Westinghouse UK
AP1000® GENERIC DESIGN ASSESSMENT
Resolution Plan for GI-AP1000-IH-04
Internal Explosion Safety Case Substantiation

MAIN ASSESSMENT AREA	RELATED ASSESSMENT AREA(S)	RESOLUTION PLAN REVISION	GDA ISSUE REVISION
Internal Hazards	-	9	2

GDA ISSUE:	Provide substantiation to support claims and arguments made within the area of internal explosion.
ACTION: GI-AP1000-IH-04.A1	Provide substantiation of the safety case for explosion within Battery Rooms. This should include consideration of a multi-legged argument associated with the following: • Potential hydrogen accumulation rates during normal and fault conditions. • Consideration of heating, ventilation, and air conditioning (HVAC) systems. • Hydrogen detection. • Engineered protection systems associated with the cessation of battery charging. • Civil structures in place to prevent propagation of a hydrogen explosion to redundant trains of protection. Administrative controls or procedures presented as risk mitigation. The list above should not be considered to be exhaustive and the items detailed above are provided as a means to inform Westinghouse of ONR expectations. With agreement from the Regulator this action may be completed by alternative means.
ACTION: GI-AP1000-IH-04.A2	Provide substantiation of the safety case for the routing of the hydrogen pipework within areas containing Class 1 SSCs. This should include consideration of a multi-legged argument associated with the following: • Potential hydrogen accumulation rates during normal and fault conditions. • Consideration of heating, ventilation, and air conditioning (HVAC) systems. • Hydrogen detection. • Civil structures in place to prevent propagation of a hydrogen explosion to redundant trains of protection. • Administrative controls or procedures presented as risk mitigation. The list above should not be considered to be exhaustive and the items detailed above are provided as a means to

	inform Westinghouse of ONR expectations. With agreement from the Regulator this action may be completed by alternative means.
RELEVANT REFERENCE DOCUMENTATION RELATED TO GDA ISSUE	
Technical Queries	TQ-AP1000-1286
Regulatory Observations	RO-AP1000-31
Other Documentation	UKP-GW-GLR-001 Rev 3 UKP-GW-GL-793 Rev 0

Scope of work:

GI-AP1000-IH-04.A1:

Provide substantiation of the safety case for explosion within Battery Rooms. This should include consideration of a multi-legged argument associated with the following:

1. Potential hydrogen accumulation rates during normal and fault conditions.
2. Consideration of heating, ventilation, and air conditioning (HVAC) systems.
3. Hydrogen detection.
4. Engineered protection systems associated with the cessation of battery charging.
5. Civil structures in place to prevent propagation of a hydrogen explosion to redundant trains of protection.
6. Administrative controls or procedures presented as risk mitigation.

With agreement from the Regulator this action may be completed by alternative means.

GI-AP1000-IH-04.A2:

Provide substantiation of the safety case for the routing of the hydrogen pipework within areas containing Class 1 SSCs. This should include consideration of a multi-legged argument associated with the following:

1. Potential hydrogen accumulation rates during normal and fault conditions.
2. Consideration of heating, ventilation, and air conditioning (HVAC) systems.
3. Hydrogen detection.
4. Civil structures in place to prevent propagation of a hydrogen explosion to redundant trains of protection.
5. Administrative controls or procedures presented as risk mitigation.

With agreement from the Regulator this action may be completed by alternative means.

Description of work:

The **AP1000®** design minimises the use of explosive materials near Class 1 SSCs in the nuclear island. Based on prior safety case assessments, there are only 3 sources of such materials: hydrogen generation in the battery rooms during charging operations, and leakage from a small hydrogen supply line servicing the CVS system, and leakage from piping of the WLS and WGS systems The response to this Issue addresses all of the above.

