

**Westinghouse UK**  
**AP1000® GENERIC DESIGN ASSESSMENT**  
**Resolution Plan for GI-AP1000-RC-02**  
**Primary Sampling Systems**

MAIN ASSESSMENT AREA	RELATED ASSESSMENT AREA(S)	RESOLUTION PLAN REVISION	GDA ISSUE REVISION
Reactor Chemistry	Mechanical Engineering / Radiation Protection / Human Factors / Radwaste / Environment Agency	4	0

<b>GDA ISSUE:</b>	Demonstrate that the sampling arrangements for the primary circuit and connected auxiliary systems of the <b>AP1000®</b> plant are adequate to support safe operation of the plant.
<b>ACTION: GI-AP1000-RC-02.A1</b>	<p>Westinghouse to provide a detailed schedule of sampling required to support operation of the <b>AP1000</b> plant. This schedule should include consideration of all modes of operation and should consider:</p> <ul style="list-style-type: none"> <li>• Parameters to be measured from which location and the frequency of sampling.</li> <li>• The schedule should be clearly linked back to the safety case.</li> <li>• Where the sample is expected to be collected (i.e. using the Grab Sample Panel (GSP), radiochemical laboratory or local provisions).</li> <li>• Primary circuit and auxiliaries, including but not limited to the Spent Fuel Pool and Waste Liquid System (WLS).</li> </ul> <p>The details should be specific to the <b>AP1000</b> plant and any differences in plant design; reference to industry guidelines is not a sufficient response in itself.</p> <p>With agreement from the Regulator this action may be completed by alternative means.</p>
<b>ACTION: GI-AP1000-RC-02.A2</b>	<p>Westinghouse to provide a justification and evidence that the primary sampling systems (PSS) in the <b>AP1000</b> plant will support the sampling schedule delivered under A1. The response by Westinghouse should consider:</p> <ul style="list-style-type: none"> <li>• Specific features of the <b>AP1000</b> design, such as the location of cooling provisions and the maintenance of high pressure lines.</li> </ul>

	<ul style="list-style-type: none"> <li>• The effect of recent design changes on system performance should be considered, for example the reduction in line diameter.</li> <li>• Specific consideration should be given to representative sampling of zinc, corrosion products and hydrogen.</li> <li>• A justification should be given to which sample lines are or are not included in the PSS, specifically why backup cooling systems are not sampled through the PSS and why the design of the <b>AP1000</b> plant does not include an inlet sample from the Chemical Volume control System (CVS).</li> <li>• Justification and evidence should be given on the use of a GSP, as opposed to a ventilated enclosure (as expected in the SAPs ECV 1 - ECV1 – 10 and associated paragraphs), and sampling provisions outside of the GSP (i.e. as currently for some systems and not others).</li> <li>• Justification should be provided for not including a boron meter as a means of continuously monitoring the coolant boron concentration now that a design change to flowing samples has been included.</li> <li>• The impact of the design change on the served and dependant systems should be clearly reviewed and documented (for example, the impact of increased PSS flow on the WLS input or CVS make-up requirements).</li> <li>• Evidence should be provided to demonstrate that waste generation of the system is within the safety case and that the design has sufficient redundancy to accommodate operational transients.</li> </ul> <p>With agreement from the Regulator this action may be completed by alternative means.</p>
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**RELEVANT REFERENCE DOCUMENTATION RELATED TO GDA ISSUE**

<b>Technical Queries</b>	TQ- <b>AP1000</b> -533 TQ- <b>AP1000</b> -535 to TQ- <b>AP1000</b> -541
<b>Regulatory Observations</b>	RO- <b>AP1000</b> -55.A8
<b>Other Documentation</b>	<p>Step 4 – Reactor Chemistry Assessment of the Westinghouse <b>AP1000</b> - AR 11/008</p> <p>SAPs - ENM4, ENM7, EMC24, ECV 1 – ECV 10</p> <p>T/AST/023 - Control of Processes Involving Nuclear Matter</p> <p>SSG-13 - IAEA Safety Standard Chemistry Programme for Water Cooled Nuclear Power Plants</p>

