National BIM Standard - United States® Version 3

4 Information Exchange Standards

4.2 Construction Operation Building information exchange (COBie) – Version 2.4

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4.2.1 Scope

4.2.1.1 Business Case Description

Author’s Editorial Comment: Business process models supporting COBie were first documented in a U.S. Army Technical Report (East 2007). These business models were developed from a series of industry advisory panel meetings conducted in 2006 and 2007. Additional clarification of the scope of processes pertaining to the life-cycle of facility assets were proposed in East 2010. At the time of submission of this document another update to COBie-related business processes is being finalized for editing as part of a U.S. Army Technical Report (Fallon 2013). The objective of the research contained in this report was to use business process modeling in conjunction with “lean” management approaches, as in East 2011, to compare current with COBie-based business processes. As part of the NBIMS-US™ V3 COBie standard, an updated set business models developed in the latest report is provided for direct inclusion in the standard. Based on the rules NBIMS-US™ V3 Technical Subcommittee Evaluation Criteria for Revised information exchange submissions, the information provided in this section should be considered a Moderate Change.

4.2.1.1.1 Life-Cycle Phase List

- Study and Define Needs
- Develop Design Criteria
- Study Technical Feasibility
- Communicate Results Decision
- Develop Program – Space Program
- Develop Program – Product Program
- Prepare Invitation to Bid and Receive Proposal (Pre-Design)
- Explore Concepts – Design Early
- Develop Design – Design Schematic
- Develop Design – Design Coordinated
- Finalize Design – Design Final
- Prepare Invitation to Bid and Receive Proposals (Post Design)
- Respond to Pre-Proposal Inquiries
- Develop Pre-Construction Plan
- Identify Discrepancies
- Prepare Submittal Information – Product Type Selection
- Prepare Submittal Information – System Layout
- Organize Submittal Information
- Perform Submittal Review – Submittal Issue
- Provide Resources
- Execute Construction Activities
- Perform Equipment Testing
• Inspect and Approve Work
• Define, Record and Certify Discrepancies
• Closeout

While the use of shared, structured information, such as COBie, can be shown to have a direct impact on the speed and quality of value-added tasks, the business cases described below do not consider these beneficial effects. This is because in a generic model, such effects were too complex to model in the first study of the life-cycle impact of having COBie data. As a result, the business cases described here are conservative in their estimates. COBie 2.4 business cases are based on the value-added analysis technique published in East 2010. This approach organizes work operations into tasks that add value to the final product and those that do not. Work operations that do not add value are targeted for elimination in the streamlined business process.

The following opportunities for streamlining the production, exchange, use, and maintenance of COBie data through the elimination of non-value added operations are characterized by the following classification:

1. **VALIDATION** savings from the ability to programmatically check the space and equipment data for completeness, conformance to standards and conformance to requirements.
2. **COPYING** savings from reliance on electronic documents and data as the project record.
3. **HANDLING** savings from the adoption of managed project collaboration and management systems for transmittal and automated logging of project documents.
4. **SEARCHING** savings from the ability to electronically compare product data to product specifications.
5. **REFORMATTING** savings from adoption of a single, open standard data format for information relating to managed assets.
6. **RECREATING** savings from the use of a standard, structured data format for moving space and equipment information through the project process and into facility management, eliminating the need for data re-entry. In addition, rework is a form of recreation.

Savings can be achieved in non-value added tasks to different degrees. Some tasks can be completely eliminated, while others can be automated or streamlined. Of the 25 life cycle processes studied in Fallon 2013, 19 of these would obtain a savings from the expected approach. The following processes are defined and include the analysis of possible savings from the use of COBie-based information exchanges.

**4.2.1.1.1 Study and define needs**

Standard facility information must be available in order to determine the basic requirements for a potential project. The Owner identifies the need and either develops technical criteria for the facility if none exist or utilizes existing technical criteria if available. If it does exist, this information must be checked for relevancy every five years to remain consistent with overall needs. Potential savings in this process include, but may not be limited to, the following:

• Reproduction savings from reliance on electronic documents and the elimination of paper.
4.2.1.1.1.2 Develop design criteria

Specification information for equipment based on facility criteria is generated early in the planning process by the Owner. This information must be checked for relevancy every five years to remain consistent with overall needs. Potential savings in this process include, but may not be limited to, the following:

- Reproduction savings from reliance on electronic documents and the elimination of paper.

4.2.1.1.1.3 Study technical feasibility

The Feasibility Study allows the Owner to evaluate different options (typically three) based on the identified requirements before finalizing specific information about a project. The Architect or Planner develops the study based on the information contained in the Facility Criteria and Discipline Specification information exchanges. Potential savings in this process include, but may not be limited to, the following:

- Reproduction savings from reliance on electronic documents and the elimination of paper
- Elimination of administrative costs associated with handling paper document transmittals as well as the delivery expense. Managed electronic collaboration systems will notify intended recipients when e-documents are released and automatically log both the issuing and viewing of those documents.

4.2.1.1.1.4 Communicate results decisions

Initial criteria about a project must be established in order to evaluate the project feasibility. The Owner evaluates the Facility Criteria, Discipline Specifications, and Feasibility Study to determine whether or not to move forward with the project. Potential savings in this process include, but may not be limited to, the following:

- Reproduction savings from reliance on electronic documents and the elimination of paper.

4.2.1.1.1.5 Develop program – space program

Once the Project Definition has been established and approved, further development of the project requirements can occur. The Architect or Planner evaluates information contained in the Project Definition information exchange to identify space needs based on the facility type. Space requirements, based on facility type, are located online in electronic document format and must be downloaded. These documents are typically printed by the end user. If no standard facility space criteria exist, it must be created by referencing similar facility types. Potential savings in this process include, but may not be limited to, the following:

- Design professionals typically re-enter the Owner’s space requirements into the system they use for space programming. COBie-formatted data permits data to be transferred directly from the Owner to the Architect or Planner’s system
- Requirements associated with each space are typically gathered and then documented on Room Data Sheets. COBie format would either eliminate the need to produce room data sheets or support automation of their production
- The Architect/Planner sends the Space Program to the Owner’s Representative for review. Currently, this is done by comparing 2 documents. Use of COBie format would permit automated checking.
- If the Architect/Planner could automate checking of his work product against the Owner’s requirements, then a rework/re-review cycle could be eliminated.
4.2.1.1.6 Develop program – product program

The Architect or Planner evaluates information contained in the Project Definition information exchange to identify product needs based on the facility type. Requirements for products based on facility type are located online in electronic document format and must be downloaded. These documents are typically printed by the end user. If no standard facility product criteria exist, it must be created by referencing similar facility types. Potential savings in this process include, but may not be limited to, the following:

- Design professionals typically re-enter the Owner’s product standards into the system they use for design. COBie-formatted product standards would permit direct transfer from the Owner to the Architect or Planner’s system.
- If the Owner’s Representative returns the Product Program because it does not meet the Owner’s product requirements, the Architect/Planner must recreate the Product Program.
- The Architect/Planner sends the Product Program to the Owner’s Representative for review. Currently, this is done by comparing 2 documents. Use of COBie format would permit automated checking.
- If the Architect/Planner could automate checking of his work product against the Owner’s requirements, then a rework/re-review cycle could be eliminated.
- Reproduction savings from reliance on electronic documents and the elimination of paper.
- Elimination of administrative costs associated with handling paper document transmittals as well as the delivery expense. Managed electronic collaboration systems will notify intended recipients when e-documents are released and automatically log both the issuing and viewing of those documents.

4.2.1.1.7 Prepare invitation to bid and receive proposals (pre-design)

Once the major criteria have been determined, the Owner’s Representative prepares and distributes a Request for Proposal (RFP). Potential savings in this process include, but may not be limited to, the following:

- Reproduction savings from reliance on electronic documents and the elimination of paper in both soliciting and submitting proposals.
- Elimination of administrative costs associated with handling paper document transmittals as well as the delivery expense. A managed electronic collaboration system with a “bidding” module can handle distribution of Requests for Proposal, receiving questions, issuing addenda and receiving and securing the proposals submitted by design firms.

4.2.1.1.8 Explore concepts – design early

The Architect utilizes the specific information produced during pre-design to develop a solution that reflects the requirements stated in the Project Definition, Space Program, and Product Program. Currently, the owner requires 6 hard copies to be submitted for each review cycle. The Architect performs a QA/QC check before submitting to the Owner’s Representative. After receiving the submission, the Owner’s Representative validates the documents (reviews) and provides comments to the Architect. The Architect and Consultants are then required to update the documents based on the comments. After
revisions are made, the Architect resubmits. Potential savings in this process include, but may not be limited to, the following:

- Although the Owner’s requirements might be provided as e-documents, the design team typically reformats the information to be compatible with their design systems. COBie-formatted requirements data permits direct transfer from the Owner to the design consultants’ systems.

- If the Owner’s Representative rejects the Concept Design because it does not meet the Owner’s space requirements, the Architect must recreate the Concept Design.

- COBie would permit the Architect to automate checking of his Concept Design against the Owner’s space requirements, saving the Architect time and potentially eliminating a rework/re-review cycle.

- The Architect sends the Design Early documents to the Owner’s Representative for review. Currently, this review is done manually. Use of COBie format would permit automated checking of space program at this phase.

- Reproduction savings from reliance on electronic documents and the elimination of paper

- In a paper-based process, review comments often need to be transferred to multiple document copies.

- Elimination of administrative costs associated with handling paper document transmittals as well as the delivery expense. Managed electronic collaboration systems will notify intended recipients when e-documents are released and automatically log both the issuing and viewing of those documents.

4.2.1.1.1.9 Develop design – design schematic

The Architect further develops the approved Design Early deliverable documents to produce the Design Schematic documents. Currently, the owner requires 6 hard copies to be submitted for each review cycle. The Architect performs a QA/QC check before submitting to the Owner’s Representative. After receiving the submission, the Owner’s Representative validates the documents and provides comments to the Architect. The Architect and Consultants are then required to update the documents based on the comments. After revisions are made, the Architect resubmits. Potential savings in this process include, but may not be limited to, the following:

- Design Schematic phase requires quantity take-offs (QTOs) for cost estimating. QTOs are a recreation of information because the items have already been documented in the drawings or BIM. COBie addresses spaces and products/equipment. It provides space areas and product types and counts.

- If the Owner’s Representative rejects the Design Schematic documents because the design does not meet the Owner’s space or product requirements, the Architect must recreate the design.

- Although the Owner’s requirements might be provided as e-documents, the design team spends considerable time developing product type templates (or BIM content), as well as specifications. COBie-formatted requirements data could be used directly.

- If the Architect and his Consultants could automate checking of their design against the Owner’s space and product requirements, they would save checking time and a rework/re-review cycle could potentially be eliminated.

- The Architect sends the Design Schematic documents to the Owner’s Representative for review. Currently, this is review is done manually. Use of COBie format would permit automated checking of space and product program at this phase.
• Reproduction savings from reliance on electronic documents and data and the elimination of paper
• In a paper-based process, review comments often need to be transferred to multiple document copies.
• Elimination of administrative costs associated with handling paper document transmittals as well as the delivery expense. Managed electronic collaboration systems will notify intended recipients when e-documents are released and automatically log both the issuing and viewing of those documents.

4.2.1.1.10 Develop design – product type template, product type candidate

As the design progresses, performance characteristics and suitable products for the building systems are identified. System types and equipment are identified by the Specifier based on the facility requirements. Six copies are required to be submitted for review. Some products are defined in more detail by identifying manufacturers and model numbers which meet requirements (Basis of Design). In these cases, 3 qualifying products should be listed. Potential savings in this process include, but may not be limited to, those identified in the previous section.

4.2.1.1.11 Develop design – design coordinated

The Architect further develops the approved Design Schematic deliverable documents to produce the Design Coordinated documents. In addition, the building systems are coordinated to eliminate spatial interferences. This is the major coordination submittal before the final delivery package. The owner requires 6 hard copies to be submitted for each review cycle. Due to the higher level of coordination and increase in number of interested reviewing parties, more copies are sometimes needed. The Architect performs a QA/QC check before submitting to the Owner’s Representative. After receiving the submission, the Owner’s Representative validates the documents and provides comments to the Architect. The Architect and Consultants are then required to update the documents based on the comments. After revisions are made, the Architect resubmits. Potential savings in this process include, but may not be limited to, the following:

• Design Coordinated phase requires quantity take-offs (QTOs) for cost estimating. QTOs are a recreation of information because the items have already been documented in the drawings or BIM. COBie addresses spaces and products/equipment. It provides space areas and product types and counts.
• If the Owner’s Representative rejects the Design Coordinated documents because the design does not meet the Owner’s space or product requirements, the Architect must recreate the design.
• Although the Owner’s requirements might be provided as e-documents, the design team spends considerable time developing product type templates (or BIM content), as well as specifications. COBie-formatted requirements data could be used directly.
• Candidate Products (typically 3 qualifying products) are identified for each product type template. This is done through reviewing product literature. Standard, structured product data available in COBie format would allow automated product selection based on the product type templates.
• If the Architect and his Consultants could automate checking of their design against the Owner’s space and product requirements, they would save checking time and a rework/re-review cycle could potentially be eliminated.
• The Architect sends the Design Coordinated documents to the Owner’s Representative for review. Currently, this is review is done manually. Use of COBie format would permit automated checking of space areas and product data against Owner requirements.
- Reproduction savings from reliance on electronic documents and data and the elimination of paper
- In a paper-based process, review comments often need to be transferred to multiple document copies.
- Elimination of administrative costs associated with handling paper document transmittals as well as the delivery expense. Managed electronic collaboration systems will notify intended recipients when e-documents are released and automatically log both the issuing and viewing of those documents.

4.2.1.1.12 Develop design – product type candidate

The performance requirements of building systems and equipment are further refined and documented by the Specifier during this phase. Any equipment, products, or systems not selected previously are identified. Specific manufacturers and model numbers are noted. Three qualifying products are identified. Six copies are submitted for each review cycle. Potential savings in this process include, but may not be limited to, those identified in the previous section.

4.2.1.1.13 Finalize design – design final

The Design Final package is the final set of contract documents ready for bid solicitation by the Owner. This final design deliverable does not require another review by the Owner’s Representative. Potential savings in this process include, but may not be limited to, the following:

- Design Final phase requires quantity take-offs (QTOs) for cost estimating. QTOs are a recreation of information because the items have already been documented in the drawings or BIM. COBie addresses spaces and products/equipment. It provides space areas and product types and counts.
- Design Final requires a Quality Control Review to evaluate both technical accuracy and discipline coordination. COBie supports automate checking of the design against the Owner’s space and product requirements, saving checking time.
- Reproduction savings from reliance on electronic documents and data and the elimination of paper.
- In a paper-based process, review comments often need to be transferred to multiple document copies.
- Elimination of administrative costs associated with handling paper document transmittals as well as the delivery expense. Managed electronic collaboration systems will notify intended recipients when e-documents are released and automatically log both the issuing and viewing of those documents.

4.2.1.1.14 Finalize design – product type candidate

At this phase of the project all equipment and system types must be identified by the Specifier. Product information from the Design Coordinated phase is incorporated into this phase. Three (3) qualifying products for each type required must be listed. Potential savings in this process include, but may not be limited to, those identified in the previous section.

4.2.1.1.15 Prepare invitation to bid and receive proposals (post-design)

Once the design is complete, the Owner packages the Design Final Documents information together with other owner-supplied information (e.g., contractual terms) and creates a Request for Proposals (RFP)
Package. This becomes the official bid set. Potential savings in this process include, but may not be limited to, the following:

- Reproduction savings from reliance on electronic documents and the elimination of paper in both soliciting and submitting proposals
- Elimination of administrative costs associated with handling paper document transmittals as well as the delivery expense. A managed electronic collaboration system with a “bidding” module can handle distribution of Requests for Proposal, receiving questions, issuing addenda and receiving and securing the bids submitted by Contractors.

4.2.1.1.16 Respond to pre-proposal inquiries

Before finalizing a bid proposal, the Contractor typically requests additional information or clarification of some bid documents. Potential savings in this process include, but may not be limited to, the following:

Elimination of administrative costs associated with handling paper document transmittals as well as the delivery expense. A managed electronic collaboration system with a “bidding” module can handle receipt of bidder questions and issuing addenda.

4.2.1.1.17 Develop pre-construction plan

The Contractor is required to develop a Pre-Construction Plan that describes how the Contractor will make provisions for managing the construction of the facility. This is sent as a submittal package. Refer to the Submittal Package exchange for detailed requirements related to transmitting and handling Pre-Construction Plan submittals. Savings from COBie exchanges were not explicitly identified in the referenced study.

4.2.1.1.18 Identify discrepancies

The Contractor submits a Request for Information (RFI) to ask for clarification during the construction process. These questions may be due to but not restricted to ambiguities or contradictions in the drawings or to site conditions. Potential savings in this process include, but may not be limited to, the following:

- Elimination of administrative costs associated with handling paper document transmittals as well as the delivery expense. A managed electronic collaboration system with a “bidding” module can handle receipt of bidder questions and issuing addenda.

4.2.1.1.19 Prepare submittal information – product type selection

The Contractor and Sub-Contractors gather information for products identified in the Design Final documents and prepare submittals. Refer to the Submittal Package exchange for detailed requirements related to transmitting and handling Product Type Selection submittals. Savings from COBie exchanges were not explicitly identified in the referenced study. Note that benefits from having standard product template data through the Life-Cycle information exchange for Equipment Assets and Specifiers’ Properties information exchange (SPie) projects are expected to address many issues related to streamlining the delivery of facility asset information.

4.2.1.1.20 Prepare submittal information – system layout

The Contractor and Sub-Contractors review information for products identified in the Design Final documents and prepare shop drawings. Refer to the Submittal Package exchange for detailed requirements related to transmitting and handling System Layout submittals. Savings from COBie
exchanges were not explicitly identified in the referenced study. Note that benefits from having standard system layout data through the HVAC information exchange (HVACie), Water System information exchange (WSie), Electrical System information exchange (SPARKie), and Building Automation Management information exchange (BAMie) are expected to be addressed directly in those projects.

4.2.1.1.1.21 Organize submittal information

The Contractor organizes the required submittal information and creates Submittal Packages to be reviewed by the Owner’s Representative and/or Architect. Six hard copies are required to be submitted for review. Potential savings in this process include, but may not be limited to, the following:

- Contractors and Subcontractors must extract product requirements from the specifications. COBie provides product requirements in a concise, computable form.
- Contractors must compile disparate product data formats into Product Submittal Items and Submittal Packages for the Architect’s approval. COBie formats product data consistently.
- Contractors must validate product data against the specifications before including them in a Submittal. COBie supports automated checking of the data against the product specifications, saving time and reducing the number of Product Submittals rejected. This reduces rework. (See Recreating above.)
- Reproduction savings from reliance on electronic documents and data and the elimination of paper
- In a paper-based process, review comments often need to be transferred to multiple Submittal copies.
- Elimination of administrative costs associated with handling paper document Submittals as well as the delivery expense. These costs are high, due to the large number of documents and the requirement for multiple copies. Managed electronic collaboration systems will notify reviewers when Submittal Packages are uploaded, automatically log both the release and the reviewing of those documents and track ball-in-court responsibility and due dates.

4.2.1.1.22 Perform submittal review – submittal issue

The Architect and/or Sub-Consultants validate the submittals provided by the Contractor and provide comments. Multiple hard copies are required. Potential savings in this process include, but may not be limited to, the following:

- If a Submittal Item is rejected by the reviewer (typically the Architect and the Architect’s Consultants), the Contractor or Subcontractor must redo the Submittal. COBie supports automated validation product characteristics against the specification, lowering the number of Product Submittals rejected.
- Submittal reviewers (typically the Architect and the Architect’s Consultants) must also check Product Submittal data against the specifications. COBie supports automated checking, saving time.
- Reproduction savings from reliance on electronic documents and data and the elimination of paper
- In a paper-based process, review comments often need to be transferred to multiple Submittal copies.
- Elimination of administrative costs associated with handling paper document Submittals as well as the delivery expense. These costs are high, due to the large number of documents and the requirement for multiple copies. Managed electronic collaboration systems will notify reviewers
when Submittal Issues are uploaded, automatically log both the release and the reviewing of those documents and track ball-in-court responsibility and due dates.

4.2.1.1.23 Provide resources

The Contractor contacts a Supplier to order equipment and materials. The Supplier then provides a price quote to the Contractor for the equipment and/or materials. The Contractor verifies the specifications of the equipment and/or materials in the quote against approved submittal documentation and then submits them to the Owner’s Representative and/or Architect for approval. Savings from COBie exchanges were not explicitly identified in the referenced study.

4.2.1.1.24 Execute construction activities

The Contractor installs the building equipment, materials, and systems using the design final drawings, approved shop drawings, product data, and manufacturer’s instructions. Potential savings in this process include, but may not be limited to, the following:

- While the project is on-going, the Contractor must continually prepare a Product Installation report that describes the status of installed components and corresponding data. The Contractor then spends time in the office processing these notes and compiling the Report. The COBie worksheet would be a vehicle for field data entry, as well as a reference to components. This would allow the Contractor to reduce office time.
- Elimination of administrative costs associated with handling paper documents as well as the delivery expense.

4.2.1.1.25 Perform equipment testing

After the Contractor completes the installation process, the equipment/systems must be tested by activating the equipment. This testing must be completed with the Owner’s Representative and Manufacturer’s representative present. Savings from COBie exchanges were not explicitly identified in the referenced study.

4.2.1.1.26 Inspect and approve work

When the Contractor has completed installation of equipment or systems, a notification is sent to the Architect indicating the installed item is ready for inspection/observation. The Architect conducts regular inspections of the installed construction work. The findings of the inspections including any deficiencies with the installation of the construction work are documented in a report. If deficiencies are identified in the inspection report, the Contractor corrects them and then requests a re-inspection. Potential savings in this process include, but may not be limited to, the following:

- The Architect must validate each Contractor Pay Request through a site visit to determine work progress. Typically, the Architect takes drawings to the site to check that items billed have been put in place. The Architect also notes any defects in workmanship. The Architect then spends time in the office composing field notes and quantifying work put in place to support or refute the Pay Request. COBie would provide a definitive list of items required per room or floor that could be “checked off” and automatically totaled. This would allow the Architect to reduce office time.
- Elimination of administrative costs associated with handling paper documents as well as the delivery expense. Managed electronic collaboration systems can notify the Contractor if the Pay Request has been accepted or rejected and deliver the Observation Field Report with tracking.

4.2.1.1.27 Define, record and certify discrepancies
The Architect creates a final punch-list based upon a survey of the completed construction work. The Contractor corrects the deficiencies identified in the punch-list. The Architect verifies that the Contractor has corrected the deficiencies in the punch-list by performing a final walkthrough. Savings from COBie exchanges were not explicitly identified in the referenced study.

4.2.1.1.28 Closeout

The Contractor gathers all as-built information related to the project and forwards the information to the Owner. Four copies are typically required. Potential savings in this process include, but may not be limited to, the following:

- Contractor must assemble the Turnover Package. A managed electronic collaboration system stores and indexes all documents submitted as they are uploaded. This greatly reduces the time required to find the necessary documents and assemble the Turnover Package, saving the Contractor time, improving the completeness and quality of the Turnover Package, and making the Turnover Package available to the Owner at an earlier date.
- Reproduction savings from turnover of electronic documents and data and the elimination of paper. Typically four sets of Turnover documents are required.
- Elimination of administrative costs associated with handling paper documents as well as the delivery expense.

4.2.1.1.2 Business Case Analysis

Three business cases were developed to support the COBie 2.4 specification. The first two were developed for the commonly used Office Building and Medical Clinic models (East 2012a). These models were used as a representation of commercial and medical facilities. The third business case, a Chicago Transit Authority (CTA) station construction program, was also analyzed. The inclusion of the CTA construction program allowed the study authors to evaluate: (1) the assumptions regarding savings and values used on the experimental BIM models and (2) to demonstrate how mixed paper/electronic approaches are included in the business process analysis.

The business process analysis conducted contains 210 variables related to the specification, documentation and fulfillment of managed asset requirements across the complete life-cycle of COBie-related information exchanges. These variables included information about numbers of drawing sets, count and complexity of space inventories, extent of specifications, numbers of equipment schedules and required copies of product data sheets. The analysis assumes that there were no changes to the requirements in the contracts other than a change from traditional to COBie-based business processes.

The baseline, or Current Process, used in analyzing the Office and Clinic projects assumed a paper-based communication and documentation system. The Expected Process assumes an electronic collaboration communication and documentation system and use of standard, structured data (COBie) for data exchanges. The COBie Calculator determined the expected values of the variables affected. The analysis conducted evaluated considered which of the previously classified non-value added activities could be eliminated or streamlined, when compared to a traditional process.

The Office project was based on a federal typical Army standard office building. The total square footage was 40,053 SF. There were 50 product types and 1,706 scheduled components in the sample model. The table below shows the results of the total analysis across each of the new COBie business processes, and all types of users.
### Table 1 Business Case - Office Project

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<thead>
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<th>OmniClass™ Project Phase (Table31)</th>
<th>Current Cost ($)</th>
<th>Expected Cost ($)</th>
<th>Savings ($)</th>
<th>Savings (%)</th>
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<tr>
<td>Inquiry Issue</td>
<td>$1,210.00</td>
<td>$30.00</td>
<td>$1,180.00</td>
<td>98%</td>
</tr>
<tr>
<td>Pre-Construction Plan</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Inquiry Issue (RFI)</td>
<td>$1,280.00</td>
<td>$10.00</td>
<td>$1,270.00</td>
<td>95%</td>
</tr>
<tr>
<td>Product Type Selection</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>System Layout</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Submittal Package</td>
<td>$34,400.00</td>
<td>$3,000.00</td>
<td>$31,400.00</td>
<td>91%</td>
</tr>
<tr>
<td>Submittal Issue</td>
<td>$73,500.00</td>
<td>$400.00</td>
<td>$73,100.00</td>
<td>99%</td>
</tr>
<tr>
<td>Purchase Order</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Product Installation</td>
<td>$41,005.00</td>
<td>$5.00</td>
<td>$41,000.00</td>
<td>100%</td>
</tr>
<tr>
<td>Start-Up</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Product Inspection</td>
<td>$15,900.00</td>
<td>$600.00</td>
<td>$15,300.00</td>
<td>96%</td>
</tr>
<tr>
<td>Punch-list Issue</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Turnover Package</td>
<td>$6,300.00</td>
<td>$100.00</td>
<td>$6,200.00</td>
<td>98%</td>
</tr>
<tr>
<td>Total</td>
<td>$232,000.00</td>
<td>$10,000.00</td>
<td>$222,000.00</td>
<td>96%</td>
</tr>
</tbody>
</table>

The Medical Clinic project is based on an actual government medical clinic whose design drawings and operations and maintenance manuals have been provided, in redacted form. The total square footage was 49,571 SF. There were 155 product types and 3,950 components in the sample model. The table below shows the results of the total analysis across each of the new COBie business processes, and all types of users.

### Table 2 Business Case - Medical Clinic

<table>
<thead>
<tr>
<th>OmniClass™ Project Phase (Table31)</th>
<th>Current Cost ($)</th>
<th>Expected Cost ($)</th>
<th>Savings ($)</th>
<th>Savings (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility Criteria</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Design Specification</td>
<td>$135.00</td>
<td>-</td>
<td>$135.00</td>
<td>100%</td>
</tr>
<tr>
<td>Feasibility Study</td>
<td>$670.00</td>
<td>$10.00</td>
<td>$660.00</td>
<td>99%</td>
</tr>
<tr>
<td>Project Definition</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Space Program</td>
<td>$840.00</td>
<td>$10.00</td>
<td>$830.00</td>
<td>99%</td>
</tr>
<tr>
<td>Product Program</td>
<td>$1,900.00</td>
<td>$5.00</td>
<td>$1,895.00</td>
<td>99%</td>
</tr>
<tr>
<td>Request for Proposal</td>
<td>$900.00</td>
<td>$100.00</td>
<td>$800.00</td>
<td>89%</td>
</tr>
<tr>
<td>Design Early</td>
<td>$20,840.00</td>
<td>$300.00</td>
<td>$20,900.00</td>
<td>98%</td>
</tr>
<tr>
<td>Design Schematic</td>
<td>$33,400.00</td>
<td>$1,900.00</td>
<td>$31,500.00</td>
<td>94%</td>
</tr>
<tr>
<td>Design Coordinated</td>
<td>$91,100.00</td>
<td>$12,600.00</td>
<td>$82,700.00</td>
<td>86%</td>
</tr>
</tbody>
</table>
The third business case was conducted on the Chicago Transit Authority (CTA) station program. Unlike the Office and Clinic analysis, described above, the CTA utilized a web-based managed collaboration system with automated workflow and some paper-based communication in executing its projects. CTA processes combined the exchange of paper and e-paper documents. CTA did not make use of standard, structured data for exchanges, i.e. COBie. Changes to the business process model variables were made to take into account the use of CTA’s web-based collaboration tools. This result of comparing the current CTA processes with a process that captured asset information, via COBie is provided in the table below.

Table 3 - Business Case Transit Authority

<table>
<thead>
<tr>
<th>OmniClass™ Project Phase (Table31)</th>
<th>Current Cost ($)</th>
<th>Expected Cost ($)</th>
<th>Savings ($)</th>
<th>Savings (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility Criteria</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Design Specification</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Feasibility Study</td>
<td>$10.00</td>
<td>$10.00</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Project Definition</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Space Program</td>
<td>$510.00</td>
<td>$10.00</td>
<td>$500.00</td>
<td>98%</td>
</tr>
<tr>
<td>Product Program</td>
<td>$890.00</td>
<td>$30.00</td>
<td>$860.00</td>
<td>97%</td>
</tr>
<tr>
<td>Request for Proposal</td>
<td>$80.00</td>
<td>$80.00</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Design Early</td>
<td>$11,800.00</td>
<td>$300.00</td>
<td>$11,500.00</td>
<td>97%</td>
</tr>
<tr>
<td>Design Schematic</td>
<td>$31,800.00</td>
<td>$1,500.00</td>
<td>$30,300.00</td>
<td>95%</td>
</tr>
<tr>
<td>Design Coordinated</td>
<td>$68,000.00</td>
<td>$7,600.00</td>
<td>$60,400.00</td>
<td>89%</td>
</tr>
<tr>
<td>Design Final</td>
<td>$28,200.00</td>
<td>$1,900.00</td>
<td>$26,300.00</td>
<td>93%</td>
</tr>
<tr>
<td>Request for Proposal</td>
<td>$20.00</td>
<td>$10.00</td>
<td>$10.00</td>
<td>50%</td>
</tr>
<tr>
<td>Inquiry Issue</td>
<td>$100.00</td>
<td>$100.00</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Pre-Construction Plan</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Inquiry Issue (RFI)</td>
<td>$3,200.00</td>
<td>$300.00</td>
<td>$2,900</td>
<td>91%</td>
</tr>
<tr>
<td>Product Type Selection</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>System Layout</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Submittal Package</td>
<td>$32,700.00</td>
<td>$1,800.00</td>
<td>$30,900.00</td>
<td>94%</td>
</tr>
<tr>
<td>Submittal Issue</td>
<td>$61,400.00</td>
<td>$500.00</td>
<td>$60,900.00</td>
<td>99%</td>
</tr>
<tr>
<td>Purchase Order</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Product Installation</td>
<td>$12,900.00</td>
<td>-</td>
<td>$12,900.00</td>
<td>100%</td>
</tr>
<tr>
<td>OmniClass™ Project Phase (Table 31)</td>
<td>Current Cost ($)</td>
<td>Expected Cost ($)</td>
<td>Savings ($)</td>
<td>Savings (%)</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-----------------</td>
<td>------------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Start-Up</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Product Inspection</td>
<td>$326,800.00</td>
<td>$13,100.00</td>
<td>$313,700.00</td>
<td>96%</td>
</tr>
<tr>
<td>Punch-list Issue</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0%</td>
</tr>
<tr>
<td>Turnover Package</td>
<td>$15,400.00</td>
<td>$300.00</td>
<td>$15,100.00</td>
<td>98%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$594,000.00</strong></td>
<td><strong>$28,000.00</strong></td>
<td><strong>$566,000.00</strong></td>
<td><strong>95%</strong></td>
</tr>
</tbody>
</table>

In comparing the savings projected from first two projects, developed from the buildingSMART alliance® Common BIM File repository and the savings projected in the third project, based on real life-cycle information collected through direct observation the conclusion be reached when evaluating these business cases is that the predicted savings are surprisingly consistent. In hindsight this result is consistent with the model that been developed to evaluate these business cases. This is because a consistent percentage of savings can be achieved for projects of any size when changing from paper-based document processing to using web-based tools that exchange COBie-based information. This consistent percent savings across all types of projects was directly due to the types of business operations contained in the business process models that could be eliminated as a result of no longer having to create, recreate, transmit and manually check data provided in COBie versus document-based formats.

4.2.1.2 Participants and stakeholders

Author’s Editorial Comment: Information about participants and stakeholders were not explicitly provided in NBIMS-US™ V2 COBie documentation although the information could be found in originally referenced project reports. As part of the NBIMS-US™ V3 COBie submission, an updated list of participants and stakeholder is provided for direct inclusion in the standard. Based on the rules NBIMS-US™ V3 Technical Subcommittee Evaluation Criteria for Revised Information Exchange documents, the information provided in this section should be considered a moderate change.

