Model Checker MVP

Step-by-Step Industry Guide

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Multi-agency Effort by

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01-01 Introduction of MC MVP

It is crucial that Building Information Modelling (BIM) models submitted by Qualified Persons (QPs) adhere to the standards outlined in the CORENET X Code of Practice (CX COP) for effective regulatory review by Agencies. To support the Industry, CORENET X (CX) Model Checker (MC), a **supplementary tool**, can be used to automatically validate BIM files in IFC+SG format against basic Industry Foundation Classes (IFC) standards, modelling standards, and selected regulatory requirements.

MC MVP is a beta version of CX MC, which covers IFC Schema Check and Quality Check (QC). It will be expanded progressively in the next phases to include Regulatory Compliance Check[1] (RC). These checks have been developed based on learning points from past submitted projects, established IFC standards, and good modelling practices from the CORENET X Community of Practice (COPr). We have also shared these learning points through various platforms, including seminars and the CX website.

QPs can make use of the MC MVP to validate the BIM models at design stage before making a formal submission in CX. This can facilitate self-checking by the Industry to identify non-compliances or issues early, to ensure compliance with CX COP and reduce iterations with the Agencies during a formal submission.

The MC MVP is not intended to replace QP's review of code compliance. QPs should review the submissions thoroughly to ensure compliance prior to submission.

[1] Regulatory Compliance Checks identifies non-compliances of BIM models against Agencies' regulatory requirements. Examples of such requirements are adequate headroom provision, parking provision range, minimum Tree Protection Zone, etc.

01-02 Key Features of MC MVP

MC MVP comprises 3 distinct categories of checks:

- ✓ IFC Schema Check
- ✓ Quality Check
- ✓ Regulatory Compliance Check *(not in current MC MVP)*

IFC Schema Check serves as the first step of validation. It is designed to evaluate if BIM models meet the basic schema standards before further processing. Adherence to these standards ensures BIM models can be properly viewed and processed in subsequent stages by the MC or the Agencies.

Quality Check (QC) ensures the QPs have coordinated across disciplines and input the necessary information in the BIM models for Agencies to conduct the regulatory review, by evaluating the completeness of model information against the CX COP requirements.

The Regulatory Compliance Check (RC) will assess compliance of the submission against a specified set of rules when the necessary information is present in the BIM models.

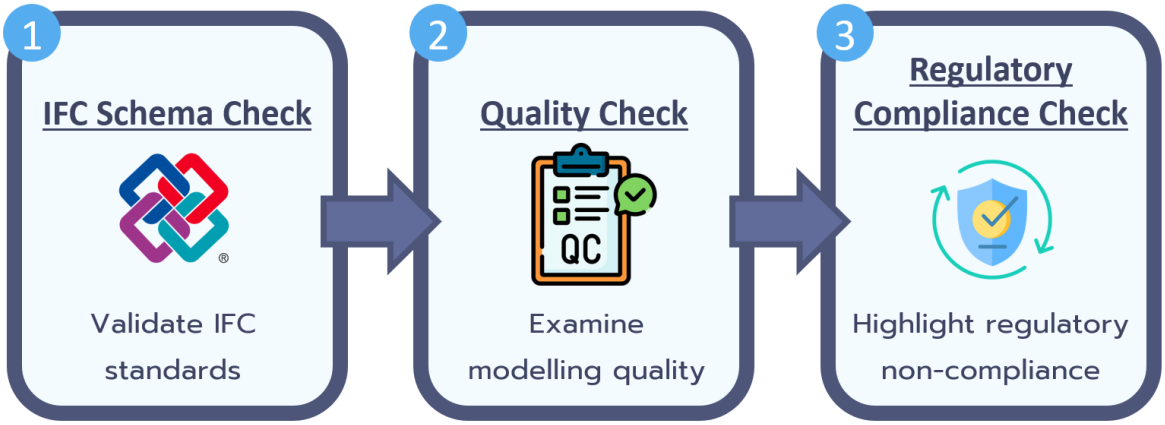


Table 1A illustrates the description, common issues and what QP should do to pass MC MVP checks.

Table 1A: Key Features of MC MVP

	Description	Common Issues	What QP should do
IFC Schema Check	This fundamental check informs QPs upfront if BIM models meet basic IFC standards and would therefore prevent further processing of the BIM models.	• IFC schema versions • Corrupted files	Revise the BIM models to address the issues and upload the BIM models again.
Quality Check	This check ensures BIM models across all disciplines meet the minimum quality standards specified in the CX COP for effective regulatory review.	• Missing mandatory properties • Improper geo-location alignment across different discipline models	Verify the consistency and completeness of information across all discipline models before submission to facilitate efficient agency review.
Regulatory Compliance Check *(not in current MC MVP)*	This check identifies non-compliances of BIM models against Agencies' regulatory requirements.	• Insufficient headroom clearance • Undersized bicycle parking lots	Review and confirm regulatory compliance of the design before submission.

01-03 When to Use MC MVP

➢ Before Submission to Agencies

The QP should ensure that the BIM models comply with IFC schema and contain the information required by CX COP. This is to ensure that the BIM models can be properly viewed and processed in subsequent stages by Agencies after submission. Additionally, BIM models should be checked for regulatory compliance to reduce iterations with the Agencies and avoid delays from resubmissions.

Hence, it is important that the QP conducts at least one round of Pre-Submission Check by MC to identify and address modelling issues and non-compliances before every submission to the Agencies.

➢ At the Point of Submission to Agencies

At the point of submission to the Agencies, the BIM models that are to be submitted will need to go through a Formal Submission Check. IFC Schema Check will automatically run upon uploading of BIM models to ensure basic IFC standard is complied with. Thereafter, Quality Check will run on the BIM models submitted to evaluate the consistency and completeness of the information contained.

QPs can also make use of other existing tools, like IFC+SG Validators. You may refer to CX Website for more details of 3rd party application(s) to help with preparation of IFC+SG models.

02 IFC Schema Check

The IFC Schema Check helps the QP identify crucial modelling issues according to IFC schema standards. Adherence to these standards ensures BIM models can be properly viewed and processed in subsequent stages by the Agencies. Table 2A below summarises the checks covered under IFC Schema Check and how QP can properly prepare the BIM models to pass the respective checks.

Table 2A: IFC Schema Check

	Check Description	How to prepare IFC file to comply
1	File is not corrupted or has no unexpected errors.	➢ Open IFC file in an IFC viewer before submitting to ensure it is exported successfully.
2	File is in supported IFC schema version. Only IFC4 up to IFC4 add 2 TC1 by buildingSMART are supported.	➢ Ensure the supported IFC schema is selected in export setting. ➢ IFC schema version can be verified in properties under IfcProject.
3	Model(s) must have one IfcProject.	➢ Do not merge/split IFC files using non-certified IFC editor. ➢ Do not edit content of IFC file.
4	Project must have at least one IfcSite and any IfcSite shall be under an IfcProject.	
5	Entity must be an Ifc entity found under respective IFC schema.	
6	Entity must have mandatory attributes.	

Table 2B below shows examples of error messages the QP may see in Detail Result Message. QP may refer to Table 2A above to verify their BIM models.

Table 2B: Detail Result Message

Error Code	Check Description	Example of Error Message
IFC0000001	IFC file is complete, not corrupted, and can be read.	[IFC0000001] Please contact the helpdesk for further assistance, as general or unexpected errors have occurred and resulted in model translation failure.
IFC0000101	IFC file uses a supported schema version. Only IFC4 up to IFC4 add 2 TC1 by buildingSMART are supported for MC MVP.	[IFC0000101] The IFC file uses an unsupported schema version.
IFC0000102	Every IFC model must have at least one site.	[IFC0000102] The IFC model does not have at least one site.
IFC0000103	All entities contained in the IFC model can be recognized under the official IFC schema.	[IFC0000103] Entity is not recognized under the official IFC schema.

IFC0000104	Mandatory attributes defined by the IFC schema are properly referenced in the model.	[IFC0000104] Message: Mandatory attribute is missing (RelatedBuildingElement) Line: IFCRELSPACEBOUNDARY EntityId: 2167926
IFC0000106	Every IFC file contains a required IfcProject entity.	[IFC0000106] IfcProject entity is missing.

03 Quality Check

Quality Check (QC) consists of 6 types of checks to validate whether the BIM models contain the information required as per the CX COP, which may affect Regulatory Compliance Check by MC MVP and subsequent processing by Agencies. These checks will help guide the QP to revise the BIM models to comply with requirements in CX COP before making a formal submission. Table 3A: Quality Check below illustrates the 6 checks covered by QC, and how QP can properly prepare the BIM models to pass the respective checks. Please refer to Appendix - Quality Check Rules for more details of the checks.

Table 3A: Quality Check

	Check Description	How to Prepare IFC file
QC01	Building Storey Naming Check if building storeys follow typical naming convention.	➢ Name a building storey in a logical and clear manner following standard naming conventions. Refer to Table 6A: Examples of Building Storey Naming
QC02	Clash Detection Check for significant clashes between selected entities especially structural elements.	➢ Make sure all disciplines' models are updated and coordinated. Please refer to CX COP for details.
QC03	Modelling inputs following IFC+SG in CX COP Check that parameters are correctly provided as per Section 4 of CX COP.	➢ Use IFC+SG interoperability tool to set up the file and ensure the values are filled up in accordance with CX COP.
QC04	Completeness of room tagging Check that rooms/spaces are properly modelled and tagged in BIM models.	➢ Ensure every habitable space (indoor/outdoor), functional space (shaft/maintenance) and fully enclosed space are tagged with a room.
QC05	Alignment of BIM Model Coordinates Check that every one of the BIM models in the same submission contain the same coordinates to ensure good federation of coordinated BIM models.	➢ Set up the model with recommended method. Refer to detailed guide on CX Website.
QC06	Level Consistency Verify that same level name in different models for the same submission has the same finished floor level (FFL), and vice versa across all the BIM models submitted.	➢ Coordinate among project team members to ensure the same set of FFL and storey naming are used across disciplines.

