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**STEP 4 REGULATORY ISSUE RI-AP1000-2
AND REGULATORY ISSUE ACTIONS RI-AP1000-2.A1 TO A3
CIVIL ENGINEERING DESIGN METHODOLOGY**

I acknowledge your letter UN REG WEC00142 of 3 February 2010 enclosing comments on both the intended RI-AP1000-2 and associated draft Regulatory Issue Actions RI-AP1000-2.A1 to A3. I have considered your comments and where I consider it appropriate I have amended the documents. I have also accepted your requested changes of dates for resolution.

The UK Regulators are notifying you by this letter of the declaration of Regulatory Issue RI-AP1000-2 and associated Regulatory Issue Actions RI-AP1000-2.A1 to A3 which are attached.

Please acknowledge receipt of this Regulatory Issue and associated Regulatory Issue Actions by 1 March 2010.

Yours sincerely,

Nuclear Installations Inspectorate

WESTINGHOUSE AP1000 GENERIC DESIGN ASSESSMENT

REGULATORY ISSUE

RI-AP1000-02

Civil Engineering Design Methodology

ORIGINATED BY / ORGANISATION:	APPROVED BY / ORGANISATION:	ASSESSMENT AREA	DATE RAISED:
A COATSWORTH /ND	R JENNINGS / ND	Civil Engineering	16 February 2010

REGULATORY ISSUE:	<p>The concrete filled steel structural modules (CA modules) are outside the scope of applicability of the substantive provisions of WEC's chosen design standard American Concrete Institute (ACI) standard ACI 349-01.</p> <p>WEC has neither fully defined nor adequately justified the design methodology or methodologies used for CA modules.</p> <p>The UK Regulators expect this to be addressed in response to the attached Regulatory Issue Actions (RIAs).</p>
ACKNOWLEDGEMENT REQUIRED BY:	1 March 2010
RESOLUTION REQUIRED BY:	30 October 2010

BACKGROUND / REGULATOR EXPECTATIONS

This RI is concerned with the methodology used for the design of concrete filled steel structural modules and of connections between and to such modules.

This action takes account of TQ-AP1000-69, TQ-AP1000-143, TQ-AP1000-253, TQ-AP1000-447 and of RO-AP1000-041. No response to RO-AP1000-041 has been received.

APP-GW-GLR-045 Revision 0, Section 2.2.4.2 (Critical Sections reinforcement design states):

The Nuclear Island reinforced concrete critical sections are designed in accordance with the American Concrete Institute (ACI) standard ACI 349-01, 'Code Requirements for Nuclear Safety Related Concrete Structures'.

APP-GW-C1-001 Revision 1 "Civil/ Structural Design Criteria" section 6.2 states that for seismic category I and category II structures:

Concrete structures shall be designed in accordance with ACI-349 for the load combination and load factors given in Table 3 and Table 5.

The design of concrete filled steel structural modules (CA modules) lies outside the scope of applicability of the substantive provisions of the American Concrete Institute (ACI) standard ACI 349-01 cited by WEC. HSE's Safety Assessment Principle ECS.5 addresses the eventuality that there is no applicable or relevant design code or standard for a nuclear safety related component:

Engineering principles: safety classification and standards	Use of experience, tests or analysis	ECS.5
In the absence of applicable or relevant codes and standards, the results of experience, tests, analysis, or a combination thereof, should be applied to demonstrate that the item will perform its safety function(s) to a level commensurate with its classification.		

HSE's Safety Assessment Principle ERL.1 and the paragraphs 176 and 177 that follow it provide further guidance:

Engineering principles: reliability claims	Form of claims	ERL.1
The reliability claimed for any structure, system or component important to safety should take into account its novelty, the experience relevant to its proposed environment, and the uncertainties in operating and fault conditions, physical data and design methods.		

176 Adequate reliability and availability should be demonstrated by suitable analysis and data.

177 Where reliability data is unavailable, the demonstration should be based on a case-by-case analysis and include:

- a) a comprehensive examination of all the relevant scientific and technical issues;
- b) a review of precedents set under comparable circumstances in the past;

- c) an independent third-party assessment in addition to the normal checks and conventional design;
- d) periodic review of further developments in technical information, precedent and best practice.

Where there is no applicable or relevant design code or standard for a nuclear safety related component the design methodology must be clearly and unambiguously defined in a high level document for use by design engineers.

A design methodology not compliant with a relevant design standard must be adequately justified. In our GDA Step 3 Report (Ref 1) we noted our concerns on the design of the CA modules regarding:

- transverse shear;
- in-plane shear;
- and, the effect of thermal loads on the plate to concrete bond.

Justification of the design methodology is required to cover these three concerns in particular. The justification should also address the need, noted in our GDA Step 3 Report, to satisfy ND as to how connections between similar and dissimilar modules, and between modules and basemats meet our expectations of:

Clear load paths;

And, ductile detailing.

Additionally WEC has presented proposed changes to its design of the Enhanced Shield Building (Ref 2). These proposals have not yet been formally submitted to ND. Such proposals will need to be justified.

WEC is required to review the implications of changes to the design methodology for all nuclear safety related structures or parts of nuclear safety structures using concrete filled steel structural modules.