4.2.1.2.1 Participants List

- 4Projects
- AEC 3 Ltd
- AssetWORKS
- ARCHIBUS
- Asite Solutions Ltd
- Autodesk, Inc
- Bentley Facilities
- Bentley Systems
- City of Chicago, Chicago Transit Authority
- CxAlloy
- DRofus
- DRRW, Inc
- EagleCMMS
- EcoDomus, Inc
- FM: Systems
- Graphisoft SE
- Hitchcock Consulting, Inc
- International Business Machines, Inc
- Kristine Fallon and Associates
- LATISTA
- Onuma
- Organization for the Advancement of Structured Information Standards, Open Building Information Exchange (oBIX) Technical Committee
- National Information Exchange Model (NIEM)
- Nemetschek Vectorworks, Inc.
- Plannon
- TC9, Inc
- TMA Systems
- University of Chicago
4.2.1.2.2 Stakeholders List

Owners
Planners
Architects
Consulting Engineers
Construction Managers
Contractors
Sub-Contractors
Fabricators
Suppliers
Manufacturers
Commissioning Agents
Facility Operators
Facility Managers
Asset Managers
Software Developers
System Analysts
Systems Integrators

4.2.1.2.3 Stakeholders coverage analysis

The table below briefly describes how each COBie constituents’ concerns are addressed through the COBie standard.

Table 4 Stakeholder Coverage Analysis

<table>
<thead>
<tr>
<th>Constituent</th>
<th>Coverage Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owners</td>
<td>The format for the specification of requirements is provided by COBie. A generic guide to the contents of COBie, the COBie Guide, should be updated for a given owner's requirements before specifying COBie.</td>
</tr>
<tr>
<td>Planners</td>
<td>An extended version of the COBie format, defining specific requirements for the planning and programming stage has been defined as the BPie project.</td>
</tr>
<tr>
<td>Architects</td>
<td>Quality standards required by the COBie Guide ensure that designers create COBie data that matches the content of all scheduled assets.</td>
</tr>
<tr>
<td>Consulting Engineers</td>
<td>Quality standards required by the COBie Guide ensure that designers create COBie data that matches the content of all scheduled assets. Merging rules described in this standard provide implementation support required.</td>
</tr>
<tr>
<td>Construction Managers</td>
<td>COBie business case analysis supports streamlining those activities that have non-value added operations.</td>
</tr>
<tr>
<td>Contractors</td>
<td>COBie business case analysis supports streamlining those activities that have non-value added operations.</td>
</tr>
<tr>
<td>Sub-Contractors</td>
<td>COBie business case analysis supports streamlining those activities that have non-value added operations.</td>
</tr>
<tr>
<td>Constituent</td>
<td>Coverage Analysis</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Constituent</td>
<td>Coverage Analysis</td>
</tr>
<tr>
<td>Fabricators</td>
<td>COBie business case analysis supports streamlining those activities that have non-value added operations.</td>
</tr>
<tr>
<td>Suppliers</td>
<td>COBie business case analysis supports streamlining those activities that have non-value added operations.</td>
</tr>
<tr>
<td>Manufacturers</td>
<td>COBie business case analysis supports streamlining those activities that have non-value added operations.</td>
</tr>
<tr>
<td>Commissioning Agents</td>
<td>COBie business case analysis supports streamlining those activities that have non-value added operations.</td>
</tr>
<tr>
<td>Facility Operators</td>
<td>Allows handover information to be imported prior to operating the facility.</td>
</tr>
<tr>
<td>Facility Managers</td>
<td>Allows handover information to be imported prior to managing the facility.</td>
</tr>
<tr>
<td>Asset Managers</td>
<td>Allows handover information to be imported prior to managing the facility’s assets.</td>
</tr>
<tr>
<td>Software Developers</td>
<td>Improved IFC specification, and support for IFC 4, assist those using IFC. Updated XML formats will decrease the cost of XML-based exchanges and use in web-services.</td>
</tr>
<tr>
<td>System Analysts</td>
<td>Improved IFC specification, and support for IFC 4, assist those using IFC. Updated XML formats will decrease the cost of XML-based exchanges and use in web-services.</td>
</tr>
<tr>
<td>Systems Integrators</td>
<td>Improved IFC specification, and support for IFC 4, assist those using IFC. Updated XML formats will decrease the cost of XML-based exchanges and use in web-services.</td>
</tr>
</tbody>
</table>

4.2.2. Normative References

Author’s Editorial Comment: This section updates the “Criteria Reference Standards (Other)” included in the COBie NBIMS-US™ V2 documentation, section A.8. New reference standards, Schematron and NIEM, were added to this document to reflect changes necessary for NBIMS-US™ V3. Based on the rules NBIMS-US™ V3 Technical Subcommittee Evaluation Criteria for Revised Information Exchange submissions, the information provided in this section should be considered a moderate change.

4.2.2.1 References and standards

4.2.2.1.1 Reference standards list

4.2.2.1.1.1 Industry Foundation Class (IFC) Model, Version 2x3

4.2.2.1.1.2 Industry Foundation Class (IFC) Model, Version 4 (ISO 16739)
4.2.2.1.1.3 Standard for Product Exchange (STEP) (ISO 10303)

ISO 10303-11, Industrial automation systems and integration — Product data representation and exchange — Part 11: description methods: The EXPRESS Language Reference Manual. This is the format of figures found in the referenced MVD.

ISO 10303-21, Industrial automation systems and integration — Product data representation and exchange — Part 21: Implementation methods: Clear text encoding of the exchange structure. This is typically referred to as the STEP Physical File Format.

ISO 10303-28, Industrial automation systems and integration — Product data representation and exchange — Part 28: Implementation methods: XML representations of EXPRESS schemas and data, using XML schemas. This is typically referred to as ifcXML.

4.2.2.1.1.4 Schematron (ISO/IEC 19757-3:2006)

Author’s Editorial Comment: The open source COBie Tool Kit has been since March 2012 the tool used to test files against the COBie format requirements. The rules used in the COBie Tool Kit, provided as an Annex to this standard, were developed and are maintained in Schematron format.

An international standard format for the development of testing rules for COBie files is based on ISO/IEC 19757-3:2006 Information technology -- Document Schema Definition Language (DSDL) -- Part 3: Rule-based validation – Schematron. Schematron is widely used and available from ISO free of charge. Schematron has proven easy to use since its rules are based on XML tree searching and uses the XPATH programming language.

The use of Schematron is optional. Any other testing tool may be used provided that those tools test their algorithms to equivalence with the Schematron rules provided in this standard and included in the COBie Tool Kit application.

4.2.2.1.1.5 National Information Exchange Model (NIEM), version 2.1

Author’s Editorial Comment: NBIMS-US™ V2 COBie 2.26 allows three alternative exchange formats. These formats are the STEP Physical File Format, the ifcXML format, and SpreadsheetML format. For the purposes of the COBie standard there is no difference between these formats. The format selection criterion has been left up to the interest of the market place. The most widely used of these three formats, to date, has been the SpreadsheetML format. SpreadsheetML is an XML schema reflecting the organization of spreadsheet data in Microsoft Excel 2003.

While the spreadsheet view of COBie data has been essential to COBie’s understanding and success to date, software vendors have expressed concern with the spreadsheet format. The first concern is that the SpreadsheetML schema is a semi-proprietary XML specification directly tied to Microsoft Excel 2003. Eventually such a format will be depreciated by Microsoft and NBIMS-US™ will have to select an alternate format. European users of COBie have also expressed concern since they are restricted and in some cases prohibited adopting proprietary data standards.

The second concern with the SpreadsheetML XML is the complexity of that schema. The structure of SpreadsheetML is closely tied to the structure of a spreadsheet. One issue with this spreadsheet-based structure is that the COBie in spreadsheet form is a “referential” schema rather than a “nested” schema. The “nested” approach is more likely to be used by software developers as it is more compact and requires less testing than the nested schema.
The third concern expressed by many software firms and system integrators has been a concern that buildingSMART standards based on STEP or the SpreadsheetML are inconsistent with streamlined XML schema used to support system-to-system direct web-service interfaces. Such a streamlined XML schema would also more readily support the development and adoption of sub-schema that could be used to spark a productivity revolution in the construction industry.

As a result of these concerns, the COBie project team developed an alternative XML schema to support a broader use of the facility asset information found in COBie files. The new XML schema format for COBie data, whose technical details are discussed in detail in later sections of this standard, is called COBieLite. An essential design criterion in the development of COBieLite was that COBieLite conform to existing, freely available, highly-visible, United States national XML schema standards. The National Information Exchange Model (NIEM) a United States Government standard was selected as the basis from which the COBieLite schema would be developed.

NIEM is a United States Government standard developed by the U.S. Department of Homeland Security and the U.S. Department of Justice. NIEM currently contains a variety of schemas used at the federal and state levels of United States government. Domains currently included in this schema that relate to the buildingSMART mission include justice, public safety, emergency and disaster management, and homeland security enterprises. Schemas for building interiors, such as those that could be provided through buildingSMART alliance® standards are not currently included in the NIEM catalogue; however, COBieLite will facilitate such a discussion and further the exchange of COBie data into communities that use information about facilities, not just those who design, build, and operate them.

4.2.2.1.2. (Not used)

4.2.2.1.2.1 OmniClass™ Construction Classification System

Author’s Editorial Comment: OmniClass™ has been used in COBie example files in lieu of using contract-specific or customer-specific classification systems.

The use of classification is required for the following COBie information: Contacts, Facility, Space, Type, and Zone. The specification of specific taxonomies must be specified by contract based on regional, local, or owner specification. From the point of view of the standard the selection of a classification system is, therefore arbitrary. Examples developed for COBie files have been developed using OmniClass taxonomy. Given that OmniClass has been used in COBie examples, the following OmniClass tables are referenced in this standard:

Table 11 – Construction Entities by Function

Table 13 – Spaces by Function

Table 21 – Work Results

Table 23 – Products

4.2.2.1.3 Referenced programs and projects

4.2.2.1.3.1 Specifiers’ Properties information exchange (SPie)

The objective of the SPIe project is to create set of product templates that can be used by manufacturers to export product data into an open-standard format consumed by designers, specifiers, builders, owners, and operators. This project extends manufacturers’ efforts in Building Information Modeling, e-marketplaces, and standard identification tagging and delivers value through the entire supply chain. For
more information on SPie please see http://www.nibs.org/?page=bsa_spie for more information on this project.

4.2.2.1.3.2 Operators’ Properties information exchange (OPie)

The objective of OPie was to identify properties needed by facility operators and maintenance technicians beyond those properties identified by the SPie project. This project was initiated by the U.S. Army Corps of Engineers, Construction Engineering Research Laboratory in 2011. During this project survey forms to validate information commonly used by U.S. Army Installation Command personnel working on military installations was created and distributed to the National Institute of Building Sciences, Facility Maintenance and Operations Committee for review. An insufficient number of responses (three partial responses) were received. The project was closed due to lack of industry interest. There not being a sponsor to move this project forward, an official buildingSMART alliance® project was never initialized.

Following 2012 conversations between Dr. East and members of the Norwegian government it may be possible that information being collected on operators properties in Norway could be used to validate the information gleaned from U.S. Army sources. At the time of this standard no further information is available on the OPie project.

4.2.2.1.3.3 Life-Cycle information exchange (LCie)

LCie is a refinement of the processes required to exchange complete or partial COBie data sets. While COBie is focused on the major contractual exchanges of complete model files, LCie is focused on the individual transactions needed to build those complete sets of COBie data. First proposed in East 2010, LCie has been further developed since that time and is now the basis for the process models found in this standard. An additional NBIMS-US™ V3 standard defining the product supply chain, developed from the LCie project, is expected to be submitted. Additional information about the LCie project may be found here: http://www.nibs.org/?page=bsa_lcie.

4.2.2.1.3.4 Heating, Ventilating, and Air Conditioning information exchange (HVACie)

To model a complete building system more than COBie information is required. At the time of the COBie NBIMS-US™ V2 submission it was proposed by the author that a generic Equipment Layout information exchange (ELie) project would be sufficient for this purpose. Further investigation revealed that domain-specific versions of ELie would be needed to implement domain-specific business rules governing each system. As a result, the ELie project was depreciated in 2011 and a series of new projects was undertaken by the U.S. Army, Corps of Engineers, Engineer Research and Development Center.

A system model must describe the complete set of components that make up those systems, the assemblies of those components, such as chillers and electrical distribution boards, and the logical (systems, zones, circuits) and physical connections (feeders, piping, ductwork) that allow those systems to perform their function. The geometry of the system is also critical to understanding their function so full geometry is also required. The format for the proposed IFC MVD must be IFC. A subset of the system model that contains scheduled assets can be represented in COBie.

The first demonstration of the HVACie format was held at the buildingSMART alliance® January 2013 Challenge event. More information on this specific project may be found here: http://www.nibs.org/?page=bsa_hvacie.

4.2.2.1.3.5 Electrical System information exchange (SPARKie)

To model a complete building system more than COBie information is required. At the time of the COBie NBIMS-US™ V2 submission it was proposed by the author that a generic Equipment Layout information exchange
exchange (ELie) project would be sufficient for this purpose. Further investigation revealed that domain-specific versions of ELie would be needed to implement domain-specific business rules governing each system. As a result, the ELie project was depreciated in 2011 and a series of new projects was undertaken by the U.S. Army, Corps of Engineers, Engineer Research and Development Center.

A system model must describe the complete set of components that make up those systems, the assemblies of those components, such as chillers and electrical distribution boards, and the logical (systems, zones, circuits) and physical connections (feeders, piping, ductwork) that allow those systems to perform their function. The geometry of the system is also critical to understanding their function so full geometry is also required. The format for the proposed IFC MVD must be IFC. A subset of the system model that contains scheduled assets can be represented in COBie. More information on this specific project may be found here: http://www.nibs.org/?page=bsa_sparkie.

4.2.2.1.3.6 Water System information exchange (WSie)

To model a complete building system more than COBie information is required. At the time of the COBie NBIMS-US™ V2 submission it was proposed by the author that a generic Equipment Layout information exchange (ELie) project would be sufficient for this purpose. Further investigation revealed that domain-specific versions of ELie would be needed to implement domain-specific business rules governing each system. As a result, the ELie project was depreciated in 2011 and a series of new projects was undertaken by the U.S. Army, Corps of Engineers, Engineer Research and Development Center.

A system model must describe the complete set of components that make up those systems, the assemblies of those components, such as chillers and electrical distribution boards, and the logical (systems, zones, circuits) and physical connections (feeders, piping, ductwork) that allow those systems to perform their function. The geometry of the system is also critical to understanding their function so full geometry is also required. The format for the proposed IFC MVD must be IFC. A subset of the system model that contains scheduled assets can be represented in COBie. More information on this specific project may be found here: http://www.nibs.org/?page=bsa_wsie.

4.2.2.1.3.7 Building Automation Management information exchange (BAMie)

To model a complete building system more than COBie information is required. At the time of the COBie NBIMS-US™ V2 submission it was proposed by the author that a generic Equipment Layout information exchange (ELie) project would be sufficient for this purpose. Further investigation revealed that domain-specific versions of ELie would be needed to implement domain-specific business rules governing each system. As a result, the ELie project was depreciated in 2011 and a series of new projects was undertaken by the U.S. Army, Corps of Engineers, Engineer Research and Development Center.

A system model must describe the complete set of components that make up those systems, the assemblies of those components, such as chillers and electrical distribution boards, and the logical (systems, zones, circuits) and physical connections (feeders, piping, ductwork) that allow those systems to perform their function. The geometry of the system is also critical to understanding their function so full geometry is also required. The format for the proposed IFC MVD must be IFC. A subset of the system model that contains scheduled assets can be represented in COBie. More information on this specific project may be found here: http://www.nibs.org/?page=bsa_bamie.

4.2.2.1.3.8 Building Programming information exchange (BPie)

There have been several buildingSMART and related projects aimed at the capture of architectural programming information to support both the architectural programming effort, delivery of standard Request for Proposal documents to more clearly communicate owners’ requirements, and to perform the automated assessment of spatial compliance of later design documents. These projects include the
Portfolio and Asset management – Performance Requirements (PAMPeR), International Alliance for Interoperability's AR-5 Project, the buildingSMART international Room Data Sheet 'aquarium' project, the United States General Services Administration project, the buildingSMART Spatial Compliance information exchange (SCie, pronounced 'ski') project, and a new Norwegian effort whose aims are similar to the projects above. While each of these projects have explored some aspects of the contracted information exchanges needed to create an open standard for architectural programming, none of these projects have achieved a critical mass to be recognized as national standards and be widely implemented internationally. The objective of the BPie project is to develop a consolidated international specification for the contracted delivery of architectural programming information by the evaluation and consolidation of previous project results.

Of critical concern to those attempting to use contracted information exchanges is the need to repeat the results of testing conducted under controlled conditions. This requires the precise specification of both data format and content constraints. In addition, common test models must be used in the context of automated testing programs. Finally, software companies shall be required to provide native versions of test models, configuration guides, and usage instructions to ensure repeatability by those not directly participating in these efforts.

The first demonstration of the BPie format was conducted in January 2013 at the buildingSMART alliance® Challenge. At this event BPie information was exported using the COBie SpreadsheetML format. More information on this project may be found here: http://www.nibs.org/?page=bsa_bpie.

4.2.3 Terms and definitions

Author’s Editorial Comment: The listing of terms and definitions was not required in NBIMS-US™ V2 submissions. The information provided here reflects the compilation of the terms and definitions found in NBIMS-US™ V2 as updated for the current COBie version. Based on the rules NBIMS-US™ V3 Technical Subcommittee Evaluation Criteria for Revised Information Exchange submissions, the information provided in this section should be considered a moderate change.

4.2.3.1 Normative terms and definitions

The following terms and definitions are the applicable terms derived from the Industry Foundation Class Model View Definition. These terms are listed in alphabetical order.

4.2.3.1.1 actor
person, an organization, or person acting on behalf of an organization. A specialization of the general term object. See COBie contact.

4.2.3.1.2 attribute
unit of information within an entity, defined by a particular type or reference to a particular entity. There are three kinds of attributes: direct attributes, inverse attributes and derived attributes. See COBie attribute.

4.2.3.1.3 building
a building represents a structure that provides shelter for its occupants or contents and stands in one place. The building is also used to provide a basic element within the spatial structure hierarchy for the components of a building project (together with site, story, and space). See COBie facility.
4.2.3.1.4 building story
The building story has an elevation and typically represents a (nearly) horizontal aggregation of spaces that are vertically bound. See COBie floor.

4.2.3.1.5 constraints on attributes
data type restricting the values of attributes. The most general constraint is about the existence of attribute values. There are basically two types: mandatory and optional attributes. Values of mandatory attributes must be provided whereas values of optional attributes may be omitted. For aggregation data types such as Set, List, or Array, the existence constraint is often refined by a minimal and maximal number of elements, which is also known as cardinality.

4.2.3.1.6 derived attribute
unit of information computed from other attributes using an expression defined in the schema.

4.2.3.1.7 direct attribute
scalar values or collections including Set (unordered, unique), List (ordered), or Array (ordered, sparse) as defined in [ISO 10303-11] Similar to the term "field" in common programming languages.

4.2.3.1.8 element
tangible physical product that can be described by its shape representation, material representations, and other properties. A specialization of the general term product. See COBie.Component.

4.2.3.1.9 element occurrence
element's position within the project coordinate system and its containment within the spatial structure.

4.2.3.1.10 entity
class of information defined by common attributes and constraints as defined in [ISO 10303-11]. Similar to the term "class" in common programming languages but describing data structure only (not behavior such as methods).

4.2.3.1.11 enumeration
construct that allows an attribute value to be one of multiple predefined values identified by name. Similar to the "Enumeration" construct as defined in [ISO 10303-11]. Similar in concept to "enum" in common programming languages.

4.2.3.1.12 external reference
link to information outside the data set, with direct relevance to the specific information the link originates from inside the data set.

4.2.3.1.13 feature
parametric information and additional property information modifying the shape representation of an element to which it applies.

4.2.3.1.14 group

4.2.3.1.15
identification
capability to find, retrieves, report, change, or delete specific instances without ambiguity.

4.2.3.1.16
instance
occurrence of an entity. Similar to the term "instance of a class" in object oriented programming.

4.2.3.1.17
inverse attribute
unit of information defining queries for obtaining related data and enforcing referential integrity. Similar to the term "navigation property" in entity-relational programming frameworks.

4.2.3.1.18
library
catalogue, database or holder of data, that is relevant to information in the data set. It is information referenced from an external source that is not copied into the data set.

4.2.3.1.19
object
anything perceivable or conceivable that has a distinct existence, albeit not material.

4.2.3.1.20
object occurrence
characteristics of an object as an individual. Similar to "object", "instance", "individual," “component" in other publications.

4.2.3.1.21
object types
common characteristics shared by multiple object-occurrences. Similar to "class", "template", and "type" in other publications.

4.2.3.1.22
process
object-occurrence located in time, indicating "when". See COBie job.

4.2.3.1.23
process occurrence
conceptual object that may occur at a particular time.

4.2.3.1.24
process type
common characteristics shared by multiple process occurrences.

4.2.3.1.25
product
physical or conceptual object that occurs in space. It is specialization of the general term object. See COBie.Component.

4.2.3.1.26
product occurrence
physical or conceptual object that may have a location in space and shape characteristics.
4.2.3.1.27
**product type**
common characteristics shared by multiple product occurrences. See COBie.Type.

4.2.3.1.28
**project**
encapsulation of related information for a particular purpose providing context for information contained within. Context information may include default measurement units or representation context and precision.

4.2.3.1.29
**property**
unit of information that is dynamically defined as a particular entity instance. Similar to "late-bound" or "run-time" in programming terminology. See COBie.Attribute.

4.2.3.1.30
**property occurrence**
unit of information providing a value for a property identified by name.

4.2.3.1.31
**property template**
metadata for a property including name, description, and data type. Similar in concept to "extension property" in common programming languages.

4.2.3.1.32
**property set occurrence**
unit of information containing a set of property occurrences, each having a unique name within the property set.

4.2.3.1.33
**property set template**
set of property templates serving a common purpose and having applicability to objects of a particular entity. Similar in concept to "extension class" in common programming languages.

4.2.3.1.34
**proxy**
object that does not hold a specific object type information. A specialization of object occurrence.

4.2.3.1.35
**quantity**
measurement of a scope-based metric, specifically length, area, volume, weight, count, or time.

4.2.3.1.36
**quantity occurrence**
unit of information providing a value for a quantity.

4.2.3.1.37
**quantity set**
unit of information containing a set of quantity occurrences, each having a unique name within the quantity set.

4.2.3.1.38
**relationship**
unit of information describing an interaction between items.
4.2.3.1.39
representation
unit of information describing how an object is displayed, such as physical shape or topology.

4.2.3.1.40
resource
entity with limited availability such as materials, labor, or equipment. A specialization of the general term object. The "resource definition data schemas" section is unrelated to this concept. See COBie resource.

4.2.3.1.41
resource occurrence
entity with inherent financial cost, which may be passed onto processes, products, and controls to which it is assigned.

4.2.3.1.42
resource type
common characteristics shared by multiple resource occurrences.

4.2.3.1.43
select
construct that allows an attribute value to be one of multiple types or entities. Similar to the "Select" construct as defined in [ISO 10303-11]. Similar to a "marker interface" in common programming languages.

4.2.3.1.44
space
area or volume bounded actually or theoretically. See COBie space.

4.2.3.1.45
system
organized combination of related parts within an AEC product, composed for a common purpose or function or to provide a service. System is essentially a functionally related aggregation of products. See COBie system.

4.2.3.1.46
transaction
a discrete exchange of specific a defined subset of a larger information exchange specification.

4.2.3.1.47
type
basic information construct derived from a primitive, an enumeration, or a select of entities. Similar to the "Type" construct as defined in [ISO 10303-11]. Similar in concept to "typedef" or "value type" in common programming languages. See COBie type.

4.2.3.1.48
zone
a zone is a group of spaces, partial spaces or other zones. See COBie zone.

4.2.3.2 Informative terms and definitions

The terms and definitions below list column headings and common terms found in the COBie spreadsheet implementation format.
4.2.3.2.1 Common COBie spreadsheet terms and definitions

There are two sets of information present in each worksheet in a COBie spreadsheet. These are author information and originating system information. Author information allows those producing a specific COBie data set to identify if they, or someone before, created or changed the information provided. Author information is mandatory on all COBie data rows. Author information is comprised of:

4.2.3.2.1.1 CreatedBy
the contact email of the person or company creating or updating a row of COBie data.

4.2.3.2.1.2 CreatedOn
the date on which the information provided in a row of COBie data was created or updated by the person or company identified in the created by field. Originating system information is information that allows COBie a row of COBie data to be referenced back to the computer software that initially generated that information. If supported by the computer software, this information allows COBie data to be synchronized with the originating computer software. Originating system information is only required if the information provided in a given row of COBie data was produced through computer software. Originating System information is comprised of:

4.2.3.2.1.3 ExternalSystem
the name of the computer system generating the row of COBie data.

4.2.3.2.1.4 ExternalObject
the name of the data object within the computer system that holds the data provided in a given row of COBie data. The default values for external object are the associated IFC entities that are mapped (and those that are excluded) when transforming IFC data to a given row of COBie data.

4.2.3.2.1.5 ExternalIdentifier
the unique identifier of the identified external object that would allow COBie data to be matched back to the data from which it was developed in the named external system.

4.2.3.2.2 Specific COBie spreadsheet terms and definitions

The following terms and definitions are provided in the order that the COBie worksheets are presented in the COBie spreadsheet form. Common author and Originating system information, described above, are excluded.

4.2.3.2.2.1 contact
A worksheet in the COBie spreadsheet. Each row in the Contact worksheet identifies a person or company referenced elsewhere in a COBie spreadsheet. Contact.Email is the primary key for this worksheet.

4.2.3.2.2.2 Contact.Email
A well-formed email address used to identify this specific Contact.

4.2.3.2.2.3 Contact.Category
the category of business in which the specific Contact is engaged. If allowable values are not specified by contract, the default value for this information is the current OmniClass Table 34.

4.2.3.2.2.4
Contact.Company
the name of the company for the Contact.

4.2.3.2.2.5
Contact.Phone
the telephone number for the Contact.

4.2.3.2.2.6
Contact.Department
the name of the department for the Contact.

4.2.3.2.2.7
Contact.OrganizationCode
the organizational code for the Contact.

4.2.3.2.2.8
Contact.GivenName
if the Contact is a person, the given name of the Contact

4.2.3.2.2.9
Contact.FamilyName
the Contact is a person, the family name of the Contact

4.2.3.2.2.10
Contact.Street
the street address for the Contact.

4.2.3.2.2.11
Contact.PostalBox
the postal box address for the Contact.

4.2.3.2.2.12
Contact.Town
the city or town address for the Contact.

4.2.3.2.2.13
Contact.StateRegion
the state or regional address for the Contact.

4.2.3.2.2.14
Contact.PostalCode
the zip, or postal code, address for the Contact.

4.2.3.2.2.15
Contact.Country
the country for the Contact.

4.2.3.2.2.16
Facility
a worksheet in the COBie spreadsheet. There may only be one row in the facility worksheet. Projects composed of multiple facilities, shall be described by separate COBie spreadsheets. Facility.Name is the primary key for this worksheet.
4.2.3.2.2.17
Facility.Name
the name of the Facility as it appears on design drawings, or as otherwise specified by contract.

4.2.3.2.2.18
Facility.Category
the category of facility described by the COBie data set. If allowable values are not specified by contract, the default value for this information is the current OmniClass Table 11.

4.2.3.2.2.19
Facility.ProjectName
the name of the Project as it appears on design drawings, or as otherwise specified by contract.

4.2.3.2.2.20
Facility.SiteName
the name of the Site as it appears on design drawings, or as otherwise specified by contract.

4.2.3.2.2.21
Facility.LinearUnits
the associated unit of measurement applied to all COBie information other than that found in the Attribute and Impact worksheets.

4.2.3.2.2.22
Facility.AreaUnits
the associated unit of measurement applied to all COBie information other than that found in the Attribute and Impact worksheets.

4.2.3.2.2.23
Facility.VolumeUnits
the associated unit of measurement applied to all COBie information other than that found in the Attribute and Impact worksheets.

4.2.3.2.2.24
Facility.CurrencyUnit
the associated unit of measurement applied to all COBie information other than that found in the Attribute and Impact worksheets.

4.2.3.2.2.25
Facility.AreaMeasurement
the associated measurement method used to calculate spatial are measurement applied to all COBie information other than that found in the Attribute worksheet.

4.2.3.2.2.26
Facility.ExternalSiteObject
for information originating in IFC models this information is an additional object identifier, allowing information about this Facility to be referenced back to the computer software that initially generated that information.

4.2.3.2.2.27
Facility.ExternalSiteIdentifier
for information originating in IFC models this information is an additional object identifier, allowing information about this Facility to be referenced back to the computer software that initially generated that information.
4.2.3.2.28
Facility.ExternalFacilityObject
for information originating in IFC models this information is an additional object identifier, allowing information about this Facility to be referenced back to the computer software that initially generated that information.

4.2.3.2.29
Facility.ExternalFacilityIdentifier
for information originating in IFC models this information is an additional object identifier, allowing information about this Facility to be referenced back to the computer software that initially generated that information.

4.2.3.2.30
Facility.Description
a general text description of the facility.

4.2.3.2.31
Facility.ProjectDescription
a general text description of the project.

4.2.3.2.32
Facility.SiteDescription
a general text description of the site.

4.2.3.2.33
Facility.Phase
the designation of the phase of the project reflected in a given COBie data set.

4.2.3.2.34
Floor
a worksheet in the COBie spreadsheet. Floors are the vertical levels of a vertical facility. Geographic areas, such as a facility’s site, may also be identified on the floor worksheet. Floor.Name is the primary key for this worksheet.

4.2.3.2.35
Floor.Name
the name of the floor as it appears on other contract documents, such as design drawings.

4.2.3.2.36
Floor.Category
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Floor”, “Roof”, and “Site”.

4.2.3.2.37
Floor.Description
a general text description of the floor.

4.2.3.2.38
Floor.Elevation
elevation at the top of the floor structure. If allowable values are not specified by contract, the default value is measured as a relative value compared to the facilities datum.

4.2.3.2.39
Floor.Height
distance between top of floor structure to bottom of structure above. Typically applicable to rows having the Floor.Category of “Floor”.

4.2.3.2.2.40
**Space**
a worksheet in the COBie spreadsheet. Spaces are the horizontal decomposition of floors into areas which have common functional purpose and user. Vertically, spaces run from top of floor to bottom of slab above. Occupied space runs to bottom of the ceiling as expressed by Space.UsableHeight. Large Spaces which have more than a single functional purpose or user may be separated into individual spaces. Spaces may also be used on floors of type “Roof” or “Site” to identify spatial regions outside a facility enclosure. Space.Name is the primary key for this worksheet.

4.2.3.2.2.41
**Space.Name**
the Space.Name must match the value found on design drawings at the equivalent project stage of the current deliverable.

4.2.3.2.2.42
**Space.Category**
the category of space described by the COBie data set. If allowable values are not specified by contract, the default value for this information is the current OmniClass Table 13.

4.2.3.2.2.43
**Space.FloorName**
a foreign key identifying the COBie.Floor.Name.

4.2.3.2.2.44
**Space.Description**
the description of the space found on design drawings at the equivalent project stage of the current deliverable.

4.2.3.2.2.45
**Space.RoomTag**
signage provided for each space. Signage applied to doors, if different, is identified as Attribute records related to each applicable door. The information here is equivalent to that found in construction signage submittals.

4.2.3.2.2.46
**Space.UsableHeight**
distance from top of finished floor to bottom of ceiling. If there is no ceiling then this value must match Floor.Height.

4.2.3.2.2.47
**Space.GrossArea**
total space area as specified in the design contract and calculated by the identified Facility.AreaMeasurement.

4.2.3.2.2.48
**Space.NetArea**
usable space areas as specified in the design contract and calculated by the identified Facility.AreaMeasurement

4.2.3.2.2.49
**Zone**
a worksheet in the COBie spreadsheet. Zones are aggregations of spaces that provide some common purpose. Zone.Name, Zone.Category, and Zone.SpaceName provide the compound key for this worksheet.

4.2.3.2.2.50
Zone.Name
the name of the specific function performed by a group of spaces within a given

4.2.3.2.2.51
Zone.Category
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: "Circulation Zone", "Lighting Zone", "Fire Alarm Zone", "Historical Preservation Zone", "Occupancy Zone", and "Ventilation Zone".

4.2.3.2.2.52
Zone.SpaceNames
a foreign key identifying the COBie.Space.Name. The plural designation of “SpaceNames” indicating use of a delimited list of Space.Name values is depreciated in COBie version 2.4.

4.2.3.2.2.53
Zone.Description
a general text description of the zone.

4.2.3.2.2.54
Type
a worksheet in the COBie spreadsheet. Types are the different products and equipment to be installed in the facility. Type.Name is the primary key for this worksheet.

4.2.3.2.2.55
Type.Name
the Type.Name must match the value found on design drawing schedules at the equivalent project stage of the current deliverable.

4.2.3.2.2.56
Type.Category Type
the category of type described by the COBie data set. If allowable values are not specified by contract, the default value for this information is the current OmniClass Table 23.