Table 3B QC Report Message below shows examples of report messages the QP may see in QC results. QP may refer to Table 3A on how to prepare their BIM models.

Table 3B: QC Report Message

	Result Type	Example of Report Messages
QC01	Pass	Building Storey Name follows typical Naming Convention.
	Fail	Building Storey Name does not follow typical Naming Convention.
QC02	Fail	Clash between Structural Column (1eCGXqafj4Xvy_S$F7b8k4) and Door (116dLc1hL0axHXiaSP72Hr)
	Alert	Clash between Structural Column (1eCGXqafj4Xvy_S$F7b8k4) and Pipe (0YjFwVzLfDchh4h2TbrMdg)
QC03	Alert	The property <FireRating> does not have a valid value.
	Alert	The property <ConstructionMethod> is found under the wrong property set.
	Alert	The property set <SGPset_Material> or the required property <MaterialGrade> is not found.
	Alert	The property set <SGPset_Column> is found under the wrong IFC element.
	Alert	The element is not mapped to the valid Ifc Entity.
QC04	Pass	The entire slab is covered by spaces.
	Alert	This slab contains one or more areas uncovered by spaces. Total remaining area: 749.673m^2.
QC05	Pass	Cartesian (x, y, z) coordinates of all models are the same.
	Alert	Cartesian (x, y, z) coordinates of the models are not the same.
	Info	Cartesian (x, y, z) coordinates of <ST1> are (1, 1, 1).
QC06	Alert	There are 3 no.s of 1st Storey with different Finished Floor Levels 0.550m (from AR1.ifc, MP1.ifc), 0.500m (from ST1.ifc).
	Alert	1st Storey (from AR1.ifc), Basement 1 (from ST1.ifc) contain the same Finished Floor Levels of 1.725m.

04 Step-by-Step Guide to Access MC on SP

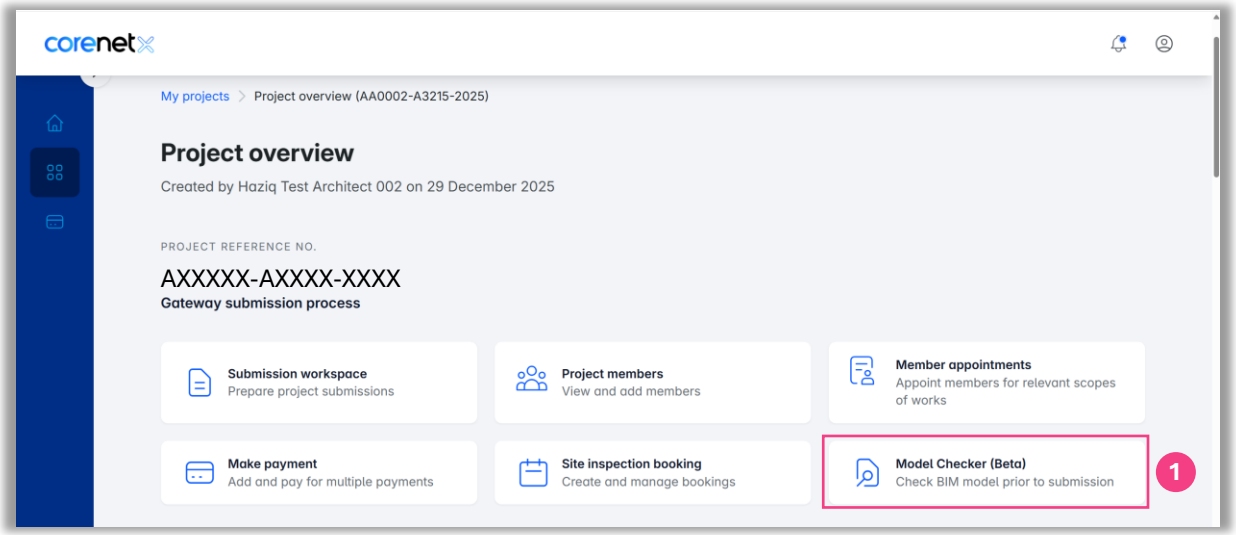
04-01 Pre-Submission Check

Before making a formal submission, QPs can use the Pre-Submission Check feature on the Submission Portal (SP) to self-check their BIM models and ensure they are ready for formal submission. **The results of the Pre-Submission Check are meant only for the project team's own review, and not for regulatory agencies' review.** For MC MVP, the Pre-Submission Check consists of IFC Schema Check, Quality Check as described in Key Feature of MC MVP (01-02). This section provides detailed steps for QPs to access the available checks.

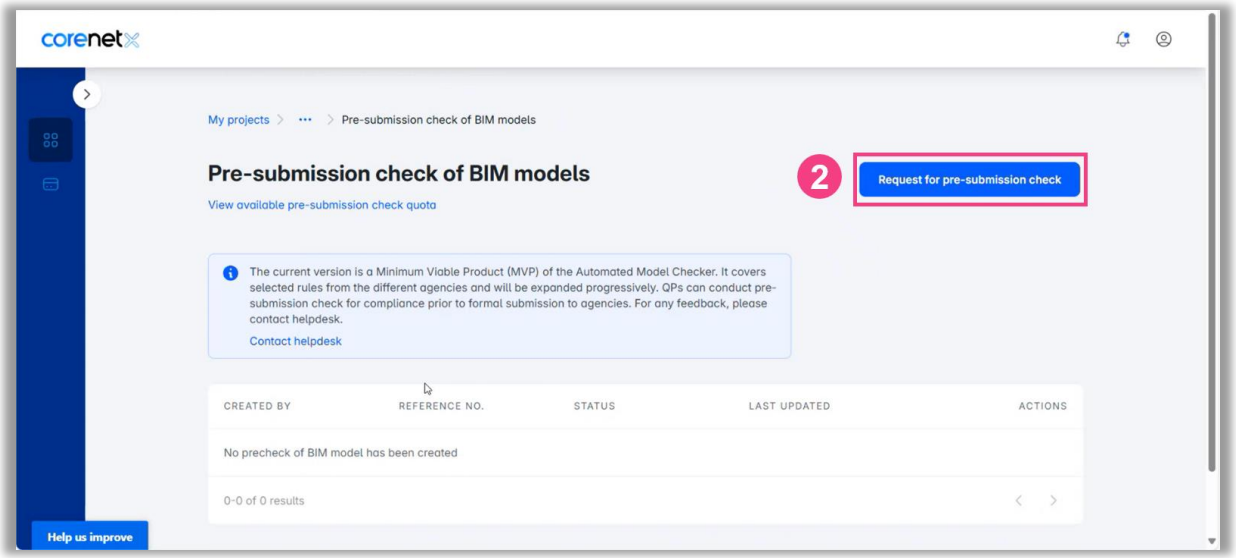
04-01-01 Request for Pre-Submission Check

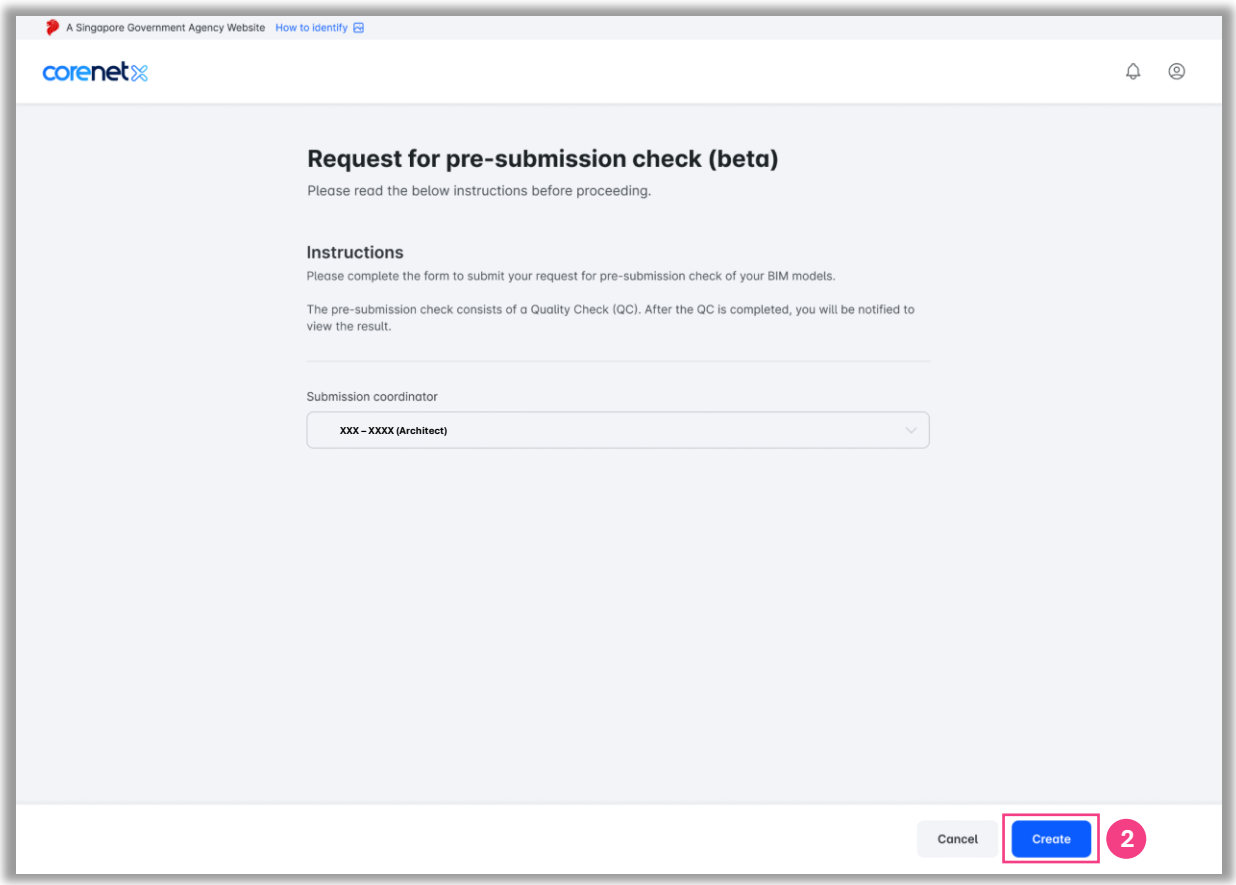
After creating a project on SP, QP may select the project under **My projects**. To request for Pre-Submission Check for the selected project, QP may follow the steps below:

- Step 1: Select **Model Checker (Beta)** under **Project overview**

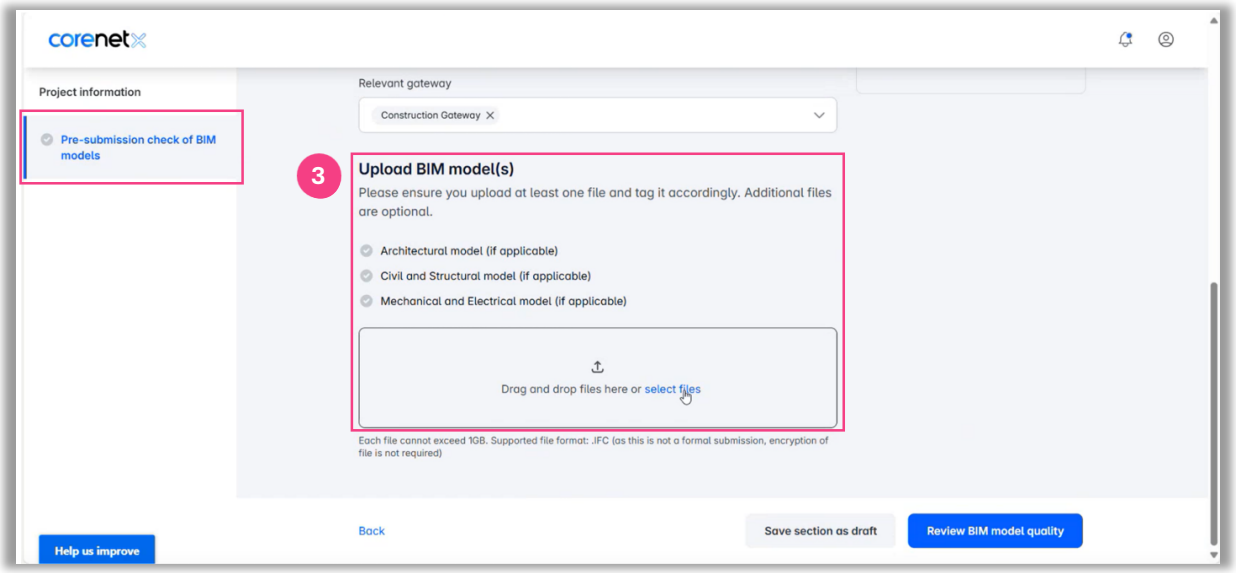


➢ Step 2: Click on **Request for pre-submission check**, go through **Instructions**, and click on **Create** to proceed with the MC checks.





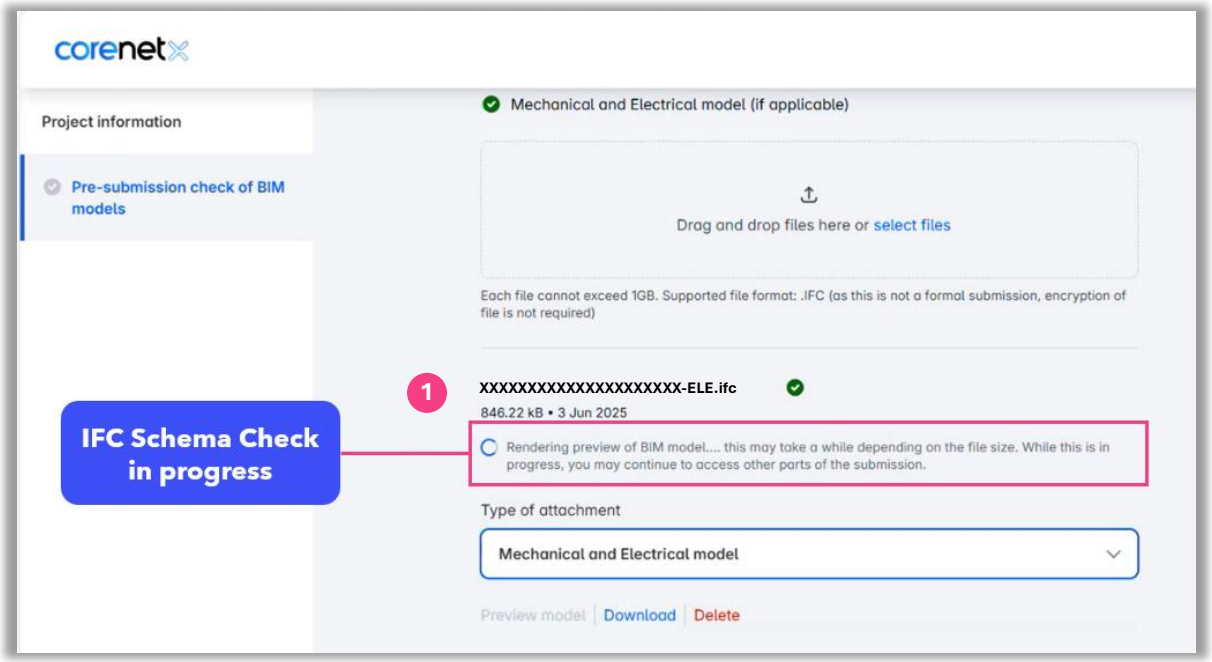
- Step 3: Drag and drop files or click on **select files** under **Upload BIM model(s)**. QP is required to declare the discipline of each BIM model uploaded.



04-01-02 Pre-submission IFC Schema Check

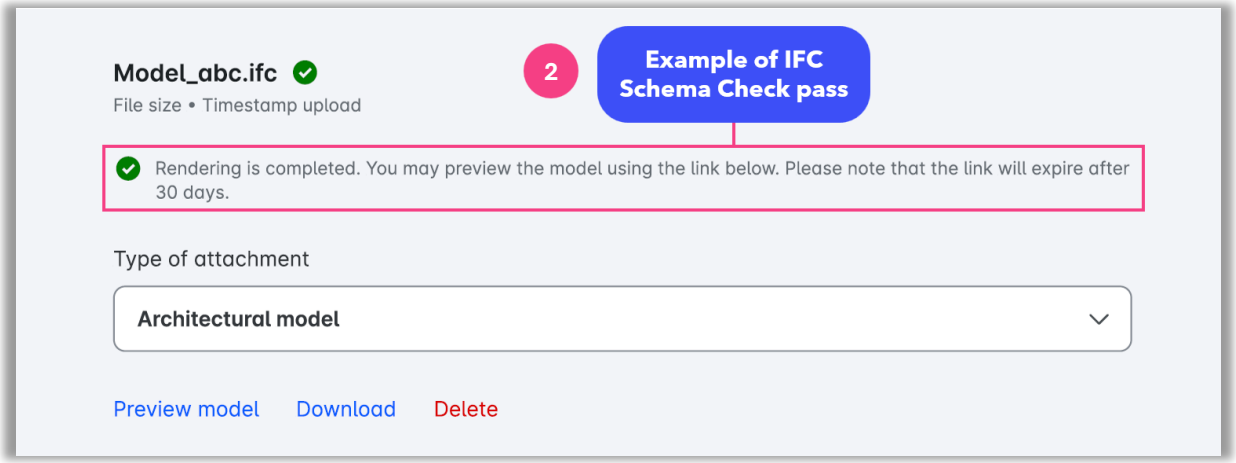
QP may follow the steps below to conduct IFC Schema Check under **Pre-submission check** of BIM models:

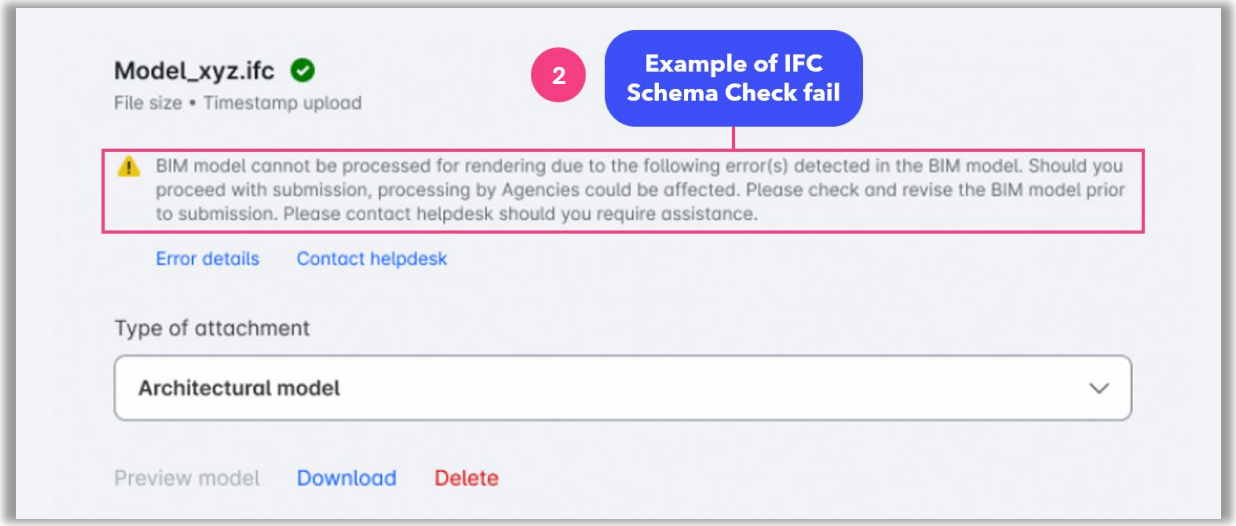
- Step 1: After BIM models are uploaded on SP, MC will automatically perform IFC Schema Check. QP may view the progress of Pre-Submission Check on the right panel.



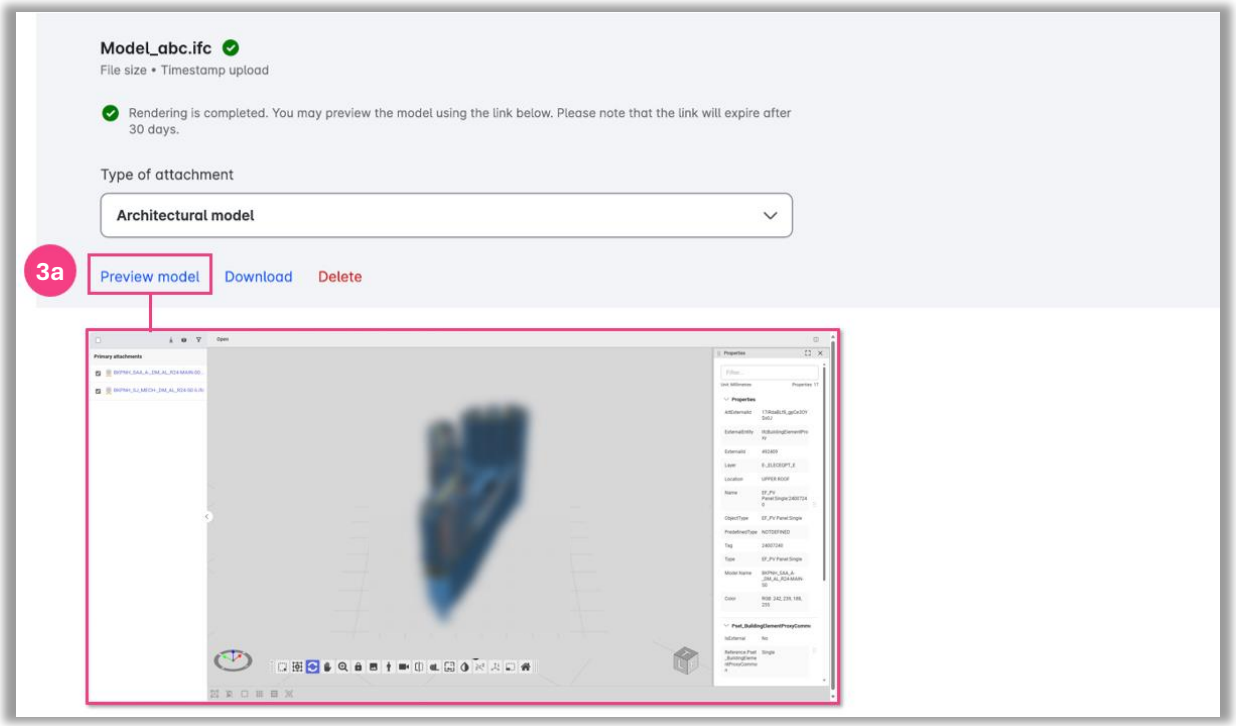
➢ Step 2: View IFC Schema Check results

SP will display a message to the QP that BIM models have passed or failed IFC Schema Check. If BIM models have failed IFC Schema Check, the selected project cannot proceed to Quality Check.

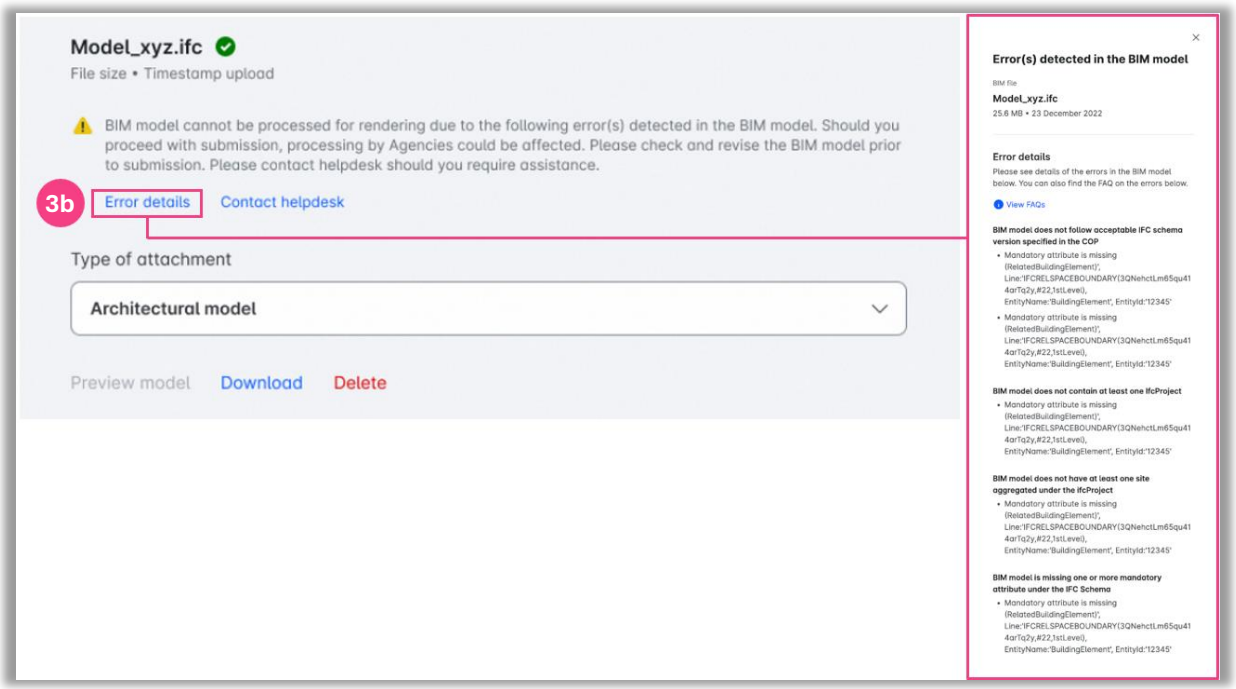




- Step 3a: For BIM models which have passed IFC Schema Check, QP will be able to preview model by clicking on **Preview model**.