References

1. HSE: 2009: Generic Design Assessment – New Civil Reactor Build: Step 3 Civil Engineering and External Hazards Assessment of the Westinghouse AP1000. Nuclear Directorate Division 6 Assessment Report No. AR09/034-P.
2. Westinghouse: AP1000 Shield Building - Meeting with NRC and others. 18 November 2009.

WESTINGHOUSE AP1000 GENERIC DESIGN ASSESSMENT

REGULATORY ISSUE ACTION

RI-AP1000-2.A1

Civil Engineering Design Methodology –

Definition of design methodology for concrete filled steel structural modules and their connections

ORIGINATED BY / ORGANISATION:	APPROVED BY / ORGANISATION:	ASSESSMENT AREA	DATE RAISED:
A COATSWORTH /ND	R JENNINGS / ND	Civil Engineering	16 February 2010

ACTION:	WEC is required to both complete and if necessary revise its document Design Methodology for Structural Modules APP-GW-SUP-001 Revision 0 dated 2003.		
ACKNOWLEDGEMENT REQUIRED BY:	1 March 2010		
RESOLUTION REQUIRED BY:	15 February 2010		

REGULATOR EXPECTATIONS

WEC has chosen to adopt a steel-concrete sandwich modular structural form in lieu of conventional reinforced concrete. This form of construction is to be used for the Enhanced Shield Wall, most of the in-containment structures, parts of the Auxiliary Building , and, though not of major safety significance, parts of the Turbine Building.

WEC document "Design Methodology for Structural Modules" APP-GW-SUP-001 Revision 0 dated 2003 is incomplete, eg section 7.6 "Design of Base Connections" simply contains the word "LATER". The design of connections, whether between units, between units and conventional reinforced concrete, or between units

and the basemat, is regarded by ND as a critical subject to be addressed in the safety case. Omission of a critical part of the methodology is unacceptable.

ND notes the failure to complete such a high level document since its initial approved issue in early 2003. ND also notes that the document has not been revised in the light of any evolution during the subsequent design process. WEC is expected to complete and if necessary update the document "Design Methodology for Structural Modules" APP-GW-SUP-001 to define the methodology current in its GDA Step 4 submission.

ND is aware that WEC is actively considering major design changes to the design methodology for the Shield Building, including the addition of through going shear reinforcement, a change in plate material, and a change in plate thickness. Any such design changes should be set out in a further revision to the document "Design Methodology for Structural Modules" APP-GW-SUP-001.

ND considers that the current design methodology should be fully defined by the indicated date for resolution. The design methodology, as revised if necessary, should subsequently be justified (as required by RI-AP1000-2.A2, for which a later resolution date has been set) eg by large scale tests for which WEC has presented its intent.

WESTINGHOUSE AP1000 GENERIC DESIGN ASSESSMENT

REGULATORY ISSUE ACTION

RI-AP1000-2.A2

Civil Engineering Design Methodology -

Demonstration of the adequacy of a non-code based methodology

ORIGINATED BY / ORGANISATION:	APPROVED BY / ORGANISATION:	ASSESSMENT AREA	DATE RAISED:
A COATSWORTH /ND	R JENNINGS / ND	Civil Engineering	16 February 2010

ACTION:	WEC is required to demonstrate the adequacy of its specified design methodology, revised if necessary following structural testing, for structural modules.		
ACKNOWLEDGEMENT REQUIRED BY:	1 March 2010		
RESOLUTION REQUIRED BY:	30 June 2010		

REGULATOR EXPECTATIONS

Design guidance for steel-concrete sandwich modular structural form is not covered by substantive clauses in WEC's specified design standard ACI 349-01 or indeed by any standard commonly known in Europe or the USA.

Therefore WEC needs to demonstrate by whatever combination appears necessary of:

- appropriate reference to relevant design guidance;
- analysis;

- structural testing.

that its design methodology, fabrication specification, installation and construction process provide equivalent reliability to that which would be achieved by an appropriate design standard.

A move away from guidance detailed in design standards may reduce inherent reliability and will certainly increase the difficulty of the safety justification. Any assessment based on beyond code performance should consider safety classification and relevant levels of reliability and conservatism.

WESTINGHOUSE AP1000 GENERIC DESIGN ASSESSMENT

REGULATORY ISSUE ACTION

RI-AP1000-2.A3

Civil Engineering Design Methodology –

Implications of design changes to the Enhanced Shield Wall for other nuclear safety related civil structures formed of concrete filled steel structural modules

ORIGINATED BY / ORGANISATION:	APPROVED BY / ORGANISATION:	ASSESSMENT AREA	DATE RAISED:
A COATSWORTH /ND	R JENNINGS / ND	Civil Engineering	16 February 2010

ACTION:	WEC is required to review the implications of changes to its design methodology for CA structural modules, such as revealed for the Enhanced Shield Building at a meeting with NRC, also attended by ND, on 17 November 2009. WEC should ensure that the review considers implications of the changes for other nuclear structures, or parts of structures, having a similar form of construction and similar nuclear safety classification (UK classifications). The implications should similarly be considered for all nuclear safety structures, or parts of structures similarly constructed, taking due regard of any lesser or greater nuclear safety classification.		
ACKNOWLEDGEMENT REQUIRED BY:	1 March 2010		
RESOLUTION REQUIRED BY:	30 October 2010		

REGULATOR EXPECTATIONS

WEC presented its revised design proposals for the Enhanced Shield Building at a meeting between WEC and NRC on 17 November 2009. Design changes for all affected structures should be formally submitted.