**Scope of work:**

Westinghouse will evaluate the sampling arrangements for the primary circuit and connected auxiliary systems of the **AP1000** plant to demonstrate they are adequate to support safe operation of the plant or to provide design alternatives. This will include a clear and detailed definition of all sampling requirements including frequencies and locations of sampling for all plant modes of operation. In addition, a definition of relevant good practice for a sampling system and programme will be developed. Based on these sampling requirements and definitions, Westinghouse will provide justification and technical evidence that the **AP1000** plant Primary Sampling System (PSS) is adequate to support safe operation of the plant or provide design alternatives or modifications.

**Description of work:**

The activities that will be undertaken to resolve GI-**AP1000**-RC-02 will be divided into two phases:

1. To address action GI-**AP1000**-RC-02.A1, Westinghouse will create a sample schedule that will be documented in **UKP-GW-GL-091**, "**AP1000** Sample Schedule" which will provide the **AP1000** plant sampling requirements for the primary system and its auxiliaries to support safe operation of the **AP1000** plant in all operating modes. This definition of the **AP1000** plant sampling requirements is independent of the detailed aspects of the sampling system used to obtain the samples. In addition, a definition of relevant good practice for sample system designs will be created as input into the review of the system design.
2. To address action GI-**AP1000**-RC-02.A2, Westinghouse will conduct an evaluation of the current **AP1000** plant PSS against the sampling requirements defined in the **AP1000** plant Sample Schedule, relevant good practice and operational experience. This evaluation will include justification for samples included within the PSS and for the samples from other primary auxiliary systems that are sampled via other means. This will be documented in a UK specific document, "Evaluation of the **AP1000** plant Primary Sampling Arrangements". The purpose of this evaluation is to either confirm ONR concerns / identify design shortfalls and potential areas of enhancement or to generate adequate evidence to demonstrate that the current **AP1000** plant PSS design meets its operating requirements and that sampling of other primary auxiliary systems can be safely and adequately sampled. This will be a holistic review including system design requirements and goals, safety functional requirements, capability of the system, reliability of the system, representativeness of the samples and waste generation. An ALARP assessment will be performed considering design alternatives to address any design shortfalls and potential desired enhancements identified.

**Action GI-AP1000-RC-02.A1: Establishment of the AP1000 Plant Primary Sampling System Requirements in UKP-GW-GL-091 and UKP-GW-GL-101**

It is the responsibility of the utility to develop their own plant specific radiochemistry programme which would include a detailed sample schedule indicating the sample

frequencies for the various chemistry parameters. However, to address GI-**AP1000**-RC-02.A1 and establish the operating requirements of the sampling features to support the operation of the plant, Westinghouse will develop an example of a detailed sampling schedule required to support the operation of the **AP1000** plant. The sampling schedule will include the following aspects.

- This sampling schedule will be based on International non-**AP1000** plant specific sources such as the Electric Power Research Institute primary chemistry guidelines as well as on **AP1000** plant specific sources such as the **AP1000** plant chemistry manual, the **AP1000** plant Technical Specifications and the Westinghouse Supplement to EPRI PWR Primary Water Chemistry Guidelines Rev. 6 for the **AP1000** Standard Plant. There is a linkage between this task and the chemistry aspects of GI-**AP1000**-CC-01, Limits and Conditions. The content of the two tasks will need to be consistent.
- The sampling schedule will address the primary system and its auxiliaries including but not limited to the RCS, CVS, SFS, RNS, PXS, WGS and WLS.
- Normal operation (**AP1000** plant Technical Specification Modes 1 & 2), startup (**AP1000** plant Technical Specification Modes 3 & 4) and cold shutdown (**AP1000** plant Technical Specification Modes 5 & 6) will be addressed in the sampling schedule.
- Transient sampling requirements other than startup and shutdown.
- A detailed description of the **AP1000** plant sample frequency for each of the plant modes will be provided by identifying which samples are taken in each mode, which chemistry parameters will be analysed in each sample, and what the chemistry parameter frequencies are for each sample will be provided.
- Any necessary local sampling requirements will be identified, as well as the locations where these samples will be taken.