4.2.3.2.2.57
Type.Description
a general text description of the type. If description is present on design drawings schedules, this value must match.

4.2.3.2.2.58
Type.Asset
A classification of the asset within one row. If allowable values are not specified by contract, the default values are: “Fixed” and “Movable”.

4.2.3.2.2.59
Type.Manufacturer
during construction and handover phase: the Contact.Email of the installed product. During planning and design phase: not applicable.

4.2.3.2.2.60
Type.ModelNumber
during construction and handover phase: the manufacture’s model number of the installed product. During planning and design phase: not applicable.

4.2.3.2.2.61
**Type.WarrantyGuarantorParts**
during construction and handover phase: the Contact.Email of the party, or parties, responsible for replacement parts during the warranty period. During planning and design phase: not applicable.

4.2.3.2.2.62
**Type.WarrantyDurationParts**
during construction and handover phase: the length of the warranty period for replacement parts provided by the product manufacturer. During planning and design phase: not applicable.

4.2.3.2.2.63
**Type.WarrantyGuarantorLabor**
during construction and handover phase: the Contact.Email of the party, or parties, responsible for labor costs during the warranty period. Typically the same as Type.WarrantyGuarantorParts. During planning and design phase: not applicable.

4.2.3.2.2.64
**Type.WarrantyDurationLabor**
during construction and handover phase: the length of the warranty period for labor repairs provided by the product manufacturer. Typically the same as Type.WarrantyDurationParts. During planning and design phase: not applicable.

4.2.3.2.2.65
**Type.WarrantyDurationUnit**
the identification of the unit of measure associated with values found in Type.WarrantyDurationParts and Type.WarrantyDurationLabor. If allowable values are not specified by contract, the default values are: “month” and “year”.

4.2.3.2.2.66
**Type.ReplacementCost**
during construction and handover phase: The manufacture’s suggested retail price for this type. During planning and design phase: not applicable.

4.2.3.2.2.67
**Type.ExpectedLife**
during handover phase: the expected service life of the product type given the level of service within the facility. During planning, design, and construction phase: left blank unless conducting total cost of ownership studies.

4.2.3.2.2.68
**Type.DurationUnit**
the identification of the unit of measure associated with value found in Type.ExpectedLife. If allowable values are not specified by contract, the default values are: “month” and “year”.

4.2.3.2.2.69
**Type.Warranty**
description a general text description of the warranty.

4.2.3.2.2.70
**Type.NominalLength**
an approximate measure of the bounding box surrounding the product type.
4.2.3.2.71
Type. NominalWidth
an approximate measure of the bounding box surrounding the product type.

4.2.3.2.72
Type.NominalHeight
an approximate measure of the bounding box surrounding the product type.

4.2.3.2.73
Type.ModelReference
during construction and handover phase: the manufacturer’s catalog or reference resource, such as
website, where information about the installed product type may be found. During planning and design
phase: not applicable.

4.2.3.2.74
Type.Shape
during planning and design phase: specific constraints that should be/have been considered during the
specification process. During construction and handover phase: the text description of associated
information found on a product manufacturer’s product data sheet.

4.2.3.2.75
Type.Size
during planning and design phase: specific constraints that should be/have been considered during the
specification process. During construction and handover phase: the text description of associated
information found on a product manufacturer’s product data sheet.

4.2.3.2.76
Type.Color
during planning and design phase: specific constraints that should be/have been considered during the
specification process. During construction and handover phase: the text description of associated
information found on a product manufacturer’s product data sheet.

4.2.3.2.77
Type.Finish
during planning and design phase: specific constraints that should be/have been considered during the
specification process. During construction and handover phase: the text description of associated
information found on a product manufacturer’s product data sheet.

4.2.3.2.78
Type.Grade
during planning and design phase: specific constraints that should be/have been considered during the
specification process. During construction and handover phase: the text description of associated
information found on a product manufacturer’s product data sheet.

4.2.3.2.79
Type.Material
during planning and design phase: specific constraints that should be/have been considered during the
specification process. During construction and handover phase: the text description of associated
information found on a product manufacturer’s product data sheet.

4.2.3.2.80
Type.Constituents
during planning and design phase: specific constraints that should be/have been considered during the
specification process. During construction and handover phase: the text description of associated
information found on a product manufacturer’s product data sheet.
4.2.3.2.81
**Type.Features**
during planning and design phase: specific constraints that should be/have been considered during the specification process. During construction and handover phase: the text description of associated information found on a product manufacturers product data sheet.

4.2.3.2.82
**Type.AccessibilityPerformance**
during planning and design phase: specific constraints that should be/have been considered during the specification process. During construction and handover phase: the text description of associated information found on a product manufacturers product data sheet.

4.2.3.2.83
**Type.CodePerformance**
during planning and design phase: specific constraints that should be/have been considered during the specification process. During construction and handover phase: the text description of associated information found on a product manufacturers product data sheet.

4.2.3.2.84
**Type.SustainabilityPerformance**
during planning and design phase: specific constraints that should be/have been considered during the specification process. During construction and handover phase: the text description of associated information found on a product manufacturers product data sheet.

4.2.3.2.85
**Component**
a worksheet in the COBie spreadsheet. Components are the individual instances of the products identified by Type. Component.Name is the primary key for this table.

4.2.3.2.86
**Component.Name**
the Component.Name must match the value found on design drawing schedules at the equivalent project stage of the current deliverable. For equipment scheduled by Type (and not Component) naming requirements to ensure unique names for every component shall be specified by contract.

4.2.3.2.87
**Component.TypeName**
a foreign key identifying the COBie.Type.Name.

4.2.3.2.88
**Component.Space**
a foreign key identifying the COBie.Space.Name. For components not contained in a single space, the value shall refer to the space from which the equipment is most likely to be maintained.

4.2.3.2.89
**Component.Description**
a general text description of the component.

4.2.3.2.90
**Component.SerialNumber**
the serial number of the installed equipment. Component.SerialNumber must match the value found on installed equipment nameplates. During planning and design phase: not applicable.

4.2.3.2.91
Component.InstallationDate
the date on which the product or equipment was placed in its final location. During planning and design phase: not applicable.

Component.WarrantyStartDate
the date on which the product or equipment was first powered. During planning and design phase: not applicable.

Component.TagNumber
if a tag is required to be affixed to the product or equipment during construction, this value is the designation for this product or equipment found on the associated tag. During planning and design phase: not applicable. During planning and design phase: not applicable.

Component.BarCode
the bar code found on the installed product name plate. During planning and design phase: not applicable.

Component.AssetIdentifier
an alternative identifier for the specific component to be used as defined by associated contract.

System
a worksheet in the COBie spreadsheet. Systems are aggregations of components that provide some common function. System.Name, System.Category, and System.ComponentNames provide the compound key for this worksheet.

System.Name
the name of the specific function performed by a group of components within a given System.Category.

System.Category
the category of the system described by the COBie data set. If allowable values are not specified by contract, the default value for this information is the current OmniClass Table 21.

System.ComponentNames
a foreign key identifying the COBie.Component.Name. The plural designation of “ComponentNames” indicating use of a delimited list of Component.Name values is depreciated in COBie version 2.4 in favor of the use of a single row for each System.Component.

System.Description
a general text description of the system.

Assembly
a worksheet in the COBie spreadsheet. Assemblies are types (or components) that contain other types or (components). Assembly.Name is the primary key for this table.
the name of the assembly identifies a type or component that owns or encloses other types or components.

4.2.3.2.2.102
AssemblySheetName
specifies references in this row as pertaining to COBie data in either the “Type” or “Component” worksheet.

4.2.3.2.2.103
AssemblyParentName
identifies the the COBie.Type.Name or COBie.Component.Name of the object enclosing Assembly.ChildNames.

4.2.3.2.2.104
AssemblyChildNames
identifies the COBie.Type.Name or COBie.Component.Name of the objects owned or enclosed by the Assembly.ParentName.

4.2.3.2.2.105
AssemblyAssemblyType
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Fixed”, “Optional”, “Included”, “Excluded”, “Layer”, “Patch”, and “Mix”.

4.2.3.2.2.106
AssemblyDescription
a general text description of the assembly.

4.2.3.2.2.107
Connection
a worksheet in the COBie spreadsheet. Connections describe the logic connections between COBie data in either the “Type” or “Component” worksheet. Connection.Name is the primary key for this table.

4.2.3.2.2.108
ConnectionRowName1
the name of the connection between the two parts identified a COBie data row.

4.2.3.2.2.109
ConnectionConnectionType
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Control”, “Flow”, “Return”, “Supply”, and “Structural”.

4.2.3.2.2.110
ConnectionSheetName
specifies references in this row as pertaining to COBie data in either the “Type” or “Component” worksheet.

4.2.3.2.2.111
ConnectionRowName1
a foreign key identifying the upstream COBie.Type.Name or COBie.Component.Name.

4.2.3.2.2.112
ConnectionRowName2
a foreign key identifying the downstream COBie.Type.Name or COBie.Component.Name.
Connection.RealizingElement
the object, if appropriate, that creates the connection.

4.2.3.2.2.114
Connection.PortName1
the name of the output connection port on Connection.RowName1

4.2.3.2.2.115
Connection.PortName2
the name of the input connection port on Connection.RowName2

4.2.3.2.2.116
Connection.Description
a general text description of the connection

4.2.3.2.2.117
Spare
a worksheet in the COBie spreadsheet. Spare records identify the on-site spare parts, replacement parts, and lubricants needed to maintain the facility. Spare.Name and Spare.TypeName form the compound key for this worksheet.

4.2.3.2.2.118
Spare.Name
the name of the item.

4.2.3.2.2.119
Spare.Category
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Part”, “PartSet”, “Lubricant”, “Other”, “Spare”, and “SpareSet”.

4.2.3.2.2.120
Spare.TypeName
a foreign key identifying the COBie.Type.Name.

4.2.3.2.2.121
Spare.Suppliers
a foreign key identifying the COBie.Contact.Name of the companies supplying spare parts.

4.2.3.2.2.122
Spare.Description
a general text description of the spare.

4.2.3.2.2.123
Spare.SetNumber
a general text description, if applicable, identifying the manufacturer’s spare part set number.

4.2.3.2.2.124
Spare.PartNumber
a general text description, if applicable, identifying the manufacturer’s spare part number.

4.2.3.2.2.125
Resource
a worksheet in the COBie spreadsheet. Resource records identify the tools, materials, and training needed to maintain the facility. Resource.Name is the primary key for this table.
4.2.3.2.2.126
Resource.Name
the name of the resource that is required to be used on the project. This resource may be shared across multiple Jobs.

4.2.3.2.2.127
Resource.Category
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Labor”, “Material”, “Tools”, and “Training”.

4.2.3.2.2.128
Resource.Description
a general text description of the resource.

4.2.3.2.2.129
Job
a worksheet in the COBie spreadsheet. Job records identify the variety of work that is required to operate, maintain, startup, shutdown, troubleshoot a given COBie.Type. Job.Name, Job.TypeName, and Job.TaskNumber create the compound key for this worksheet.

4.2.3.2.2.130
Job.Name
the name of the job

4.2.3.2.2.131
Job.Category

4.2.3.2.2.132
Job.Status
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Not Yet Started”, “Started”, and “Completed”.

4.2.3.2.2.133
Job.TypeName
a foreign key identifying the COBie.Type.Name.

4.2.3.2.2.134
Job.Description
a general text description of the job. There are typically three uses of this field. First, the Job.Description may contain a general description of the job, with all steps outlined in an associated document. Second, the Job.Description may contain the complete set of all numbered steps. To assist CMMS/CAFM vendors these steps should be delimited with a semicolon. Finally the Job.Description may contain one of several linked steps using the Job.TaskNumber and Job.Priors.

4.2.3.2.2.135
Job.Duration
length of time required to perform the job.

4.2.3.2.2.136
Job.DurationUnit
unit of time associated with Job.Duration.
4.2.3.2.137
Job.Start
the length of time, from the delivery of the COBie data set when the next occurrence of the Job should take place.

4.2.3.2.138
Job.TaskStartUnit
the unit of time associated with Job.Start.

4.2.3.2.139
Job.Frequency
the length of time between each service period

4.2.3.2.140
Job.FrequencyUnit
the unit of time associated with Job.Frequency.

4.2.3.2.141
Job.TaskNumber
if Job.Description contains a series of individual operations, this is the identification nonzero integers used to reference each step. Job.TaskNumber becomes the third part of the compound key, if Job.Description contains a series of individual operations; otherwise it is ignored. The first Job.Description in the series shall have a value of “0” and provide the general information about the job whose tasks follow.

4.2.3.2.142
Job.Priors
if Job.Description contains a series of individual operations, this is a comma delimited list of the Job.TaskNumber for all prior jobs. The first Job.Description in the series shall have a value of “0”.

4.2.3.2.143
Job.ResourceNames
a comma delimited list of foreign keys containing Resource.Name values.

4.2.3.2.144
Impact
a worksheet in the COBie spreadsheet. Impact records identify the health, safety, economic, or environmental impacts related to the assets found in the facility. Impact.Name is the primary key of this worksheet.

4.2.3.2.145
Impact.Name
the name of the impact.

4.2.3.2.146
Impact.ImpactType
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Cost”, “ClimateChange”, “PrimaryEnergyConsumption”

4.2.3.2.147
Impact.ImpactStage
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Production”, “Installation”, “Maintenance”, “Replacement”, “Use”, and “Reuse”.

4.2.3.2.148
Impact.ImpactStage  
a classification of the life cycle stage of information contained within one row. If allowable values are not specified by contract, the default values are: “Production”, “Installation”, “Maintenance”, “Replacement”, “Use”, and “Reuse”.

4.2.3.2.2.149  
Impact.SheetName  
specifies a required reference to COBie data in any other COBie worksheet.

4.2.3.2.2.150  
Impact.RowName  
a foreign key identifying the row in the associated Impact.SheetName.

4.2.3.2.2.151  
Impact.Value  
a quantification of the impact described in a given row.

4.2.3.2.2.152  
Impact.ImpactUnit  
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “currency”, “kgCO2e”, “MJ”, “other”, or “n/a”.

4.2.3.2.2.153  
Impact.LeadInTime  
a description of the length of time before the impact is expected.

4.2.3.2.2.154  
Impact.Duration  
a description of the length of time over which the impact occurs.

4.2.3.2.2.155  
Impact.LeadOutTime  
a description of the length of time after the impact before the cycle resumes.

4.2.3.2.2.156  
Impact.Description  
a general text description of the impact.

4.2.3.2.2.157  
Document  

4.2.3.2.2.158  
Document.Name  
the name of the document.

4.2.3.2.2.159  
Document.Category  
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Preconstruction Submittals”, “Shop Drawings”, “Product Data”, “Samples”, “Design Data”, “Test Reports”, “Certificates”, “Manufacturer Instructions”, “Manufacturer Field Reports”, “Operation and Maintenance”, “Closeout Submittals”, “Contract Drawings”, “Design Review

4.2.3.2.160 Document.ApprovalBy
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Owner Approval”, “Contractor Certified”, and “Information Only”.

4.2.3.2.161 Document.Stage
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “As Built”, “Submitted”, “Approved”, “Exact Requirement”, “Maximum Requirement”, “Minimum Requirement”, and “Requirement”.

4.2.3.2.162 Document.SheetName
specifies references in this row as pertaining to COBie data in any other COBie worksheet.

4.2.3.2.163 Document.RowName
a foreign key identifying the row in the associated Document.SheetName.

4.2.3.2.164 Document.Directory
the path name to the file. If COBie is delivered on a portable media the directory should be the relative path name from the COBie file to the referenced document. If the COBie file references documents that are available on the World Wide Web, the complete path name to the document including the internet protocol used shall be included. In all cases the document directory should include the trailing “/” of all path names.

4.2.3.2.165 Document.File
the name of the file, with file extension, that contains the associated information.

4.2.3.2.166 Document.Description
a general text description of the description.

4.2.3.2.167 Document.Reference
if different from the Document.Directory/Document.File this is a reference to documents provided from manufacturers’ catalogs or websites.

4.2.3.2.168 Attribute
a worksheet in the COBie spreadsheet. Attribute records identify external files that provide information associated with data in a given COBie deliverable. Attribute.Name, Attribute.SheetName, Attribute.RowName, Attribute.Category comprises the compound key for this worksheet.

4.2.3.2.169 Attribute.Name
the name of the attribute.

4.2.3.2.170 Attribute.Category
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “As Built”, “Submitted”, “Approved”, “Exact Requirement”, “Maximum Requirement”, “Minimum Requirement”, and “Requirement”.

4.2.3.2.2.171
Attribute.SheetName
specifies references in this row as pertaining to COBie data in any other COBie worksheet.

4.2.3.2.2.172
Attribute.Row Name
a foreign key identifying the row in the associated Attribute.SheetName.

4.2.3.2.2.173
Attribute.Value
the value of the attribute.

4.2.3.2.2.174
Attribute.Unit
the unit defining the value of the attribute.

4.2.3.2.2.175
Attribute.Description
a general text description of the attribute.

4.2.3.2.2.176
Attribute.AllowedValues
a comma delimited list of one or more allowed values.

4.2.3.2.2.177
Coordinate
a worksheet in the COBie spreadsheet. Coordinate records identify simple geometric information associated with data in a given COBie deliverable. Coordinate.Name is the primary key for this worksheet.

4.2.3.2.2.178
Coordinate.Name
the name of the coordinate.

4.2.3.2.2.179
Coordinate.Category
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “point”, “lineend-one”, “lineend-two”, “box-lowerleft”, and “box-upperright”.

4.2.3.2.2.180
Coordinate.SheetName
specifies references in this row as pertaining to COBie data in a COBie.Facility, COBie.Floor, COBie.Space, COBie.Type or COBie.Coordinate worksheet.

4.2.3.2.2.181
Coordinate.RowName
a foreign key identifying a specific row in the Coordinate.SheetName.

4.2.3.2.2.182
Coordinate.CoordinateXAxis
relative coordinate of the referenced object.
4.2.3.2.2.183
Coordinate.CoordinateYAxis
relative coordinate of the referenced object.

4.2.3.2.2.184
Coordinate.CoordinateZAxis
relative coordinate of the referenced object.

4.2.3.2.2.185
Coordinate.ClockwiseRotation
rotation of the referenced object around the identified point, if applicable.

4.2.3.2.2.186
Coordinate.ElevationalRotation
rotation of the referenced object around the identified point, if applicable.

4.2.3.2.2.187
Coordinate.YawRotation
rotation of the referenced object around the identified point, if applicable.

4.2.3.2.2.188
Issue
a worksheet in the COBie spreadsheet. Issue records identify allow the exchange of business process and exception reporting information related to other parts of a given COBie deliverable. Issue.Name, Issue.SheetName, Issue.RowName comprise the compound key for this worksheet.

4.2.3.2.2.189
Issue.Name
the name of the coordinate.

4.2.3.2.2.190
Issue.Type
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Change”, “Claim”, “Coordination”, “Environmental”, “Function”, “IndoorAirQuality”, “Installation”, “RFI”, “Safety”, and “Specification”.

4.2.3.2.2.191
Issue.Risk
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Very High”, “High”, “Moderate”, “Low”, and “Unknown”.

4.2.3.2.2.192
Issue.Chance
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Has Occurred”, “High”, “Moderate”, “Low”, and “Unknown”.

4.2.3.2.2.193
Issue.Impact
a classification of the type of information contained within one row. If allowable values are not specified by contract, the default values are: “Very High”, “High”, “Moderate”, “Low”, and “Unknown”.

4.2.3.2.2.194
Issue.SheetName1
specifies references in this row as pertaining to COBie data in any other COBie worksheet.
4.2.3.2.2.195
Issue.RowName1
a foreign key identifying a specific row in the Issue. SheetName1.

4.2.3.2.2.196
Issue.SheetName2
specifies references in this row as pertaining to COBie data in any other COBie worksheet.

4.2.3.2.2.197
Issue.RowName2
a foreign key identifying a specific row in the Issue. SheetName2.

4.2.3.2.2.198
Issue.Description
a general text description of the issue.

4.2.3.2.2.199
Issue.Owner
a foreign key identifying the COBie.Contact.

4.2.3.2.2.200
Issue.Mitigation
a general text description of the mitigation.

4.2.4 Symbols and abbreviated terms

Author’s Editorial Comment: The listing of symbols and abbreviated terms was not required in NBIMS- US™ V2 submissions. The information provided here reflects the compilation of the terms and definitions found in NBIMS-US™ V2 as updated for the current COBie version. Based on the rules NBIMS-US™ V3 Technical Subcommittee Evaluation Criteria for Revised Information Exchange submissions, the information provided in this section should be considered a moderate change.

4.2.4.1
AEC
architecture, engineering, and construction

4.2.4.2
BAMie
building automation management information exchange format

4.2.4.3
BIM
building information modelling

4.2.4.4
bSa
buildingSMART alliance®

4.2.4.5
bSi
buildingSMART International

4.2.4.6
COBie
construction-operations building information exchange format

4.2.4.7
COBieLite
NIEM compliant COBie XML schema, files conforming to that schema

4.2.4.8
FM
facility management

4.2.4.9
GUID
globally unique identifier

4.2.4.10
IFC
industry foundation classes

4.2.4.11
ifcXML
an XML schema for IFC Step files based on STEP XML transformation rules

4.2.4.12
IFD
international framework for dictionaries

4.2.4.13
HVACie
heating, ventilating, and air conditioning information exchange format

4.2.4.14
LCie
life-cycle information exchange format

4.2.4.15
MVD
model view definition

4.2.4.16
NBIMS-US™
National BIM Standard-United States®

4.2.4.17
NiBS
National Institute of Building Sciences

4.2.4.18
NIEM
national information exchange model

4.2.4.19
Sparkie
electrical system information exchange format
4.2.4.20
SPF
STEP physical file

4.2.4.21
SpreadsheetML
an XML schema for Microsoft Excel spreadsheet 2003

4.2.4.22
STEP
standard for the exchange of product data

4.2.4.23
URI
uniform resource identifier

4.2.4.24
US
United States of America

4.2.4.25
UUID
universally unique identifier

4.2.4.26
WSie
water system information exchange format

4.2.5 Business process documentation

Author’s Editorial Comment: Business processes supporting COBie were first documented in a U.S. Army Technical Report (East 2007). These business models were developed from a series of industry advisory panel meetings conducted in 2006 and 2007. Additional clarification of the scope of processes pertaining to the life-cycle of facility assets were proposed in East 2010. At the time of submission of this standard another update to COBie-related business processes is being finalized for editing as part of a U.S. Army Technical Report (Fallon 2013). The objective of the research contained in this report was to use business process modeling in conjunction with “lean” management approaches, as in East 2011, to compare current with COBie-based business processes. As part of the NBIMS-US™ V3 updated COBie standard, an updated set business models developed in the latest report is provided for direct inclusion in the standard. Based on the rules NBIMS-US™ V3 Technical Subcommittee Evaluation Criteria for Revised Information Exchange standards, the information provided in this section should be considered a moderate change.

4.2.5.1 Process models provided

4.2.5.1.1 Business process list
- Study and Define Needs
- Develop Design Criteria
- Study Technical Feasibility
- Communicate Results Decision
- Develop Program – Space Program
- Develop Program – Product Program
- Prepare Invitation to Bid and Receive Proposal (Pre-Design)
- Explore Concepts – Design Early
- Develop Design – Design Schematic
4.2.5.1.2 Business process descriptions

4.2.5.1.2.1 Study and define needs

Definition: Standard facility information must be available in order to determine the basic requirements for a potential project. The Owner identifies the need and either develops technical criteria for the facility if none exist or utilizes existing technical criteria if available. If it does exist, this information must be checked for relevancy every five years to remain consistent with overall needs.

4.2.5.1.2.2 Develop design criteria

Specification information for equipment based on facility criteria is generated early in the planning process by the Owner. This information must be checked for relevancy every five years to remain consistent with overall needs.

4.2.5.1.2.3 Study technical feasibility

Definition: The Feasibility Study allows the Owner to evaluate different options (typically three) based on the identified requirements before finalizing specific information about a project. The Architect or Planner develops the study based on the information contained in the Facility Criteria and Discipline Specification information exchanges.

4.2.5.1.2.4 Communicate results decisions

Initial criteria about a project must be established in order to evaluate the project feasibility. The Owner evaluates the Facility Criteria, Discipline Specifications, and Feasibility Study to determine whether or not to move forward with the project.

4.2.5.1.2.5 Develop program – space program

Once the Project Definition has been established and approved, further development of the project requirements can occur. The Architect or Planner evaluates information contained in the Project Definition information exchange to identify space needs based on the facility type. Space requirements, based on facility type, are located online in electronic document format and must be downloaded. These
documents are typically printed by the end user. If no standard facility space criteria exist, it must be created by referencing similar facility types.

4.2.5.1.2.6 Develop program – product program

The Architect or Planner evaluates information contained in the Project Definition information exchange to identify product needs based on the facility type. Requirements for products based on facility type are located online in electronic document format and must be downloaded. These documents are typically printed by the end user. If no standard facility product criteria exist, it must be created by referencing similar facility types.

4.2.5.1.2.7 Prepare invitation to bid and receive proposals (pre-design)

Once the major criteria have been determined, the Owner’s Representative prepares and distributes a Request for Proposal (RFP).

4.2.5.1.2.8 Explore concepts – design early

The Architect utilizes the specific information produced during pre-design to develop a solution that reflects the requirements stated in the Project Definition, Space Program, and Product Program. Currently, the owner requires 6 hard copies to be submitted for each review cycle. The Architect performs a QA/QC check before submitting to the Owner’s Representative. After receiving the submission, the Owner’s Representative validates the documents (reviews) and provides comments to the Architect. The Architect and Consultants are then required to update the documents based on the comments. After revisions are made, the Architect resubmits.

4.2.5.1.2.9 Develop design – design schematic

The Architect further develops the approved Design Early deliverable documents to produce the Design Schematic documents. Currently, the owner requires 6 hard copies to be submitted for each review cycle. The Architect performs a QA/QC check before submitting to the Owner’s Representative. After receiving the submission, the Owner’s Representative validates the documents and provides comments to the Architect. The Architect and Consultants are then required to update the documents based on the comments. After revisions are made, the Architect resubmits.

4.2.5.1.2.10 Develop design – product type template

As the design progresses, performance characteristics and suitable products for the building systems are identified. System types and equipment are identified by the Specifier based on the facility requirements. Six copies are required to be submitted for review. Some products are defined in more detail by identifying manufacturers and model numbers which meet requirements (Basis of Design). In these cases, 3 qualifying products should be listed.

4.2.5.1.2.11 Develop design – design coordinated

The Architect further develops the approved Design Schematic deliverable documents to produce the Design Coordinated documents. In addition, the building systems are coordinated to eliminate spatial interferences. This is the major coordination submittal before the final delivery package. The owner requires 6 hard copies to be submitted for each review cycle. Due to the higher level of coordination and increase in number of interested reviewing parties, more copies are sometimes needed. The Architect performs a QA/QC check before submitting to the Owner’s Representative. After receiving the submission, the Owner’s Representative validates the documents and provides comments to the
Architect. The Architect and Consultants are then required to update the documents based on the comments. After revisions are made, the Architect resubmits.

4.2.5.1.2.12 Develop design – product type candidate

The performance requirements of building systems and equipment are further refined and documented by the Specifier during this phase. Any equipment, products, or systems not selected previously are identified. Specific manufacturers and model numbers are noted. Three qualifying products are identified. Six copies are submitted for each review cycle.

4.2.5.1.2.13 Finalize design – design final

The Design Final package is the final set of contract documents ready for bid solicitation by the Owner. This final design deliverable does not require another review by the Owner’s Representative.

4.2.5.1.2.14 Finalize design – product type candidate

At this phase of the project all equipment and system types must be identified by the Specifier. Product information from the Design Coordinated phase is incorporated into this phase. Three (3) qualifying products for each type required must be listed.

4.2.5.1.2.15 Prepare invitation to bid and receive proposals (post-design)

Once the design is complete, the Owner packages the Design Final Documents information together with other owner-supplied information (e.g., contractual terms) and creates a Request for Proposals (RFP) Package. This becomes the official bid set.

4.2.5.1.2.16 Respond to pre-proposal inquiries

Before finalizing a bid proposal, the Contractor typically requests additional information or clarification of some bid documents.

4.2.5.1.2.17 Develop pre-construction plan

The Contractor is required to develop a Pre-Construction Plan that describes how the Contractor will make provisions for managing the construction of the facility. This is sent as a submittal package. Refer to the Submittal Package exchange for detailed requirements related to transmitting and handling Pre-Construction Plan submittals.

4.2.5.1.2.18 Identify discrepancies

The Contractor submits a Request for Information (RFI) to ask for clarification during the construction process. These questions may be due to but not restricted to ambiguities or contradictions in the drawings or to site conditions.

4.2.5.1.2.19 Prepare submittal information – product type selection

The Contractor and Sub-Contractors gather information for products identified in the Design Final documents and prepare submittals. Refer to the Submittal Package exchange for detailed requirements related to transmitting and handling Product Type Selection submittals.
4.2.5.1.2.20 Prepare submittal information – system layout

The Contractor and Sub-Contractors review information for products identified in the Design Final documents and prepare shop drawings. Refer to the Submittal Package exchange for detailed requirements related to transmitting and handling System Layout submittals.

4.2.5.1.2.21 Organize submittal information

The Contractor organizes the required submittal information and creates Submittal Packages to be reviewed by the Owner’s Representative and/or Architect. Six hard copies are required to be submitted for review.

4.2.5.1.2.22 Perform submittal review – submittal issue

The Architect and/or Sub-Consultants validate the submittals provided by the Contractor and provide comments. Six hard copies are required.

4.2.5.1.2.23 Provide resources

The Contractor contacts a Supplier to order equipment and materials. The Supplier then provides a price quote to the Contractor for the equipment and/or materials. The Contractor verifies the specifications of the equipment and/or materials in the quote against approved submittal documentation and then submits them to the Owner’s Representative and/or Architect for approval.

4.2.5.1.2.24 Execute construction activities

The Contractor installs the building equipment, materials, and systems using the design final drawings, approved shop drawings, product data, and manufacturer’s instructions.

4.2.5.1.2.25 Perform equipment testing

After the Contractor completes the installation process, the equipment/systems must be tested by activating the equipment. This testing must be completed with the Owner’s Representative and Manufacturer’s representative present.

4.2.5.1.2.26 Inspect and approve work

When the Contractor has completed installation of equipment or systems, a notification is sent to the Architect indicating the installed item is ready for inspection/observation. The Architect conducts regular inspections of the installed construction work. The findings of the inspections including any deficiencies with the installation of the construction work are documented in a report. If deficiencies are identified in the inspection report, the Contractor corrects them and then requests a re-inspection.

4.2.5.1.2.27 Define, record and certify discrepancies

The Architect creates a final punch-list based upon a survey of the completed construction work. The Contractor corrects the deficiencies identified in the punch-list. The Architect verifies that the Contractor has corrected the deficiencies in the punch-list by performing a final walkthrough.

4.2.5.1.2.28 Closeout

The Contractor gathers all as-built information related to the project and forwards the information to the Owner. Four copies are typically required.
4.2.5.1.3 Business process model diagrams

Business process models were created at a lower-level of detail than is typically required. This additional level of detail was included to demonstrate the value of data-centric information exchange, versus document-centric exchanges typical of practice in the design and construction industry today. This allows the models themselves to directly address the question of business case since, with data-centric exchanges; all non-value added tasks required for working with documents may be eliminated. Each business process diagram begins with the definition of the Current Process workflow. On top of that current process color codes that describe where tasks were eliminated, automated, or streamlined are shown in the COBie-based Expected Process.

When using these business process models, please consult the following legend.

