

Westinghouse UK
AP1000® GENERIC DESIGN ASSESSMENT
Resolution Plan for GI-AP1000-IH-06
Substantiation and Analysis of the Consequences of Dropped Loads and
Impact from Lifting Equipment Included Within the AP1000 Design

MAIN ASSESSMENT AREA	RELATED ASSESSMENT AREA(S)	RESOLUTION PLAN REVISION	GDA ISSUE REVISION
Internal Hazards	Mechanical Engineering Human Factors Fault Studies Civil Engineering	6	2

GDA ISSUE:	Substantiation and analysis of the consequences of dropped loads and impact from lifting equipment included within the AP1000® design.
ACTION: GI-AP1000-IH-06.A1	<p>Identify and substantiate all claims made on SSCs associated against the effects of dropped load and impact. This approach should, in the first instance, consider the potential consequences of a dropped load or impact on a quantitative basis to determine significance of the dropped load or impact. This should then lead to detailed multi-legged arguments to demonstrate that the provisions in place to ensure that the risk to nuclear safety of a load drop or impact was ALARP and that such analysis may take into account:</p> <ul style="list-style-type: none"> • Claims on civil structures. • Additional physical protection. • Limits and conditions on the use of the lifting equipment. • Provision of detailed load path routes avoiding areas of highest nuclear significance. • Measures (both system based and administratively controlled) in place to ensure the potential for impact of the load is minimised. <p>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.</p>
RELEVANT REFERENCE DOCUMENTATION RELATED TO GDA ISSUE	
Technical Queries	TQ-AP1000-1272
Regulatory Observations	RO-AP1000-31
Other Documentation	UKP-GW-GLR-001 Rev 3 UKP-GW-GL-793 Rev 0

Scope of work:

Westinghouse will identify and substantiate all claims made on SSCs associated with the effects of dropped load and impact and, in the first instance, consider the potential consequences of a dropped load or impact on a quantitative basis to determine significance of the dropped load or impact.

This should then lead to detailed multi-legged arguments to demonstrate that the provisions in place to ensure that the risk to nuclear safety of a load drop or impact was ALARP and that such analysis may take into account:

- Claims on civil structures.
- Additional physical protection.
- Limits and conditions on the use of the lifting equipment.
- Provision of detailed load path routes avoiding areas of highest nuclear significance.
- Measures (both system based and administratively controlled) in place to ensure the potential for impact of the load is minimised.

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

Description of work:

The likelihood of mechanical failure due to inherent defects within the lifting systems is characterised as very low, due to the rigorous quality assurance regimes to be applied during manufacture, and associated level of EMIT applied during the lifetime of the plant, including test lifts as appropriate. However, evaluation of the following equipment, as a minimum, will be performed for potential damage to the principal means of delivering Category A (i.e. cat A-1 SSCs) and supporting Category B SSCs necessary for the safe shutdown or control of the plant from the following heavy lift-capable cranes within the nuclear island:

MH01 Polar Crane	MH40 Auxiliary Building Staging Area Hoist
MH02 Cask Handling Crane	MH40 Maintenance and Equipment Hatch Hoists
MH09 Containment and Auxiliary Building Elevators	MH40 MSIV Hoists
MH11 Shield Building Elevator	MH50 Scissor Lift
MH18 Corridor Lift Platform	MH60 Filter Cask Cart
MH19 Shield Building Annulus Baskets and Hoists	FH02 Fuel Handling Machine
MH20 Rail Car Bay Crane	

Evaluations will include consequential assessments of impacts to the Category A (i.e. cat A-1 SSCs) and supporting Category B SSCs as described below. These assessments will initially consider the load drop consequences on a qualitative basis, depending upon the extent and likelihood of these consequences, further quantitative assessment may be undertaken. The need for quantitative studies will be dependent upon the impact to the Category A and supporting B SSC's safety function during the time period when they are required operational. These consequential assessments will include load drops:

- Within the immediate vicinity of the expected path of the crane for those periods at which the crane and SSC are required operational whilst noting that GDA Finding AF-AP1000-ME-23 calls for a future licensee to ensure that safe load paths are in fact specified through appropriate design and safety documentation, and procedures.
- On potentially impacted elevations below the handling devices that may logically be impacted by structural failures for those times at which the crane and SSCs are required operational.

As part of these consequence assessments, consideration will be given to safety case claims made upon civil structures, physical protection, load paths, conditions of use of the lifting equipment and any other engineered or administrative protection, as part of a multi-legged safety argument.

Should the consequences of these assessments be found unacceptable (i.e.; the Category A or supporting Category B SSC safety function is compromised to the extent of being inoperable when needed), Westinghouse shall take further action to assess and implement appropriate design changes in accordance with standard procedures.

Further, based on the results of the assessment of impacts described above, dedicated handling equipment (such as the reactor vessel internals lift rig) will be identified and their design basis assessed relative to the use of industry-accepted codes and standards in supporting the safety case.