In addition, Westinghouse will develop a report to document the definition of relevant good practice and operating experience to be used for the design of a primary sampling system within a plant of similar configuration. This will provide an input along with the sample schedule for action GI-**AP1000**-RC-02.A2

#### **Action GI-AP1000-RC-02.A2: Evaluation of the AP1000 Sampling Arrangements for the Primary System and its Auxiliaries in UKP-GW-GL-099**

This new document will evaluate the capability of the **AP1000** plant primary sampling system as presented in the GDA design reference point and other primary sampling design features (local sampling of auxiliary systems) to fulfil their role in support of **AP1000** plant operation. This document will include the following:

1. An overview of the primary sampling system general design requirements and design goals and reference to the appropriate detailed evidentiary documentation.  
(Westinghouse documentation, operational experience, relevant good practice, etc.)
2. A description and discussion of the **AP1000** plant PSS including an overview of the design identifying specific features such as the location of all sample

points (what is sampled through the PSS and what is not and the relevant justification), the location of the sample coolers, transitions from high pressure to low pressure and the grab sample panel. The discussion will include operator safety aspects during sampling including estimated worker doses.

A justification will be provided to which sample lines are or are not included in the PSS, specifically why the SFS, BDS, RNS and IRWST are not sampled through the PSS, why the design of the **AP1000** plant does not include a CVS inlet sample and other potential deficiencies identified in the Step 4 report. Also, a justification of the grab sample panel versus a ventilated enclosure will be compared and included.

3. A general description of how each sample is collected including the sample collection times as well as the necessary purge frequencies and times. The total time spent on sampling activities will be calculated by using the sample collection time, purge time and the time for the operator to manipulate the valves for sample collection. The total time spent on sampling activities will be compared to the capability of the system (required purge and sample times versus required sampling intervals). This evaluation will either demonstrate that the current **AP1000** plant PSS is capable to support the detailed sampling schedule or will identify current **AP1000** plant PSS system capability shortfalls and potential areas of enhancements.
4. A discussion and evaluation of the impact of the **AP1000** plant PSS and the required sampling activities on other **AP1000** plant systems. This will include, but not necessarily be limited to, an evaluation of the CVS make-up requirements and liquid and gaseous waste capacity requirements for waste generated during sampling operations in the various plant modes.
5. An evaluation of the reliability and operability of the **AP1000** plant PSS system design as presented in the GDA design reference point based on operating experience and review of the Failure Modes and Effects Analysis (FMEA). The result will be to either demonstrate the adequacy of the design or to identify any design shortfalls or potential areas for enhancement. More precisely, the design adequacy and reliability of the major components of the system (manifold, valves, grab sample panel, etc) will be reviewed. Based on the results of the FMEA, the importance of each major component for the PSS system to support safe operation will be discussed. Additionally, specific ONR concerns related to system reliability and accessibility will be discussed.
6. An evaluation of the **AP1000** plant primary sampling system's ability to provide representative samples for zinc, corrosion products and dissolved hydrogen will be performed either to demonstrate the adequacy of the design or to identify any design shortfall or potential areas of enhancement. It will describe the purging operations of the **AP1000** plant PSS system design as presented in the GDA design reference point to support representative sampling and review the effects that line diameter and system faults (a leaking valve, cross contamination, etc.) would have on a sample. The evaluation will also justify the ability of the primary sampling system design to effectively sample for suspended solids as well as evaluating the need for continuous,

on-line boron sampling and justification for sufficient CVS sampling penetrations.

