RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

APR1400 Design Certification

Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**247-8314**
SRP Section:	**14.03.02 - Structural and Systems Engineering – Inspections, Tests, Analyses, and Accceptance Criteria**
Application Section:	**Tier 1, 02.02.01**
Date of RAI Issue:	**10/14/2015**

Question No. 14.03.02-1

Tier 1 Section 2.2.1, Nuclear Island Structures

10 CFR 52.47(b)(1), requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations. SRP Section 14.3, and in particular, Sections 14.3.2 and Appendix C provide guidance in developing design descriptions, figures, and ITAAC for structural related items. The staff reviewed DCD Tier 1, Section 2.2.1, Nuclear Island Structures, and noted that Section 2.2.1.1, Design Description, does not include some of the key attributes applicable to the NI structures.

Therefore, the applicant is requested to include the following items or justify why they are not described:

(a) Site grade elevation

(b) For the design basis loads - external events: tornado loading

In addition, the staff reviewed DCD Tier 1, Tables 2.2.1-1 and 2.2.1-2 for the NI structures and identified some items that need to be addressed to ensure the adequacy of the ITAAC. These are described below.

1. The title for DCD Tier 1 Table 2.2.1-1 should be corrected because it only identifies walls, while the table entries include wall and floor thicknesses.

2. For DCD Tier 1, Table 2.2.1-2, Nuclear Island Structures ITAAC, the following items should be addressed:

ITAAC 1 identifies the ITAAC for the configuration of the NI structures. For the Design Commitment and Acceptance Criteria columns, the statements identify the basic configuration of the NI structures as shown in Figures 2.2.1-1 through 2.2.1-13. It is not clear why the statements in the two columns do not also refer to the Design Description in Section 2.2.1.1 in addition to Figures 2.2.1-1 through 2.2.1-13. Including the reference to Section 2.2.1.1 would ensure that the configuration information in the design description is also part of the ITAAC.

ITAAC 2.a identifies the ITAAC for the containment to be designed and constructed to meet the requirements of ASME, Section III, Division 2. If this statement is to apply to the entire containment, then Division 1 should also be identified since it is applicable to steel portions of the containment not backed by concrete. If this statement was intended to only apply to the containment excluding the steel portions of the containment not backed by concrete, then that should be clarified in the ITAAC statement. Also, designation of this information should be consistent in the three ITAAC columns - Design Commitment; Inspections, Tests, and Analyses and Acceptance Criteria.

ITAAC 2.b identifies the ITAAC for the containment penetrations to be designed and constructed to meet ASME Section III. For completeness, the applicable Division 1 and/or 2 of ASME Section III should be identified in the three ITAAC columns. Furthermore, since the penetration assembly contains portions which are backed by concrete and portions that are not backed by concrete, the ITAAC statement and applicable Division 1 and/or 2 should be identified and consistent with each other.

ITAAC 2.c identifies the ITAAC for the containment and its penetrations to ensure they retain their pressure boundary integrity associated with the design pressure. The designation of the ASME Section III, Divisions 1 and 2, is not identified in the second and third columns of the ITAAC.

ITAAC 4 identifies the key dimensions of the NI structures and the need for a report that concludes that the NI structure as-built wall and slab thickness conform with the structural configuration as described in Table 2.2.1-1. Explain why the as-built criteria don’t also include the information in Figures 2.2.1-1 through 2.2.1-13.

It should be noted that wherever ITAAC, in terms of numerical data (e.g., dimensions), are identified a tolerance or range should be included to avoid having difficulties by the COL applicant in meeting these ITAAC.

3. For Table 2.2.1-3, Seismic Classification of the Building, it identifies the Essential Service Water Supplier Structure. In DCD Tier 2, Table 3.2-1, Classification of Structures, Systems, and Components, this nomenclature does not appear; however, the structure entitled, Essential Service Water Building does appear. This should be clarified and a single consistent nomenclature for the structures should be made in both DCD Tier 1 and Tier 2.