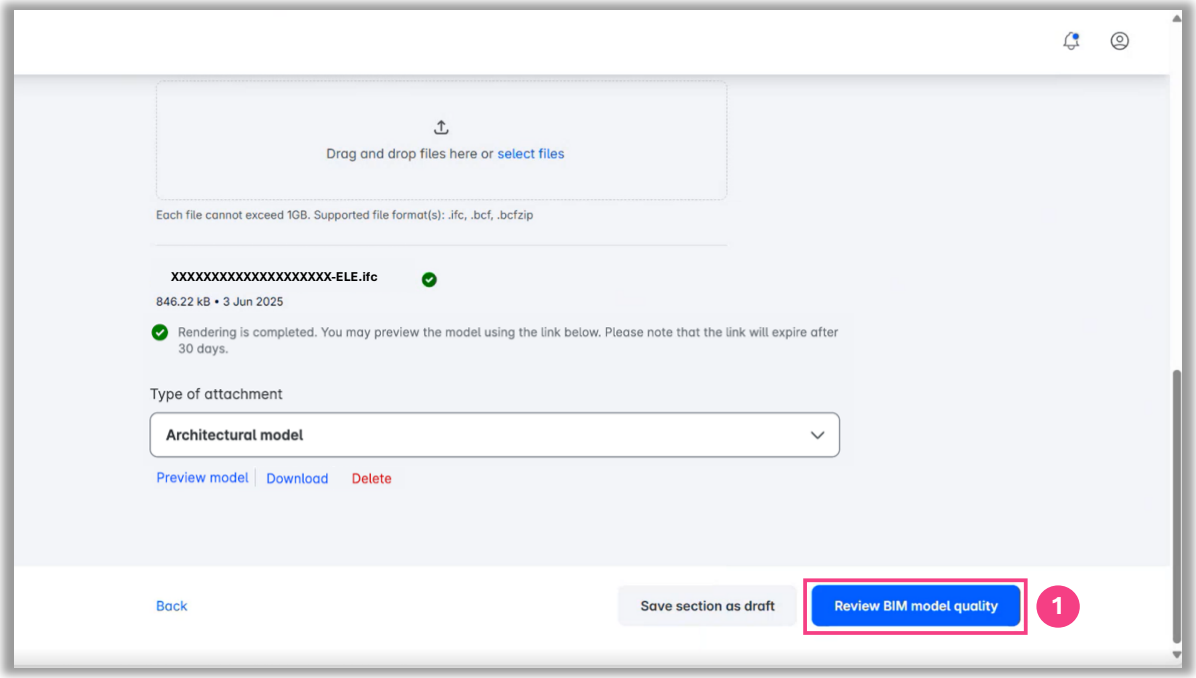
- Step 3b: For BIM models which have failed IFC Schema Check, QP may click on **Error details** to open Detail Result Message and review the model issues accordingly.



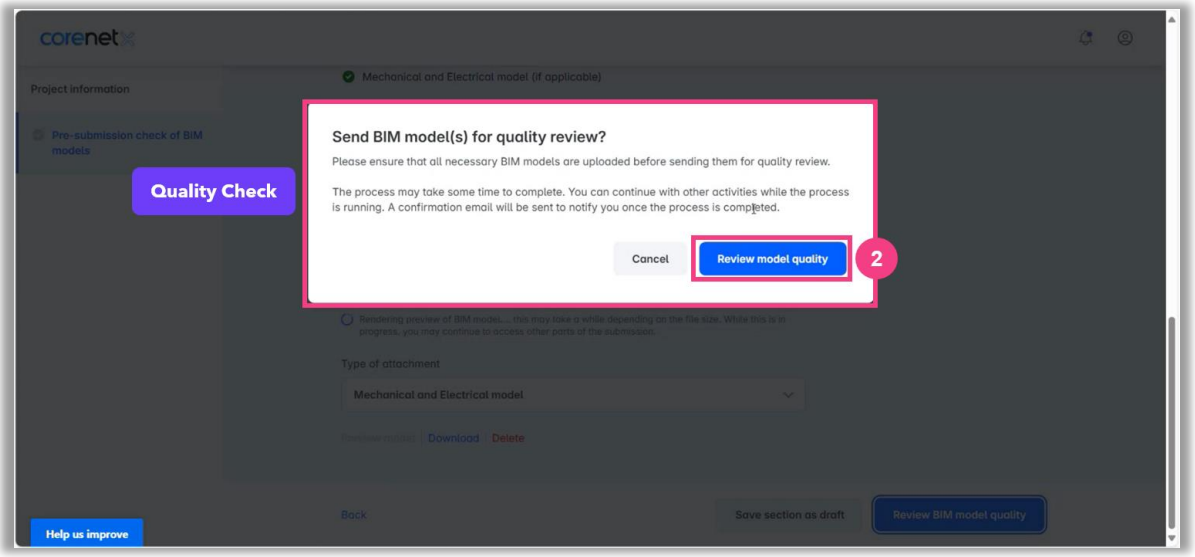
04-01-03 Pre-submission Quality Check

After all BIM models have been uploaded and passed IFC Schema Check, QP may follow the steps below to conduct Quality Check under **Pre-submission check** of BIM models:

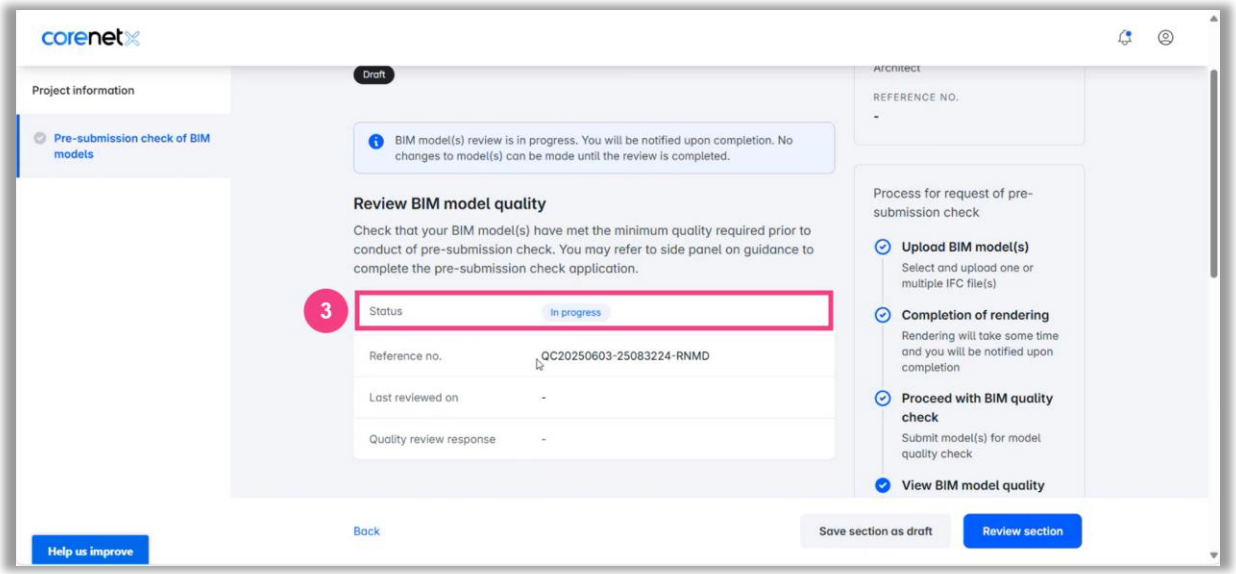
- Step 1: Click on **Review BIM model quality** to proceed to Quality Check



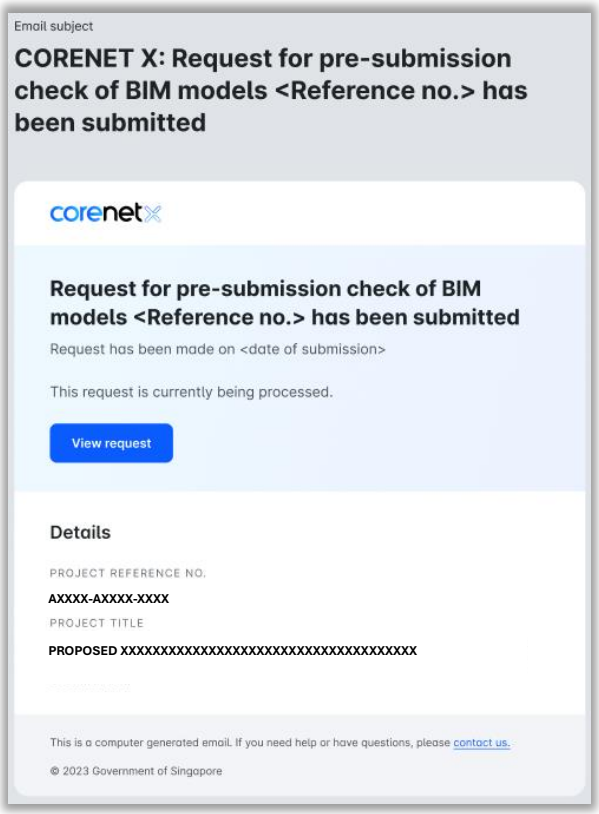
- Step 2: Click on **Review model quality** to start Quality Check.



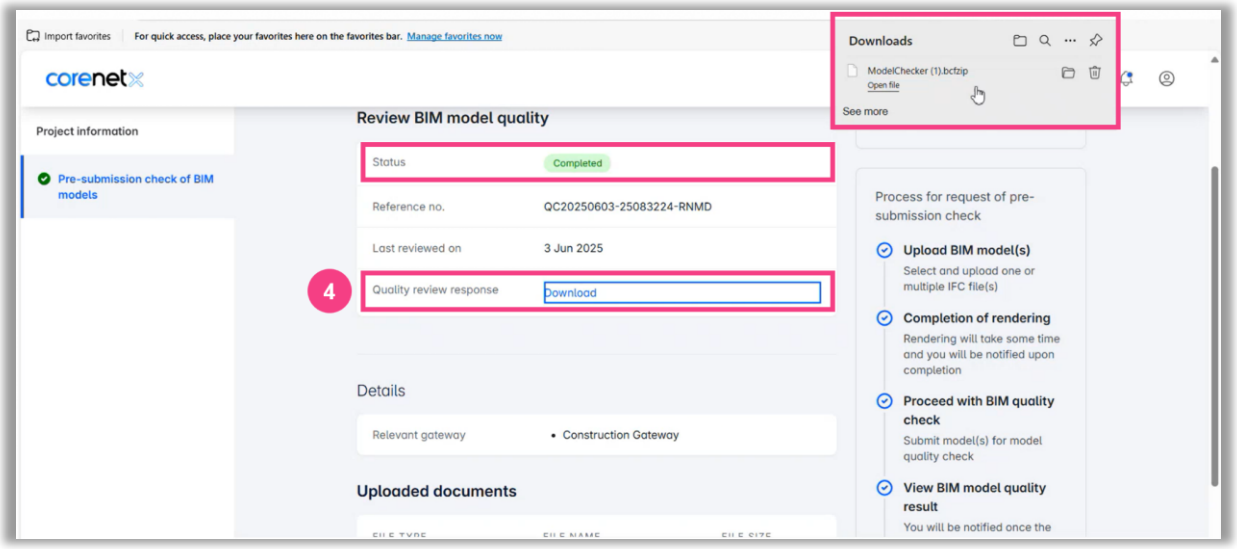
- Step 3: After QP clicks on **Review model quality**, MC will conduct Quality Check on the BIM model(s) that were uploaded and the **Status** under **Review BIM model quality** will show "In progress". QP will be notified via email that the request of Pre-Submission Check has been submitted.



