the RC construction to the spent fuel pools and adjacent pools when subject to minor, chronic leaks from the pools. • An evaluation of the effects on the structural capacity of the same RC walls/slabs from the above effects on the rebar. With agreement from the Regulator this action may be completed by alternative means.

RELEVANT REFERENCE DOCUMENTATION RELATED TO GDA ISSUE	
Technical Queries	TQ-**AP1000**-1218 TQ-**AP1000**-1270
Regulatory Observations	None
Other Documentation	DCP_JNE_000496 (UN REG WEC 000469)

Scope of work:
Justify that adequate measures are in place to both detect and to allow for the collection of potential leakage from the spent fuel pool and fuel transfer canal by providing a primary and secondary barrier against leakage and providing redundant means of leakage detection and demonstrate that minor undetected leakage will not critically impact the structural integrity of the pool.

Description of work:
<u>Action 1</u> The **AP1000**® spent fuel pool is part of the CA20 structural module. The walls of the spent fuel pool are constructed using 0.5” (1.27 mm) duplex plate. This barrier is a much more significant barrier than the non structural liner plates used as liners in operating spent fuel pools. The welds in the spent fuel pool are equipped with a system of leak chases as described in the responses to TQ-**AP1000**-1218 and TQ-**AP1000**-1270. The leak chases are provided to prevent borated water from getting behind the various pool liner plates and potentially corroding the structural elements behind the pool liners. The pools within the design that are filled with borated water are lined with Duplex 2101. The Duplex plate serves as the first barrier to prevent borated water from coming into contact with the structural elements located behind the plate. Leak chases are provided along each weld in these pools. The leak chase subsystems in the fuel handling area are part of the Radioactive Waste Drain System (WRS). The leak chase subsystems consist of collection channels (which are part of the CA modules) surrounding pool welds, collection piping, headers, collection pots, and the associated valves and instrumentation. The leak chase subsystems are zoned to allow identification of the source of leakage. Headers are provided for each of the zones with isolation valves to support leakage testing and localisation of the leak. Pots with level instruments are provided to collect and detect the leakage. The leak chase collection channels are also fabricated using Duplex plate or equivalent material.

Leakage through the leak chase channels is captured in leak chase collection pots. The leak chase collection pots are designed and built in accordance with ASME Code, Section VIII. The collection pots are stainless steel. The leak chase pots collect the leakage from the leak chase piping and in conjunction with the associated level instruments provide a means for quantification and detection of the source of leakage. Each collection pot contains level instrumentation which provides an alarm to alert an operator that the pot contains liquid. The operator can then use the leak chase zone isolation valves to determine the origin of the leakage.

Based on the design of the structure and the levels of protection provided, undetected leakage from the spent fuel pool or other sources containing borated water is not expected to get behind the module walls and erode the concrete or structural steel behind the module walls. Duplex plate is used on the surface of the modules in contact with borated water. These walls are designed as class 1 structures. The weld locations in these plates are fitted with leak chases. The leak chases are also fabricated from Duplex plate of equivalent material. The leak chases channel any potential leakage to collection pots which provide indication to operators that leakage exists. This leakage can be quantified and then, if deemed necessary, an operator can isolate the different leak chase zones to identify the location of the leakage and determine if any remedial action needs taken.

Notwithstanding these robust design features, Westinghouse is proposing to perform an assessment to evaluate whether any additional leakage detection means in the area below the spent fuel pool would be ALARP. In the very unlikely event of leakage through both the primary spent fuel pool duplex plate welds and the stainless steel leak chases or leakage through the 0.5” (1.27 mm) duplex plate at a location not along a weld, there is a potential for borated water to get behind the pool duplex plate. Westinghouse would consider such an event to be beyond design basis. In this event, the leakage will slowly migrate down the plate along the concrete and over a long period of time has the potential to migrate into the basemat and eventually into the environment.

To perform the ALARP assessment, Westinghouse will evaluate both the existing design and alternative options. An option that will be investigated includes examining the benefits of adding a series of weep holes in the walls and ceiling of the waste holdup tank rooms below to provide an additional means of detection to prevent any potential leakage from causing significant damage to the structure elements behind the module plates or from reaching the environment. If leakage were to occur, boron crystallisation would be visible at the weep holes which would be detected by the licensee during periodic visual inspections of the weep holes in the waste holdup tank rooms.