- Eliminated Tasks
- Automated Tasks
- Streamlined Tasks
- Unchanged Tasks from Current LCie Process
### LCie Process Study / Define Needs | LCie Exchange 010 Facility Criteria

<table>
<thead>
<tr>
<th>Owner</th>
<th>Data Exchange</th>
<th>Architect</th>
<th>Data Exchange</th>
<th>Contractor</th>
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<tr>
<td>010.01 Identify Need</td>
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<tr>
<td>Does Facility Type Criteria Exist?</td>
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<td>Has It Been Updated in 5 years?</td>
<td>Yes</td>
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<td>No</td>
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<td>010.02.10 Review Existing Facility Criteria</td>
<td></td>
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<td>010.02.20 Appoint Criteria Team</td>
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<tr>
<td>010.02.30 Produce Facility Criteria</td>
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</tr>
<tr>
<td>010.02.40 Copy Facility Criteria</td>
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</table>

**Legend**

- Eliminated Tasks
- Automated Tasks
- Streamlined Tasks
- Unchanged Tasks

---

**Figure 1 Study/Define Needs Process Model**
### Develop Design Criteria Process Model

#### Table: LCie:020 Discipline Specifications

<table>
<thead>
<tr>
<th>Owner</th>
<th>Data Exchange</th>
<th>Architect</th>
<th>Data Exchange</th>
<th>Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>02G01 Identify Need</strong></td>
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<td><strong>020.0210 Review Existing Discipline Specification</strong></td>
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<tr>
<td><strong>No</strong></td>
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<tr>
<td><strong>Yes</strong></td>
<td><strong>020.0330 Produce Discipline Specification</strong></td>
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<tr>
<td><strong>No</strong></td>
<td><strong>020.0240 Copy Discipline Specification</strong></td>
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</tbody>
</table>

#### Diagram:
- **Legend:**
  - Eliminated Tasks
  - Automated Tasks
  - Streamlined Tasks
  - Unchanged Tasks

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**Figure 2 Develop Design Criteria Process Model**
<table>
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<th>Owner</th>
<th>Data Exchange</th>
<th>Architect/Planner</th>
<th>Data Exchange</th>
<th>Contractor</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
<td>030.01 Receive Facility Criteria and Discipline Specifications</td>
<td>030.02 Review Facility Criteria and Discipline Specifications Data</td>
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<tr>
<td></td>
<td></td>
<td>030.03 Produce Feasibility Study</td>
<td>030.04 Copy Feasibility Study</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>030.05 Send Feasibility Study</td>
<td>030.06 Review Feasibility Study</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>030.07 Receive Feasibility Study</td>
<td>030.08 Review of Feasibility Study</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>030.09 Review Feasibility Study</td>
<td>030.10 Proceed to Project Definition</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>030.11 Receive Feasibility Study Review Comments</td>
<td>030.12 Log Receipt of Review Comments</td>
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</tr>
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<td></td>
<td></td>
<td>030.13 Review Feasibility Study</td>
<td>030.14 Copy Revised Feasibility Study</td>
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<tr>
<td></td>
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<td>030.15 Send Revised Feasibility Study</td>
<td>030.16 Log Transmittal of Revised Feasibility Study</td>
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<td>030.10.20 Send Comments to Planner</td>
<td>030.10.10 Proceed to Project Definition</td>
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<td>030.10.21 Log Transmittal of Feasibility Study Comments</td>
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</table>

**Legend**
- Eliminated Tasks
- Automated Tasks
- Streamlined Tasks
- Unchanged Tasks

**Figure 3 Study Technical Feasibility Process Model**
Figure 4 Communicate Results Decisions Process Model
# Figure 5 Develop Program - Space Program Process Model

<table>
<thead>
<tr>
<th>Owner's Representative</th>
<th>Data Exchange</th>
<th>Planner/Architect</th>
<th>Data Exchange</th>
<th>Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>050.01 Utilize Project Definition to Develop Space Program Criteria</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>050.02 Evaluate Space Program Information</td>
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</tr>
<tr>
<td>050.07 Receive Space Program</td>
<td></td>
<td>050.03 Revise Space Program Criteria as Necessary</td>
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<td></td>
</tr>
<tr>
<td>050.08 Log Receipt of Space Program</td>
<td></td>
<td>050.04 Revise Space Program Criteria as Necessary</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>050.05 Send Copies of Space Program</td>
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<tr>
<td></td>
<td></td>
<td>050.06 Log Transmittal of Space Program</td>
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<tr>
<td></td>
<td></td>
<td>050.11 Receive Comments</td>
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<td></td>
<td></td>
<td>050.12 Log Receipt of Space Program Comments</td>
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<td></td>
<td></td>
<td>050.13 ReSearch for Space Program Criteria as Necessary</td>
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<tr>
<td></td>
<td></td>
<td>050.14 Send Revised Copies of Space Program</td>
<td></td>
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</tr>
<tr>
<td></td>
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<td>050.15 Log Transmittal of Revised Space Program</td>
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**Legend**
- Eliminated Tasks
- Automated Tasks
- Streamlined Tasks
- Unchanged Tasks

**Review Cycle**
Figure 6 Develop Program - Product Program Process Model
Figure 7 Prepare Invitation to Bid and Receive Proposals (Pre-Design) Process Model
Figure 8 Explore Concepts - Design Early Process Model
Figure 9 Develop Design - Design Schematic Process Model
Figure 10 Develop Design - Design Coordinated Process Model
Figure 11 Product Type Template Process Model
Figure 12 Develop Design – Product Type Candidate Process Model
### Figure 13 Finalize Design - Design Final Process Model

<table>
<thead>
<tr>
<th>Owner's Representative</th>
<th>Data Exchange</th>
<th>Architect</th>
<th>Data Exchange</th>
<th>Contractor</th>
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<td>11007 Receive Design Final and Product Type Candidate Documents</td>
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<td>11001 Receive Design Coordinated Documents Approval from Owner</td>
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<td>11008 Log Received Design Final Documents for Bidding Process</td>
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<td>11002 Produce Design Final Documents</td>
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<td>11009 Produce Design Final Documents for Bidding Process</td>
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<td>11003 Receive Consultant’s Design Final Documents</td>
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<td>11004 Produce Check Set of Design Final Documents</td>
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<td>11005 Validate Checklist before Submission through BIM/GRC Process</td>
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<td>11006.20 Copy Design Final Documents</td>
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<td>11006.30 Send Design Final Documents</td>
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<td>11006.10 Make Corrections</td>
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<td>11006.10 Make Corrections</td>
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</tbody>
</table>

**LEGEND**
- Eliminated Tasks
- Automated Tasks
- Streamlined Tasks
- Unchanged Tasks

**DOCUMENT REQUIREMENTS**
- Revised Basis of Design Narrative
- Design Final Drawings/Schedules
- Calculations
- Geotechnical Report
- Environmental Report
- Life Cycle Cost Analysis
- Energy Analysis
- Building Heating & Cooling Load
- Color Boards
- Cost Estimate
- Quality Control Data
- Code Compliance Certification
- Color Documentation Binder
- Project Information Form

**Figure 13 Finalize Design - Design Final Process Model**
Figure 14 Finalize Design – Product Type Candidate Process Model
Figure 15 Prepare Invitation to Bid and Receive Proposals (Post-Design) Process Model
### Figure 16 Respond to Pre-Proposal Inquiries Process Model

<table>
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<tr>
<th>Owner's Representative</th>
<th>Data Exchange</th>
<th>Architect</th>
<th>Data Exchange</th>
<th>Contractor</th>
</tr>
</thead>
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<td>130.07 Log Receipt of Inquiry Issue (Clarification)</td>
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<td>130.08 Send Inquiry Issue (Clarification) to Architect</td>
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<td>130.09 Log Transmittal of Inquiry Issue (Clarification)</td>
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<td>130.15 Receive Response to Inquiry Issue (Clarification) from Architect</td>
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<td>130.16 Receive Inquiry Issue (Clarification) Response</td>
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<td>130.21 Log Transmittal of Inquiry Issue (Clarification) Response</td>
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<tr>
<td>130.10 Receive Inquiry Issue (Clarification)</td>
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<td>130.11 Log Receipt of Inquiry Issue (Clarification)</td>
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<td>130.12 Review Inquiry Issue (Clarification)</td>
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<td>130.14 Send Inquiry Issue (Clarification) Response</td>
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**Legend**
- Eliminated Tasks
- Automated Tasks
- Streamlined Tasks
- Unchanged Tasks


<table>
<thead>
<tr>
<th>Owner’s Representative</th>
<th>Data Exchange</th>
<th>Architect</th>
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<th>Contractor</th>
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**Legend**
- Eliminated Tasks
- Automated Tasks
- Streamlined Tasks
- Unchanged Tasks

**Figure 17 Develop Pre-Construction Plans Process Model**
LCie Process: Identify Discrepancies | LCie Exchange 150 Inquiry Issue (RFI)

<table>
<thead>
<tr>
<th>Owner's Representative</th>
<th>Data Exchange</th>
<th>Architect</th>
<th>Data Exchange</th>
<th>Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>15G06: Receive Inquiry Issue (RFI) from Contractor</td>
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<td>15G10: Receive Inquiry Issue (RFI)</td>
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<td>15Q01: Acquire/Review Building Documents</td>
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<tr>
<td>15G07: Log Receipt of Inquiry Issue (RFI)</td>
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<td>15G11: Log Receipt of Inquiry Issue (RFI)</td>
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<td>15Q02: Define Inquiry Issue (RFI)</td>
</tr>
<tr>
<td>15G08: Send Inquiry Issue (RFI) to Architect</td>
<td></td>
<td>15G12: Review Inquiry Issue (RFI)</td>
<td></td>
<td>15Q03: Produce Questions</td>
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<td>15G09: Log Transmission of Inquiry Issue (RFI)</td>
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<td>15G13: Send Inquiry Issue (RFI)</td>
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<td>15Q04: Send Inquiry Issue (RFI)</td>
</tr>
<tr>
<td>15Q10: Receive Response to Inquiry Issue (RFI) from Architect</td>
<td></td>
<td>15G14: Log Receipt of Response to Inquiry Issue (RFI)</td>
<td></td>
<td>15Q05: Log Receipt of Inquiry Issue (RFI)</td>
</tr>
</tbody>
</table>

**Legend**
- Eliminated Tasks
- Automated Tasks
- Streamlined Tasks
- Unchanged Tasks

Figure 18 Identify Discrepancies Process Model
Figure 19 Prepare Submittal Information Product Type Selection Process Model
Figure 20 System Layout Process Model
Figure 21 Organize Submittal Information Process Model
Figure 22 Perform Submittal Review - Submittal Issue Process Model
Figure 23 Provide Resources Process Model
Figure 24 Execute Construction Activities Process Model
<table>
<thead>
<tr>
<th>Owner's Representative Data Exchange</th>
<th>Architect Data Exchange</th>
<th>Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>210.01 Receive Equipment and Materials</td>
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<tr>
<td>210.02 Review Purchase Order</td>
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<tr>
<td>Correct Equipment Received? No</td>
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<td></td>
</tr>
<tr>
<td>210.03.10 Log Receipt of Equipment and Materials</td>
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</tr>
<tr>
<td>210.03.11 Review Manufacturer’s Installation Instructions</td>
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<tr>
<td>210.03.12 Install Equipment, Materials, and Building Systems – Record Component Data</td>
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<tr>
<td>210.04 Reformat Product Installation Report</td>
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<td>210.05 Send Product Installation Report</td>
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<td></td>
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<tr>
<td>210.07 Receive Product Installation Report</td>
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<tr>
<td>210.08 Log Receipt of Product Installation Report</td>
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<td>210.09 Correct Issue with Purchase Order</td>
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<tr>
<td>210.10 Is Installation Complete? No</td>
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</table>

**Figure 25 Product Installation Process Model**
**Figure 26 Perform Equipment Testing Process Model**
<table>
<thead>
<tr>
<th>LCie Process: Inspect and Approved Work</th>
<th>LCie Exchange: 230 Product Inspection</th>
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</thead>
<tbody>
<tr>
<td>Owner’s Representative</td>
<td>Data Exchange</td>
</tr>
</tbody>
</table>

**Figure 27 Inspect and Approve Work Process Model**

**LCie Process: Inspect and Approved Work**

- Request for Product Inspection
  - 230.02 Review Contract Drawings
  - 230.03 Conduct Product Inspection
  - 230.04 Reformat Product Inspection Report
  - 230.05 Send Product Inspection Report to Contractor
  - 230.06 Log Transmission of Product Inspection Report

**LCie Exchange: 230 Product Inspection**

- 230.01 Request Product Inspection
  - 230.07 Receive Product Inspection Report
  - 230.08 Validate Receipt of Product Inspection Report
  - 230.09 Review Product Inspection Report
  - Issues with Installed Work?
    - Yes
      - 230.10 Correct Deficiencies
    - No
      - 230.11 Request Re-inspection

**Legend**

- Eliminated Tasks
- Automated Tasks
- Streamlined Tasks
- Unchanged Tasks
Figure 28 Define, Record, and Certify Discrepancies Process Model
### LCie Process Closeout | LCie Exchange: 250 Turnover Package

<table>
<thead>
<tr>
<th>Owner</th>
<th>Data Exchange</th>
<th>Architect</th>
<th>Data Exchange</th>
<th>Contractor</th>
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</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

**Legend**
- **Eliminated Tasks**
- **Automated Tasks**
- **Streamlined Tasks**
- **Unchanged Tasks**

**Figure 29 Closeout Process Model**

- **25G05**: Receive Copies of the Turnover Package
- **25G06**: Log Receipt of the Turnover Package
- **25G07**: Review Turnover Package
- **25G08**: File Turnover Package
- **25G01**: Complete Turnover Package
- **25G02**: Copy Turnover Package
- **25G03**: Send Copy of Turnover Package
- **25G04**: Log Transmittal of Turnover Package

Record (as-built drawings)
Record Specifications
Final Approved Shop Drawings
Operations & Maintenance Manuals
OMSI Files
Commissioning Report

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4.2.5.2 Representative process models

4.2.5.2.1 Stakeholder coverage analysis

The rows in the figure below illustrate the stakeholders participating in each COBie-related business processes. The specific processes are listed in each column.

![Figure 30 Stakeholder Coverage](image)

4.2.5.2.2 Process coverage analysis

See Figure 30, above.

4.2.5.2.3 Contract documentary deliverable list

For each of the business processes identified in the COBie standard a list of the corresponding traditional contracted deliverable is provided. This information is provided as part of the NBIMS-US™ V3 standard to identify current document-based deliverables that can be replaced, in-all or in-part, by the information exchange standard defined in this document.

Table 5 Study and Define Needs Document List

<table>
<thead>
<tr>
<th>Information Content:</th>
<th>Facility Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contracted Exchange/Deliverable:</td>
<td>Facility Criteria</td>
</tr>
</tbody>
</table>
Table 6 Develop Design Criteria Document List

| Information Content: | • Type Data
• Product Data |
| Contracted Exchange/Deliverable: | • Discipline Specification |

Table 7 Study Technical Feasibility Document List

| Information Content: | • Feasibility Study Options |
| Contracted Exchange/Deliverable: | • Feasibility Study |

Table 8 Communicate Results Decision Document List

| Information Content: | • Detailed Project Scope
• Preliminary Budgetary Cost Information
• Site Location & Approval
• Economic Analysis
• Facility Planning Data |
| Contracted Exchange/Deliverable: | • Project Definition |

Table 9 Develop Program – Space Program Document List

| Information Content: | • Facility Space Requirements |
| Contracted Exchange/Deliverable: | • Space Program |

Table 10 Develop Program – Product Program Document List

| Information Content: | • Facility Product Requirements |
| Contracted Exchange/Deliverable: | • Product Program |

Table 11 Prepare Invitation to Bid and Receive Proposal (Pre-Design) Document List

| Information Content: | • Project Definition
• Space Program
• Product Program |
| Contracted Exchange/Deliverable: | • Request for Proposal (RFP) |

Table 12 Explore Concepts – Design Early Document List

| Information Content: | • Concept Design Drawings
• Cost Estimate
• Calculations |
| Contracted Exchange/Deliverable: | • Design Early |

Table 13 Develop Design – Design Schematic Document List

| Information Content: | • Basis of Design Narrative
• Design Schematic Drawings
• Energy Analysis
• Life Cycle Cost Analysis
• Cost Estimate
• Geotechnical Report
• Calculations
• Environmental Report
• Outline Specifications |
| Contracted Exchange/Deliverable: | • Design Schematic |
### Table 14 Develop Design – Design Coordinated Document List

| Information Content:                  | • Basis of Design Narrative  
|                                      | • Design Coordinated Drawings  
|                                      | • Energy Analysis  
|                                      | • Life Cycle cost Analysis  
|                                      | • Cost Estimate  
|                                      | • Geotechnical Report  
|                                      | • Calculations  
|                                      | • Environmental Report  
|                                      | • Project Information Form  
|                                      | • Outline Specifications  
|                                      | • Submittal Register  
| Contracted Exchange/Deliverable:     | • Design Coordinated  
|                                      | • Product Type Template  

### Table 15 Finalize Design – Design Final Document List

| Information Content:                  | • Basis of Design Narrative  
|                                      | • Design Final Drawings  
|                                      | • Energy Analysis  
|                                      | • Life Cycle cost Analysis  
|                                      | • Cost Estimate  
|                                      | • Geotechnical Report  
|                                      | • Calculations  
|                                      | • Environmental Report  
|                                      | • Project Information Form  
|                                      | • Quality Control Data  
|                                      | • Color Documentation Binder  
|                                      | • Code Compliance Certification  
|                                      | • Specifications  
|                                      | • Submittal Register  
| Contracted Exchange/Deliverable:     | • Design Final  
|                                      | • Product Type Candidate  

### Table 16 Prepare Invitation to Bid and Receive Proposals (Post Design) Document List

| Information Content:                  | • Final Design Documents  
|                                      | • Specifications  
| Contracted Exchange/Deliverable:     | • Request for Proposal (RFP)  

### Table 17 Respond to Pre-Proposal Inquiries Document List

| Information Content:                  | • Clarification Request  
| Contracted Exchange/Deliverable:     | • Inquiry Issue (Clarification)  

### Table 18 Develop Pre-Construction Plan Document List

| Information Content:                  | • Equipment Lists  
|                                      | • Certificates of Insurance  
|                                      | • Surety Bonds  
|                                      | • List of Proposed Subcontractors  

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<thead>
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| Contracted Exchange/Deliverable:              |
| Pre-Construction Plan                        |

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| Contracted Exchange/Deliverable:              |
| Product Type Selection                      |

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| Contracted Exchange/Deliverable:              |
| System Layout                                      |

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| Contracted Exchange/Deliverable:              |
| Submittal Package                             |

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| Contracted Exchange/Deliverable:              |
| Submittal Issue                                |
Table 24 Provide Resources Document List

| Information Content: | ▪ Purchase Order |
| Contracted Exchange/Deliverable: | ▪ Purchase Order |

Table 25 Execute Construction Activities Document List

| Information Content: | ▪ Design Final Drawings  
▪ Product Type Candidate  
▪ Approved Shop Drawings  
▪ Manufacturer’s Instructions |
| Contracted Exchange/Deliverable: | ▪ Product Installation |

Table 26 Perform Equipment Testing Document List

| Information Content: | ▪ Equipment Start-Up Test Results |
| Contracted Exchange/Deliverable: | ▪ Equipment Start-Up Report |

Table 27 Inspect and Approve Work Document List

| Information Content: | ▪ Observation Field Report |
| Contracted Exchange/Deliverable: | ▪ Product Inspection |

Table 28 Define, Record and Certify Discrepancies Document List

| Information Content: | ▪ Previous Product Inspections  
▪ Final Walkthrough Report  
▪ Field Reports |
| Contracted Exchange/Deliverable: | ▪ Punch-list Issue |

Table 29 Closeout Document List

| Information Content: | ▪ Operations and Maintenance Manuals  
▪ Record of Designated Equipment  
▪ Materials Data Files  
▪ Commissioning Report  
▪ Record Specifications  
▪ Record (As-Built) Drawings  
▪ Final Approved Shop Drawings |
| Contracted Exchange/Deliverable: | ▪ Turnover Package |

4.2.5.2.4 Contract documentary deliverable analysis

4.2.5.2.4.1 Study and define needs

Facility Criteria may be provided in COBie format as templates of specific space types. The requirements for spatial finishes and equipment may also be easily incorporated into the COBie format.

Allowing space types to be represented in a COBie format is an additional business rule that is defined in the previously noted BPie project.
4.2 5.2.4.2 Develop design criteria

Product Type information commonly found in construction specifications may be developed as a constraint model in COBie format against specific product types. The specific requirements for product types may be defined in COBie as attributes. COBie.Attributes allows the specification of properties as requirements. COBie.Attributes also allows the listing of allowed sets of values and optional values.

The definition of product specifications may be addressed in the LCie and SPIe documents. Based on such definitions automated checking of product-specific information may be conducted in many types of exchanges later in the project. Note that such checks are not the same as projects related to checking building code compliance.

4.2.5.2.4.3 Study technical feasibility

Feasibility Studies that produce information for each option about facility spaces, equipment and other assets may be compared against technical criteria requirements. Such checks can identify constraint violations, but will not evaluate the quality of design from any other than a purely technical point of view.

4.2.5.2.4.4 Communicate results decision

There are many aspects of project definition that are not supported by COBie exchanges; however, information about the detailed project scope may be communicated.

4.2.5.2.4.5 Develop program – space program

The Space Program may be provided in COBie format as specific space types and instances of those types. The requirements for spatial finishes and equipment may also be easily incorporated into the COBie format.

Space types represented for COBie is defined in the previously noted BPie project. Note that having the criteria for each space type in COBie format and having the Space Program deliverables also in COBie format allows automated constraint checking to be accomplished between the planned facility and the owner's criteria.

4.2.5.2.4.6 Develop program – product program

The Product Program may be provided in COBie format as specific space types and instances of those types. The requirements for spatial finishes and equipment may also be easily incorporated into the COBie format.

Note that having the criteria for each product type in COBie format and having the Product Program deliverables also in COBie format allows automated constraint checking to be accomplished between the planned facility and the owner’s program and specifications’ criteria.

4.2.5.2.4.7 Prepare invitation to bid and receive proposal (pre-design)

While there are many aspects of the design RFP that cannot be represented in COBie format, clearly the Space and Product Program are able to be represented in COBie.

4.2.5.2.4.8 Explore concepts – design early
The majority of the deliverables produced in the Early Design stage are not relevant to COBie. When considering alternative layouts during the early design stage, however, checking these layouts against the owner’s criteria and RFP Space/Product Program may assist the designer from making choices in violation of the owner’s requirements.

The architectural drawings produced at this stage do contain scheduled facility asset information pertaining to Spaces, Doors, Windows, Plumbing Fixtures, and Lighting Fixtures. The information in these schedules is represented in COBie and submitted with the drawings.

4.2.5.2.4.9 Develop design – design schematic

Many of the deliverables produced during design have information content that is partially, or completely, found within the COBie data set. As a result designers may obtain significant benefits from the export of design deliverable reports using COBie-required data that present in their native design systems. Several specific deliverables are described in the paragraphs below.

The Basis of Design Narrative, with respect to those aspects that are required for the commissioning process, can be directly mapped to the COBie data set. The identification of building systems and zones, and the overall design factors may be documented in the COBie.Zone, COBie.System and COBie.Attributes entities. Those product types whose basis of design has been selected at this point in the design may be captured through the COBie.Type and COBie.Attribute entities.

Another format of the Basis of Design Narrative, with respect to the specifics of selecting assets and their properties is represented on design drawings as schedules. From scheduled asset information design product data sheets (product type templates) and room data sheets may also be exported. Such information may be used to check the current design against previous design stages for changes, and to evaluate later contractor submissions for appropriate finish and product selections.

Information supporting a variety of types of cost analysis such as life-cycle cost analysis and cost estimates may be supported by COBie. The use of COBie data to for counting assets would be a valuable shortcut when performing drawing take-offs. Information about the quality level of those assets, contained in COBie.Type and COBie.Attribute entities may support both conceptual and detailed cost estimating.

Information related to the requirements for various products found in COBie.Type may also be used to create outline specifications for the project from the properties identified in the COBie model. Such applications are not in widespread use; however, the demonstration of such an application in December 2010 validated this potential use of COBie data.

COBie files will not contain the following types of contractual deliverables during the design stage: drawings, schematics, reports, and calculations. Information contained in design reports and calculations is outside the scope of the COBie specification. Drawing files contain a level of geometric detail that is not suitable for inclusion on COBie. The information content of drawings, particularly that information found on drawing schedules should be included in COBie. In fact, the comparison between drawings schedule information and associated COBie deliverables is the basis for the assessment of the quality of the COBie.

4.2.5.2.4.10 Develop design – design coordinated

In addition to the discussion of design deliverable coverage noted in the previous section, the coordinated design deliverable includes deliverables such as the Project Information Form and Submittal Register. These additional contractual deliverables are described in the paragraphs below.
Since information about the overall scope of the project is available through COBie, either through attribute information, or by counting objects, areas, and volumes a significant portion of the Project Information Form data often required at this stage of design is available. Automated reports from the design product, or directly from the COBie data, can provide the first draft of this report.

A portion of the submittal register may be directly created from COBie design files through the identification of a template for each product of category. The COBie.Document entity allows the identification of “required” documents. The list of each of these documents is, in fact, the submittal register. Beyond the requirement for one COBie.Document of type “Product Data” for each COBie.Type, the COBie.Type category value may be used to create a standard set of submittals for different classes of products. Products whose category is flow control devices may require the submission of test report, while products categorized as metal doors may not require (by default) an test report.

4.2.5.2.4.11 Finalize design – design final

In addition to the discussion of design deliverable coverage noted in the previous section, the coordinated design deliverable includes deliverables such as Quality Control Data, Color Documentation Binder, Code Compliance Certification, and Construction Specifications. These additional contractual deliverables are described in the paragraphs below.

As with the automated production of a portion of the submittal register, entries from COBie.Types, their categories and attributes could be used with a template of Quality Control standards to produce a draft quality control specification and/or plan for the project. While such an application does not currently exist, the development of templates based on national product type classifications is within a realm of possible applications to automate the production of contract deliverables based on COBie data.

Information about color selections from the COBie data can be used to provide the outline for the Color Documentation Binder. Specific Color chips could be provided as attached COBie.Documents further automating the process. Photographs of fabric and texture samples should be required for project documentation and these may be included as COBie.Document entries. While the owner must be able to physically have a copy of the colors and samples, the electronic record document maybe completely generated from a simple report based on COBie.Data.

4.2.5.2.4.12 Prepare invitation to bid and receive proposals (post design)

The deliverable for this stage of the project is request for proposal package. The inclusion of a construction-documents stage COBie file, for information only, would ensure that bidders have a more even basis for their bids since individual companies would consistently count information provided in electronic versus drawing or native formats.

Concerns of liability are moot since the COBie data matches the schedule data on the drawings. If there are errors, then the normal error resolution process proceeds.

4.2.5.2.4.13 Respond to pre-proposal inquiries

The capture of requests for information or clarifications may be directly accomplished through the COBie data format. The use of this format actually enhances the value of the information and improves the speed of processing the inquiry. The value of the information is increased since such information becomes linked directly with the objects in question. The speed of inquiry may be improved since the meta-data contained in the COBie-related information package may be used to automatically route the object to the appropriate party responsible to answer the question.
4.2.5.2.4.14 Develop pre-construction plan

There are many deliverables required of the construction contractor during the pre-construction phase. The paragraphs below describe the way in which COBie data may be used to support and streamline such processes. Such streamlining is possible since the contractor producing the deliverable can use reports from COBie construction documents stage files to fill in much of the content of that deliverable.

The first set of information provided by contractors is often the lists of companies and persons needing access to the job site. This list, if provided in COBie.Contacts, allows the capture of information that may be used through the rest of the construction project. As installers capture nameplate data, or commissioning agents identify punch-list items, the names of each of these persons will be available through COBie pick-lists developed from project access control lists that are updated from COBie.Contacts as the project proceeds.

While COBie data will not directly contribute to the creation of the contractors Critical Path Method schedule, links between the building assets to be installed in a given activity and their upstream quality control and supply chain activities, may be linked to schedule activities. Such an capability, available as a result of having the COBie data, allows the contractor to integrate data systems ensuring that work on the project can be accomplished without any of the information falling “between the cracks.” For example setting up the scheduling software to produce equipment installation worksheets the equipment is to be installed, and directing them to associated subcontractor personnel would directly support the ability to evaluate the completion of specific schedule activities and the percentage of equipment installed on a given activity.

Given the zones, systems, and equipment being installed on the project some aspects of Health and Safety Plans, Work Plans, Quality Control Plans and Environmental Protection plans may be developed from COBie data. This would be accomplished by having templates for specific classifications of work. When that work is identified in a COBie file that portion of the template is used to create the project-specific plan.

The paragraphs above identify pre-construction deliverables that are likely to be supported by COBie-based data extracts are identified. There are also several pre-construction deliverables that are outside the scope of workflows associated with COBie. These include Certificates of Insurance, Bonds, Schedule of Prices, and Contractors’ equipment lists.

4.2.5.2.4.15 Identify discrepancies

Similar to coverage noted in Respond to Pre-Proposal Inquiries.

4.2.5.2.4.16 Prepare submittal information – product type selection

A variety of information related to submittals is either directly or indirectly, captured in COBie. The majority of this information can be linked to COBie data sets through the COBie.Document entity. Such information includes: Product Data, Design Data, Test Reports, Certifications, Manufacturers’ Instructions, Manufacturers’ Field Reports, and Operations and Maintenance Data.

Although it is not common practice today, several types of submittal data may provided in a data-oriented format using discrete COBie data exchanges either through SpreadsheetML or COBieLite versions directly from product manufacturers. That information includes Product Data and Operations and Maintenance Data. Work on other projects such as the SPIe and LCIe project will provide specific content and format specifications for such direct information exchanges.
4.2.5.2.4.17 Prepare submittal information – system layout

System layout drawings were originally envisioned to be able to be provided through COBie, however, additional work on the HVACie, WSie, Sparkie, and BAMie projects have indicated that the best method for the exchange of system layout information are domain-specific Model View Definitions. A COBie extract of the managed assets contained within that specific domain system, for system manuals would however be possible to produce.

4.2.5.2.4.18 Organize submittal information

The preparation and transmission of submittals is outside the context of COBie. While COBie-based data may be the content of such information exchanges, LCie defines an example data structure for the exchange of such information.

4.2.5.2.4.19 Perform submittal review – submittal issue

Similar to coverage noted in Respond to Pre-Proposal Inquiries.

4.2.5.2.4.20 Provide resources

The production of purchase orders as a result of submittal approvals is outside the context of the COBie. While COBie-based data may be the content of such information exchanges, AGC-XML defines an example data structure for the exchange of such information.

4.2.5.2.4.21 Execute construction activities

During the process of building construction a number of specific contract deliverables are required. Some of these deliverables are supported directly, or indirectly, by the use of COBie. The production of drawings, such as as-built drawings and as-built shop drawings are not supported by COBie. The scheduled asset information on these drawings does, however, directly translate to COBie.

As assets are installed on the project the installed equipment list deliverable, used to support contractor payment requests, maybe directly represented in COBie format. The specific subset of the COBie schema applicable for such an exchange are defined in the LCie for managed asset specification.

4.2.5.2.4.22 Perform equipment testing

Equipment start-up and performance reports may be linked to COBie data. In addition, the start-up, or energization, date for a given piece of equipment is to be documented in COBie as the COBie.Component.WarrantyStartDate. The reports themselves may be linked to the specific COBie.Component through the COBie.Document entity.

4.2.5.2.4.23 Inspect and approve work

Similar to coverage noted in Section 5.2.3.2.13 Respond to Pre-Proposal Inquiries. Reports developed at this stage are compiled sets of COBie.Issues.

4.2.5.2.4.24 Define, record and certify discrepancies

Similar to coverage noted in Section 5.2.3.2.13 Respond to Pre-Proposal Inquiries. Reports developed at this stage are compiled sets of COBie.Issues.
4.2.5.2.4.25 Closeout

Given that COBie was specifically designed to capture the construction handover package all of the contents of the turnover package are either included, or referenced, within the COBie data structure. The paragraphs below describe each of these handover package contents and where such information is found within the COBie format.

Operations and Maintenance manuals produced by manufacturers may be included in COBie in one of three methods. First, an electronic copy of the manufacturer’s booklet containing a product’s manuals may be referenced in the COBie.Document entity and referenced back to the associated COBie.Type entity. Second, the set of activities for a given task may be directly included in the COBie.Job worksheet. Finally, if the individual activities within the entire set activities require different tools, materials, or training to accomplish, then the individual activities may be listed separately and linked to the needed COBie.Resource. It is the expectation that when product manufacturers begin to provide product data in SPie format, that these companies will provide their O&M manuals in COBie format as well.

Documentation of installed equipment also called, Record of Designated Equipment, can all be provided in COBie format. The COBie deliverable completely replaces this deliverable. Associated Material Data Files and Material Safety Data Sheets (MSDS) files may be provided in PDF format and linked to the COBie.Type through the COBie.Document tab.

Much of the information found in the Commissioning report directly relates to COBie data. Specific tests an evaluation of associated design narratives can be directly captured in COBie format. Information not conducive to capturing COBie format maybe captured in PDF files and directly linked to the associated Zone, System, or Component.

If paper copies of final record copies of the as-built drawings complete set of contract documents with all modifications, and shop drawings, are not required these may be provided in PDF format and linked through the COBie.Document tab.

4.2.5.3 Process models formatting

The Business Process Modelling Notation (BPMN) template for MS Visio was used to create the process models found earlier in this section. The production of these models contained two enhancements. First, a swim-land to identified information exchanges has been added to simplify the diagram and emphasize that its primary purpose to identify information exchanges. Second, the level of detail and legend used for the NBIMS-US™ V3 COBie standard directly supports the economic evaluation of business process changes.

4.2.6. Exchange requirement documentation

Author’s Editorial Comment: The NBIMS-US™ V3 COBie standard updates the information provided in NBIMS-US™ V2. In some cases new information is also provided as required by the NBMS-US™ V3 submission criteria. The following errors in NBIMS-US™ V2 were corrected in this version of the standard:

- Zones use IfcZone rather than IfcSpatialZone to ease compatibility with IFC2x3.
- Task mappings changed to use IfcRecurrencePattern.Interval
- Product dimensions changed to use custom property set rather than IfcBoundingBox, as the nominal dimensions are not necessarily the same as the calculated geometric extents, and excluding geometry from COBie simplifies usage.
• Product material mappings changed to use IfcMaterialConstituentSet.
• File mappings now use IfcProxy (in addition to IfcRelAssociatesDocument) to capture metadata consistently and support documents without associated objects. Such documents must be associated with the overall Facility object.