Response

The responses to the request to include the site grade elevation and tornado loading in DCD Tier 1, Subsection 2.2.1.1 are described in (a) and (b) below.

(a) The site grade elevation is established at a plant elevation of 98 ft 8 in according to DCD Tier 1, Table 2.1-1. DCD Tier 1, Subsection 2.2.1.1 will be revised to include this site grade elevation.

(b) Tornado loading will be added to the external events description as a design basis load. DCD Tier 1, Subsection 2.2.1.1 will be revised as shown in the attachment associated with this response.

Response to the items regarding DCD Tier 1, Tables 2.2.1-1 and 2.2.1-2 and the ITAAC for NI structures are provided below.

1. The title of DCD Tier 1, Table 2.2.1-1 will be revised to identify floor thickness.

2. The responses to item 2 regarding DCD Tier 1, Table 2.2.1-2 are as follows:

   (1) ITAAC 1 will be revised to include the design description of Section 2.2.1.1 in the commitment and acceptance criteria of ITAAC 1.

   (2) The portion of containment in ITAAC 2.a is applicable to the prestressed concrete containment structure with steel liner not including the steel portions of the containment not backed by concrete. ITAAC 2.a will be revised to clarify the meaning of containment in ITAAC 2.a. Also, ASME Section III, Division 2 will be designated as the applicable code to the containment to maintain consistency in the three ITAAC columns.

   (3) The containment penetrations in ITAAC 2.b contain portions not backed by concrete and backed by concrete which are in accordance with ASME Section III, Division 1 and Division 2, respectively. ITAAC 2.b will be revised to identify that ASME Section III, Division 1 (portions not backed by concrete) and Division 2 (portions backed by concrete); both are designated for the containment penetrations.

   (4) ITAAC 2.c will be revised to identify ASME Section III, Division 2 for the structural integrity test.

   (5) DCD Tier 1, Table 2.2.1-2 will be revised to include Figures 2.2.1-1 through 2.2.1-13 in the as-built criteria for the containment.

   (6) The tolerance for the thickness of the walls and slabs identified in DCD Tier 1, Table 2.2.1-1 is -1/4 inch and +1 inch as stated in the note (1) of Table 2.2.1-1.

3. DCD Tier 1, Table 2.2.1-3 will be revised to use Essential Service Water Building as a single consistent nomenclature in both DCD Tier 1 and Tier 2.

Impact on DCD

DCD Tier 1, Subsection 2.2.1.1 and Tables 2.2.1-1 through 2.2.1-3 will be revised as indicated in the attachment associated with this response.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Reports.

2.2 Structural and System Engineering

This section provides discussions on building structures and structural aspects of major components. The nuclear island (NI) structures, emergency diesel generator building, turbine generator building, compound building and structural aspects of reactor pressure vessel and in-core instrument guide tube system are discussed. In addition, the protection against internal and external hazards is discussed.

2.2.1 Nuclear Island Structures

2.2.1.1 Design Description

The NI structures house, protect, and support plant equipment and provide personnel and equipment access, support for systems and components under operating loads, radiation shielding, structural components to withstand loads due to design basis external and internal events, physical separation between divisions of safety-related equipment, and barriers to minimize or prevent the release of radioactive materials. The NI structures are safety related structures that consist of the reactor containment building (RCB) and the auxiliary building (AB). The NI structures are designed to withstand the effect of an aircraft impact.

The RCB and AB are structurally separated but founded on a common reinforced concrete basemat which is embedded below the finished plant grade level.

The RCB structure is composed of a prestressed concrete containment, and reinforced concrete internal structures with steel structures.

The plant grade level is established at a plant elevation of 98 ft 8 in.

The containment is a steel lined prestressed concrete structure which consists of a right cylinder with a hemispherical dome on the reinforced concrete common basemat. The cylinder and dome of the containment is prestressed by a post-tensioning system consisting of horizontal and inverted "U" vertical tendons. There are three buttresses equally spaced around the cylinder to anchor horizontal tendon. There is no structural connection between free standing portion of the containment and adjacent structures other than penetrations and their supports. The containment retains its integrity at pressure and temperature conditions associated with the most limiting design basis accident without exceeding the design leakage rate. Access to the containment is provided through

personnel air locks and an equipment hatch. Penetrations are provided for electrical and mechanical components and for the transport of nuclear fuel.