<u>Action 2</u>
Unlike the spent fuel pool, the west wall of the fuel transfer canal that is part of module CA20 is only a partial wall. The single panel serves as a concrete form and provides the corrosion resistant fluid retention boundary. The structural strength of the full wall is developed by the reinforced concrete construction behind the single panel duplex plate. The duplex plate is equipped with leak chases along its welds. In the extremely unlikely event of leakage through both the primary duplex plate welds and the stainless steel leak chases or leakage through the duplex plate at a location not along a weld, there is a potential for borated water to get behind the duplex plate in the west wall of the fuel transfer canal. In this event, the leakage will slowly migrate down the plate along the

concrete and over a long period of time has the potential to migrate into the basemat and eventually into the environment. The steel plate along the west wall of auxiliary building extends down to the basemat at elevation 66’-6”. The base of the upender pit in the fuel transfer canal is at elevation 92’-1”.

Similar to the rooms below the spent fuel pool, Westinghouse will perform an ALARP assessment that evaluates the existing design and potential design alternatives. Similar to Action 1, an option that will be evaluated that includes adding weep holes in the plate in this wall and ceiling below the fuel transfer canal. Adding weep holes in the plate in this wall and ceiling below the fuel transfer canal provides an additional means of detection to prevent any potential leakage from causing significant damage to the structure elements behind the plates or from reaching the environment.

Additionally, a future licensee is expected to establish a groundwater monitoring program. Section 12.3.5.3 of the European DCD identifies the need for a future licensee to establish this program. One of the areas of the site specifically identified to be included in this program is along the west of the auxiliary building in the area of the fuel transfer canal. This would provide a third means of detection in the highly unlikely event leakage would migrate through the 5’-0” (1.52 m) thick reinforced concrete west wall of the auxiliary building. For this to occur, there would need to be a failure in the primer duplex plate or a failure along a weld in the plate and in the leak chase that that went undetected for an extended period of time.

<u>Action 3</u>
The north wall of the spent fuel pool forms part of the boundary of the CA20 module. The stainless steel plate along the north wall of the spent fuel pool forms is also used as a leave in place formwork for the reinforced concrete wall behind it. The duplex plate is equipped with leak chases along its welds. In the extremely unlikely event of leakage through both the primary plate welds and the stainless steel leak chases or leakage through the duplex plate at a location not along a weld, there is a potential for borated water to get behind the duplex plate. In this event, the leakage will slowly migrate down the plate along the concrete and over a long period of time has the potential to migrate into the basemat and eventually into the environment. As the leakage would tend to run down the plate, significant corrosion through the concrete wall would not be expected. Regardless, the reinforced concrete wall along that location is extremely robust and minor corrosion that may occur would not have significant effect on the structural integrity of the wall.

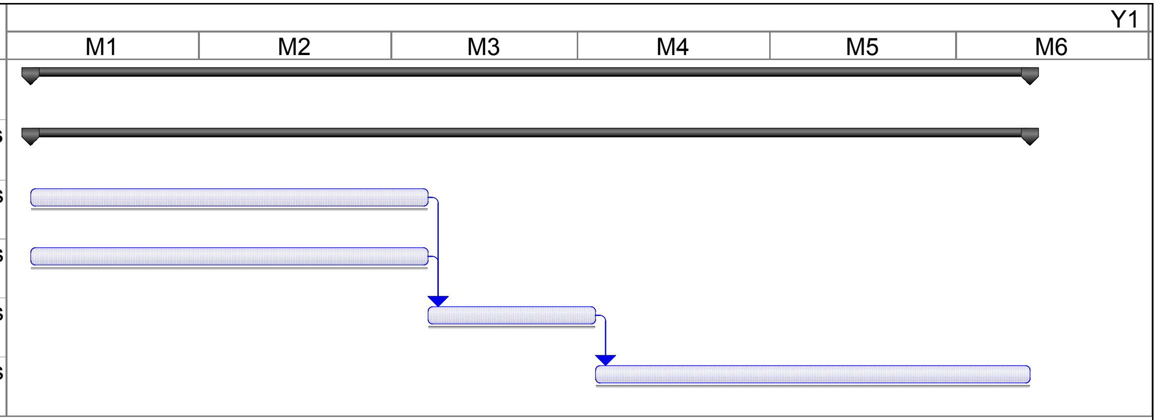
The north wall of the spent fuel pool is aligned with the north wall of the waste holdup tank rooms below. As discussed in the description for Action 1 above, Westinghouse is proposing to perform an ALARP assessment to evaluate the current design and potential design alternatives. An alternative option includes adding additional leakage detection methods by means of weep holes in this room. If leakage would to occur, boron crystallisation would be visible at the weep holes which would be detected by the licensee during periodic visual inspections of the weep holes in the waste holdup tank rooms.