Based on the rules NBIMS-US™ V3 Technical Subcommittee Evaluation Criteria for Revised Information Exchange submissions, the information provided in this section should be considered a moderate change.

4.2.6.1 Exchange requirements legibility

4.2.6.1.1 Exchange requirements list

- Facility Criteria
- Discipline Specifications
- Project Definition
- Space Program
- Product Program
- Design Early
- Design Schematic
- Design Coordinated
- Design Issue
- Product Type Template
- Product Template
- Bid Issue
- Product Type Selection
- System Layout
- Product Installation
- Product Inspection
- Construction Issue
- Product Type Parts
- Product Type Warranty
- Product Type Maintenance
- System Operation
- Space Condition
- Product Parts Replacement
- Space Occupancy
- Space Activity Renovation
- Remodel
- Expand
- Demolish

4.2.6.1.2 Exchange requirement classification list

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### Table 31 Classification of Design Exchanges

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### Table 32 Classification of Construction Exchanges

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<td>31-30 30 21</td>
<td>34-35 14 00</td>
<td>32-21 11 14</td>
<td>1.43</td>
<td>1.43</td>
<td>1.43 Prepare Bid and Submit</td>
</tr>
<tr>
<td>Product Type Selection</td>
<td>31-40 20 27 Submittal Processing</td>
<td>34-35 14 00</td>
<td>32-21 00 00</td>
<td>4.2 Provide Resources (Goods and Services)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System Layout</td>
<td>31-40 20 27 Submittal Processing</td>
<td>34-35 14 00</td>
<td>32-21 00 00</td>
<td>4.11 Develop Construction Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product Installation</td>
<td>31-40 40 11 17</td>
<td>34-35 14 00</td>
<td>32-21 17 41</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3 Build Building</td>
</tr>
<tr>
<td>Product Inspection</td>
<td>31-40 40 91 17 Evaluation</td>
<td>34-35 14 00</td>
<td>32-21 17 00</td>
<td>4.34 Inspect and Approve Work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction Issue</td>
<td>31-40 40 91 17 Evaluation</td>
<td>34-21 14 00</td>
<td>32-21 17 00</td>
<td>4.34 Inspect and Approve Work</td>
<td></td>
<td></td>
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<tr>
<td>Product Type Parts</td>
<td>31-40 50 00 Commissioning</td>
<td>34-35 17 00</td>
<td>32-21 00 00</td>
<td>4.4 Perform Commissioning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product Type Warranty</td>
<td>31-40 50 00 Commissioning</td>
<td>34-35 17 00</td>
<td>32-21 00 00</td>
<td>4.4 Perform Commissioning</td>
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</tr>
<tr>
<td>Product Type Maintenance</td>
<td>31-40 50 00 Commissioning</td>
<td>34-35 17 00</td>
<td>32-21 00 00</td>
<td>4.4 Perform Commissioning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commision</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>System Operation</td>
<td>31-40 50 00 Commissioning</td>
<td>34-35 17 00</td>
<td>32-21 00 00</td>
<td>4.4 Perform Commissioning</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 33 Classification of Operational Exchanges

<table>
<thead>
<tr>
<th>Project Phase</th>
<th>Contracting Phase</th>
<th>Contracted Exchanges</th>
<th>OmniClass Table 31–Phase</th>
<th>OmniClass Table 34–Actor</th>
<th>OmniClass Table 32–Service</th>
<th>buildingSMART alliance® Draft Tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>O &amp; M</td>
<td></td>
<td>Space Condition</td>
<td>31-50 20 21 Facility Inspection</td>
<td>34-41 11 00 Facility Manager</td>
<td>32-41 51 11 Inspecting</td>
<td>5.3 Evaluate Conditions and Detect Problems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Product Parts Replacement</td>
<td>31-50 20 11 Facility Operation</td>
<td>34-41 21 00 Maintenance</td>
<td>32-41 47 11 11 Facility Repairing</td>
<td>5.4 Develop Solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Space Occupancy</td>
<td>31-50 10 17 Use</td>
<td>34-41 11 00 Facility Manager</td>
<td>32-41 47 21 Space Planning</td>
<td>5.7 Perform Use of Facility/Building</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Space Activity Renovation</td>
<td>31-50 30 11 Facility Renovation</td>
<td>34-41 11 00 Facility Manager</td>
<td>32-41 47 21 Space Planning</td>
<td>5.8 Perform Facility/Building Renovation</td>
</tr>
<tr>
<td>Repurpose</td>
<td></td>
<td>Remodel</td>
<td>31-50 30 14 Facility Remodeling</td>
<td>34-41 11 00 Facility Manager</td>
<td>32-41 47 11 17 Facility Upgrading</td>
<td>5.10 Perform Facility/Building Expansion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Expand</td>
<td>31-50 30 17 Facility Expansion</td>
<td>34-41 11 00 Facility Manager</td>
<td>32-41 47 11 17 Facility Upgrading</td>
<td>5.10 Perform Facility/Building Expansion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Demolish</td>
<td>31-60 35 00 Recycling</td>
<td>34-41 11 00 Facility Manager</td>
<td>32-41 47 11 17 Facility Upgrading</td>
<td>5.11 Disposal, Reuse, Recycling</td>
</tr>
</tbody>
</table>

### 4.2.6.1.3 Exchange Requirement Coverage Analysis

### Table 34 Exchange Requirements Coverage

<table>
<thead>
<tr>
<th>Exchange</th>
<th>Process</th>
<th>Sender</th>
<th>Receiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility Criteria</td>
<td>31-10 00 00 Inception Phase</td>
<td>34-10 11 00 Owner</td>
<td>34-10 11 11 Developer</td>
</tr>
<tr>
<td>Discipline Specifications</td>
<td>31-10 00 00 Inception Phase</td>
<td>34-10 11 17 Public Entity</td>
<td>34-10 11 11 Developer</td>
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<tr>
<td>Project Definition</td>
<td>31-20 00 00 Conceptualization Phase</td>
<td>34-10 11 11 Developer</td>
<td>34-20 21 11 Planner</td>
</tr>
<tr>
<td>Space Program</td>
<td>31-30 00 00 Criteria Definition Phase</td>
<td>34-10 11 11 Developer</td>
<td>34-20 11 11 Architect</td>
</tr>
<tr>
<td>Product Program</td>
<td>31-30 00 00 Criteria Definition Phase</td>
<td>34-10 11 11 Developer</td>
<td>34-20 11 11 Architect</td>
</tr>
<tr>
<td>Design Early</td>
<td>31-40 00 00 Design Phase</td>
<td>34-20 11 11 Architect</td>
<td>34-10 11 11 Developer</td>
</tr>
<tr>
<td>Design Schematic</td>
<td>31-40 00 00 Design Phase</td>
<td>34-20 11 11 Architect</td>
<td>34-10 11 11 Developer</td>
</tr>
<tr>
<td>Design Coordinated</td>
<td>31-40 00 00 Design Phase</td>
<td>34-20 11 11 Architect</td>
<td>34-20 11 21 Engineer</td>
</tr>
<tr>
<td>Design Issue</td>
<td>31-40 00 00 Design Phase</td>
<td>34-20 11 21 Engineer</td>
<td>34-20 11 11 Architect</td>
</tr>
<tr>
<td>Product Type Template</td>
<td>31-40 00 00 Design Phase</td>
<td>34-20 11 11 Architect</td>
<td>34-20 11 41 Specifier</td>
</tr>
<tr>
<td>Product Template</td>
<td>31-40 00 00 Design Phase</td>
<td>34-20 11 41 Specifier</td>
<td>34-20 11 11 Architect</td>
</tr>
<tr>
<td>Bid Issue</td>
<td>31-60 00 00 Implementation Phase</td>
<td>34-35 15 11 Contractor</td>
<td>34-20 11 11 Architect</td>
</tr>
<tr>
<td>Product Type Selection</td>
<td>31-60 00 00 Implementation Phase</td>
<td>34-35 10 21 Supplier</td>
<td>34-20 11 11 Architect</td>
</tr>
<tr>
<td>System Layout</td>
<td>31-60 00 00 Implementation Phase</td>
<td>34-35 15 11 Contractor</td>
<td>34-20 11 21 Engineer</td>
</tr>
<tr>
<td>Product Installation</td>
<td>31-60 00 00 Implementation Phase</td>
<td>34-35 15 11 Contractor</td>
<td>34-20 11 11 Architect</td>
</tr>
<tr>
<td>Product Inspection</td>
<td>31-60 00 00 Implementation Phase</td>
<td>34-20 51 11 Reviewer</td>
<td>34-35 10 21 Supplier</td>
</tr>
<tr>
<td>Construction Issue</td>
<td>31-60 00 00 Implementation Phase</td>
<td>34-20 51 17 Inspector</td>
<td>34-35 15 11 Contractor</td>
</tr>
<tr>
<td>Product Type Parts</td>
<td>31-60 00 00 Implementation Phase</td>
<td>34-35 10 21 Supplier</td>
<td>34-10 11 00 Owner</td>
</tr>
</tbody>
</table>
4.2.6.2 Exchange requirements detail

4.2.6.2.1 Exchange requirements definition

4.2.6.2.1.1 Criteria - facility criteria

This exchange includes high-level criteria specific to the building to be constructed, but without regard for particular disciplines. Entities exported for this exchange include the following:

- IfcProject: Directory and context of data is provided.
- IfcActor: Project participants, roles, and contact information is provided.
- IfcSite: Site (General) information must be provided to identify the site upon which the facility is placed.
- IfcBuilding: Facility (General) information must be provided to identify the facilities in which floors and spaces may be found.
- IfcBuildingStory: Provide the name of each conceptual/physical vertical level of each of the facilities identified in the project wrapper, elevation value and units above local project datum, floor to Floor height and units.
- IfcSpace: Provide the name and floor for each space.
- IfcSpatialZone: Identify conceptual zones within the building that have a similar or grouped pattern of use. For example, zones may refer to mechanical heating zones, alarm systems zones, or groups of spaces to be used for specific clients.
- IfcPropertySet: Properties may be specified to indicate requirements at particular objects.

4.2.6.2.1.2 Criteria - discipline specifications

This exchange includes discipline-specific criteria, indicating scope and function of building systems and distribution systems. Entities exported for this exchange include the following:

- IfcProject: Directory and context of data is provided.
- IfcActor: Project participants, roles, and contact information is provided.
• IfcSystem: Building systems and distribution systems are be identified and specified.
• IfcPropertySet: Properties may be specified to indicate requirements at particular objects.

4.2.6.2.1.3 Project initiation - project definition

This exchange includes initial project information to describe a project and its contents. Entities exported for this exchange include the following:

• IfcProject: Directory and context of data is provided.
• IfcActor: Project participants, roles, and contact information is provided.
• IfcSite: Site (General) information must be provided to identify the site upon which the facility is placed.
• IfcBuilding: Facility (General) information must be provided to identify the facilities in which floors and spaces may be found.

4.2.6.2.1.4 Requirements - space program

This exchange includes requirements for the spatial layout of a building. Entities exported for this exchange include the following:

• IfcBuildingStory: Provide the name of each conceptual/physical vertical level of each of the facilities identified in the project wrapper, elevation value and units above local project datum, floor to floor height and units.
• IfcSpace: Provide the name and floor for each space.
• IfcSpatialZone: Identify conceptual zones within the building that have a similar or grouped pattern of use. For example, zones may refer to mechanical heating zones, alarm systems zones, or groups of spaces to be used for specific clients.
• IfcRelAssociatesClassification: Classifications may be applied to categorize spaces by function.
• IfcPropertySet: Properties may be specified to indicate requirements at particular objects.

4.2.6.2.1.5 Requirements – product program

This exchange includes requirements for physical components of a building. Entities exported for this exchange include the following:

• IfcElement: Identify general requirements of products to be used within the building.
• IfcRelAssociatesClassification: Classifications may be applied to categorize products by function.
• IfcPropertySet: Properties may be specified to indicate requirements at particular objects.

4.2.6.2.1.6 Design stage - design early

This exchange includes building layout information and allocation of products without regard for placement. Entities exported for this exchange include the following:

• IfcBuildingStory: Provide the name of each conceptual/physical vertical level of each of the facilities identified in the project wrapper, elevation value and units above local project datum, floor to Floor height and units.
• IfcSpace: Provide the name and floor for each space.
• IfcElement: Identify general requirements of elements within the building.
• IfcElementType: Identify specific product model types to be considered for use.
• IfcSystem: System name for each system must be identified before it can be associated with specific products and zones.
• IfcRelAssociatesClassification: Classifications may be applied to categorize spaces by function.
• IfcPropertySet: Properties may be specified to indicate requirements at particular objects.

4.2.6.2.1.7 Design stage - design schematic

This exchange includes building layout information and allocation of products with placement and connectivity. Entities exported for this exchange include the following:

• IfcSpace: Provide the name and floor for each space.
• IfcElement: Identify general requirements of elements within the building.
• IfcElementType: Identify specific product model types to be considered for use.
• IfcSystem: System name for each system must be identified before it can be associated with specific products and zones.
• IfcRelConnectsElements: Indicate mounting connections between elements.
• IfcRelConnectsPorts: Indicate port connections between elements.
• IfcRelAssociatesClassification: Classifications may be applied to categorize spaces by function.
• IfcPropertySet: Properties may be specified to indicate requirements at particular objects.

4.2.6.2.1.8 Design stage - design coordinated

This exchange includes building layout information and allocation of products with placement, connectivity, and assignment to systems and project participants. In IFC4, zones may be indicated spatially with functional designation, material constituents are supported to identify multiple materials and properties. Entities exported for this exchange include the following:

• IfcSpace: Provide the name and floor for each space.
• IfcElement: Identify general requirements of elements within the building.
• IfcElementType: Identify specific product model types to be considered for use.
• IfcSystem: Design building systems, structural systems, and distribution systems.
• IfcSpatialZone: Design zones for distribution systems.
• IfcRelConnectsElements: Indicate mounting connections between elements.
• IfcRelConnectsPorts: Indicate port connections between elements.
• IfcRelAssociatesMaterial: Indicate materials, layers, and profiles of elements.
• IfcRelAssignsToActor: Indicate project participants responsible for systems and elements.
• IfcRelAssignsToGroup: Indicate partitioning of building elements to systems.
• IfcPropertySet: Properties may be specified to indicate requirements at particular objects.
• IfcRelAssociatesClassification: Classifications may be applied to categorize products and systems by function.
• IfcElementQuantity: Quantities may be indicated on building elements and spatial structures.

4.2.6.2.1.9 Design stage - design issue

This exchange includes final design information with formal documents, and amended with design issue requests and responses. Entities exported for this exchange include the following:

• IfcActionRequest: Indicate reported issues and resolutions.
• IfcRelAssociatesDocument: Indicate external documents.

4.2.6.2.1.10 Design Stage - Product Type Template

This exchange includes definitions of properties to be captured by product templates.

Property templates are now supported in IFC4. Project composition excluded (no placeholder building is necessary). Entities exported for this exchange include the following:

• IfcRelAssociatesClassification: Classifications may be applied to categorize properties by common definitions.
• IfcPropertySetTemplate: Property set templates may be specified to indicate information to be provided for product types.
• IfcSimplePropertyTemplate: Property templates may be specified to describe each property within a property set.

4.2.6.2.1.11 Design stage - product template

This exchange includes product type information for specific product models provided by manufacturers.

Product types may be declared within a project without having any occurrences in IFC4. Project composition excluded (no placeholder building is necessary). Project libraries added (to provide link to originating property set templates). Entities exported for this exchange include the following:

• IfcProjectLibrary: Referenced libraries of property set templates are indicated.
• IfcPropertySet: Properties may be specified to indicate requirements at particular objects.
• IfcElementType: Identify specific product model types to be considered for use.
• IfcRelAssociatesClassification: Classifications may be applied to categorize product types.
• IfcRelAssociatesMaterial: Identify material constituents and material properties.

4.2.6.2.1.12 Construction stage - bid issue

This exchange includes bid submission information with formal documents, and amended with bid issue requests and responses. The IfcActionRequest entity captures all reported issues (or requests to do something), for which tasks may be assigned to carry out work to address an issue. Entities exported for this exchange include the following:

• IfcActionRequest: Indicate reported issues and resolutions.
• IfcRelAssociatesDocument: Indicate external documents.

4.2.6.2.13 Construction stage - product type selection

This exchange includes product type information for product models selected to be used, without regard for particular placement. Product types may be declared within a project without having any occurrences in IFC4. Project composition excluded (no placeholder building is necessary). Project libraries added (to provide link to originating property set templates). Entities exported for this exchange include the following:

• IfcProjectLibrary: Referenced libraries of product types are indicated.
• IfcElementType: Identify specific product model types to be considered for use.
• IfcRelDefinesByType: Indicate product types to be used at specific occurrences.
• IfcPropertySet: Properties may be specified to indicate requirements at particular objects.

4.2.6.2.14 Construction Stage - System Layout

This exchange includes detailed system connectivity information for building systems and distribution systems. Entities exported for this exchange include the following:

• IfcElement: Indicate specific element placement within the building.
• IfcSystem: Indicate system design and topology.
• IfcRelConnectsElements: Indicate general connections between elements.
• IfcRelConnectsPorts: Indicate port connections between elements.
• IfcPropertySet: Properties may be specified to indicate requirements at particular objects.

4.2.6.2.15 Construction stage - product installation

This exchange includes product placement information, including serial numbers at specific installations. Entities exported for this exchange include the following:

• IfcElement: Identify general requirements of elements within the building.
• IfcPropertySet: Properties may be specified to indicate requirements at particular objects.

4.2.6.2.16 Construction stage - product inspection

This exchange includes product inspection issues reported, which may require replacement of installed products. Entities exported for this exchange include the following:

• IfcActionRequest: Report issues related to products.

4.2.6.2.17 Construction stage – construction issue

This exchange includes construction issues reported, which may require additional labor. Entities exported for this exchange include the following:
• IfcActionRequest: Report issues related to construction.

4.2.6.2.1.18 Construction stage – product type parts

This exchange includes product part information, which may be used for addressing components for connectivity or replacement. IFC4 allows product types to have assigned process types and resource types, which may indicate standard processes (i.e. manufacturer-defined) for servicing or replacing parts. Entities exported for this exchange include the following:

• IfcTaskType: Indicate product part replacement processes.
• IfcConstructionProductResourceType: Indicate available resources and costs for part replacement.

4.2.6.2.1.19 Construction stage – product type warranty

This exchange includes product warranty information for parts and labor. Entities exported for this exchange include the following:

• IfcTaskType: Indicate warranty periods.
• IfcSubContractResourceType: Indicate warranty contracts.
• IfcRelAssociatesDocument: Indicate external documents for warranties.

4.2.6.2.1.20 Construction stage – product type maintenance

This exchange includes product maintenance information, including expected maintenance tasks and procedures. Entities exported for this exchange include the following:

• IfcTask: Schedule product maintenance processes.
• IfcConstructionResource: Schedule product maintenance resources.
• IfcRelAssociatesDocument: Indicate external documents for maintenance.

4.2.6.2.1.21 Construction stage – system operation

This exchange includes system operation information, including system operation procedures and events. Entities exported for this exchange include the following:

• IfcTask: Schedule system operation processes.
• IfcConstructionResource: Schedule system operation resources.
• Operations & Maintenance

4.2.6.2.1.22 O&M stage – space condition

This exchange includes reporting on the condition of spaces over time. In IFC4, all time-phased information is captured using performance-based properties on IfcPerformanceHistory. This allows for data to be recorded for multiple time periods (avoiding the single property set restriction), and to provide a
uniform way of accessing and rendering time-phased data such that software applications need not be aware of particular properties. A property set should be defined for recording space conditions over time. Entities exported for this exchange include the following:

- **IfcPropertySet**: Properties may be specified to indicate condition details.

### 4.2.6.2.1.23 O&M stage – product parts replacement

This exchange includes reporting on the replacement of product parts over time. In IFC4, the process and resource model has been formalized, such that replacement of parts may be considered as a MAINTENANCE task with assigned resources for materials, labor, equipment, products, crews, subcontracts. Entities exported for this exchange include the following:

- **IfcTask**: Report parts replacement over time.
- **IfcConstructionResource**: Report parts replacement resources.
- **IfcPropertySet**: Properties may be specified to indicate details.

### 4.2.6.2.1.24 O&M stage – space occupancy

This exchange includes scheduling occupancy of spaces over time. Entities exported for this exchange include the following:

- **IfcOccupant**: Indicate occupants.
- **IfcTask**: Indicate scheduled occupancy periods.
- **IfcSubContractResource**: Indicate leases for space occupancy.
- **IfcRelAssignsToActor**: Indicate current owner(s) and/or occupant(s) of a space.
- **IfcRelAssignsToProduct**: Indicate occupancy periods of spaces.
- **IfcRelAssignsToProcess**: Indicate resources assigned to space occupancy periods.
- **IfcPropertySet**: Properties may be specified to indicate details.

### 4.2.6.2.1.25 O&M stage – space activity renovation

This exchange includes scheduling reconfiguration of spaces over time. Entities exported for this exchange include the following:

- **IfcTask**: Indicate renovation tasks.
- **IfcConstructionResource**: Indicate renovation resources.
- **IfcRelAssignsToProduct**: Indicate elements to be renovated.
- **IfcRelAssignsToProcess**: Indicate resources assigned to tasks.
- **IfcPropertySet**: Properties may be specified to indicate details.

### 4.2.6.2.1.26 Recycle stage – remodel

This exchange includes changing the building layout of an existing structure. Entities exported for this exchange include the following:
• IfcTask: Indicate renovation tasks.
• IfcConstructionResource: Indicate renovation resources.
• IfcRelAssignsToProduct: Indicate elements to be renovated.
• IfcRelAssignsToProcess: Indicate resources assigned to tasks.
• IfcPropertySet: Properties may be specified to indicate details.

4.2.6.2.1.27 (not used)

4.2.6.2.1.28 Recycle stage – expand

This exchange includes expanding the building layout of an existing structure. Entities exported for this exchange include the following:

• IfcTask: Indicate renovation tasks.
• IfcConstructionResource: Indicate renovation resources.
• IfcRelAssignsToProduct: Indicate elements to be renovated.
• IfcRelAssignsToProcess: Indicate resources assigned to tasks.
• IfcPropertySet: Properties may be specified to indicate details.

4.2.6.2.1.29 Recycle stage – demolish

This exchange includes demolishing an existing structure partially or in full. Entities exported for this exchange include the following:

• IfcTask: Indicate renovation tasks.
• IfcConstructionResource: Indicate renovation resources.
• IfcRelAssignsToProduct: Indicate elements to be renovated.
• IfcRelAssignsToProcess: Indicate resources assigned to tasks.
• IfcPropertySet: Properties may be specified to indicate details.

4.2.6.2.1.30 Use of assemblies within COBie

To simplify interoperability, part composition is excluded in this MVD. Work related to the inclusion of assemblies has, however, been mapped to support related MVD’s for HVAC, water, and electrical systems. Use of Assembly information for NBIMS-US™ V3 must be specified as a supplemental implementers’ agreement, only if required by contract.

4.2.6.2.1.31 Use of connections within COBie

To simplify interoperability, element and port connectivity was excluded in this MVD. Work related to the inclusion of ports has, however, been mapped to support related MVD’s for HVAC, water, and electrical systems. Use of Connection information for NBIMS-US™ V3 must be specified as a supplemental implementers’ agreement, only if required by contract.

4.2.6.2.1.32 Use of impacts within COBie
Proposed IFC 4 TC1 extensions may include PSet_EnvironmentalImpact. Once that extension has been developed, and mapping back to IFC 2x3 have been accomplished, implementers’ agreements may support the use of Impact information.

4.2.6.2.1.33 Use of coordinates within COBie

Exchange requirements governing COBie described in this standard identify the relationship between asset information and spatial geometry simply that of “spatial containment.” Spatial containment means that each individually named asset shall be identified as being “in” one space. When equipment is in a single space, as is the case with the vast majority of equipment with a facility, this requirement needs no clarification. For the special case of large equipment placed in the ceiling, spanning several spaces, the space associated with the equipment the one from which the equipment is most typically maintained. There are yet other situations, such as equipment located on a large geographic site where some geometric placement information may be helpful.

Given the very limited ability of COBie, in spreadsheet view, to represent only points, lines, and boxes, COBie is not able to provide any significant geometric representation. COBie may, in special cases, however, assist in identifying the location of equipment. To support these special cases, the following entities may, optionally, have the following Coordinate representations in COBie.

Table 35 Use of Coordinates with COBie

<table>
<thead>
<tr>
<th>Entity</th>
<th>Coordinate Type</th>
<th>Required value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facility</td>
<td>Lower-Left Corner</td>
<td>Typically set to 0,0,0</td>
</tr>
<tr>
<td>Floor</td>
<td>Lower-Left Corner</td>
<td>Relative to Facility</td>
</tr>
<tr>
<td>Space</td>
<td>Lower-Left &amp; Upper-Right Corner</td>
<td>Relative to Floor</td>
</tr>
<tr>
<td>Component</td>
<td>Lower-Left &amp; Upper-Right Corner</td>
<td>Relative to Floor</td>
</tr>
<tr>
<td>Assembly</td>
<td>Lower-Left &amp; Upper-Right Corner</td>
<td>Relative to Floor</td>
</tr>
</tbody>
</table>

Use of Coordinate information for NBIMS-US™ V3 must be specified as a supplemental implementers’ agreement, only if required by contract.

4.2.6.2.1.34 Use of attributes within COBie – mapping between IFC and SpreadsheetML

Implementers agreements documented in buildingSMART alliance® Challenge events have separately document the updates needed for custom property sets that are provided separately from mandatory standards. These implementers agreements, found in the COBie responsibility matrix, have resolved implementation issues to ensure that the quality COBie data can be demonstrated to match the same data found on design drawing schedules and manufacturers data sheets. The standardization of specific property sets is outside the scope of the COBie effort.

4.2.6.2.1.35 Use of attributes within COBie – product data

Attributes sets for standard equipment types have not been submitted for consencus review during NBIMS-US™ V3. In the absence of NBIMS-US™ standard the COBie Guide, a published commentary, states that the attributes found in a COBie file must match those product data properties found on the associated contract deliverables.

4.2.6.2.2 Business rule list

The business rules verify that exchange of COBie data conform to the required data specification can be generalized into rule classes. Application of these rules results in the verification that the internal integrity of a COBie data set is correct. These rules do not validate the COBie deliverable against contract-specific requirements. The list of COBie rule classes is provided in the list below.
While the specific content of information exchanges related to Spatial and Product assets differs as a project progresses, the business rules used to verify the integrity of the information are exactly the same for all such exchanges. The following information exchanges share the business rules noted in the table below:

- Facility Criteria Exchange
- Space Program
- Product Program
- Early Design
- Design Schematic
- Design Coordinated
- System Layout

<table>
<thead>
<tr>
<th>Entity</th>
<th>COBie Metadata</th>
<th>COBie Contact</th>
<th>External Data Constraints</th>
<th>Classification</th>
<th>Spatial Composition</th>
<th>Conversion Units</th>
<th>Project Declaration</th>
<th>Group Assignment</th>
<th>Object Typing</th>
<th>Property Sets</th>
<th>Quantities on Occurrences</th>
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<th>Spatial Containment</th>
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The business rules associated with Discipline Specifications exchanges differ from those listed in the previous table since these discipline-specific exchanges are concerned with the technical specifications of product oriented assets. Note that the requirement for discipline specifications to have ifcBuilding, ifcSite, ifcProject entities is an artefact of the modelling of such information using the Industry Foundation Class Model only.

Table 37 Business Rules – Discipline Specifications

<table>
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<th>Entity</th>
<th>COBie Metadata</th>
<th>COBie Contact</th>
<th>External Data Constraints</th>
<th>Classification</th>
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</table>

Business rules associated with product definition are a sub-set of those required to define the requirements for the program, and the design that is proposed to meet those requirements. Business rules associated with COBie files submitted at the Project Definition stage are noted in the table below.

Table 38 Business Rules – Project Definition

<table>
<thead>
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There are exchanges related to the identification and resolution of issues on the project. While the content and timing of these exchanges differ the following exchanges all share a common set of rules used to verify the internal consistency of the information exchange:

- Design Issue
- Bid Issue
- Product Inspection
- Construction Issue

<table>
<thead>
<tr>
<th>Table 39 Business Rules – Issue Type Exchanges</th>
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</table>

<table>
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Many information exchanges that build to create COBie data pertain to exchanges about product types. This begins with an initial configuration of a generic product, to the identification of explicit product types, to the selection of possible candidates for that specification, and then through construction during the submittal process. The following product type exchanges share the business rules found in the table below:

- Product Type Template
- Product Type Selection
- Product Type Warranty
- Product Type Parts

IfcActor applies to all exchanges, except the initial exchange Product Type Template. IfcConstructionResourceType only applies to the Product Type Parts, exchange.

Table 40 Business Rules – Product Type Exchanges

<table>
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<th>Entity</th>
<th>COBie Metadata</th>
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<th>External Data Constraints</th>
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<th>Spatial Composition</th>
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* NOTE: The inclusion of this entity is required for complete specification of IFC-based file exchange; however, such information is not directly required by the exchange itself if the information is provided through a transactional or web-service exchange. The transactional specification for Product Type Exchanges may be found in the NBIMS-US™ V3 LCie standard.

The specifics of individual product instances, as defined by ifcElement entities are added for:

- Product Template
- Product Installation
### Table 41 Business Rules – Product Installation

<table>
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<th>Entity</th>
<th>COBie Metadata</th>
<th>COBie Contact</th>
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* NOTE: The inclusion of this entity is required for complete specification of IFC-based file exchange; however, such information is not directly required by the exchange itself if the information is provided through a transactional or web-service exchange, versus a COBie file-based exchange. The transactional specification for Product Type Exchanges may be found in the NBIMS-US™ V3 LCie standard.

Information about operations and maintenance activities introduces the entity of an ifcTask to the exchange requirement. Business rules pertaining to those tasks ensure appropriate connection of the tasks to their associated type objects and allow sequencing of operations within tasks. The following exchanges share the business rules listed in the table below:

- Product Type Maintenance
- System Operations

### Table 42 Business Rules – O&M Information Type Exchanges

<table>
<thead>
<tr>
<th>Entity</th>
<th>COBie Metadata</th>
<th>COBie Contact</th>
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*NOTE: The inclusion of this entity is required for complete specification of IFC-based file exchange; however, such information is not directly required by the exchange itself if the information is provided through a transactional or web-service exchange, versus a COBie file-based exchange. The transactional specification for Product Type Exchanges may be found in the NBIMS-US™ V3 LCie standard. Upon commencement of the operation of the facility information about service orders used to repair or replace individual parts of fixed assets can be captured in the following exchange. While the information in the underlying COBie data is not changed, information about the filters, lubricants, or replacement parts are exchanged in the ifcConstructionResource entity.

Table 43 Business Rules – Product Parts Replacement

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<th>Object Typing</th>
<th>property Sets</th>
<th>Quantities on Occurrences</th>
<th>Spatial Containment</th>
</tr>
</thead>
<tbody>
<tr>
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<td>x</td>
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<tr>
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<tr>
<td>IfcZone</td>
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<tr>
<td>IfcActor</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>
* NOTE: The inclusion of this entity is required for complete specification of IFC-based file exchange; however, such information is not directly required by the exchange itself if the information is provided through a transactional or web-service exchange, versus a COBie file-based exchange. The transactional specification for Product Type Exchanges may be found in the NBIMS-US™ V3 LCie standard.

Surveys of space condition and occupancy share a common data set. The exchanges using the following post-occupancy spatial exchanges are defined in the table below:

- Space Condition
- Space Occupancy

Table 44 Business Rules - Post-occupancy Space Exchanges

<table>
<thead>
<tr>
<th>Entity</th>
<th>COBie Metadata</th>
<th>COBie Contact</th>
<th>Description</th>
<th>Spatial Composition</th>
<th>Conversion</th>
<th>Project Declaration</th>
<th>Group Assignment</th>
<th>Property Sets</th>
<th>Quantities on Occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td>IfcSpace</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IfcBuildingStorey</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IfcBuilding</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IfcSite</td>
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<tr>
<td>IfcProject</td>
<td>X</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<td></td>
<td></td>
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<tr>
<td>IfcZone</td>
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<td>x</td>
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<tr>
<td>IfcActor</td>
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</tr>
</tbody>
</table>

Note that this definition of a spatial occupancy survey may be too narrow for some facility managers. If a given facility manager also collects information about product-based assets during their surveys, then the “Post-Occupancy Type Exchanges” table may be used.