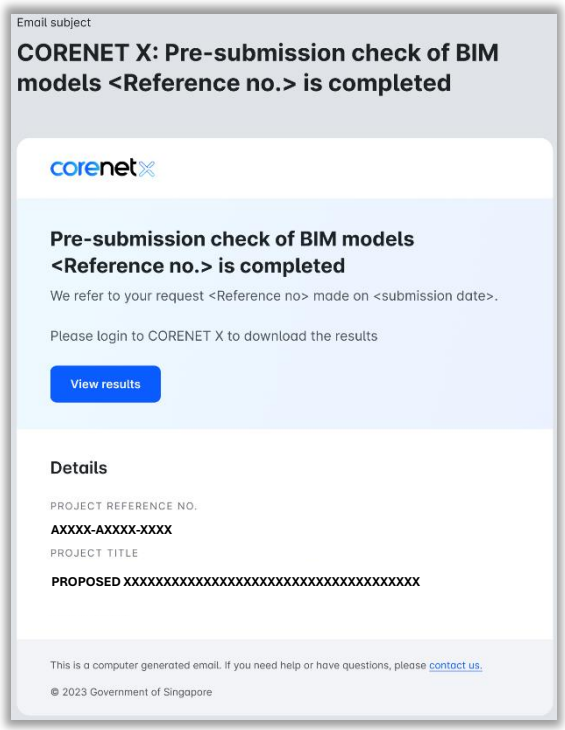
Example of Email Notification



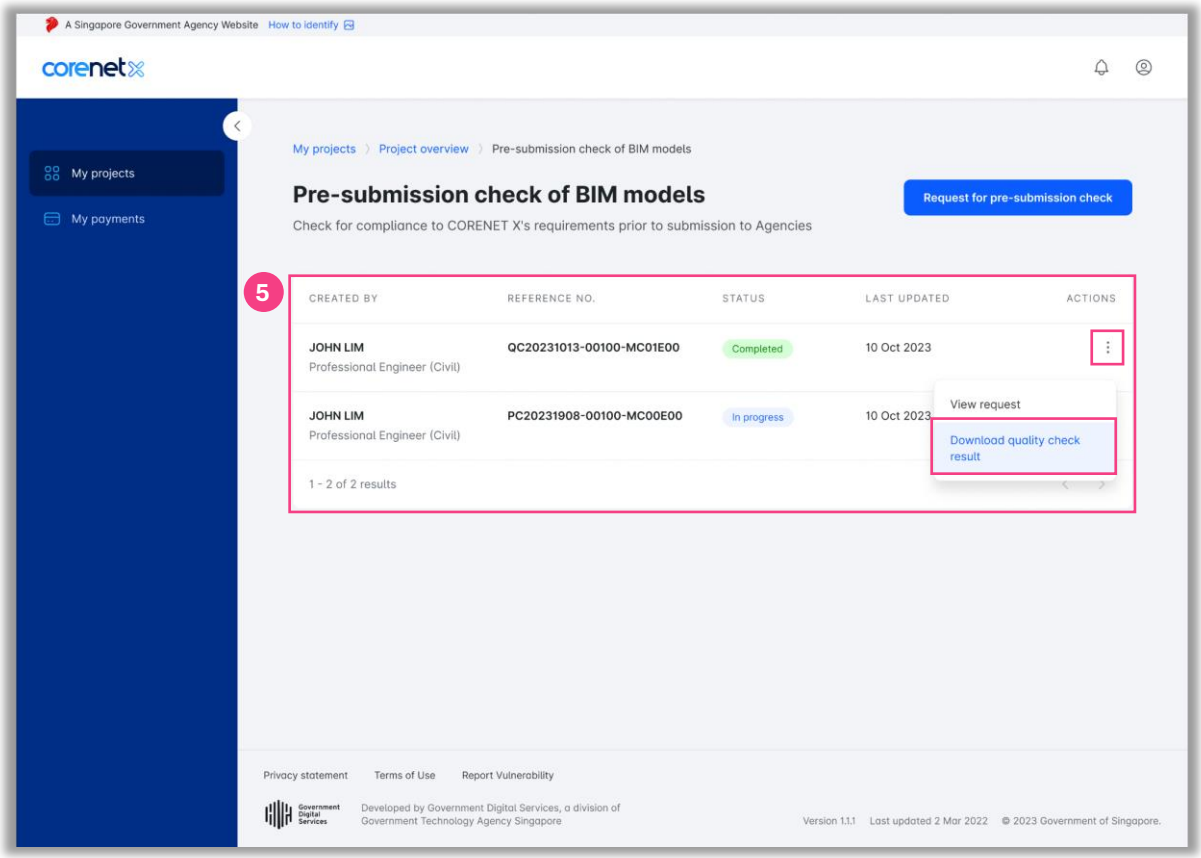
- Step 4: Upon completion of QC checks, **Status** under **Review BIM model quality** will be updated to "**Completed**" and QP will be notified via email. QC results will be available on SP for QP to download in BCF format and view the results using a BCF viewer or native BIM software.



Example of Email Notification



- Step 5: All checks done via the Pre-Submission Check are recorded on SP for QP's reference and can be viewed in the table **Pre-submission check of BIM models** as shown below. QC results can be downloaded again by clicking on the three dots.