<u>Action 4</u>
As discussed in the description of work for Actions 1-3, Westinghouse intends to perform an ALARP evaluation to review the **AP1000** spent fuel pool leak chase design. The

ALARP evaluation will provide confidence that adequate means of leakage prevention and detection are available for the **AP1000** spent fuel pool. As described above in the extremely unlikely event of leakage through both the primary plate welds and the stainless steel leak chases or leakage through the duplex plate at a location not along a weld, there is a potential for borated water to get behind the duplex plate. As the leakage would tend to run down the plate, significant corrosion through the concrete wall would not be expected. However, if borated water did get behind the liner plate, it is likely that there would be some corrosion of the carbon steel reinforcement behind the plate. This is true for a spent fuel pool in any operating reactor. For the leakage to go undetected, it would have to be very minor. The response to this action will provide data to demonstrate what would be the corrosion rate of the carbon steel if it were exposed to water from the spent fuel pool. In response to item 2 of this action, Westinghouse has already generated calculations that demonstrate that the capacity of the shear studs in the duplex plate exceeds the required structural capacity. This information is captured in the previously submitted calculation documenting the General Design of Shear Studs for Structural Modules. This information coupled with the response to the first item in this action will demonstrate that minor leakage through the spent fuel pool liner will not cause a structural failure of the spent fuel pool.

Schedule/ programme milestones:
Because all Resolution Plan start dates are subject to future contract placements, dates are presently undefined; therefore schedule dates have been anonymised for consistency. Actual dates will be inserted when contracts are placed. Note: ONR review time indicated on the schedule is a generic assumption. Actual review time may be shorter or longer.

ID	Task Name	Duration
1	**GI-AP1000-CE.04 Resolution Plan**	**115 days**
2	**Action 1-4: Fuel Handling Area Leakage Detection**	**115 days**
3	Perform Leakage Detection ALARP Assessment	46 days
4	Evaluate Potential for Reinforcement Corrosion	46 days
5	Prepare & Submit Action Response	19 days
6	WEC Support ONR Review	50 days



Project: Simple Resolution Plan
Date: Fri 17/06/11

Task	Milestone	External Tasks
Split	Summary	External Milestone
Progress	Project Summary	Deadline

Methodology:
To resolve this issue, Westinghouse will perform an ALARP assessment. The ALARP assessment will include a review of available industry data to evaluate if failures in spent fuel pool liners have occurred in the past and what the causes of the failures may have been. The assessment will also include a review with the appropriate Westinghouse experts. The assessment will consist of a review of the current design and potential design alternatives. The review will examine the safety aspects of the current design and potential design alternatives. The ALARP assessment will also examine the feasibility of any potential design alternatives. The ALARP assessment will form the basis for the resolution of this issue.

Justification of adequacy:
The plan outlined in the description of work along in conjunction with the the information previously provided in response to TQ-**AP1000**-1218 and TQ-**AP1000**-1270 will demonstrate that redundant barriers and means of detection are provided to protect against potential leakage from the spent fuel pool and fuel transfer canal in the fuel handling area. The response will further demonstrate that minor leakage will not impact the structural integrity of the pool.

Impact assessment:
Chapter 16 of the PCSR will be updated to reflect the closure of this GDA Issue.