Post-Occupancy exchanges allow a delivered facilities information to be kept up to date. Information exchanges related to specific work orders should be maintained within CMMS/CAFM systems as part of work order processing and are outside the larger scope of the project life-cycle identified in this standard. COBie defines several exchanges in which information about a part of a facility, or an entire facility, may be updated. The table below identifies the business rules associated with the exchange of the following post-occupancy information exchanges:

- Product Parts Replacement
- Space Activity Renovation
- Remodel
- Expand
- Demolish

### Table 45 Business Rules – Post-occupancy Space & Product Exchanges

<table>
<thead>
<tr>
<th>Entity</th>
<th>COBie Metadata</th>
<th>COBie Contact</th>
<th>External Data Constraints</th>
<th>Classification</th>
<th>Spatial Composition</th>
<th>Conversion Units</th>
<th>Project Declaration</th>
<th>Group Assignment</th>
<th>Object Typing</th>
<th>Property Sets</th>
<th>Quantities on Occurrences</th>
<th>Spatial Containment</th>
</tr>
</thead>
<tbody>
<tr>
<td>IfcSpace</td>
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<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
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<tr>
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<td>IfcSystem</td>
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<tr>
<td>ifcElementType</td>
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<td>IfcActor</td>
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</tbody>
</table>

In addition to these business rules the following expected set of categorization is expected to be provided on COBie data files. For COBie data extracted from IFC models COBie transformation rules, defined in Annexes to these documents provide the default settings. While some classifications have been developed based on IFC type enumerations, these classifications represent the general practice within the United States. As such these are provided for information only as specific regions, owners, and contracts may require alternative values for such information. The listing below is presented in a format that corresponds to the order in which these fields are encountered within the COBie Spreadsheet version.

**Contact.Category** - if allowable values are not specified by contract, the default value for this information is the current OmniClass Table 34.

**Facility.Category** - If allowable values are not specified by contract, the default value for this information is the current OmniClass Table 11.

**Floor.Category** - If allowable values are not specified by contract, the default values are: “Floor”, “Roof”, and “Site”.

**Space.Category** - If allowable values are not specified by contract, the default value for this information is the current OmniClass Table 13.
**Zone.Category** - If allowable values are not specified by contract, the default values are: “Circulation Zone”, “Lighting Zone”, “Fire Alarm Zone”, “Historical Preservation Zone”, “Occupancy Zone”, and “Ventilation Zone”.

**Type.Category** - If allowable values are not specified by contract, the default value for this information is the current OmniClass Table 23.

**Type.AssetType** - If allowable values are not specified by contract, the default values are: “Fixed” and “Movable”.

**Type.WarrantyDurationUnit** - If allowable values are not specified by contract, the default values are: “month” and “year”.

**Type.DurationUnit** - If allowable values are not specified by contract, the default values are: “month” and “year”.

**System.Category** - If allowable values are not specified by contract, the default value for this information is the current OmniClass Table 21.

**Assembly.AssemblyType** - If allowable values are not specified by contract, the default values are: “Fixed”, “Optional”, “Included”, “Excluded”, “Layer”, “Patch”, and “Mix”.

**Connection.ConnectionType** - If allowable values are not specified by contract, the default values are: “Control”, “Flow”, “Return”, “Supply”, and “Structural”.

**Spare.Category** - If allowable values are not specified by contract, the default values are: “Part”, “PartSet”, “Lubricant”, “Other”, “Spare”, and “SpareSet”.

**Resource.Category** - If allowable values are not specified by contract, the default values are: “Labor”, “Material”, “Tools”, and “Training”.


**Job.Status** - If allowable values are not specified by contract, the default values are: “Not Yet Started”, “Started”, and “Completed”.

**Impact.ImpactType** - If allowable values are not specified by contract, the default values are: “Cost”, “ClimateChange”, and “PrimaryEnergyConsumption”.

**Impact.ImpactStage** - If allowable values are not specified by contract, the default values are: “Production”, “Installation”, “Maintenance”, “Replacement”, “Use”, and “Reuse”.

**Impact.ImpactUnit** - If allowable values are not specified by contract, the default values are: “currency”, “kgCO2e”, “MJ”, “other”, or “n/a”.

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Document.ApprovalBy - If allowable values are not specified by contract, the default values are: “Owner Approval”, “Contractor Certified”, and “Information Only”.

Document.Stage - If allowable values are not specified by contract, the default values are: “As Built”, “Submitted”, “Approved”, “Exact Requirement”, “Maximum Requirement”, “Minimum Requirement”, and “Requirement”.

Attribute.Category - If allowable values are not specified by contract, the default values are: “As Built”, “Submitted”, “Approved”, “Exact Requirement”, “Maximum Requirement”, “Minimum Requirement”, and “Requirement”.

Coordinate.Category - If allowable values are not specified by contract, the default values are: “point”, “line-end-one”, “line-end-two”, “box-lowerleft”, and “box-upperright”.

Issue.Type - If allowable values are not specified by contract, the default values are: “Change”, “Claim”, “Coordination”, “Environmental”, “Function”, “IndoorAirQuality”, “Installation”, “RFI”, “Safety”, and “Specification”.

Issue.Risk - If allowable values are not specified by contract, the default values are: “Very High”, “High”, “Moderate”, “Low”, and “Unknown”.

Issue.Chance - If allowable values are not specified by contract, the default values are: “Has Occurred”, “High”, “Moderate”, “Low”, and “Unknown”.

Issue.Impact - If allowable values are not specified by contract, the default values are: “Very High”, “High”, “Moderate”, “Low”, and “Unknown”.

4.2.6.2.3 Business Rule Definition

Classification - Verify presence of a classification system composed of a number part and a name part are present.

Conversion Units - Verify that common units for COBie required object properties have been identified.

COBie Metadata - Verify unique object naming according to COBie business rules.

COBie Contact - Verify identification of authorship or responsible party.

Control Assignment - Verify that the party responsible for resolution of specific issues is a valid COBie Contact.


Group Assignment - Verify that group assignments are internally consistent.
Object Typing - Verify that product assets have a valid Type associated with them.

Project Declaration - Verify that values are present in required project information fields.

Property Sets - Verify the proper structure of any property sets associated with any object. Of particular interest is that all numeric properties have explicitly defined units.

Quantities on Occurrences - Verify that values are identified for properties have been provided either through specific object properties, or property sets.

Sequential Connectivity - Verify that identified tasks are appropriately linked to related entities and that individual operations, if specified, are provided sequentially.

Spatial Composition - Verify the relations between spatial objects exist according to COBie business rules. For Components, verify that all components are assigned to a specific Space.

Spatial Containment - Verify that each managed asset is associated with a Space.

4.2.6.3 Exchange requirements reusability

4.2.6.3.1 Related business process list

Business processes that deliver information about a wide variety of assets can be found in the NBIMS-US™ V3 BPie and LCie standards. Assets specific to individual systems, represented by other NBIMS-US™ V3 standards (HVACie, Sparkie, WSie, and BAmie) require the exchange of information about a limited subset of the entire list of building assets. COBie processes serve as the template for the exchange of facility asset information (Spaces and Equipment) in each of these standards.

The table below identifies the general categories of COBie by phase of project, using OmniClass Table 31, and compares those processes to the processes identified in related NBIMS-US™ V3 information exchange submissions.

<table>
<thead>
<tr>
<th>Phase of Project</th>
<th>Building Programming (BPie)</th>
<th>COBie</th>
<th>Mechanical System Design (HVACie)</th>
<th>Electrical System Design (Sparkie)</th>
<th>Plumbing System Design (WSie)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31-10 00 00 Inception Phase</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31-20 00 00 Conceptualization Phase</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>31-30 00 00 Criteria Definition Phase</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
4.2.6.3.2 Related exchange requirements list

Given that COBie defines asset-related the processes defined generically (in BPie and LCie), or within the context of a specific design and construction discipline (HVACie, Sparkie, WSie, BAMie) as noted in the previous section, it is the case that COBie also defines the generic requirements for exchange of information about these same spatial and equipment assets. The following lists the COBie exchange requirements that may be relevant to other projects.

- Facility Criteria
- Discipline Specifications
- Project Definition
- Space Program
- Product Program
- Design Early
- Design Schematic
- Design Coordinated
- Design Issue
- Product Type Template
- Product Template
- Bid Issue
- Product Type Selection
- System Layout
- Product Installation
- Product Inspection
- Construction Issue
- Product Type Parts
- Product Type Warranty
- Product Type Maintenance
- System Operation
- Space Condition
- Product Parts Replacement
- Space Occupancy
- Space Activity Renovation
- Remodel
- Expand
- Demolish

4.2.6.3.3 Related exchange requirement reuse analysis

A detailed reuse analysis was conducted between the COBie, a life-cycle specification and the following design-side projects and proposed standards:

- BPie
- BAMie
- HVACie
- SPARKie
- WSie

The analysis conducted recognized that the projects identified above version 1.0 specification that focused not on the life-cycle nature of the exchanges but focused on the definition of the design-side
exchanges. This focus was necessary in order to establish that information that should be provided by designers in each context. Future extensions to these projects can further complete the table below since updated during construction and operations would also share many of the same exchange requirements. The table below demonstrates potential re-use of information contained in COBie, with other buildingSMART alliance® information exchange projects.

<table>
<thead>
<tr>
<th>Table 47 Exchange Requirement Reuse Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exchange</td>
</tr>
<tr>
<td>Facility Criteria</td>
</tr>
<tr>
<td>Discipline Specifications</td>
</tr>
<tr>
<td>Project Definition</td>
</tr>
<tr>
<td>Space Program</td>
</tr>
<tr>
<td>Product Program</td>
</tr>
<tr>
<td>Design Early</td>
</tr>
<tr>
<td>Design Schematic</td>
</tr>
<tr>
<td>Design Coordinated</td>
</tr>
<tr>
<td>Design Issue</td>
</tr>
<tr>
<td>ProductTypeTemplate</td>
</tr>
<tr>
<td>Product Template</td>
</tr>
<tr>
<td>Bid Issue</td>
</tr>
<tr>
<td>ProductTypeSelection</td>
</tr>
<tr>
<td>System Layout</td>
</tr>
<tr>
<td>Product Installation</td>
</tr>
<tr>
<td>Product Inspection</td>
</tr>
<tr>
<td>Construction Issue</td>
</tr>
<tr>
<td>Product Type Parts</td>
</tr>
<tr>
<td>ProductTypeWarranty</td>
</tr>
<tr>
<td>ProductTypeMaintenance</td>
</tr>
<tr>
<td>System Operation</td>
</tr>
<tr>
<td>Space Condition</td>
</tr>
<tr>
<td>ProductPartsReplacement</td>
</tr>
<tr>
<td>Space Occupancy</td>
</tr>
<tr>
<td>Space ActivityRenovation</td>
</tr>
<tr>
<td>Remodel</td>
</tr>
<tr>
<td>Expand</td>
</tr>
<tr>
<td>Demolish</td>
</tr>
</tbody>
</table>

4.2.7 Model view definition documentation

Author’s Editorial Comment: The NBIMS-US™ V2 standard did not include the content of the associated MVD. NBIMS-US™ V2 referenced the buildingSMART international Facility Management Handover Model View Definition (MVD) web site as the source for the COBie MVD. This NBIMS-US™ V3 standard replaces the originally referenced MVD with the MVD documentation found in this section. The MVD documentation provided in this chapter reproduces information needed for the COBie MVD from the IFC.
reference standard. A web-based set of information using the buildingSMART international ifcDocs XML schema will be published to allow users the familiar IFC schema browsing capability. Based on the rules NBIMS-US™ V3 Technical Subcommittee Evaluation Criteria for Revised Information Exchange submissions, the information provided in this section should be considered a moderate change.

4.2.7.1 Data definitions list

The list of IFC entities contained in this MVD is shown below:

- IfcSpace
- IfcBuildingStory
- IfcBuilding
- IfcSite
- IfcProject
- IfcZone
- IfcSystem
- IfcElement
- IfcElementType
- IfcTask
- IfcActor
- IfcActionRequest
- IfcProcess
- IfcGroup
- IfcPropertySet
- IfcAnnotation
- IfcRelConnectsPorts
- IfcWorkSchedule
- IfcRelAssociatesDocument
- IfcRelConnectsWithRealizingElements
- IfcConstructionProductResource
- IfcConstructionProductResourceType

4.2.7.2 Data definitions

Each data definition is listed by name along with description and specifications in EXPRESS schema definition (ISO-10303-11) and XML Schema Definition (XSD). The XSD representation is directly consumable by software tools for editing XML data exchange, while the EXPRESS representation provides rich metadata suitable for translation into programming languages and database schemas.

Data definitions are adapted from Industry Foundation Classes, where any attributes that are unused are stripped or omitted; in EXPRESS, such stripped attributes use the type “IfcStrippedOptional”, preserving the order of attributes for file format compatibility; in XSD, such stripped attributes are simply omitted as XML formats use named tags without any order dependency.

4.2.7.2.1 IfcSpace definition

A space represents an area or volume bounded actually or theoretically. Spaces are areas or volumes that provide for certain functions within a building.

A space is associated to a building story (or in case of exterior spaces to a site). A space may span over several connected spaces. Therefore a space group provides for a collection of spaces included in a story. A space can also be decomposed in parts, where each part defines a partial space. This is defined by the CompositionType attribute of the supertype IfcSpatialStructureElement which is interpreted as follow:

- COMPLEX = space group
- ELEMENT = space
PARTIAL = partial space

NOTE: View definitions and implementation agreements may restrict spaces with CompositionType=ELEMENT to be non-overlapping.

The IfcSpace is used to build the spatial structure of a building (that serves as the primary project breakdown and is required to be hierarchical). The spatial structure elements are linked together by using the objectified relationship IfcRelAggregates. The figure below shows the IfcSpace as part of the spatial structure. It also serves as the spatial container for space related elements.

NOTE: Detailed requirements on mandatory element containment and placement structure relationships are given in view definitions and implementer agreements.

![Figure 31 ifcSpace - Spatial Structure](image)

The following guidelines should apply for using the Name, Description, LongName and ObjectType attributes.

- Name holds the unique name (or space number) from the plan.
- Description holds any additional information field the user may have specified, there are no further recommendations.
- LongName holds the full name of the space, it is often used in addition to the Name, if a number is assigned to the room, then the descriptive name is exchanged as LongName.
- ObjectType holds the space type, i.e. usually the functional category of the space.

NOTE: In cases of inconsistency between the geometric representation of the IfcSpace and the combined geometric representations of the surrounding IfcRelSpaceBoundary, the geometric representation of the space should take priority over the geometric representation of the surrounding space boundaries. The figure below describes the heights and elevations of the IfcSpace.
Figure 32 ifcSpace - Heights

HISTORY New entity in IFC1.0

Attribute Use Definition
- elevation of the space (top of construction slab) equals elevation of story: provided by IfcBuildingStory.Elevation relative to IfcBuilding.ElevationOfRefHeight
- elevation of the space flooring (top of flooring on top of slab): provided by IfcSpace.ElevationWithFlooring relative to IfcBuilding.ElevationOfRefHeight
- height of space (top of slab below to bottom of slab above): provided by BaseQuantity with Name="Height"
- floor height of space (top of slab below to top of flooring): provided by BaseQuantity with Name="FinishFloorHeight"
- net height of space (top of flooring to bottom of suspended ceiling): provided by BaseQuantity with Name="FinishCeilingHeight"

EXPRESS Specification:

ENTITY IfcBuildingStorey
  SUBTYPE OF (IfcSpatialStructureElement);
Attribute Definitions:

**Elevation**

Elevation of the base of this storey, relative to the 0,00 internal reference height of the building. The 0.00 level is given by the absolute above sea level height by the ElevationOfRefHeight attribute given at IfcBuilding.

Inheritance Graph:

**ENTITY** IfcBuildingStorey

**ENTITY** IfcRoot

GlobalId : IfcGloballyUniqueId;
OwnerHistory : OPTIONAL IfcOwnerHistory;
Name : OPTIONAL IfcLabel;
Description : OPTIONAL IfcText;

**ENTITY** IfcObjectDefinition

INVERSE

HasAssignments : SET OF IfcRelAssigns FOR RelatedObjects;
HasContext : SET [0:1] OF IfcRelDeclarations FOR RelatedDefinitions;
IsDecomposedBy : SET OF IfcRelAggregates FOR RelatingObject;
Decomposes : SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
HasAssociations : SET OF IfcRelAssociates FOR RelatedObjects;

**ENTITY** IfcObject

ObjectType : OPTIONAL IfcStrippedOptional;

INVERSE

IsTypedBy : SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;
IsDefinedBy : SET OF IfcRelDefinesByProperties FOR RelatedObjects;

**ENTITY** IfcProduct

ObjectPlacement : OPTIONAL IfcStrippedOptional;
Representation : OPTIONAL IfcStrippedOptional;

INVERSE

**ENTITY** IfcSpatialElement

LongName : OPTIONAL IfcStrippedOptional;

INVERSE

ContainsElements : SET OF IfcRelContainedInSpatialStructure FOR RelatingStructure;

**ENTITY** IfcSpatialStructureElement

CompositionType : OPTIONAL IfcStrippedOptional;

**ENTITY** IfcBuildingStorey

Elevation : OPTIONAL IfcStrippedOptional;

END_ENTITY;

```xml
<xs:element name="IfcBuildingStorey" type="ifc:IfcBuildingStorey" substitutionGroup="ifc:IfcSpatialStructureElement" nillable="true"/>
<xs:complexType name="IfcBuildingStorey">
  <xs:complexContent>
    <xs:extension base="ifc:IfcSpatialStructureElement"/>
  </xs:complexContent>
</xs:complexType>
```
4.2.7.2.2 IfcBuildingStory Definition

The building story has an elevation and typically represents a (nearly) horizontal aggregation of spaces that are vertically bound.

A story is (if specified) associated to a building. A story may span over several connected storys. Therefore story complex provides for a collection of storys included in a building. A story can also be decomposed in (horizontal) parts, where each part defines a partial story. This is defined by the composition type attribute of the supertype IfcSpatialStructureElements which is interpreted as follow:

- **COMPLEX**: building story complex
- **ELEMENT**: building story
- **PARTIAL**: partial building story

EXAMPLE In split level houses, a story is split into two or more partial storys, each with a different elevation. It can be handled by defining a story, which includes two or more partial storys with the individual elevations.

The IfcBuildingStory is used to build the spatial structure of a building (that serves as the primary project breakdown and is required to be hierarchical). The spatial structure elements are linked together by using the objectified relationship IfcRelAggregates. The figure below shows the IfcBuildingStory as part of the spatial structure. It also serves as the spatial container for building and other elements.

NOTE: Detailed requirements on mandatory element containment and placement structure relationships are given in view definitions and implementer agreements.
HISTORY  New entity in IFC1.0

**Attribute Use Definition**
The figure below describes the heights and elevations of the IfcBuildingStory.

- elevation of story provided by: IfcBuildingStory.Elevation as a local height value relative to IfcBuilding.ElevationOfRefHeight, it is usually the top of construction slab
- net height of story, also referred to as total height or system height (top of construction slab to top of construction slab above): provided by BaseQuantity with Name="GrossHeight"
- net height of story (top of construction slab to bottom of construction slab above): provided by BaseQuantity with Name="NetHeight"

**Figure 33 ifcBuildingStory - Spatial Structure**

**Figure 34 ifcBuildingStory - Heights**

**EXPRESS Specification:**

**ENTITY** IfcBuildingStorey

**SUBTYPE OF** (IfcSpatialStructureElement);

Elevation : **OPTIONAL** IfcStrippedOptional;
Attribute Definitions:

**Elevation** : Elevation of the base of this storey, relative to the 0,00 internal reference height of the building. The 0.00 level is given by the absolute above sea level height by the ElevationOfRefHeight attribute given at IfcBuilding.

Inheritance Graph:

**ENTITY IfcBuildingStorey**

**ENTITY IfcRoot**

**ENTITY IfcObjectDefinition**

**ENTITY IfcObject**

**ENTITY IfcProduct**

**ENTITY IfcSpatialElement**

**ENTITY IfcBuildingStorey**

```xml
<xs:element name="IfcBuildingStorey" type="ifc:IfcBuildingStorey" substitutionGroup="ifc:IfcSpatialStructureElement" nillable="true"/>
<xs:complexType name="IfcBuildingStorey">
  <xs:complexContent>
    <xs:extension base="ifc:IfcSpatialStructureElement"/>
  </xs:complexContent>
</xs:complexType>
```
4.2.7.2.3 IfcBuilding definition

A building represents a structure that provides shelter for its occupants or contents and stands in one place. The building is also used to provide a basic element within the spatial structure hierarchy for the components of a building project (together with site, story, and space).

NOTE Definition from ISO 6707-1:

Construction work that has the provision of shelter for its occupants or contents as one of its main purpose and is normally designed to stand permanently in one place.

A building is (if specified) associated to a site. A building may span over several connected or disconnected buildings. Therefore building complex provides for a collection of buildings included in a site. A building can also be decomposed in (vertical) parts, where each part defines a building section. This is defined by the composition type attribute of the supertype IfcSpatialStructureElements which is interpreted as follow:

- **COMPLEX**: building complex
- **ELEMENT**: building
- **PARTIAL**: building section

The IfcBuilding is used to build the spatial structure of a building (that serves as the primary project breakdown and is required to be hierarchical). The spatial structure elements are linked together by using the objectified relationship IfcRelAggregates. The figure below shows the IfcBuilding as part of the spatial structure. It also serves as the spatial container for building and other elements.

![Figure 35 IfcBuilding - Spatial Structure](image-url)
HISTORY New entity in IFC1.0.

NOTE: detailed requirements on mandatory element containment and placement structure relationships are given in view definitions and implemener agreements.

Systems, such as building service or electrical distribution systems, zonal systems, or structural analysis systems, relate to IfcBuilding by using the objectified relationship IfcRelServicesBuildings.

Attribute Use Definition

The figure below describes the heights and elevations of the IfcBuilding. It is used to provide the height above sea level of the project height datum for this building, that is, the internal height 0.00. The height 0.00 is often used as a building internal reference height and equal to the floor finish level of the ground floor.

- base elevation of building provided by: IfcBuilding.ElevationOfRefHeight, it is usually the top of construction slab
- base elevation of terrain at the perimeter of the building provided by: IfcBuilding.ElevationOfTerrain, it is usually the minimum elevation is sloped terrain
- total height of building, also referred to as ridge height (top of roof structure, e.g. the ridge against terrain): provided by BaseQuantity with Name="TotalHeight"
- eaves height of building (base of roof structure, e.g. the eaves against terrain): provided by BaseQuantity with Name="EavesHeight"
EXPRESS Specification:

ENTITY IfcBuilding
  SUBTYPE OF (IfcSpatialStructureElement);
  ElevationOfRefHeight : OPTIONAL IfcStrippedOptional;
  ElevationOfTerrain : OPTIONAL IfcStrippedOptional;
  BuildingAddress : OPTIONAL IfcStrippedOptional;
END_ENTITY;

Attribute Definitions:

ElevationOfRefHeight : Elevation above sea level of the reference height used for all storey elevation measures, equals to height 0.0. It is usually the ground floor level.

ElevationOfTerrain : Elevation above the minimal terrain level around the footprint of the building, given in elevation above sea level.

BuildingAddress : Address given to the building for postal purposes.

Inheritance Graph:

ENTITY IfcBuilding
ENTITY IfcRoot
  GlobalId : IfcGloballyUniqueId;
  OwnerHistory : OPTIONAL IfcOwnerHistory;
  Name : OPTIONAL IfcLabel;
  Description : OPTIONAL IfcText;
END_ENTITY;
4.2.7.2.4 IfcSite Definition

A site is a defined area of land, possibly covered with water, on which the project construction is to be completed. A site may be used to erect, retrofit or turn down building(s), or for other construction related developments.

NOTE Term according to ISO6707-1 vocabulary "area of land or water where construction work or other development is undertaken".

A site may include a definition of the single geographic reference point for this site (global position using WGS84 with Longitude, Latitude and Elevation). The precision is provided up to millionth of a second and it provides an absolute placement in relation to the real world as used in exchange with geospatial information systems. If asserted, the Longitude, Latitude and Elevation establish the point in WGS84 where the point 0.,0.,0. of the LocalPlacement of IfcSite is situated.

The geometrical placement of the site, defined by the IfcLocalPlacement, shall be always relative to the spatial structure element, in which this site is included, or absolute, i.e. to the world coordinate system, as established by the geometric representation context of the project. The world coordinate system, established at the IfcProject.RepresentationContexts, may include a definition of the true north within the XY plane of the world coordinate system, if provided, it can be obtained at IfcGeometricRepresentationContext.TrueNorth.

A project may span over several connected or disconnected sites. Therefore site complex provides for a collection of sites included in a project. A site can also be decomposed in parts, where each part defines a site section. This is defined by the composition type attribute of the supertype IfcSpatialStructureElements which is interpreted as follow:

- COMPLEX = site complex
- ELEMENT = site
- PARTIAL = site section

The IfcSite is used to build the spatial structure of a building (that serves as the primary project breakdown and is required to be hierarchical). The figure below shows the IfcSite as part of the spatial structure. In addition to the logical spatial structure, also the placement hierarchy is shown. In this example the spatial structure hierarchy and the placement hierarchy are identical.

NOTE: Detailed requirements on mandatory element containment and placement structure relationships are given in view definitions and implementer agreements.

HISTORY New entity in IFC1.0.
Figure 37 ifcSite - Spatial Structure

Attribute Use Definition

The figure below describes the heights and elevations of the IfcSite. It is used to provide the geographic longitude, latitude, and height above sea level for the origin of the site. The origin of the site is the local placement.

The provision of longitude, latitude, height at the IfcSite for georeferencing is provided for upward compatibility reasons. It requires a single instance of IfcSite and WGS84 as coordinate reference system.

For exact georeferencing (or referencing to any other geographic coordinate system other than WSG84) the entities IfcCoordinateReferenceSystem and IfcMapConversion have to be used to define an exact mapping of the project engineering coordinate system to the geographic (or map) coordinate system.

- reference height of site is provided by: IfcSite.RefElevation, it is given according to the height datum used at this location.
- the reference height of each building situated at the site is given against the same height datum used at this location.
- the elevations of each story belonging to each building are given as local height relative to the reference height of the building.
EXPRESS Specification:

ENTITY IfcSite
  SUBTYPE OF (IfcSpatialStructureElement);
    RefLatitude : OPTIONAL IfcStrippedOptional;
    RefLongitude : OPTIONAL IfcStrippedOptional;
    RefElevation : OPTIONAL IfcStrippedOptional;
    LandTitleNumber : OPTIONAL IfcStrippedOptional;
    SiteAddress : OPTIONAL IfcStrippedOptional;
END_ENTITY;

Attribute Definitions:

RefElevation : Datum elevation relative to sea level.
LandTitleNumber : The land title number (designation of the site within a regional system).
SiteAddress : Address given to the site for postal purposes.

Inheritance Graph:

ENTITY IfcSite
  ENTITY IfcRoot
    GlobalId : IfcGloballyUniqueId;
    OwnerHistory : OPTIONAL IfcOwnerHistory;
    Name : OPTIONAL IfcLabel;

Figure 38 ifcBuilding - Heights
4.2.7.2.5 IfcProject Definition

IfcProject indicates the undertaking of some design, engineering, construction, or maintenance activities leading towards a product. The project establishes the context for information to be exchanged or shared, and it may represent a construction project but does not have to. The IfcProject’s main purpose in an exchange structure is to provide the root instance and the context for all other information items included.

The context provided by the IfcProject includes:

- the default units
- the geometric representation context for exchange structures including shape representations
- the world coordinate system
- the coordinate space dimension
• the precision used within the geometric representations, and
• optionally the indication of the true north relative to the world coordinate system

HISTORY New entity in IFC1.0

IFC4 CHANGE The attributes RepresentationContexts and UnitsInContext are made optional and are promoted to supertype IfcContext.

Informal Propositions:

There shall only be one project within the exchange context. This is enforced by the global rule IfcSingleProjectInstance.

EXPRESS Specification:

ENTITY IfcProject
  SUBTYPE OF (IfcContext);
  WHERE
  HasName : EXISTS(SELF\IfcRoot.Name);
  CorrectContext : NOT(EXISTS(SELF\IfcContext.RepresentationContexts)) OR (SIZEOF(QQUERY(Temp <*
    SELF\IfcContext.RepresentationContexts |
    'IFCREPRESENTATIONRESOURCE.IFCGEOMETRICREPRESENTATIONSUBCONTEXT' IN
    TYPEOF(Temp) )) = 0);
  NoDecomposition : SIZEOF(SELF\IfcObjectDefinition.Decomposes) = 0;
  HasOwnerHistory : EXISTS(SELF\IfcRoot.OwnerHistory);
END_ENTITY;

Formal Propositions:

HasName : The Name attribute has to be provided for IfcProject. It is the short name for the project.
CorrectContext : If a RepresentationContexts relation is provided then there shall be no instance of IfcGeometricRepresentationSubContext directly included in the set of RepresentationContexts.
NoDecomposition : The IfcProject represents the root of the any decomposition tree. It shall therefore not be used to decompose any other object definition.
HasOwnerHistory : The OwnerHistory attribute has to be provided for IfcProject. It provides the minimum of owner information for the project data set and the last change action, that applied to the whole data set.
NOTE Each individual data item, that derives from IfcRoot may have an individual OwnerHistory. It then overrides the common ownership and chance action information provided at the single IfcProject instance in an IFC data set.
IFC4 CHANGE New where rule.

Inheritance Graph:

ENTITY IfcProject
ENTITY IfcRoot
  GlobalId : IfcGloballyUniqueId;
  OwnerHistory : OPTIONAL IfcOwnerHistory;
  Name : OPTIONAL IfcLabel;
4.2.7.2.6 IfcZone Definition

A zone is a group of spaces, partial spaces or other zones. Zone structures may not be hierarchical (in contrast to the spatial structure of a project - see IfcSpatialStructureElement), i.e. one individual IfcSpace may be associated with zero, one, or several IfcZone's. IfcSpace's are grouped into an IfcZone by using the objectified relationship IfcRelAssignsToGroup as specified at the supertype IfcGroup.

NOTE Certain use cases may restrict the freedom of non hierarchical relationships. In some building service use cases the zone denotes a view based delimited volume for the purpose of analysis and calculation. This type of zone cannot overlap with respect to that analysis, but may overlap otherwise.

HISTORY New entity in IFC1.0

IFC4 CHANGE the entity is now subtyped from IfcSystem (not its supertype IfcGroup) with upward compatibility for file based exchange.

EXPRESS Specification:

ENTITY IfcZone
  SUBTYPE OF (IfcSystem);
  LongName : OPTIONAL IfcStrippedOptional;
WHERE

WR1 : (SIZEOF(SELF\IfcGroup.IsGroupedBy) = 0) OR (SIZEOF (QUERY (temp <*  
    SELF\IfcGroup.IsGroupedBy[1].RelatedObjects | NOT(('IFCPRODUCTEXTENSION.IFCZONE' IN  
    TYPEOF(temp))) OR ('IFCPRODUCTEXTENSION.IFCSPACE' IN TYPEOF(temp)) OR  
    ('IFCPRODUCTEXTENSION.IFCSPATIALZONE' IN TYPEOF(temp)))) = 0);

END_ENTITY;

Attribute Definitions:

LongName : Long name for a zone, used for informal purposes. It should be used, if available, in  
    conjunction with the inherited Name attribute.
    NOTE In many scenarios the Name attribute refers to the short name or number of a zone,  
    and the LongName refers to the full name.
    IFC4 CHANGE The attribute has been added at the end of the entity definition.

Formal Propositions:

WR1 : An IfcZone is grouped by the objectified relationship IfcRelAssignsToGroup. Only objects of  
    type IfcSpace, IfcZone and IfcSpatialZone are allowed as RelatedObjects.

Inheritance Graph:

ENTITY IfcZone  
ENTITY IfcRoot  
GlobalId : IfcGloballyUniqueId;  
OwnerHistory : OPTIONAL IfcOwnerHistory;  
Name : OPTIONAL IfcLabel;  
Description : OPTIONAL IfcText;  
ENTITY IfcObjectDefinition  
INVERSE  
HasAssignments : SET OF IfcRelAssigns FOR RelatedObjects;  
HasContext : SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;  
isDecomposedBy : SET OF IfcRelAggregates FOR RelatingObject;  
Decomposes : SET [0:1] OF IfcRelAggregates FOR RelatedObjects;  
HasAssociations : SET OF IfcRelAssociates FOR RelatedObjects;  
ENTITY IfcObject  
ObjectType : OPTIONAL IfcStrippedOptional;  
INVERSE  
isTypedBy : SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;  
isDefinedBy : SET OF IfcRelDefinesByProperties FOR RelatedObjects;  
ENTITY IfcGroup  
INVERSE  
isGroupedBy : SET OF IfcRelAssignsToGroup FOR RelatingGroup;  
ENTITY IfcSystem  
INVERSE  
ENTITY IfcZone  
LongName : OPTIONAL IfcStrippedOptional;  
END_ENTITY;

<xs:element name="IfcZone" type="ifc:IfcZone" substitutionGroup="ifc:IfcSystem" nillable="true"/>  
<xs:complexType name="IfcZone">  
<xs:complexContent>  
<xs:extension base="ifc:IfcSystem"/>  
</xs:complexType>
4.2.7.2.7 IfcSystem Definition

A system is an organized combination of related parts within an AEC product, composed for a common purpose or function or to provide a service. A system is essentially a functionally related aggregation of products. The grouping relationship to one or several instances of IfcProduct (the system members) is handled by IfcRelAssignsToGroup.

NOTE The use of IfcSystem often applies to the representation of building services related systems, such as the piping system, cold water system, etc. Members within such a system may or may not be connected using the connectivity related entities (through IfcDistributionPort).