The containment internal structures consist of reinforced concrete and structural steels that support reactor vessel and reactor coolant system. The primary shield wall supports and laterally surrounds the reactor vessel. The secondary shield wall laterally surrounds the primary shield wall and is structurally connected to the primary shield wall by reinforced concrete slabs, beams, and walls. The secondary shield wall supports steam generators and pressurizer. The containment internal structures enclose a reactor cavity area below the reactor vessel which can be flooded during a postulated accident. An indirect gas vent path is provided between the reactor cavity and the free volume of the containment.

The reactor cavity has a corium debris chamber. And the reactor cavity floor is constructed with a fill concrete on steel liner plate. The reactor cavity floor area is free from obstructions to corium debris spreading.

The AB is a reinforced concrete structure which consists of the electrical and control area, the fuel handling area, the chemical and volume control system area, the main steam valve house, and the emergency diesel generator area. The AB laterally surrounds the RCB and is divided by divisional walls.

The NI structures are seismic Category I, and are designed and constructed to withstand the design basis loads associated with:

1. Normal plant operation (including dead loads, live loads, lateral earth pressure loads, hydrodynamic loads, and equipment loads, including the effects of temperature and equipment vibration)

2. External events (including rain, snow, wind, flood, tornado or hurricane, tornado or hurricane generated missiles, and earthquake)

3. Internal events (including flooding, pipe rupture, equipment failure, and equipment failure generated missile)

Seismic classification of the building is shown in Table 2.2.1-3.

and Floor

Table 2.2.1-1 (1 of 10)

Definition of Wall Thicknesses for Nuclear Island Structure

Wall or Section Description	Column Lines	Floor Elevation or Elevation Range	Concrete Thickness (1)(2)	Applicable Radiation Shielding Wall (Yes/No)
Reactor Containment Building				
Containment Structures				
Cylindrical Shell	Not Applicable	From 78'-0" to 254'-6"	4'-6"	Yes
Hemispherical Dome	Not Applicable	From 254'-6" to 333'-6"	4'-0"	Yes
Common Basemat	N-S direction portion within 18'-9" from the center of RCB	From 55'-0" to 66'-0"	11'-0"	No
	E-W direction portion within 21'-1"(East) or 40'-7"(West) from the center of RCB	From 55'-0" to 66'-0"	11'-0"	No
	N-S direction portion from 18'-9" to 42'-6" from the center of RCB	From 55'-0" to 78'-0"	23'-0"	No
	East direction portion from 21'-1" to 42'-6" from the center of RCB	From 55'-0" to 76'-0"	21'-0"	No
	West direction portion from 40'-7" to 42'-6" from the center of RCB	From 55'-0" to 78'-0"	23'-0"	No
	N-S direction portion from 42'-6" to 84'-0" from the center of RCB	From 45'-0" to 78'-0"	33'-0"	No
	E-W direction portion from 42'-6" to 84'-0" from the center of RCB	From 45'-0" to 78'-0"	33'-0"	No

described in the design description of Subsection 2.2.1.1 and Figures 2.2.1-1 through 2.2.1-13.

Table 2.2.1-2 (1 of 2)