The following conditions will exclude handling equipment from further consideration in this assessment:

- The lifting device is not designed or rated to lift a heavy load in excess of a single fuel assembly and handling device, as specified in the USNRC NUREG 0612.
- The heavy load lift is not located in the vicinity of a Category A or supporting Class B SSC required to provide the principal means for the safe shutdown or control of the plant.
- The lifting device has passive devices controlling the load path in a safe manner (i.e.; Rail stop or mechanical limitation).
- The lifting device is unavailable during power operation and cannot lift a heavy load near a necessary Category A and supporting Category B SSCs during refuelings.

A discussion of these conditions, including the basis for exclusion of dropped loads and impacts associated with the above four conditions, will be documented within the deliverables of this work. Single Failure Proof is not an excluding condition for assessment of dropped load.

The deliverables for this work shall be developed to document the consequence assessment in support of the safety case for dropped loads and impact. The content of this work will be summarised in a report documented within the Westinghouse EDMS as suitable for referencing within the safety case. Specific details of the Westinghouse approach to this plan are found in the following section.

Finally, additional information will be compiled addressing:

- 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.

Schedule/ programme milestones:

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

- A summary roadmap of the Dropped Loads Safety Case.

The specific deliverables associated with this Action are calculation note(s) or report(s) suitable for referencing in the safety case as covering the following:

1. Evaluate expected travel paths for equipment removal and Installation. These would include **AP1000** Revision A drawings of the Containment and Auxiliary Building on selected elevations that clearly outline the travel path of equipment, including when cranes are utilised.
2. Document justification of conditions that exclude handling equipment from further consideration, specifically:
 - The lifting device is not designed or rated to lift a heavy load.
 - The heavy load lift is not located in the vicinity of a Category A or supporting Category B SSC required to provide the principal means for the safe shutdown or control of the plant.
 - The lifting device has passive devices controlling the load path in a safe manner.
 - The lifting device is unavailable during power operation and cannot lift a heavy load near a necessary Category A or supporting Category B SSC

during refuelings.

3. A Westinghouse Topical Report summarising the Dropped Loads Safety Case containing detailed multi-legged arguments to demonstrate that the provisions in place to ensure that the risk to nuclear safety of a load drop or impact is ALARP, including consideration of the following:
 - Using an expected lifting schedule, identify potential impacts on the principal means of SSCs with a Category A, or supporting Category B, safety function for the above listed expected travel paths.
 - Evaluate the consequences of a dropped load using the methodology identified below and the 4 point criteria used to exclude handling equipment, to identify concerns with any of the impacted lifting devices identified with the expected lifting schedule.
 - For any potential impact remaining after the assessment in Step 4 above, provide an additional assessment for use any engineered lifting device. This will either justify the consequences of the impact as acceptable, or demonstrate how the engineered lifting equipment is designed such that the risk of drop is sufficiently low.

It is noted that, consistent with GDA Finding AF-AP1000-ME-23, the responsibility to define safe load paths and validate them rests with the licensee. In this activity, Westinghouse will review 'expected' travel paths and thus illustrate how safe load paths could later be established, and what considerations would be required to confirm them.

The Westinghouse review 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 dropped loads 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.

Methodology:

The sequential process outlined in the Schedule / Programme Milestone section will be applied to this Issue. Summarising this process:

- Evaluate the heavy-lift crane travel paths.
- Document exclusion criteria.
- Identify potential impacts to Category A and supporting Category B SSCs.
- Evaluate the consequences of a dropped heavy load.
- Evaluate, if necessary, the influence of use of an engineered lifting device on the dropped load consequences.
- Deliver an updated safety case or confirm validity of existing safety case.

Each handling device and crane will be assessed individually based on location in the plant, required period of operations, hook expected travel locations, hook-rated capacity and risk proximity to Category A and supporting Category B SSCs. Additionally, usage risk of the crane as defined by the number and frequency of lifts and operator qualifications will be factored into the assessment. These criteria will determine if a further structural calculation will need to be completed to quantify the impact of a dropped heavy load.

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:

While the **AP1000** Dropped Loads safety case principles are present within PCSR, there was insufficient substantiation information available during the Step 4 GDA period to fully assess some claims, arguments and evidence. The ONR Step 4 assessment found the **AP1000** Dropped Loads safety case required a greater substantiation basis for a claim-argument-evidence reliance on the adequacy of protection provided by civil structures, crane and plant design basis, Class A and supporting Class B SSC spatial segregation, protective barriers, redundancy in safety related components and the like. Westinghouse recognised this late in Step 4 and provided a more comprehensive safety case in the later revision 0 of the PCSR. However, it is recognised that additional substantiation in a more structured format remains in order to support the Dropped Loads safety case.

This work is designed to verify and supplement substantiation of the PCSR Dropped Loads claims and arguments through assessments and evaluations for each of the lifting devices capable of moving a heavy load at a time which a potentially impacted Category A or supporting Category B system is required to be operational. Consideration is also provided for passive devices used in preventing or limiting load drops and the design of engineered load handling devices exclusively dedicated to certain lifts. Given that the