HISTORY New entity in IFC1.0

ENTITY IfcSystem
SUPERTYPE OF (IfcZone)
SUBTYPE OF (IfcGroup);
INVERSE
END_ENTITY;

Attribute Definitions:

Inheritance Graph:

ENTITY IfcSystem
ENTITY IfcRoot
GlobalId : IfcGloballyUniqueId;
OwnerHistory : OPTIONAL IfcOwnerHistory;
Name : OPTIONAL IfcLabel;
Description : OPTIONAL IfcText;
ENTITY IfcObjectDefinition
INVERSE
HasAssignments : SET OF IfcRelAssigns FOR RelatedObjects;
HasContext : SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
IsDecomposedBy : SET OF IfcRelAggregates FOR RelatingObject;
Decomposes : SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
HasAssociations : SET OF IfcRelAssociates FOR RelatedObjects;
ENTITY IfcObject
ObjectType : OPTIONAL IfcStrippedOptional;
INVERSE
IsTypedBy : SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;
IsDefinedBy : SET OF IfcRelDefinesByProperties FOR RelatedObjects;
ENTITY IfcGroup
INVERSE
IsGroupedBy : SET OF IfcRelAssignsToGroup FOR RelatingGroup;
ENTITY IfcSystem
INVERSE
END_ENTITY;
4.2.7.2.8 IfcElement definition

An element is a generalization of all components that make up an AEC product. Those elements can be logically contained by a spatial structure element that constitutes a certain level within a project structure hierarchy (site, building, story or space). This is done by using the IfcRelContainedInSpatialStructure relationship.

Elements are physically existent objects, although they might be void elements, such as holes. Elements either remain permanently in the AEC product, or only temporarily, as formwork does. Elements can be either assembled on site or pre-manufactured and built in on site.

EXAMPLE Examples of elements in a building construction context are walls, floors, windows and recesses.

An element can have material and quantity information assigned through the IfcRelAssociatesMaterial and IfcRelDefinesByProperties relationship.

In addition an element can be declared to be a specific occurrence of an element type (and thereby be defined by the element type properties) using the IfcRelDefinesByType relationship.

An element can also be defined as an element assembly that is a group of semantically and topologically related elements that form a higher level part of the AEC product. Those element assemblies are defined by virtue of the IfcRelAggregates relationship.

EXAMPLE Examples for element assembly are complete Roof Structures, made by several Roof Areas, or a Stair, composed by Flights and Landings.

Elements that performs the same function may be grouped by an "Element Group By Function". It is realized by an instance of IfcGroup with the ObjectType = "ElementGroupByFunction".

HISTORY New entity in IFC1.0

Quantity Use Definition

The quantities relating to the IfcElement are defined by the IfcElementQuantity and attached by the IfcRelDefinesByProperties. A detailed specification for individual quantities is introduced at the level of subtypes of IfcElement.

Geometry Use Definitions

The geometric representation of any IfcElement is given by the IfcProductDefinitionShape and IfcLocalPlacement allowing multiple geometric representations. A detailed specification for the local placement and shape representation is introduced at the level of subtypes of IfcElement.
EXPRESS Specification:

ENTITY IfcElement
  SUBTYPE OF (IfcProduct);
  Tag : OPTIONAL IfcStrippedOptional;
INVERSE
  ConnectedTo : SET OF IfcRelConnectsElements FOR RelatingElement;
  IsConnectionRealization : SET OF IfcRelConnectsWithRealizingElements FOR RealizingElements;
  ConnectedFrom : SET OF IfcRelConnectsElements FOR RelatedElement;
  ContainedInStructure : SET [0:1] OF IfcRelContainedInSpatialStructure FOR RelatedElements;
END_ENTITY;

Attribute Definitions:

Tag : The tag (or label) identifier at the particular instance of a product, e.g. the serial number, or the position number. It is the identifier at the occurrence level.

ConnectedTo : Reference to the element connection relationship. The relationship then refers to the other element to which this element is connected to.

IsConnectionRealization : Reference to the connection relationship with realizing element. The relationship, if provided, assigns this element as the realizing element to the connection, which provides the physical manifestation of the connection relationship.

ConnectedFrom : Reference to the element connection relationship. The relationship then refers to the other element that is connected to this element.

ContainedInStructure : Containment relationship to the spatial structure element, to which the element is primarily associated. This containment relationship has to be hierarchical, i.e. an element may only be assigned directly to zero or one spatial structure.

Inheritance Graph:

ENTITY IfcElement
ENTITY IfcRoot
  GlobalId : IfcGloballyUniqueId;
  OwnerHistory : OPTIONAL IfcOwnerHistory;
  Name : OPTIONAL IfcLabel;
  Description : OPTIONAL IfcText;
ENTITY IfcObjectDefinition
INVERSE
  HasAssignments : SET OF IfcRelAssigns FOR RelatedObjects;
  HasContext : SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
  IsDecomposedBy : SET OF IfcRelAggregates FOR RelatingObject;
  Decomposes : SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
  HasAssociations : SET OF IfcRelAssociates FOR RelatedObjects;
ENTITY IfcObject
  ObjectType : OPTIONAL IfcStrippedOptional;
INVERSE
  IsTypedBy : SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;
  IsDefinedBy : SET OF IfcRelDefinesByProperties FOR RelatedObjects;
ENTITY IfcProduct
  ObjectPlacement : OPTIONAL IfcStrippedOptional;
  Representation : OPTIONAL IfcStrippedOptional;
INVERSE
ENTITY IfcElement
Tag : OPTIONAL IfcStrippedOptional;

INVERSE
   ConnectedTo : SET OF IfcRelConnectsElements FOR RelatingElement;
   IsConnectionRealization: SET OF IfcRelConnectsWithRealizingElements FOR RealizingElements;
   ConnectedFrom : SET OF IfcRelConnectsElements FOR RelatedElement;
   ContainedInStructure : SET [0:1] OF IfcRelContainedInSpatialStructure FOR RelatedElements;

END_ENTITY;

<xs:element name="IfcElement" type="ifc:IfcElement" abstract="true" substitutionGroup="ifc:IfcProduct"
nillable="true"/>
<xs:complexType name="IfcElement" abstract="true">
   <xs:complexContent>
      <xs:extension base="ifc:IfcProduct"/>
   </xs:complexContent>
</xs:complexType>

### 4.2.7.2.9 IfcElementType definition

IfcElementType defines a list of commonly shared property set definitions of an element and an optional set of product representations. It is used to define an element specification (i.e. the specific product information, that is common to all occurrences of that product type).

NOTE The product representations are defined as representation maps (at the level of the supertype IfcTypeProduct, which gets assigned by an element instance through the IfcShapeRepresentation.Item[1] being an IfcMappedItem.

An element type is used to define the common properties of a certain type or style of an element that may be applied to instances of that element type to assign a specific style. Element types (the instantiable subtypes) may be exchanged without being already assigned to occurrences.

HISTORY New entity in IFC2x2

EXPRESS Specification:

ENTITY IfcElementType
   SUBTYPE OF (IfcTypeProduct);
      ElementType : OPTIONAL IfcStrippedOptional;
END_ENTITY;

Attribute Definitions:

ElementType : The type denotes a particular type that indicates the object further. The use has to be established at the level of instantiable subtypes. In particular it holds the user defined type, if the enumeration of the attribute 'PredefinedType' is set to USERDEFINED.

Inheritance Graph:

ENTITY IfcElementType
   ENTITY IfcRoot
      GlobalId : IfcGloballyUniqueId;
      OwnerHistory : OPTIONAL IfcOwnerHistory;
      Name : OPTIONAL IfcLabel;
4.2.7.2.10 IfcTask definition

An IfcTask is an identifiable unit of work to be carried out in a construction project.

A task is typically used to describe an activity for the construction or installation of products, but is not limited to these types. For example it might be used to describe design processes, move operations and other design, construction and operation related activities as well.

Quantities of resources consumed by the task are dealt with by defining the IfcElementQuantity for the resource and not at the instance of IfcTask.

HISTORY New entity in IFC1.0. Renamed from IfcWorkTask in IFC2x.

IFC4 CHANGE Attributes TaskTime and PredefinedType added. IfcMove and IfcOrderRequest has been removed in IFC4 and are now represented by IfcTask. IfcRelAssignsTasks relationship has been removed as well.

Attribute use definition

Each occurrence of IfcTask is given a name that is indicative of its content ( IfcRoot.Name ). A textual description of the task may be provided and this may be further elaborated by a narrative long description
A work method may be declared for the method of work used in carrying out a task. A task is identified as being either a milestone task or not. A milestone task is defined by the marker IsMilestone, and has no duration. A status and priority for each task may also be set.

**Time and duration use definition**

Compared to previous IFC releases, basic task time information (scheduled start time, scheduled finish time, duration) is now directly attached to IfcTask through the TaskTime attribute. Regular tasks are defined through IfcTaskTime. Recurring tasks are defined through IfcTaskTimeRecurring. In case a regular task is derived from a recurring task both tasks should be linked together through a IfcRelNests relationship, where IfcRelNests.IsNestedBy points to the recurring task and IfcRelNests.Nests points to all regular tasks that have been derived from the recurring task.

**Representation of other activities**

The use definitions for IfcTask have been generalised to represent other activities as well, including activities that had been defined by own entities in previous IFC releases. This includes

- Order actions
- Move operations

IfcTask represents an order that might be carried out by a Helpdesk acting the role of interface for the organization between the facility user and the functional requirement of fulfilling their needs. The actual task represented by the IfcTask entity is turning a request into an order and initiating the action that will enable the order to be completed. The IfcProjectOrder or one of its subtypes including maintenance work order, is related to the IfcTask using IfcRelAssignsToControl.

IfcTask can also be used to describe an activity that moves people, groups within an organization or complete organizations together with their associated furniture and equipment from one place to another. It thus replaces the previous IFC entity IfcMove. The functionality is represented in IfcTask as follows:

Move from: The place from which actors and their associated equipment are moving. Use IfcRelAssignsToProcess where RelatingProcess points to the task and RelatedObjects holds the location(s) from which to move.

Move to: The place to which actors and their associated equipment are moving. Use IfcRelAssignsToProduct where RelatedObjects points to the task(s) and RelatingProduct points to the location to which to move.

Punch list: A list of points concerning a move that require attention. Use LongDescription or else identify sub-tasks to track punch list items individually via IfcRelNests.

**EXPRESS Specification:**

```
ENTITY IfcTask
  SUBTYPE OF (IfcProcess);
  Status : OPTIONAL IfcStrippedOptional;
  WorkMethod : OPTIONAL IfcStrippedOptional;
  IsMilestone : IfcStrippedOptional;
  Priority : OPTIONAL IfcStrippedOptional;
  TaskTime : OPTIONAL IfcTaskTime;
```

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PredefinedType : OPTIONAL IfcStrippedOptional;

WHERE

HasName : EXISTS(SELF\IfcRoot.Name);
CorrectPredefinedType : NOT(EXISTS(PREdefinedType)) OR (PredefinedType <> IfcTaskTypeEnum.USERDEFINED) OR ((PredefinedType = IfcTaskTypeEnum.USERDEFINED) AND EXISTS(SELF\IfcObject.ObjectType));

END_ENTITY;

Attribute Definitions:

Status : Current status of the task.
NOTE Particular values for status are not specified, these should be determined and agreed by local usage. Examples of possible status values include 'Not Yet Started', 'Started', 'Completed'.

WorkMethod : The method of work used in carrying out a task.
NOTE This attribute should not be used if the work method is specified for the IfcTaskType

IsMilestone : Identifies whether a task is a milestone task (=TRUE) or not (= FALSE).
NOTE In small project planning applications, a milestone task may be understood to be a task having no duration. As such, it represents a singular point in time.

Priority : A value that indicates the relative priority of the task (in comparison to the priorities of other tasks).

TaskTime : Time related information for the task.
IFC4 CHANGE Attribute added

Formal Propositions:

HasName : The Name attribute should be inserted to describe the task name.
CorrectPredefinedType : The attribute ObjectType must be asserted when the value of PredefinedType is set to USERDEFINED.

Inheritance Graph:

ENTITY IfcTask
ENTITY IfcRoot
    GlobalId : IfcGloballyUniqueId;
    OwnerHistory : OPTIONAL IfcOwnerHistory;
    Name : OPTIONAL IfcLabel;
    Description : OPTIONAL IfcText;

ENTITY IfcObjectDefinition

INVERSE

HasAssignments : SET OF IfcRelAssigns FOR RelatedObjects;
HasContext : SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
IsDecomposedBy : SET OF IfcRelAggregates FOR RelatingObject;
Decomposes : SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
HasAssociations : SET OF IfcRelAssociates FOR RelatedObjects;

ENTITY IfcObject
    ObjectType : OPTIONAL IfcStrippedOptional;

INVERSE

IsTypedBy : SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;
IsDefinedBy : SET OF IfcRelDefinesByProperties FOR RelatedObjects;

ENTITY IfcProcess
    Identification : OPTIONAL IfcStrippedOptional;
    LongDescription : OPTIONAL IfcStrippedOptional;

INVERSE
IsPredecessorTo : SET OF IfcRelSequence FOR RelatingProcess;
IsSuccessorFrom : SET OF IfcRelSequence FOR RelatedProcess;

ENTITY IfcTask
Status : OPTIONAL IfcStrippedOptional;
WorkMethod : OPTIONAL IfcStrippedOptional;
IsMilestone : IfcStrippedOptional;
Priority : OPTIONAL IfcStrippedOptional;
TaskTime : OPTIONAL IfcTaskTime;
PredefinedType : OPTIONAL IfcStrippedOptional;
END_ENTITY;

<xs:element name="IfcTask" type="ifc:IfcTask" substitutionGroup="ifc:IfcProcess" nillable="true"/>
<xs:complexType name="IfcTask">
<xs:complexContent>
<xs:extension base="ifc:IfcProcess">
<xs:sequence>
<xs:element name="TaskTime" type="ifc:IfcTaskTime" nillable="true" minOccurs="0"/>
</xs:sequence>
</xs:extension>
</xs:complexContent>
</xs:complexType>

4.2.7.2.11 IfcActor Definition

The IfcActor defines all actors or human agents involved in a project during its full life cycle. It facilitates the use of person and organization definitions in the resource part of the IFC object model. This includes name, address, telecommunication addresses, and roles.

HISTORY New entity in IFC2.0

EXPRESS Specification:

ENTITY IfcActor
SUBTYPE OF (IfcObject);
   TheActor : IfcActorSelect;
INVERSE
END_ENTITY;

Attribute Definitions:

TheActor : Information about the actor.

Inheritance Graph:

ENTITY IfcActor
ENTITY IfcRoot

GlobalId : IfcGloballyUniqueId;
OwnerHistory : OPTIONAL IfcOwnerHistory;
Name : OPTIONAL IfcLabel;
Description : OPTIONAL IfcText;
ENTITY IfcObjectDefinition
INVERSE
4.2.7.2.12 IfcActionRequest Definition

A request is the act or instance of asking for something, such as a request for information, bid submission, or performance of work.

Requests may take many forms depending on the need including fault reports for maintenance, requests for small works, and purchase requests (where these are to be made through a help desk or buying function).

HISTORY New entity in IFC2x2.
IFC4 CHANGE Attribute RequestID renamed to Identification and promoted to supertype IfcControl, attributes PredefinedType, Status, and LongDescription added.

EXPRESS Specification:
ENTITY IfcActionRequest
  SUBTYPE OF (IfcControl);
    PredefinedType : OPTIONAL IfcStrippedOptional;
    Status : OPTIONAL IfcStrippedOptional;
    LongDescription : OPTIONAL IfcStrippedOptional;
END_ENTITY;
Attribute Definitions:

**Status**
- The status currently assigned to the request. Possible values include:
  - Hold: wait to see if further requests are received before deciding on action
  - NoAction: no action is required on this request
  - Schedule: plan action to take place as part of maintenance or other task planning/scheduling
  - Urgent: take action immediately

_IFC4 CHANGE_ The attribute has been added.

**LongDescription**
- Detailed description of the permit.

_IFC4 CHANGE_ The attribute has been added.

Inheritance Graph:

ENTITY `IfcActionRequest`

ENTITY `IfcRoot`

GlobalId: `IfcGloballyUniqueId`;
OwnerHistory: OPTIONAL `IfcOwnerHistory`;
Name: OPTIONAL `IfcLabel`;
Description: OPTIONAL `IfcText`;

ENTITY `IfcObjectDefinition`

INVERSE
- HasAssignments: SET OF `IfcRelAssigns` FOR RelatedObjects;
- HasContext: SET [0:1] OF `IfcRelDeclares` FOR RelatedDefinitions;
- IsDecomposedBy: SET OF `IfcRelAggregates` FOR RelatingObject;
- Decomposes: SET [0:1] OF `IfcRelAggregates` FOR RelatedObjects;
- HasAssociations: SET OF `IfcRelAssociates` FOR RelatedObjects;

ENTITY `IfcObject`

ObjectType: OPTIONAL `IfcStrippedOptional`;

INVERSE
- IsTypedBy: SET [0:1] OF `IfcRelDefinesByType` FOR RelatedObjects;
- IsDefinedBy: SET OF `IfcRelDefinesByProperties` FOR RelatedObjects;

ENTITY `IfcControl`

Identification: OPTIONAL `IfcStrippedOptional`;

INVERSE
- Controls: SET OF `IfcRelAssignsToControl` FOR RelatingControl;

ENTITY `IfcActionRequest`

PredefinedType: OPTIONAL `IfcStrippedOptional`;
Status: OPTIONAL `IfcStrippedOptional`;
LongDescription: OPTIONAL `IfcStrippedOptional`;

END_ENTITY;

<x:s:element name="IfcActionRequest" type="ifc:IfcActionRequest" substitutionGroup="ifc:IfcControl" nillable="true"/>
<x:s:complexType name="IfcActionRequest">
  <x:s:complexContent>
    <x:s:extension base="ifc:IfcControl"/>
  </x:s:complexContent>
</x:s:complexType>

4.2.7.2.13 IfcProcess Definition
IfcProcess is defined as one individual activity or event, that is ordered in time, that has sequence relationships with other processes, which transforms input in output, and may connect to other other processes through input output relationships. An IfcProcess can be an activity (or task), or an event. It takes usually place in building construction with the intent of designing, costing, acquiring, constructing, or maintaining products or other and similar tasks or procedures. The figure below illustrates process relationships.

NOTE Definition according to ISO9000: A process is a set of activities that are interrelated or that interact with one another. Processes use resources to transform inputs into outputs.

Processes are interconnected because the output from one process becomes the input for another process. In effect, processes are "glued" together by means of such input output relationships.

HISTORY New entity in IFC1.0.

IFC2x CHANGE The attribute Productivity has been removed.

IFC4 CHANGE The attribute Identification has been promoted from subtypes IfcTask and others.

Relationship use definition

Process information relates to other objects by establishing the following relationships:

- Nesting of processes: IfcRelNests - A process can contain sub processes and thereby be nested.
- Sequencing of processes: IfcRelSequence - Processes can be placed in sequence (including overlapping for parallel tasks), and have predecessors and successors.
• Assigning process to schedules: IfcRelAssignsToControl - Activities such as tasks, and predominately summary tasks, are assigned to a work schedule.
• Having a product assigned to the process as input: IfcRelAssignsToProcess - Products can be assigned as input to a process, such as for construction process planning.
• Having a product assigned to the process as output: IfcRelAssignsToProduct - Products can be assigned as output to a process, such as for construction process planning.
• Having a control assigned to the process as process control: IfcRelAssignsToProcess - Items that act as a control onto the process can be assigned to a process, such as for cost management (a cost item assigned to a work task).
• Having a resource assigned to the process as consumed by the process: IfcRelAssignsToProcess - Items that act as a mechanism to a process, such as labor, material and equipment in cost calculations.

EXPRESS Specification:

ENTITY IfcProcess
  ABSTRACT SUPERTYPE OF (IfcTask)
  SUBTYPE OF (IfcObject);
    Identification : OPTIONAL IfcStrippedOptional;
    LongDescription : OPTIONAL IfcStrippedOptional;
  INVERSE
    IsPredecessorTo : SET OF IfcRelSequence FOR RelatingProcess;
    IsSuccessorFrom : SET OF IfcRelSequence FOR RelatedProcess;
END_ENTITY;

Attribute Definitions:

Identification : An identifying designation given to a process or activity. It is the identifier at the occurrence level.
  IFC4 CHANGE Attribute promoted from subtypes.
LongDescription : An extended description or narrative that may be provided.
  IFC4 CHANGE New attribute.
IsPredecessorTo : Dependency between two activities, it refers to the subsequent activity for which this activity is the predecessor. The link between two activities can include a link type and a lag time.
IsSuccessorFrom : Dependency between two activities, it refers to the previous activity for which this activity is the successor. The link between two activities can include a link type and a lag time.

Inheritance Graph:

ENTITY IfcProcess
  ENTITY IfcRoot
    GlobalId : IfcGloballyUniqueId;
    OwnerHistory : OPTIONAL IfcOwnerHistory;
    Name : OPTIONAL IfcLabel;
    Description : OPTIONAL IfcText;
  END_ENTITY;

  ENTITY IfcObjectDefinition
    INVERSE
      HasAssignments : SET OF IfcRelAssigns FOR RelatedObjects;
      HasContext : SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
      IsDecomposedBy : SET OF IfcRelAggregates FOR RelatingObject;
  END_ENTITY;
Decomposes : SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
HasAssociations : SET OF IfcRelAssociates FOR RelatedObjects;

ENTITY IfcObject
  ObjectType : OPTIONAL IfcStrippedOptional;

INVERSE
  IsTypedBy : SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;
  IsDefinedBy : SET OF IfcRelDefinesByProperties FOR RelatedObjects;

ENTITY IfcProcess
  Identification : OPTIONAL IfcStrippedOptional;
  LongDescription : OPTIONAL IfcStrippedOptional;

INVERSE
  IsPredecessorTo : SET OF IfcRelSequence FOR RelatingProcess;
  IsSuccessorFrom : SET OF IfcRelSequence FOR RelatedProcess;

END_ENTITY;

<xs:element name="IfcProcess" type="ifc:IfcProcess" abstract="true" substitutionGroup="ifc:IfcObject" nillable="true"/>
<xs:complexType name="IfcProcess" abstract="true">
  <xs:complexContent>
    <xs:extension base="ifc:IfcObject"/>
  </xs:complexContent>
</xs:complexType>

4.2.7.2.14 ifcGroup Definition

IfcGroup is a generalization of any arbitrary group. A group is a logical collection of objects. It does not have its own position, nor can it hold its own shape representation. Therefore a group is an aggregation under some non-geometrical / topological grouping aspects.

NOTE Use IfcRelDecomposes together with the appropriate subtypes of IfcProduct to define an aggregation of products that may have its own position and shape representation.

EXAMPLE An example for a group is a system, since it groups elements under the aspect of their role, regardless of their position in a building.

A group can hold any collection of objects (being products, processes, controls, resources, actors or other groups). Thus groups can be nested. An object can be part of zero, one, or many groups. Grouping relationships are not required to be hierarchical nor do they imply a dependency.

NOTE Use IfcRelDecomposes together with the appropriate subtypes of IfcProduct to define an hierarchical aggregation of products.

A group can be exchanged without having already objects within the group collection.

HISTORY New entity in IFC1.0.

IFC4 CHANGE The inverse IsGroupedBy relationship is set to 0..n

Relationship use definition
Groups are assigned to other objects (such as a process or a resource) by the relationship object that refers to the corresponding object:

- Process: assigned using IfcRelAssignsToProcess
- Resource: assigned using IfcRelAssignsToResource
- Groups can be subjected to a control. The control information is then assigned:
  - Controls: affecting the group using IfcRelAssignsToControl

**EXPRESS Specification:**

```xml
ENTITY IfcGroup
  ENTITY IfcRoot
    GlobalId : IfcGloballyUniqueId;
    OwnerHistory : OPTIONAL IfcOwnerHistory;
    Name : OPTIONAL IfcLabel;
    Description : OPTIONAL IfcText;
  END_ENTITY;

ENTITY IfcObjectDefinition
  INVERSE
    HasAssignments : SET OF IfcRelAssigns FOR RelatedObjects;
    HasContext : SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
    IsDecomposedBy : SET OF IfcRelAggregates FOR RelatingObject;
    Decomposes : SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
  END_ENTITY;

ENTITY IfcObject
  INVERSE
    IsTypedBy : SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;
    IsDefinedBy : SET OF IfcRelDefinesByProperties FOR RelatedObjects;
  END_ENTITY;

ENTITY IfcGroup
  INVERSE
    IsGroupedBy : SET OF IfcRelAssignsToGroup FOR RelatingGroup;
  END_ENTITY;

<x:schema name="IfcGroup" type="ifc:IfcGroup" substitutionGroup="ifc:IfcObject" nillable="true"/>
<x:complexType name="IfcGroup">
  <xs:complexContent>
    <xs:extension base="ifc:IfcObject"/>
  </xs:complexContent>
</x:complexType
```

**4.2.7.2.15 IfcPropertySet Definition**

IfcPropertySet defines all dynamically extensible properties. The property set is a container class that holds properties within a property tree. These properties are interpreted according to their name attribute.

The same IfcPropertySet can be assigned to multiple object occurrences; it should then be assigned by a single instance of IfcRelDefinedByProperties to a set of related objects. Those property sets are referred to as shared property sets. It can also be assigned to an object type.
An IfcPropertySetTemplate may define the underlying structure, i.e. the required name, the applicable object or object types to which the property set can be attached, and the individual properties that maybe included.

NOTE  See IfcRelDefinesByType for how to override property sets assigned to an object type within the object occurrence.

HISTORY  New entity in IFC1.0

IFC4 CHANGE  All statically defined property set entities are no longer subtypes of IfcPropertySet.

Relationship use definition

Property sets are related to other objects by using the relationship object that refers to the corresponding object:

- **Occurrence Object**: IfcRelDefinesByProperties using the inverse attribute DefinesOccurrence.
- **Type Object**: using a direct link by inverse attribute DefinesType.
- **Underlying template**: IfcRelDefinesByTemplate using the inverse attribute IsDefinedBy.
- **External reference**: subtypes of IfcRelAssociates are used to provide a link to a classification system, or external library providing further reference to the property set. Accessible by inverse attribute HasAssociations.

Attribute use definition

Instances of IfcPropertySet are used to assign named sets of individual properties (complex or single properties). Each individual property has a significant name string. Some property sets are included in the IFC specification and have a predefined set of properties indicated by assigning a significant name. These property sets are listed under "property sets" main menu item within this specification and from the object documentation sheet for those object to which they are applicable. The naming convention "Pset_Xxx" applies to all those property sets that are defined as part of the IFC specification and it shall be used as the value of the Name attribute.

In addition any user defined property set can be captured. Property sets that are not declared as part of the IFC specification shall have a Name value not including the "Pset_" prefix.

EXPRESSION Specification:

```xml
ENTITY IfcPropertySet
    SUBTYPE OF (IfcPropertySetDefinition);
    HasProperties : SET [1:?] OF IfcProperty;
WHERE
    ExistsName : EXISTS(SELF\IfcRoot.Name);
    UniquePropertyNames : IfcUniquePropertyName(HasProperties);
END_ENTITY;
```

Attribute Definitions:

**HasProperties** : Contained set of properties. For property sets defined as part of the IFC Object model, the property objects within a property set are defined as part of the standard. If a property is not
contained within the set of predefined properties, its value has not been set at this time.

Formal Propositions:

**ExistsName**

The *Name* attribute has to be provided. The attribute is used to specify the signifier of the property set. The properties that are allowed to be attached to a particular property set may be given within the property set definition part of the IFC specification. Those property set definitions are references in the semantic definition section of the individual subtypes of IfcObjectDefinition.

**UniquePropertyNames**

Every individual subtype of IfcProperty within the property set shall have a unique *Name* attribute value.

Inheritance Graph:

**ENTITY** IfcPropertySet

**ENTITY** IfcRoot

GlobalId : IfcGloballyUniqueId;
OwnerHistory : OPTIONAL IfcOwnerHistory;
Name : OPTIONAL IfcLabel;
Description : OPTIONAL IfcText;

**ENTITY** IfcPropertyDefinition

INVERSE

HasContext : SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
HasAssociations : SET OF IfcRelAssociates FOR RelatedObjects;

**ENTITY** IfcPropertySetDefinition

INVERSE

DefinesType : SET OF IfcTypeObject FOR HasPropertySets;
DefinesOccurrence : SET [0:1] OF IfcRelDefinesByProperties FOR RelatingPropertyDefinition;

**ENTITY** IfcPropertySet

HasProperties : SET [1:?] OF IfcProperty;

END_ENTITY;

```xml
<xs:element name="IfcPropertySet" type="ifc:IfcPropertySet" substitutionGroup="ifc:IfcPropertySetDefinition" nillable="true"/>
<xs:complexType name="IfcPropertySet">
  <xs:complexContent>
    <xs:extension base="ifc:IfcPropertySetDefinition">
      <xs:sequence>
        <xs:element name="HasProperties">
          <xs:complexType>
            <xs:sequence>
              <xs:element ref="ifc:IfcProperty" maxOccurs="unbounded"/>
            </xs:sequence>
            <xs:attribute ref="ifc:itemType" fixed="ifc:IfcProperty"/>
            <xs:attribute ref="ifc:cType" fixed="set"/>
            <xs:attribute ref="ifc:arraySize" use="optional"/>
          </xs:complexType>
        </xs:element>
      </xs:sequence>
    </xs:extension>
  </xs:complexContent>
</xs:complexType>
```
4.2.7.2.16 IfcAnnotation Definition

An annotation is a graphical representation within the geometric (and spatial) context of a project, that adds a note or meaning to the objects which constitutes the project model. Annotations include additional points, curves, text, dimensioning, hatching and other forms of graphical notes. It also include symbolic representations of additional model components, not representing products or spatial structures, such as survey points, contour lines or similar.

NOTE Additional presentation information (often 2D) such as tag number or hatching, that is directly related to a particular product representation is included within the IfcProductDefinitionShape having various IfcShapeRepresentation's of the IfcElement (and its subtypes). Only those presentation information, that cannot be directly related to a single product, have to be wrapped within the IfcAnnotation.

If available, the annotation should be related to the spatial context of the project, by containing the annotation within the appropriate level of the building structure (site, building, story, or space). This is handled by the IfcRelContainedInSpatialStructure relationship.

HISTORY New entity in IFC2x2.

Attribute use definition

The IfcAnnotation can provide specific 0D, 1D, and 2D geometric items as representation of the annotation, offering annotation point, curves, and surfaces. The following values shall be used for the ObjectType.

- 'Annotation point' is an annotation provided by a point that has additional semantic. The inherited attribute ObjectType should be used to capture the type of point annotation, some predefined values are:
  - 'SurveyPoint': A single survey point represented by a Cartesian point. A property set may add the conditions (method, accuracy, etc. to the survey point).
  - 'SurveyArea': A set of survey points represented by Cartesian point. These coordinates are determined relative to the coordinates of a reference point, which acts as the datum for the survey. Properties attached apply equally to all points. The difference in elevation of the survey points enables terrain to be determined.
- 'Annotation curve' is an annotation provided by a curve that has additional semantic. The inherited attribute ObjectType should be used to capture the type of curve annotation, some predefined values are:
  - 'ContourLine': A line of constant elevation typically used on geographic maps where the spacing of lines at constant intervals of elevation may be used as an indication of slope.
  - 'IsoBar': A line of constant pressure typically used on weather maps or to show pressure gradient in spaces, chambers or externally.
  - 'IsoLux': A line of constant illumination typically used to show the distribution of illumination levels and/or daylighting in a space or externally.
  - 'IsoTherm': A line of constant temperature typically used to show the distribution and effect of heating or cooling within a space or to show temperature distribution on a geographic map.
- 'Annotation surface' is an annotation provided by a surface that has additional semantic. The inherited attribute ObjectType should be used to capture the type of surface annotation, some predefined values are:
• 'SurveyArea': A surface patch based on survey points.

EXPRESS Specification:

ENTITY IfcAnnotation
  SUBTYPE OF (IfcProduct);
  INVERSE
    ContainedInStructure : SET [0:1] OF IfcRelContainedInSpatialStructure FOR RelatedElements;
  END_ENTITY;

Attribute Definitions:

ContainedInStructure : Relationship to a spatial structure element, to which the associate is primarily associated.

Inheritance Graph:

ENTITY IfcAnnotation
  ENTITY IfcRoot
    GlobalId : IfcGloballyUniqueId;
    OwnerHistory : OPTIONAL IfcOwnerHistory;
    Name : OPTIONAL IfcLabel;
    Description : OPTIONAL IfcText;
  END_ENTITY;

ENTITY IfcObjectDefinition
  INVERSE
    HasAssignments : SET OF IfcRelAssigns FOR RelatedObjects;
    HasContext : SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
    IsDecomposedBy : SET OF IfcRelAggregates FOR RelatingObject;
    Decomposes : SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
    HasAssociations : SET OF IfcRelAssociates FOR RelatedObjects;
  END_ENTITY;

ENTITY IfcObject
  ObjectType : OPTIONAL IfcStrippedOptional;
  INVERSE
    IsTypedBy : SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;
    IsDefinedBy : SET OF IfcRelDefinesByProperties FOR RelatedObjects;
  END_ENTITY;

ENTITY IfcProduct
  ObjectPlacement : OPTIONAL IfcStrippedOptional;
  Representation : OPTIONAL IfcStrippedOptional;
  INVERSE
    ENTITY IfcAnnotation
    INVERSE
      ContainedInStructure : SET [0:1] OF IfcRelContainedInSpatialStructure FOR RelatedElements;
      END_ENTITY;

<xs:element name="IfcAnnotation" type="ifc:IfcAnnotation" substitutionGroup="ifc:IfcProduct" nillable="true"/>
<xs:complexType name="IfcAnnotation">
  <xs:complexContent>
    <xs:extension base="ifc:IfcProduct"/>
  </xs:complexType>
4.2.7.2.17 IfcRelConnectsPorts Definition

An IfcRelConnectsPorts relationship defines the relationship that is made between two ports at their point of connection. It may include the connection geometry between two ports.