Nuclear Island Structures ITAAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The basic configuration of the NI structures is as ~~shown in Figures 2.2.1-1 through 2.2.1-13.~~	1. Inspection of the basic configuration of the as-built nuclear island structures will be conducted.	1. The nuclear island structures conform with the basic configuration as ~~shown in Figures 2.2.1-1 through 2.2.1-13.~~
2.a The containment is designed and constructed to meet the requirements of ASME Section III, Div.2. except the steel portions of the containment not backed by concrete	2.a Inspection of the containment in accordance with the ASME Code, Section III , Div.2 will be conducted.	2.a The ASME Code design report(s) or data report(s) exist and conclude that the containment complies with the requirements of ASME Section III , Div.2.
2.b The containment penetrations are designed and constructed to meet ASME Section III.	2.b Inspection of the containment penetration in accordance with the ASME Code, Section III will be conducted.	2.b The ASME Code design report(s) or data report(s) exist and conclude that the containment penetrations comply with the requirements of ASME Section III.
2.c The containment and its penetrations retain their pressure boundary integrity associated with the design pressure.	2.c. Structural integrity test of the as-built containment will be conducted in accordance with ASME Code, Section III , Div.2.	2.c The results of the structural integrity test on the containment and its penetrations conform with the pressure testing acceptance criteria in ASME Section III, Div.2.
2.d The containment and its penetrations maintain the containment leakage rate less than or equal to the maximum allowable leakage rate associated with the peak containment pressure for the design basis accident.	2.d Inspection and leak rate testing on the containment and its penetrations will be conducted.	2.d The results of the inspection and leak rate testing demonstrate that the containment leakage rate is less than or equal to the maximum allowable limits specified in 10 CFR Part 50, Appendix J.

, Div.1 (portions not backed by concrete) and Div.2 (portions backed by concrete)

Table 2.2.1-2 (2 of 2)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
3. The NI structures are seismic Category I, and are designed and constructed to withstand the structural design basis loads.	3. A structural analysis will be performed to reconcile the as-built NI structures with the structural design basis loads.	3. A report exists and concludes that the NI structures can withstand the design basis loads.
4. The key dimensions of the NI structures are described in Table 2.2.1-1. and Figures 2.2.1-1 through 2.2.1-13	4. Inspection will be performed to verify that the as-built wall and slab thickness conform with the structural configuration.	4. A report exists and concludes that the NI structure as-built wall and slab thickness conform with the structural configuration as described in Table 2.2.1-1. and Figures 2.2.1-1 through 2.2.1-13

Table 2.2.1-3

Seismic Classification of the Building

Structure	Seismic Category
Reactor Containment Building	I
Auxiliary Building	I
Emergency Diesel Generator Building Block	I
Turbine Generator Building	II
Compound Building	II
Essential Service Water ~~Supplier Structure~~ Building	I
Component Cooling Water Heat Exchanger Building	I

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**247-8314**
SRP Section:	**14.03.02 – Structural and Systems Engineering – Inspections, Tests, Analyses, and Acceptance Criteria**
Application Section:	**SRP 14.3.2**
Date of RAI Issue:	**10/14/2015**

Question No. 14.03.02-2

10 CFR 52.47(b)(1), requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations. SRP Section 14.3, and in particular, Sections 14.3.2 and Appendix C provide guidance in developing design descriptions, figures, and ITAAC for structural related items.

The staff reviewed DCD Tier 1, Section 2.2.2, Table 2.2.1-1 and 2.2.2-2 for the EDG Building and identified some items that need to be addressed to ensure the adequacy of the ITAAC. These are described below.

1. The title for DCD Tier 1 Table 2.2.2-1 should be corrected because it only identifies walls, while the table entries include wall and floor thicknesses.

2. For DCD Tier 1, Table 2.2.2-2, Emergency Diesel Generator Building ITAAC, the following item should be addressed: ITAAC 3 identifies the key dimensions of the EDG structures and the need for a report that concludes that the EDG structure as-built wall and slab thickness conform with the structural configuration as described in Table 2.2.2-1. Explain why the as-built criteria don't also include the information in Figures 2.2.2-1 through 2.2.2-2 or include this information where appropriate.

Response

1. DCD Tier 1 Table 2.2.2-1 will be revised to identify floor thickness.

2. DCD Tier 1 Table 2.2.2-2 will be revised to include Figure 2.2.2-1 and Figure 2.2.2-2 in the as-built criteria for the EDG Building ITAAC.