GI-AP1000-IH-04.A1:

The following assessments and actions will be undertaken:

- Determine battery hydrogen generation rate to assess time to LDL.
- Consider the role of HVAC systems as part of the hydrogen gas control.
- Identify potential hydrogen detection equipment and assess the suitability of including such in the **AP1000** design.
- Review ALARP lack of ventilation control tie-in to charging system.
- Review protection of adjacent trains by civil structures and ascertain the level of suitable protection.

GI-AP1000-IH-04.A2:

- Assess hydrogen piping routing to assure lines do not pass through areas where faults could create open concentrations or ventilation could concentrate hydrogen above LDL limits.
- Assess electrical equipment classifications in areas of potential hydrogen piping leakage.
- Assess leakage from WLS and WGS systems.

Further, additional information will be included as addressing:

- Administrative controls regarding hydrogen generation. Such controls, if added to the safety case, will be of a defense in depth nature.
- The impact of the changes made to the PCSR relating to the outcome of this substantiation on other safety case submissions such as civil engineering and mechanical engineering. Any further defence in depth and ALARP measures that could be implemented into the design.

The content of work addressing actions GI-AP1000-IH-04.A1 and A2 have been summarized in draft reports or calculation notes as presented to the ONR. The final version of this information, including consideration of ONR comments, shall be presented within the Internal Explosions Topic Report, as documented within the Westinghouse EDMS and as suitable for referencing within the safety case.

Schedule / programme milestones:

In addition to the below listed actions, Westinghouse shall provide:

- A summary roadmap of the Internal Explosion Safety Case.
- A Westinghouse Topical Report summarising the Internal Explosion Safety Case.

Additional information will be compiled and presented in the PCSR and / or Topic Report addressing:

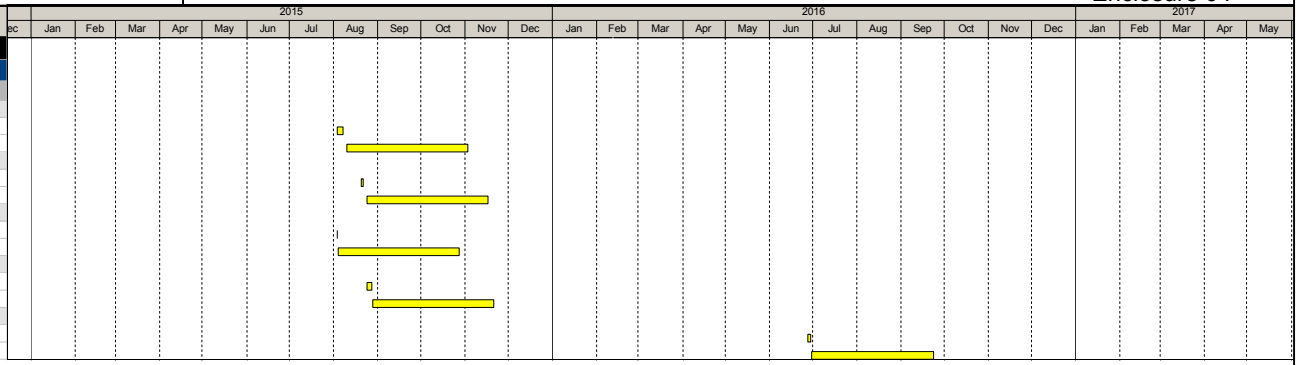
- Action GI-AP1000-IH-04.A1:
    - Battery hydrogen generation rates to assess time to LDL; suitability of hydrogen detection equipment for inclusion within the **AP1000** design; review of the ventilation control tie-in to charging system; and, review of the protection of adjacent trains by civil structures to ascertain the level of suitable protection.
- Action GI-AP1000-IH-04.A2:
    - Hydrogen piping routing relative to build-up of hydrogen concentrations in excess of the LDL; assessment of the electrical equipment classification in the areas of potential hydrogen piping leakage; and, hydrogen management in the WLS and WGS systems.
    - Administrative controls regarding hydrogen generation. Such controls, if added to the safety case, will be of a defense in depth nature.
    - The impact of the changes made to the PCSR relating to the outcome of this substantiation on other safety case submissions such as civil engineering and mechanical engineering.
    - Further defence in depth and ALARP measures that could be implemented into the design.