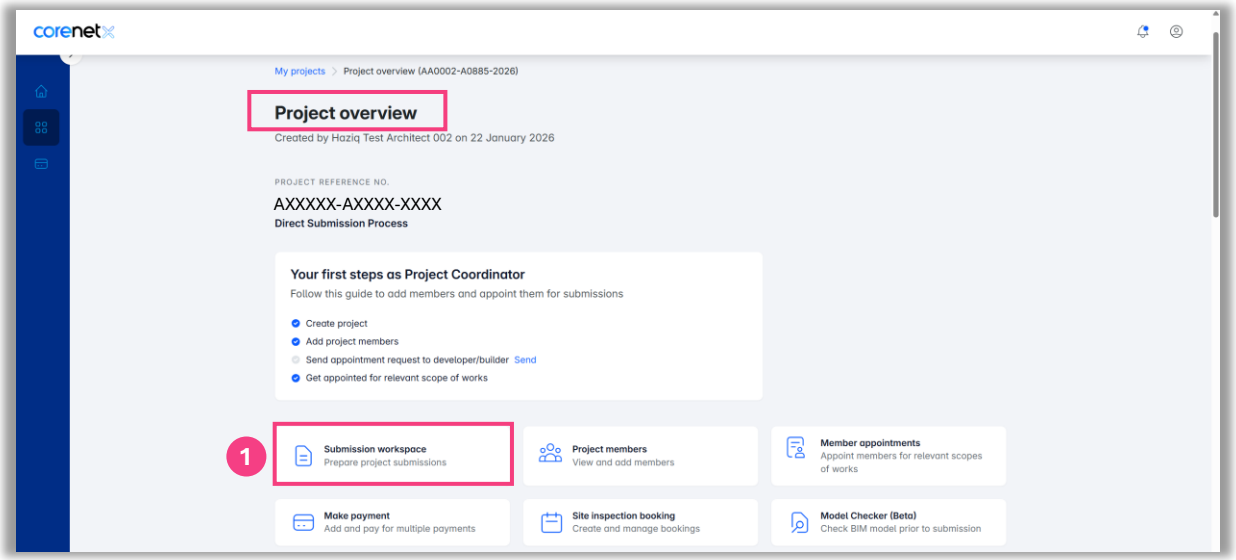


04-02 Formal Submission Check

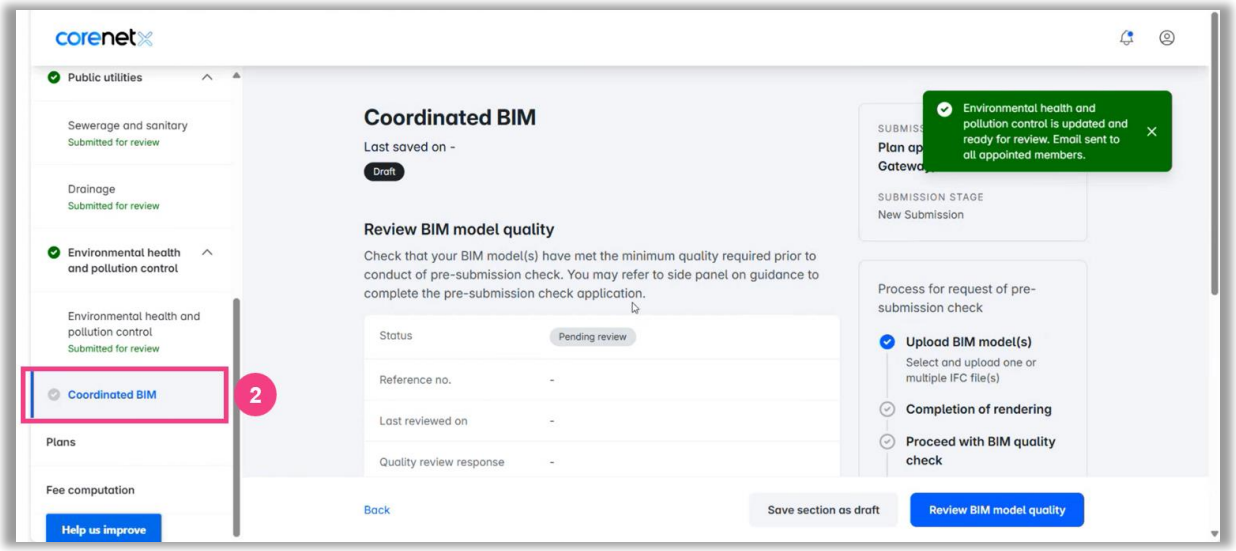
Formal Submission Check is required to be carried out before QP can proceed to make formal submission for Coordinated BIM submissions on Submission Portal (SP). The Formal Submission Check includes IFC Schema Check and Quality Check, which will ensure the BIM models submitted are ready for subsequent processing by Agencies. The process of Formal Submission Check is similar to Pre-Submission Check.

After creating a project on SP, QP may select the project for formal submission under My projects and follow the steps below to conduct the checks by MC:

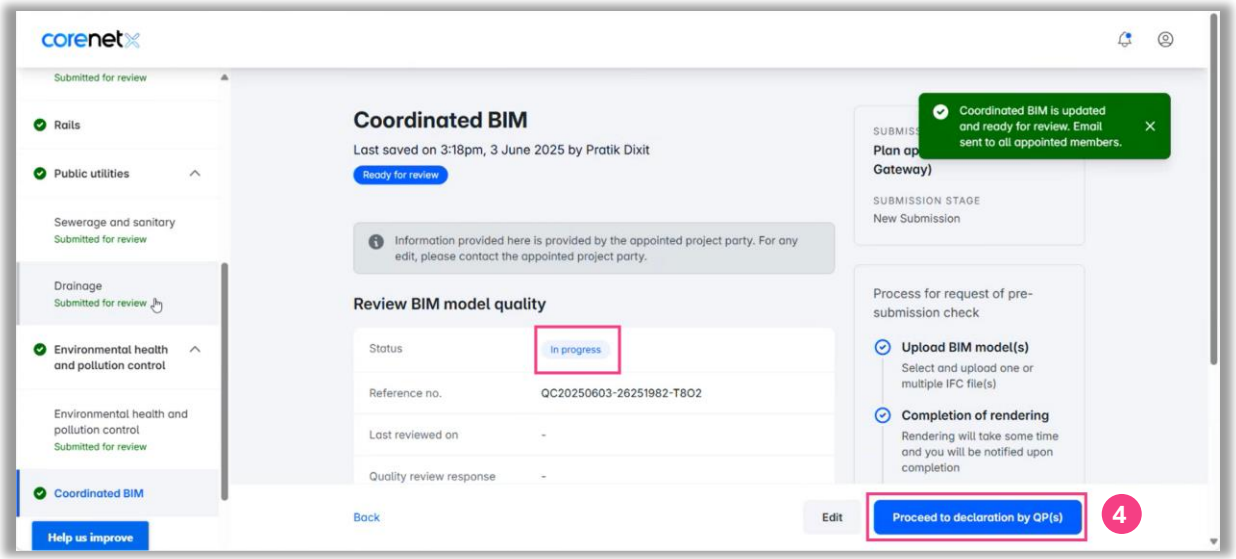
- Step 1: Select **Submission workspace** under **Project overview** to proceed with Formal Submission Check.



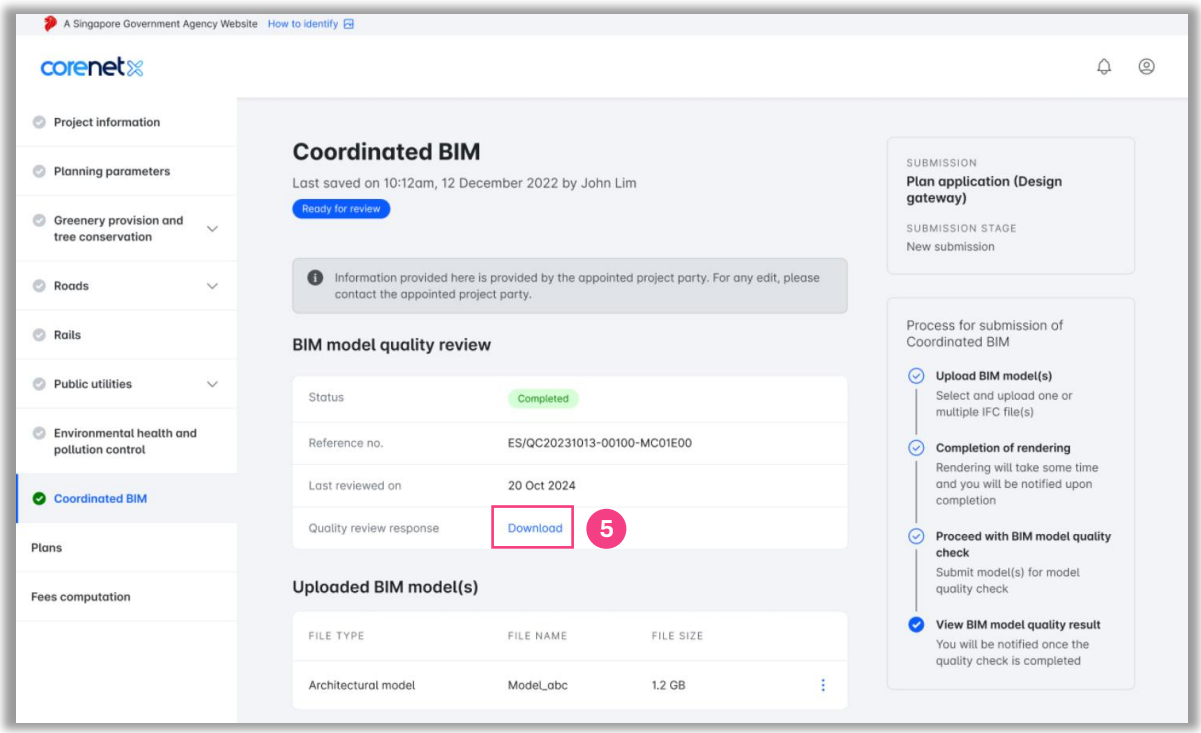
- Step 2: Select the applicable gateway (e.g. DSP, DG, or CG) in the application form. Click on **Coordinated BIM** to upload BIM model(s).



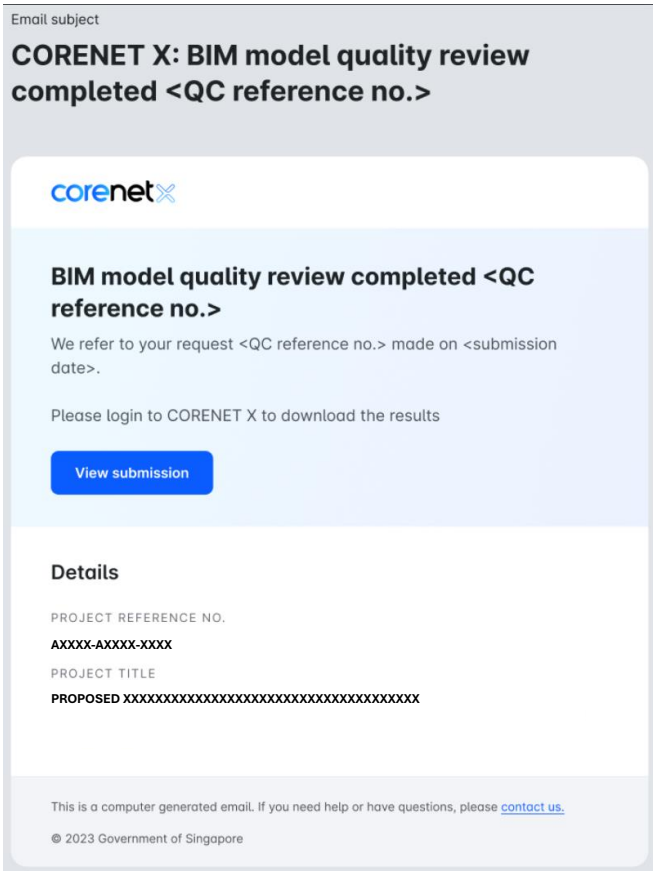
- Step 3: The steps are similar to detailed steps for Pre-Submission Check. Please refer to detailed steps of IFC Schema Check (04-01-02) and Quality Check (04-01-03) under Pre-Submission Check.
- Step 4: QP may continue with other activities on SP, such as **Proceed to declaration by QP(s)**, while MC is running Quality Check. QP will be notified via email once the Quality Check is completed. QP may proceed to submit upon completion of IFC Schema Check and after the start of Quality Check. Note that QP may proceed to submit even before Quality Check completes.