Impact on DCD

DCD Tier 1 Table 2.2.2-1 and Table 2.2.2-2 will be revised as indicated in the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Report.

and Floor

Table 2.2.2-1

Definition of Wall Thicknesses for Emergency Diesel Generator Building

Wall or Section Description	Column Lines	Floor Elevation or Elevation Range	Concrete Thickness (1)	Applicable Radiation Shielding Wall (Yes/No)
EDG Building				
Basemat	Not Applicable	100'-0"	4'-0"	No
Column Line 26.1 Wall	From AC.8 to AH.2	From 100'-0" to 135'-0"	3'-0"	No
Column Line 28 Wall	From AC.8 to AH.2	From 100'-0" to 135'-0"	3'-0"	No
Column Line AC.8 Wall	From 26.1 to 28	From 100'-0" to 135'-0""	3'-0"	No
Column Line AF Wall	From 26.1 to 28	From 100'-0" to 135'-0""	2'-6"	No
Column Line AH.2 Wall	From 26.1 to 28	From 100'-0" to 135'-0""	3'-0"	No
Floors	Not Applicable	121'-6"	2'-0"	No
Floors	Not Applicable	135'-0"	Variable From 1'-6" to 3'-0"	No
DFOT Building				
Basemat	Not Applicable	63'-0"	4'-0"	No
Column Line 26.1 Wall	From AA.1 to AC.6	From 63'-0" to 100'-0"	2'-6"	No
Column Line 27 Wall	From AA.1 to AC	From 63'-0" to 97'-6"	2'-6"	No
Column Line 28 Wall	From AA.1 to AC.6	From 63'-0" to 100'-0"	4'-0"	No
Column Line AA.1 Wall	From 26.1 to 28	From 63'-0" to 97'-6"	4'-0"	No
Column Line AC.6 Wall	From 26.1 to 28	From 63'-0" to 100'-0"	4'-0"	No
Floors	Not Applicable	97'-6"	2'-0"	No
Floors	Not Applicable	100'-0"	3'-0"	No

(1) Tolerance for the thickness of the walls and slabs is -1/4 inch and + 1 inch.

APR1400 DCD TIER 1

Table 2.2.2-2

Emergency Diesel Generator Building ITAAC

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
1. The basic configuration of the EDG building block is as shown in Figures 2.2.2-1 and 2.2.2-2.	1. Inspection of the basic configuration of the as-built EDG building block will be conducted.	1. The EDG building block conforms with the basic configuration as shown in Figures 2.2.2-1 and 2.2.2-2.
2. The EDG building block is designed and constructed to withstand the structural design basis loads.	2. A structural analysis will be performed to reconcile the as-built EDG structure with the structural design basis loads.	2. A report exists and concludes that the EDG building block can withstand the structural design basis loads.
3. The key dimensions of the EDG building block are as described in Table 2.2.2-1.	3. Inspection will be performed to verify that the as-built wall and slab thickness conform to the structural configuration.	3. A report exists and concludes that the EDG building block as-built wall and slab thickness conform with the structural configuration as described in Table 2.2.2-1.

, Figure 2.2.2-1, and Figure 2.2.2-2

, Figure 2.2.2-1, and Figure 2.2.2-2

RESPONSE TO REQUEST FOR ADDITIONAL INFORMATION

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Korea Electric Power Corporation / Korea Hydro & Nuclear Power Co., LTD

Docket No. 52-046

RAI No.:	**247-8314**
SRP Section:	**14.03.02 – Structural and Systems Engineering – Inspections, Tests, Analyses, and Acceptance Criteria**
Application Section:	**14.3.2**
Date of RAI Issued:	**10/14/2015**

Question No. 14.03.02-3

10 CFR 52.47(b)(1), requires that a DC application contain the proposed inspections, tests, analyses, and acceptance criteria (ITAAC) that are necessary and sufficient to provide reasonable assurance that, if the inspections, tests, and analyses are performed and the acceptance criteria met, a plant that incorporates the design certification is built and will operate in accordance with the design certification, the provisions of the Atomic Energy Act, and the NRC's regulations. SRP Section 14.3, and in particular, Sections 14.3.2 and Appendix C provide guidance in developing design descriptions, figures, and ITAAC for structural related items. SRP Acceptance criteria 14.3.2.II.8 indicates that the division walls are at least 2.5 m above the floor, and safety-related electrical, instrumentation, and control equipment are located at least 20cm above the floor surface.