7. A review of relevant good practice defined within UKP-GW-GL-101 (including operating PWR sampling systems worldwide) will be performed and the above mentioned aspects will be compared and contrasted with relevant good practice.
8. An ALARP assessment of the above aspects of the **AP1000** plant PSS design. This may be part of the above mentioned document or a standalone document. The ALARP assessment will include:
  - A summary of ONR concerns, design shortfalls, and potential areas of enhancements identified as part of UKP-GW-GL-091, UKP-GW-GL-101, and the UK specific document described above (UKP-GW-GL-099).
  - For each of those topics, it will identify alternative designs.
  - It will then assess the impact of the alternative design in terms of plant design, worker dose exposure, primary chemistry, etc.
  - Conclusions will be drawn upon the results. It will either justify that the current primary sampling system design is ALARP or ALARP design changes will be identified.
9. The conclusions of the ALARP assessment will be reviewed by an internal independent review team. The ALARP design changes identified will be incorporated per the Westinghouse design change process as appropriate. These potential design changes are not specifically included in this resolution plan programme as they are yet to be identified and; hence, the scope is unknown.

**Schedule/ programme milestones:**

Please see the following page for the schedule.

#	Activity Name	2015												2016												2017	
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		Jan
		1	<b>BL5 11202015-UK Generic Design Assessment (GDA) Resolution Plans (51)</b>																								
2	<b>REACTOR CHEMISTRY</b>																										
3	<b>RC.02 Primary Sampling System-Resolution Plan</b>																										
4	<b>RC.02 UKP-GW-GL-091, Sample Schedule</b>																										
5	UKP-GW-GL-091-Submit to ONR			-																							
6	UKP-GW-GL-091-ONR Review of Submittal			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
7	<b>RC.02 UKP-GW-GL-101, Definition of Good Practice</b>																										
8	UKP-GW-GL-101-Submit to ONR																										
9	UKP-GW-GL-101-ONR Review of Submittal																										
10	<b>RC.02 UKP-GW-GL-099 Rev.0 AP1000® Plant Primary Sampling System-Safety Evaluation</b>																										
11	UKP-GW-GL-099-Submit to ONR																										
12	UKP-GW-GL-099-ONR Review of Submittal																										

**Methodology:**

Westinghouse will address this GDA issue in two phases. In the first phase, Westinghouse will provide the **AP1000** plant sampling requirements for the primary system and its auxiliaries along with relevant good practice for sampling system designs. This will be done by establishing representative primary sampling operating requirements for all plant operational modes that allow for safe, reliable operation of the **AP1000** plant. The **AP1000** plant sampling requirements are independent of the system(s) performing the sampling.

In phase two, Westinghouse will demonstrate that the current **AP1000** plant PSS design meets its operating requirements in terms of capability of the system, reliability of the system, safe operation and representativeness of the sample or to confirm ONR concerns / identify design shortfalls and potential areas of enhancement or generate adequate evidence. This will be a holistic evaluation and include a review of existing relevant good practice. Design alternatives will be considered and an ALARP demonstration will be performed to either justify that the current primary sampling system design is ALARP or to identify ALARP design changes. ALARP design changes identified will be incorporated per the Westinghouse design change process as appropriate.

**Justification of adequacy:**

The activities proposed to resolve GI-**AP1000**-RC-02 will provide an evaluation of the primary sampling system to either demonstrate its adequacy or to identify design shortfalls and potential areas of enhancement. The focus areas for evaluation are the capability of the system, reliability of the system, safe operation, representativeness of the sample and comparison with relevant good practice. Design alternatives will be considered to address those shortfalls and potential areas of enhancement. The documents described above will provide evidence in the form of calculations, design evaluations and ALARP assessments to either justify the design of the **AP1000** plant primary sampling system, or to propose an ALARP design alternative. ALARP design changes identified will be incorporated per the Westinghouse design change process as appropriate.

**Impact assessment:**

The following documents are anticipated to be effected:

- PCSR – Chapter 21
- Environmental Report as appropriate
- Master Submission List
- Roadmap
- Other design documents as appropriate based on the outcome of the work to resolve this GDA issue.