The Westinghouse deliverables and compiled additional information shall be completed in accordance with the Integrated Schedule. Should the safety case require revision, this work will be scheduled accordingly or alternatively confirmation will be provided that the existing Pressure Part Failure safety case remains valid.

Further, information will be compiled within the Safety Case Topical Report addressing the impact of potential PCSR design changes relating to the outcome of this review on other safety case submissions. Identification and consideration of further defence-in-depth and ALARP measures that may be implemented into the design relative to the Safety Case shall be considered.

Please see the following page for the schedule.

#	Activity Name
1	**UK Generic Design Assessment (GDA) Resolution Plans (51)**
2	**INTERNAL HAZARDS**
3	**IH.04 Internal Explosion Safety Case Substantiation-Resolution Plan**
4	**IH.04 Section 1: Battery Room Assessment**
5	Battery Room Assessment Submit to ONR
6	Battery Room Assessment ONR Review of Submittal
7	**IH.04 Internal Explosion Roadmap**
8	Internal Explosion Roadmap - Submit to ONR
9	Internal Explosion Roadmap ONR Review of Submittal
10	**IH.04 Section 2: Hydrogen Pipeline Assessment**
11	Hydrogen Pipeline Assessment Submit to ONR
12	Hydrogen Pipeline Assessment ONR Review of Submittal
13	**IH.04 WLS/WGS Hydrogen Management Assessment**
14	Hydrogen Management Assessment Submit to ONR
15	Hydrogen Management Assessment ONR Review of Submittal
16	**IH.04 Internal Explosions Topic Report**
17	Internal Explosions Topic Report -Submit to ONR
18	Internal Explosions Topic Report -ONR Review of Submittal



29-Feb-16

Methodology:

GI-AP1000-IH-04.A1:

Hydrogen generation rates will be obtained via vendor(s) design documentation, or similarly identified requirements for batteries. Hand calculations can then be used to determine the maximum allowable amount of hydrogen generated. Vendor information shall be assessed as potential provisions to incorporating hydrogen detection in the battery rooms.

The ventilation system operability tie-in to battery charging shall be assessed regarding ALARP.

The location of adjacent Class 1 SSCs shall be determined and judgements performed regarding the protection provided by civil structures to likely explosions.

GI-AP1000-IH-04.A2:

Hand calculations can be used to assess the impact of hydrogen lines in specific areas of the plant.

Potential PCSR changes will be identified and assessed by Westinghouse Licensing personnel; ALARP reviews will be conducted through use of an expert panel.

Justification of adequacy:

GI-AP1000-IH-04.A1 and A2:

The Westinghouse analysis presented within the PCSR has correctly identified two potential sources of internal explosions within the nuclear island. The PCSR did identify sources that could give rise to an explosion but did not quantitatively specify the consequences of such an explosion. The ONR GDA Step 4 assessment concurred with this finding; however, it also concluded that additional substantiation is warranted to fully assess the potential internal explosive hazard relative to the adequacy of protection provided by spatial segregation, protective barriers, and redundancy in safety related items and safety systems.

This work verifies and augments substantiation of Internal Explosion claims and arguments. Given that the potential for such explosions is low and the compartmentalisation design of the **AP1000** plant leads to isolation of internal hazard influences, complementing existing assessments of the sourcing of explosive potential completes substantiation of the **AP1000** internal explosion safety case.

Impact assessment:
GI-AP1000-IH-04.A1 and A2: Safety case impacts (PCSR / ALARP assessment / Master Submission List), if any, are to be assessed following completion of the defined workscope and changes identified if necessary and warranted. Any design changes will be captured and evaluated as part of the Westinghouse Design Change Process.