FSAR Tier 1 Section 2.2.5.1.2 “Internal Flooding” state that key characteristics of the protective provisions against internal flooding hazards are: divisional flood barriers provided in the nuclear island against the internal flooding and safety-related electrical, instrumentation and control equipment are located above the internal design flood level, between others.

The staff is requesting the applicant to address the measure from the floor of the division walls and the distance between the floor and the safety-related electrical, instrumentation, and control equipment.

Response

DCD Tier 1, Subsection 2.2.5.1.2 and Table 2.2.5-1 will be revised to incorporate the acceptance criteria that penetrations in the divisional walls be at least 2.5 m above the floor and the minimum installation height above the floor for safety-related electrical, instrumentation, and control equipment be 20 cm.

Impact on DCD

DCD Tier 1, Subsection 2.2.5.1.2 and Table 2.2.5-1 will be revised as indicated in the attached markup.

Impact on PRA

There is no impact on the PRA.

Impact on Technical Specifications

There is no impact on the Technical Specifications.

Impact on Technical/Topical/Environmental Reports

There is no impact on any Technical, Topical, or Environmental Reports.

1. Divisional flood barriers are provided in the nuclear island against the internal flooding.

and, in addition, penetrations in the divisional walls are at least 2.5 m above the floor

2. Watertight doors are provided in the nuclear island to protect against internal flooding.

3. Penetrations in the flood barrier are sealed up to internal design flood levels.

4. Safety-related electrical, instrumentation and control equipment are located above the internal design flood level.

and at least 20 cm above the floor surface

2.2.5.1.3 Fire Barrier

The plant is subdivided into separate fire areas by fire-rated barriers, i.e., walls, floors, and ceilings, to confine the effects of fire hazards to a single area, thereby minimizing the potential for adverse effects from fires on redundant SSC important to safety.

The key characteristics of the protective provisions against fire hazards are as follows:

1. The redundant trains of systems, components and cables important to safety, except for the control room complex and inside containment, are separated from each other by fire barriers having a 3-hour rating.

2. Openings and penetrations through fire barriers are protected by components, i.e., fire doors, fire dampers, penetration seals, having fire resistance equivalent to that of the barrier.

3. MCR complex and RSR are separated from each other and other fire areas by 3-hour rated fire barriers.

2.2.5.1.4 Internally Generated Missiles (Inside and Outside Containment)

Missile protection is provided for safety-related equipment so that internally generated missiles do not cause the release of significant amount of radioactivity or prevent the safe and orderly shutdown of the reactor.

Table 2.2.5-1 (2 of 4)

Design Commitment	Inspections, Tests, Analyses	Acceptance Criteria
2. The key characteristics of the protective provisions against internal flooding hazards are as follows: - Divisional flood barriers are provided in the nuclear island against the internal flooding. - Watertight doors are provided in the nuclear island to protect against internal flooding. - Penetrations in the flood barrier are sealed up to internal design flood levels - Safety-related electrical, instrumentation and control equipment are located above the internal design flood level.	2. Inspection of the as-built protective provisions against internal flooding hazards will be conducted.	2. The as-built nuclear island structure including EDG structure conforms with the following criteria: - Divisional flood barriers exist in accordance with the approved design specifications and drawings. - Watertight doors exist according to flood barrier drawings - Penetrations in the flood barrier are sealed up to the internal design flood levels - Safety-related electrical, instrumentation, and control equipment in nuclear island are located above the internal design flood level.

and, in addition, penetrations in the divisional walls are at least 2.5 m above the floor

and at least 20 cm above the floor surface

and, in addition, penetrations in the divisional walls are at least 2.5m above the floor.

and at least 20 cm above the floor surface