- Step 5: QP will be notified via email when QC is completed and results are available for downloading from SP.



Example of Email Notification of QC Completed

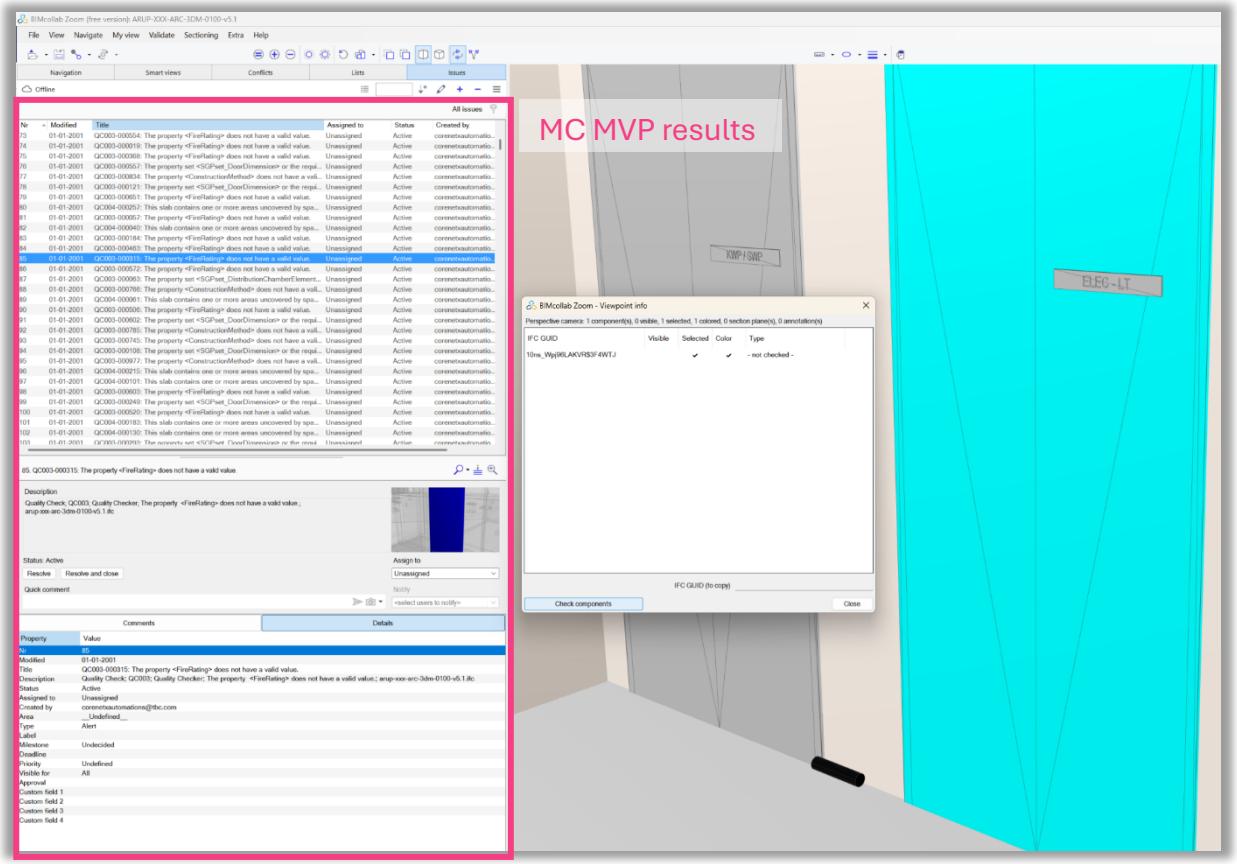


05 Understanding MC Results

MC MVP results will be provided to QPs in BIM Collaboration Format (BCF), limited to a maximum of 1,300 results due to BCF file size constraint.

After conducting MC MVP checks and downloading results from SP, QP may view the results in BCF Viewer or Native BIM Software.

Example of Viewing MC results in BCF Viewer



Details of BCF Results

Field Name	Example of Content	Example Value
Title	Result's serial number	QC001:000001
Description	This field contains: • requirement • report message • GUID of the element of the issue • model name	Building Naming Convention; Building Storey Name does not follow typical Naming Convention; 2AhbHzPtT7RwNNJyPColLV; tower 1_CS.ifc
Type	Fail/Alert result type Fail: This is not following CX COP. IFC model needs to be revised according to CX COP.	Fail

	Alert: This may be deviating from CX COP. QP to check that IFC model is prepared according to CX COP.	

06 Appendix

06-01 Quality Check Rules

06-01 Quality Check Rules

| QC01 Building Storey Naming

Rule Group	QC01
Rule Description	Building Storey Naming
Applicability of Rule	All BIM submissions for all disciplines
Details of Auto-check	This rule checks if building storeys follow typical naming convention as per typical industry practice and alert QP if there is deviation. Table 6A below shows valid and invalid examples of building storey naming.
Modelling Guide	Building storey

Table 6A: Examples of Building Storey Naming

Storey	Valid Example	Invalid Example
Above-ground floors:	✓ Storey 1 ✓ Level 20 ✓ 1st Storey ✓ 20th Level	× Storey 1st Level MPL × 20 Level × Loft Storey × 2nd Story × 1st Floor × Level one
Mezzanine floor for above-ground floors	✓ Storey 1 Mezzanine 2 Level 20 Mezzanine ✓ 1st Storey Mezzanine 2 ✓ 20th Level Mezzanine	× Mezzanine Level 1 × 4th Storey Mezzanine A
Split floor for multi-storey car park building	✓ 2nd Storey 2A	× 2nd Storey 3A × 2nd Storey A
Below-ground floors	✓ Basement 1	× Upper basement × Basement A × 1st Basement × B1 × Basement mezzanine × Basement carpark
Attic floors	✓ Attic ✓ Attic Storey	× Attic A × Attic 1 × 1st Storey Attic × Lower Attic
Roof floors	✓ Upper Roof ✓ Lower Roof Storey ✓ Roof	× Upper Roof 1 × Roof Lower
Differentiate storeys between blocks/datum	✓ 1st Storey_club house ✓ 4th Storey_Tower A ✓ 1st Storey_SFL ✓ 1st Storey_MPL	× Block 1 – 2nd Storey × 2nd Storey Block A&C

06-01 Quality Check Rules

| QC02 Clash Detection

Rule Group	QC02
Rule Description	Clash Detection
Applicability of Rule	All BIM submissions for all disciplines
Details of Auto-check	This rule checks for significant clashes between selected entities especially structural elements, based on Clash Detection matrix in CX COP. 1 issue result will be generated per pair of clash. The result will be pegged to one of the Structural element if the clash involves one or more structural elements. If there are no Structural elements involved, the result will be pegged to Architectural element or MEP element. This check allows 1mm modelling tolerance.
Modelling Guide	Clash Detection

06-01 Quality Check Rules

| QC03 Modelling inputs following IFC+SG in CX COP

Rule Group	QC03
Rule Description	Modelling inputs following IFC+SG in CX COP
Applicability of Rule	All BIM submissions for all disciplines
Details of Auto-check	This rule only checks that data in the BIM models are correctly provided as per Section 4 of CX COP. Currently, this check only covers requirements that are applicable to all project types. This rule consists of 3 types of checks: 1) Checks if a required property and its Pset are present. 2) Checks if a property contains acceptable value. 3) Checks if Ifc structure is correct a. Checks if an Object Type is under the correct Ifc Entity b. Checks if a Pset is under the correct Object Type c. Checks if a property is under the correct Pset
Modelling Guide	Section 4 in CX COP

06-01 Quality Check Rules

| QC04 Completeness of room tagging

Rule Group	QC04
Rule Description	Completeness of room tagging
Applicability of Rule	All BIM submissions for all disciplines
Details of Auto-check	This rule checks that rooms and spaces are properly modelled and tagged in BIM models by ensuring complete spatial coverage of floor areas. This check detects all IfcSpace.SPACEs that are in contact with IfcSlabs. Where an IfcSlab is fully covered by IfcSpace.SPACE(s), it is considered as compliant. Areas occupied by structural elements (columns, walls, etc.) are automatically excluded from this coverage requirement.
Modelling Guide	Space (Usage)

06-01 Quality Check Rules

| QC05 Alignment of BIM Model Coordinates

Rule Group	QC05
Rule Description	Alignment of BIM Model Coordinates
Applicability of Clause	All BIM submissions for all disciplines
Details of Auto-check	This rule checks that the submitted BIM models under the same submission contain the same geo-referencing coordinates in each of the models to help ensure good federation of coordinated BIM models.
Modelling Guide	Geo-Referencing

06-01 Quality Check Rules

| QC06 Level Consistency

Rule Group	QC06
Rule Description	Level Consistency
Applicability of Clause	All BIM submissions for all disciplines
Details of Auto-check	This rule checks that the same level name in different models for the same submission has the same FFL, which comprises 2 sub-checks: 1. Levels with the same name in different models of the same submission have the same FFL. 2. The same FFL is tagged to the levels with the same name in all models of the same submission.
Modelling Guide	Alignment of Levels and Zones Across All Disciplines' Models