The objectified relationship IfcRelConnectsPorts is required for defining how two instances of IfcPort connect together. Each of the ports is logically contained within the IfcDistributionElement by using the ordered collection IfcRelNests.

HISTORY New entity in IFC2.0, modified in IFC2x.

IFC4 CHANGE Previously the containment of the IfcPort within the IfcDistributionElement had been realized using the IfcRelConnectsPortToElement relationship.

EXPRESS Specification:

ENTITY IfcRelConnectsPorts
  SUBTYPE OF (IfcRelConnects);
  RelatingPort : IfcPort;
  RelatedPort : IfcPort;
  RealizingElement : OPTIONAL IfcStrippedOptional;
  WHERE
    NoSelfReference : RelatingPort :<>: RelatedPort;
END_ENTITY;

Attribute Definitions:

- **RelatingPort**: Reference to the first port that is connected by the objectified relationship.
- **RelatedPort**: Reference to the second port that is connected by the objectified relationship.
- **RealizingElement**: Defines the element that realizes a port connection relationship.

Formal Propositions:

- **NoSelfReference**: The instance of the **RelatingPort** shall not be the same instance as the **RelatedPort**.

Inheritance Graph:

ENTITY IfcRelConnectsPorts
  ENTITY IfcRoot
    GlobalId : IfcGloballyUniqueid;
    OwnerHistory : OPTIONAL IfcOwnerHistory;
    Name : OPTIONAL IfcLabel;
    Description : OPTIONAL IfcText;
  ENTITY IfcRelationship
  ENTITY IfcRelConnects
  ENTITY IfcRelConnectsPorts
    RelatingPort : IfcPort;
    RelatedPort : IfcPort;
    RealizingElement : OPTIONAL IfcStrippedOptional;
END_ENTITY;

<xs:element name="IfcRelConnectsPorts" type="ifc:IfcRelConnectsPorts" substitutionGroup="ifc:IfcRelConnects"/>
4.2.7.2.18 IfcWorkSchedule Definition

An IfcWorkSchedule represents a task schedule of a work plan, which in turn can contain a set of schedules for different purposes. The figure below shows the backbone structure of a work schedule that defines (1) a context through IfcRelDeclares (not necessarily the project) and (2) controls tasks (typically the schedule summary task) and resources. Please note that a work calendar shall be assigned to the summary task and not the work schedule.

HISTORY New entity in IFC2.0.

Declaration Use Definition

IfcWorkSchedule can reference a project (the single IfcProject instance) via IfcRelDeclares.

EXPRESS Specification:

ENTITY IfcWorkSchedule
SUBTYPE OF (IfcWorkControl);
   PredefinedType : OPTIONAL IfcStrippedOptional;
WHERE
   CorrectPredefinedType : NOT(EXISTS(PredefinedType)) OR (PredefinedType <>
     IfcWorkScheduleTypeEnum.USERDEFINED) OR ((PredefinedType =
     IfcWorkScheduleTypeEnum.USERDEFINED) AND EXISTS(SELF\IfcObject.ObjectType));
END_ENTITY;

Attribute Definitions:

Formal Propositions:

CorrectPredefinedType : The attribute ObjectType must be asserted when the value of the IfcWorkScheduleTypeEnum is set to USERDEFINED.
Inheritance Graph:

ENTITY IfcWorkSchedule
ENTITY IfcRoot
    GlobalId : IfcGloballyUniqueId;

Figure 40 IfcWorkSchedule
OwnerHistory : OPTIONAL IfcOwnerHistory;
Name : OPTIONAL IfcLabel;
Description : OPTIONAL IfcText;

ENTITY IfcObjectDefinition
INVERSE
HasAssignments : SET OF IfcRelAssigns FOR RelatedObjects;
HasContext : SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
IsDecomposedBy : SET OF IfcRelAggregates FOR RelatingObject;
Decomposes : SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
HasAssociations : SET OF IfcRelAssociates FOR RelatedObjects;

ENTITY IfcObject
ObjectType : OPTIONAL IfcStrippedOptional;

INVERSE
IsTypedBy : SET [0:1] OF IfcRelDefinesByType FOR RelatedObjects;
IsDefinedBy : SET OF IfcRelDefinesByProperties FOR RelatedObjects;

ENTITY IfcControl
Identification : OPTIONAL IfcStrippedOptional;

INVERSE
Controls : SET OF IfcRelAssignsToControl FOR RelatingControl;

ENTITY IfcWorkControl
CreationDate : IfcDateTime;
Creators : OPTIONAL SET [1:?] OF IfcStrippedOptional;
Purpose : OPTIONAL IfcStrippedOptional;
Duration : OPTIONAL IfcStrippedOptional;
TotalFloat : OPTIONAL IfcStrippedOptional;
StartTime : IfcDateTime;
FinishTime : OPTIONAL IfcStrippedOptional;

ENTITY IfcWorkSchedule
PredefinedType : OPTIONAL IfcStrippedOptional;
END_ENTITY;

<xs:element name="IfcWorkSchedule" type="ifc:IfcWorkSchedule" substitutionGroup="ifc:IfcWorkControl" nillable="true"/>
<xs:complexType name="IfcWorkSchedule">
  <xs:complexContent>
    <xs:extension base="ifc:IfcWorkControl"/>
  </xs:complexContent>
</xs:complexType>

4.2.7.2.19 IfcRelAssociatesDocument Definition

The objectified relationship (IfcRelAssociatesDocument) handles the assignment of a document information (items of the select IfcDocumentSelect) to objects occurrences (subtypes of IfcObject) or object types (subtypes of IfcTypeObject).

The relationship is used to assign a document reference or a more detailed document information to objects. A single document reference can be applied to multiple objects.
The inherited attribute RelatedObjects define the objects to which the document association is applied. The attribute RelatingDocument is the reference to a document reference, applied to the object(s).

HISTORY  New entity in IFC2x.

EXPRESS Specification:

ENTITY IfcRelAssociatesDocument
  SUBTYPE OF (IfcRelAssociates);
    RelatingDocument  : IfcDocumentSelect;
  END_ENTITY;

Attribute Definitions:

RelatingDocument  : Document information or reference which is applied to the objects.

Inheritance Graph:

ENTITY IfcRelAssociatesDocument
  ENTITY IfcRoot
    GlobalId : IfcGloballyUniqueId;
    OwnerHistory : OPTIONAL IfcOwnerHistory;
    Name : OPTIONAL IfcLabel;
    Description : OPTIONAL IfcText;
  END_ENTITY;

ENTITY IfcRelAssociates
  ENTITY IfcRelAssociatesDocument
    RelatedObjects : SET [1:?] OF IfcDefinitionSelect;
  END_ENTITY;

ENTITY IfcRelAssociatesDocument
  ENTITY IfcRelAssociates
    RelatedObjects : SET [1:?] OF IfcDefinitionSelect;
  END_ENTITY;

4.2.7.2.20 IfcRelConnectsWithRealizingElements Definition

IfcRelConnectsWithRealizingElements defines a generic relationship that is made between two elements that require the realization of that relationship by means of further realizing elements.
An IfcRelConnectsWithRealizingElements is a specialization of IfcRelConnectsElement where the connecting operation has the additional attribute of (one or many) realizing elements that may be used to realize or further qualify the relationship. It is defined as a ternary relationship.

EXAMPLE It may be used to describe the attachment of one element to another where the attachment is realized by a 'fixing' element such as a bracket. It may also be used to describe the mounting of one element onto another such as the requirement for the mounting major plant items onto builders work bases and/or anti-vibration isolators.

HISTORY New entity in IFC2x2.

EXPRESS Specification:

ENTITY IfcRelConnectsWithRealizingElements
  SUBTYPE OF (IfcRelConnectsElements);
    RealizingElements : SET [1:?] OF IfcElement;
    ConnectionType    : OPTIONAL IfcStrippedOptional;
END_ENTITY;

Attribute Definitions:

RealizingElements    : Defines the elements that realize a connection relationship.
ConnectionType       : The type of the connection given for informal purposes, it may include labels, like 'joint', 'rigid joint', 'flexible joint', etc.

Inheritance Graph:

ENTITY IfcRelConnectsWithRealizingElements
  ENTITY IfcRoot
    GlobalId : IfcGloballyUniqueId;
    OwnerHistory : OPTIONAL IfcOwnerHistory;
    Name : OPTIONAL IfcLabel;
    Description : OPTIONAL IfcText;
  END_ENTITY;

ENTITY IfcRelConnects
  ENTITY IfcRelConnectsElements
    ConnectionGeometry : OPTIONAL IfcStrippedOptional;
    RelatingElement    : IfcElement;
    RelatedElement     : IfcElement;
  END_ENTITY;

ENTITY IfcRelConnectsWithRealizingElements
  RealizingElements : SET [1:?] OF IfcElement;
  ConnectionType    : OPTIONAL IfcStrippedOptional;
END_ENTITY;

</xs:element name="IfcRelConnectsWithRealizingElements" type="ifc:IfcRelConnectsWithRealizingElements"
substitutionGroup="ifc:IfcRelConnectsElements" nillable="true"/>
</xs:complexType name="IfcRelConnectsWithRealizingElements">
</xs:complexContent>
</xs:extension base="ifc:IfcRelConnectsElements">
</xs:sequence>
</xs:element name="RealizingElements">
4.2.7.2.21 IfcConstructionProductResource Definition

IfcConstructionProductResource defines the role of a product that is consumed (wholly or partially), or occupied in the performance of construction.

HISTORY New entity in IFC2.0. Renamed from IfcProductResource in IFC2x.

Occurrences of IfcConstructionProductResource are usage of products to assist the process of construction. More specifically, they are usage of products that result from some construction processes and that are then used as resources to facilitate further construction. For instance, formworks can be instantiated as products resulting from the process ‘constructing formwork’. However, they are used as resources in the process ‘pouring concrete’ in a later stage of the project.

EXPRESS Specification:

ENTITY IfcConstructionProductResource
  SUBTYPE OF (IfcConstructionResource);
    PredefinedType : OPTIONAL IfcStrippedOptional;
  WHERE
    CorrectPredefinedType : NOT(EXISTS(PredefinedType)) OR (PredefinedType <>
      IfcConstructionProductResourceTypeEnum.USERDEFINED) OR ((PredefinedType =
      IfcConstructionProductResourceTypeEnum.USERDEFINED) AND EXISTS
      (SELF\IfcObject.ObjectType));
  END_ENTITY;

Attribute Definitions:

PredefinedType : Defines types of construction product resources.
  IFC4 New attribute.

Inheritance Graph:

ENTITY IfcConstructionProductResource
  ENTITY IfcRoot
    GlobalId : IfcGloballyUniqueId;
    OwnerHistory : OPTIONAL IfcOwnerHistory;
    Name : OPTIONAL IfcLabel;
    Description : OPTIONAL IfcText;
4.2.7.2.22 IfcConstructionProductResourceType Definition

The resource type IfcConstructionProductType defines commonly shared information for occurrences of construction product resources. The set of shared information may include:

- common productivities
- common cost rates
- common properties within shared property sets

It is used to define a construction product resource specification (i.e. the specific resource information that is common to all occurrences of that resource). Resource types may be exchanged without being already assigned to occurrences.

Occurrences of the IfcConstructionProductResourceType are represented by instances of IfcConstructionProductResource.

HISTORY New entity in IFC4.
Assignment use definition

In addition to assignments specified at the base class IfcConstructionResourceType, a construction product resource type may have assignments of its own using IfcRelAssignsToResource where RelatingResource refers to the IfcConstructionProductResourceType and RelatedObjects contains one or more IfcTypeProduct subtypes. Such relationship indicates the type of product to be used as input, which is instantiated as an occurrence assigned for each resource occurrence. There may be multiple chains of production where such product type may have its own task and resource types assigned.

EXPRESS Specification:

ENTITY IfcConstructionProductResourceType
  SUBTYPE OF (IfcConstructionResourceType);
  PredefinedType : IfcConstructionProductResourceTypeEnum;
  WHERE
    CorrectPredefinedType : (PredefinedType <> IfcConstructionProductResourceTypeEnum.USERDEFINED) OR
    ((PredefinedType = IfcConstructionProductResourceTypeEnum.USERDEFINED) AND
    EXISTS(SELF\IfcTypeResource.ResourceType));
END_ENTITY;

Attribute Definitions:

PredefinedType : Defines types of construction product resources.

Inheritance Graph:

ENTITY IfcConstructionProductResourceType
ENTITY IfcRoot
  GlobalId : IfcGloballyUniqueId;
  OwnerHistory : OPTIONAL IfcOwnerHistory;
  Name : OPTIONAL IfcLabel;
  Description : OPTIONAL IfcText;
ENTITY IfcObjectDefinition

INVERSE
  HasAssignments : SET OF IfcRelAssigns FOR RelatedObjects;
  HasContext : SET [0:1] OF IfcRelDeclares FOR RelatedDefinitions;
  IsDecomposedBy : SET OF IfcRelAggregates FOR RelatingObject;
  Decomposes : SET [0:1] OF IfcRelAggregates FOR RelatedObjects;
  HasAssociations : SET OF IfcRelAssociates FOR RelatedObjects;
ENTITY IfcTypeObject
  ApplicableOccurrence : OPTIONAL IfcStrippedOptional;
  HasPropertySets : OPTIONAL SET [1:?] OF IfcPropertySetDefinition;
INVERSE
  Types : SET [0:1] OF IfcRelDefinesByType FOR RelatingType;
ENTITY IfcTypeResource
  Identification : OPTIONAL IfcStrippedOptional;
  LongDescription : OPTIONAL IfcStrippedOptional;
  ResourceType : OPTIONAL IfcStrippedOptional;
INVERSE
ENTITY IfcConstructionResourceType
BaseCosts : OPTIONAL LIST [1:?] OF IfcStrippedOptional;
BaseQuantity : OPTIONAL IfcStrippedOptional;
ENTITY IfcConstructionProductResourceType
PredefinedType : IfcConstructionProductResourceTypeEnum;
END_ENTITY;

<x:element name="IfcConstructionProductResourceType" type="ifc:IfcConstructionProductResourceType"
substitutionGroup="ifc:IfcConstructionResourceType" nillable="true"/>
<x:complexType name="IfcConstructionProductResourceType">
<x:complexContent>
<x:extension base="ifc:IfcConstructionResourceType">
<x:attribute name="PredefinedType" type="ifc:IfcConstructionProductResourceTypeEnum" use="optional"/>
</x:extension>
</x:complexContent>
</x:complexType>

4.2.7.3 Data definition reference schema list

ISO 16739:2013, “Industry Foundation Classes (IFC) for data sharing in the construction and facilities
management industries,” commonly called IFC4, is the reference standard schema for data definitions in
this MVD. Use of IFC4 in this MVD is optional. Backward compatibility to IFC 2x3 is maintained for all
use of COBie and all testing described in this standard.

4.2.7.4 Concept list

The concepts used in this MVD are as follows:

- Identity
- Revision Control
- External Data Constraints
- Classification
- Spatial Composition
- Quantities on Occurrences
- Conversion Units
- Project Declaration
- Group Assignment
- Object Typing
- Spatial Containment
- Property Sets for Occurrences
- Property Sets for Types
- Task Scheduling
- Sequential Connectivity
- Contact
- Control Assignment

4.2.7.5 Concepts definition

Each entity is listed with corresponding concepts and a graph of attributes and objects representing the
combination of all concepts applied to instances of the entity. Each block in the diagram represents an
entity, where the entity name is shown at the top of the block with background in black. Each attribute
within the entity is shown in order, where black is used to indicate a direct attribute and grey is used to
indicate an inverse attribute. Notation to the right of each attribute indicates aggregation, where S
indicates a SET (unordered unique objects) and L indicates a LIST (ordered objects), the first number in
brackets indicates the minimum count, and the second number in brackets indicates the maximum count.
or “?” for unlimited. Lines connecting blocks indicates attributes that point to objects of other data definitions.

4.2.7.5.1 ifcSpace concepts definition

A space represents an area or volume bounded actually or theoretically. Spaces are areas or volumes that provide for certain functions within a building.

The volume of a space excludes coverings; the vertical dimensions start from the top of the slab below and extend to the bottom of the slab above (excluding floor coverings or dropped ceilings), and the horizontal dimensions are bounded by the extents of walls and columns (excluding coverings such as drywall). The volume of a room, however, is bounded by such coverings, and may be derived by subtracting such dimensions and indicated as the NetVolume quantity.

The diagram below illustrates the related entities, their expected cardinality, and properties.

Figure 41 ifcSpace Concepts
4.2.7.5.2 ifcBuildingStory concepts definition

A building story has an elevation and typically represents a (nearly) horizontal aggregation of spaces that are vertically bound. The diagram below illustrates the related entities, their expected cardinality, and properties.

Figure 42 ifcBuildingStory Concepts
4.2.7.5.3 ifcBuilding concepts definition

A building represents a structure that provides shelter for its occupants or contents and stands in one place. The building is also used to provide a basic element within the spatial structure hierarchy for the components of a building project (together with site, story, and space). The diagram below illustrates the related entities, their expected cardinality, and properties.
4.2 7.5.4 ifcSite concepts definition

A site is a defined area of land, possibly covered with water, on which the project construction is to be completed. A site may be used to erect building(s) or other AEC products. The diagram below illustrates the related entities, their expected cardinality, and properties.

Figure 44 ifcSite Concepts

4.2.7.5.5 ifcProject concepts definition

All IFC files must contain a single IfcProject instance that provides global context information including default units, and provides a directory of objects organized within the project.

Conversion Units:

Project Units define the units used in the data exchange. Units can be translated during export and import; that is, the originating model, data exchange and resulting model may all have different units.

The following units must be supported in all exchange scenarios:

- Length
- Area
- Volume
- Angle
- Currency
Additional units must be supported if they are needed in the context of an exchange scenario. Each measure value of the same type in the data exchange uses the same unit. When an application imports data, the following behavior relating to units is allowed:

Importing units as they are, providing the units match the units used by the importing application.

Translating to units of the same unit system, e.g. millimeters to meters.

Translating between unit systems, e.g. from millimeter to inch. The user must be prompted to accept the translation or cancel the import.

Informing the user about unsupported units and cancelling the import.

The following behavior is not allowed:

Importing units of a supported unit system without translation, if the units in the receiving application are not set to match the units used in the exchange, e.g. importing millimeters as meters.

Importing units of an unsupported unit system without translation, e.g. importing millimeters as inches without translation.

Mixing units of different unit systems is not allowed. Importing applications are required to detect invalid unit configurations, notify the user and cancel the import.

Additional restrictions have been imposed on units, with the requirement that angles must be measured in degrees (as opposed to radians).
The diagram below illustrates the related entities, their expected cardinality, and properties.

![Diagram of ifcProject Concepts]

Figure 45 ifcProject Concepts

4.2.7.5.6 ifcZone Concepts Definition

A zone is a group of spaces, partial spaces or other zones. Zone structures may not be hierarchical (in contrary to the spatial structure of a project - see IfcSpatialStructureElement), i.e. one individual IfcSpace may be assigned to zero, one, or several IfcZone's. IfcSpace's are grouped into an IfcZone by using the objectified relationship IfcRelAssignsToGroup as specified at the supertype IfcGroup.

4.2.7.5.7 ifcSystem concepts definition

A system is an organized combination of related parts within an AEC product, composed for a common purpose or function or to provide a service. A system is essentially a functionally related aggregation of products.

The following subtypes of IfcSystem are within the scope of this MVD (though corresponding schemas are not incorporated within):

IfcBuildingSystem: A set of building elements designed to support, enclose, shade, insulate, or otherwise perform a common function.

IfcDistributionSystem: A set of distribution elements designed to receive, store, maintain, distribute, or control the flow of a distribution media.
The diagram below illustrates the related entities, their expected cardinality, and properties.

Figure 46 ifcSystemConcepts
2.7.5.8 ifcElement concepts definition

An element represents a physical building component. All subtypes of IfcElement are within scope of this MVD (for example, IfcBoiler), however instantiable subtypes are not incorporated within this documentation, for brevity.
4.2.7.5.9 ifcElementType concepts definition

The diagram below illustrates the related entities, their expected cardinality, and properties.

Figure 48 ifcElementType Concepts
4.2.7.5.10 ifcTask concepts definition

Figure 49 ifcTask Concepts
4.2.7.5.11 ifcActor concepts definition

For COBie, this entity is used to hold contact information. While COBie does not elaborate specific relationships between people and other objects (such as a person occupying a space), the user who currently owns an object is indicated using IfcOwnerHistory, where such contact information may be located by finding the corresponding IfcActor. The diagram below illustrates the related entities, their expected cardinality, and properties.
4.2.7.5.12 ifcActionRequest concepts definition

The diagram below illustrates the related entities, their expected cardinality, and properties.

Figure 51 ifcActionRequest Concepts
4.2.7.5.13 ifcProcess concepts definition

A process is a set of activities that are interrelated or that interact with one another. Processes use resources to transform inputs into outputs. Processes are interconnected because the output from one process becomes the input for another process. In effect, processes are "glued" together by means of such input-output relationships.

The diagram below illustrates the related entity.

![Diagram of ifcProcess concepts](image)

Figure 52 ifcProcess Concepts

4.2.7.5.14

ifcGroup concepts definition

A group is an organization of related items for a functional purpose. Specific subtypes are used for particular scenarios.

The diagram below illustrates the related entity.
4.2.7.5.15 ifcPropertySet concepts definition

The diagram below illustrates the related entities, their expected cardinality, and properties.

4.2.7.5.16 ifcAnnotation concepts definition

The diagram below illustrates the related entities, their expected cardinality, and properties.
4.2.7.5.17 ifcRelConnectsPorts concepts definition

The diagram below illustrates the related entity.

![ifcRelConnectsPorts](image1)

Figure 56 ifcRelConnectsPort Concept

4.2.7.5.18 ifcWorkSchedule concepts definition

The diagram below illustrates the related entities, their expected cardinality, and properties.

![ifcWorkScheduleConcepts](image2)

Figure 57 ifcWorkScheduleConcepts

4.2.7.5.19 ifcRelAssociatesDocument concepts definition

The diagram below illustrates the related entity.

![ifcRelAssociatesDocument](image3)

Figure 58 ifcRelAssociates Document

4.2.7.5.20 ifcRelConnectsWithRealizingElement concepts definition

The diagram below illustrates the related entity.
Figure 59 ifcRelConnectsWithRealizingElement Concepts

4.2.7.5.21 ifcConstructionProductResource concepts definition

The diagram below illustrates the related entities, their expected cardinality, and properties.

Figure 60 ifcConstructionProductResource Concept

4.2.7.5.22 ifcConstructionProductResourceType Concepts Definition

The diagram below illustrates the related entity.

Figure 61 ifcConstructionProductResourceType Concept
4.2.7.6 Concept attributes list

Concepts are also required to have parameters, properties, or attributes that specify applicable values. For example, plumbing objects may make use of ports to enable connectivity to other objects for distribution of water, and a specific entity such as a hot water heater may have specific ports such as “ColdWaterIn” and “HotWaterOut”. Defining attributes at concepts enables re-use of concepts where the data structures are the same, but applicable values may differ.

4.2.7.6.1 External data constraints

To apply COBie in contexts outside those where STEP files might be used, this standard provides optional transformations between the underlying standard IFC specifications to schemas developed using SpreadsheetML (COBie Spreadsheet) and NIEM (COBieLite). The specifics of these alternative, optional schemas are found in Appendix A.

Transformation software, called the COBie ToolKit, is provided as open-source software. Testing using that COBie ToolKit has verified loss-less transformation between STEP, COBieSpreadsheet, and COBieLite formats (for in-scope COBie entities).

4.2.7.6.2 Classification constraints

The following classifications are provided as default values in COBie. Specific regional or client classifications may replace these classifications.

Table 48 Classification Constraints

<table>
<thead>
<tr>
<th>Entity</th>
<th>Source</th>
<th>Name</th>
<th>Tokens</th>
</tr>
</thead>
<tbody>
<tr>
<td>IfcSpace</td>
<td>Construction Specifications Institute</td>
<td>Omniclass Table 13</td>
<td>13-00 00 00</td>
</tr>
<tr>
<td>IfcBuilding</td>
<td>Construction Specifications Institute</td>
<td>Omniclass Table 11</td>
<td>11-00 00 00</td>
</tr>
<tr>
<td>IfcZone</td>
<td>Construction Specifications Institute</td>
<td>Omniclass Table 14</td>
<td>14-00 00 00</td>
</tr>
<tr>
<td>IfcSystem</td>
<td>Construction Specifications Institute</td>
<td>Omniclass Table 21</td>
<td>21-00 00 00</td>
</tr>
<tr>
<td>IfcElement</td>
<td>Construction Specifications Institute</td>
<td>Omniclass Table 22</td>
<td>22-00 00 00</td>
</tr>
<tr>
<td>IfcElementType</td>
<td>Construction Specifications Institute</td>
<td>Omniclass Table 23</td>
<td>23-00 00 00</td>
</tr>
<tr>
<td>IfcTask</td>
<td>Construction Specifications Institute</td>
<td>Omniclass Table 31</td>
<td>31-00 00 00</td>
</tr>
<tr>
<td>IfcActor</td>
<td>Construction Specifications Institute</td>
<td>Omniclass Table 34</td>
<td>34-00 00 00</td>
</tr>
<tr>
<td>IfcPropertySet</td>
<td>Construction Specifications Institute</td>
<td>Omniclass Table 49</td>
<td>49-00 00 00</td>
</tr>
</tbody>
</table>

4.2.7.6.3 Spatial composition constraints

The following entities are required to be present to comply with COBie business rules regarding spatial constraints:

- IfcSpace
• IfcBuildingStory
• IfcBuilding
• IfcSite

4.2.7.6.4 Quantities on occurrence constraints

The following IFC quantities are required to be present for any instances of IfcSpace:

• IfcQuantityLength
• IfcQuantityArea (Net)
• IfcQuantityArea (Gross)

The following IFC quantity is required to be present for any instances of IfcSpace:

• IfcQuantityLength

4.2.7.6.5 Conversion unit constraints

The following IFC conversion units are required to be associated with the IfcProject entity:

• LENGTHUNIT
• AREAUNIT
• VOLUMEUNIT
• CURRENCYUNIT

4.2.7.6.6 Project declaration constraints

The following IFC entities are required for Project Declarations:

• IfcActor
• IfcActionRequest
• IfcSystem
• IfcZone
• IfcTask
• IfcConstructionResource
• IfcTypeProduct
• IfcConstructionResourceType

4.2.7.6.7 Group assignment constraints

The following group assignments are allowed in COBie:

• ifcZone – comprised of classes of groups of IfcSpace entities
• ifcSystem – comprised of classes of groups of IfcElement entities
4.2.7.6.8 Object typing constraints

The following object typing is required in COBie:

- ifcElements are required to be typed according to ifcElementType objects

4.2.7.6.9 Spatial containment constraints

Use of geometry is limited within COBie to reflect the requirement to locate specific managed assets within spaces. As a result the following spatial containment is required in COBie:

- ifcElements are required to be located within one ifcSpace objects

4.2.7.6.10 Property sets for occurances constraints

The following property sets shall be used for all property sets on occurances:

<table>
<thead>
<tr>
<th>Table 49 Property Sets for Occurrences Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity</td>
</tr>
<tr>
<td>IfcElement</td>
</tr>
<tr>
<td>IfcTask</td>
</tr>
<tr>
<td>IfcActionRequest</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>IfcConstructionProductResource</td>
</tr>
</tbody>
</table>

4.2.7.6.11 Property Sets for Type Constraints

The following property sets shall be used for all property sets on types:

<table>
<thead>
<tr>
<th>Table 50 Property Sets for Types Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity</td>
</tr>
<tr>
<td>IfcElementType</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>IfcConstructionProductResourceType</td>
</tr>
</tbody>
</table>

4.2.7.6.12 Control Assignment Constraints

The following control assignment is required in COBie:

- ifcActionRequest objects must be assigned to ifcElement objects
4.2.7.7 Concept Relationship Description

Concepts may inherit from other concepts such that more generic rules may be defined at a higher level and more specific rules at a lower level. For example, geometry may be defined for a distribution segment (e.g. ducts, pipes, cables) that indicate permitted use of an extruded area solid (IfcExtrudedAreaSolid) which defines a 2D cross section extruded along a 3D linear segment. Such rule may be further refined for ducts to indicate that the cross-sections are further restricted to shapes such as hollow rectangles (IfcRectangleHollowProfileDef) or hollow circles (IfcCircleHollowProfileDef).

- Project
- Project Declaration
- Project Units
- Conversion Units
- Roots
- Identity
- Revision Control
- Definition
- Object Typing
- Property Sets
- Property Sets for Occurrences
- Property Sets for Types
- Quantity Sets
- Quantities on Occurrences
- Association
- Classification
- Classification expected
- Constraint
- External Data Constraints
- Assignment
- Control Assignment
- Group Assignment
- Composition
- Aggregation
- Spatial Composition
- Connectivity
- Spatial Structure
- Spatial Containment
- Sequential Connectivity
- Actor
- Contact
- Process
- Task Scheduling

4.2.7.8 Concept requirements applicability

The listing below allows software developers to more clearly understand the model concepts that are required to be applied, for a given entity, at each stage in the COBie deliverable process. In these tables the letter “R” indicates that the concept is required for a given exchange. The letter “O” means that the concept is required if (1) the information is required by contract or (2) the information is present in the COBie data model.
### Table 51 IfcSpace - Concept Applicability

| Concept              | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | ProductType Template | Product Template | Bid Issue | ProductTypeSelection | System Layout | Product Installation | Construction Issue | Product Type Parts | ProductTypeWarranty | ProductTypeMaintenance | Product Type Parts | System Operation | Space Condition | SpacePartReplacement | Space Occupancy | SpaceActivityRenovation | Remodel | Expand | Demolish | Identity | Revision Control | External Data Constraints | Classification | Spatial Composition | Quantities on Occurrences |
|----------------------|-------------------|---------------------------|--------------------|---------------|----------------|--------------|---------------|-------------------|---------------|----------------------|------------------|-----------|---------------------|----------------|---------------------|------------------|-----------------|----------------------|----------------------|------------------|----------------|------------------|----------------|----------------|-------------------------|-----------------|------------------|---------------------|
| Identity             | O                  | O                         | R                  | R             | R             | R            | R             | R                 | R             | R                    | R                | R         | R                   | R              | R                   | R                 | R               | R                    | R                    | R                 | R               | R                | R                | R               | R                        | R                | R               | R                    | R                  |
| Revision Control     | O                  | O                         | O                  | O             | O             | O            | O             | O                 | O             | O                    | O                | O         | O                   | O              | O                   | O                 | O               | O                    | O                    | O                 | O               | O                | O                | O               | O                        | O                | O               | O                    | O                  |
| External Data Constraints | O              | O                         | O                  | R             | R             | R            | R             | R                 | R             | R                    | R                | R         | R                   | R              | R                   | R                 | R               | R                    | R                    | R                 | R               | R                | R                | R               | R                        | O                | O               | O                    | O                  |
| Classification       | O                  | O                         | O                  | R             | R             | R            | R             | R                 | R             | R                    | R                | R         | R                   | R              | R                   | R                 | R               | R                    | R                    | R                 | R               | R                | R                | R               | R                        | O                | O               | O                    | O                  |
| Spatial Composition  | O                  | O                         | O                  | R             | R             | R            | R             | R                 | R             | R                    | R                | R         | R                   | R              | R                   | R                 | R               | R                    | R                    | R                 | R               | R                | R                | R               | R                        | O                | O               | O                    | O                  |
| Quantities on Occurrences | O              | O                         | O                  | R             | R             | R            | R             | R                 | R             | R                    | R                | R         | R                   | R              | R                   | R                 | R               | R                    | R                    | R                 | R               | R                | R                | R               | R                        | O                | O               | O                    | O                  |

### Table 52 IfcBuildingStory - Concept Applicability

| Concept              | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | ProductType Template | Product Template | Bid Issue | ProductTypeSelection | System Layout | Product Installation | Construction Issue | Product Type Parts | ProductTypeWarranty | ProductTypeMaintenance | Product Type Parts | System Operation | Space Condition | SpacePartReplacement | Space Occupancy | SpaceActivityRenovation | Remodel | Expand | Demolish | Identity | Revision Control | External Data Constraints | Classification | Spatial Composition | Quantities on Occurrences |
|----------------------|-------------------|---------------------------|--------------------|---------------|----------------|--------------|---------------|-------------------|---------------|----------------------|------------------|-----------|---------------------|----------------|---------------------|------------------|-----------------|----------------------|----------------------|----------------|----------------|------------------|----------------|----------------|-------------------------|-----------------|----------------|---------------------|
| Identity             | O                  | O                         | R                  | R             | R             | R            | R             | R                 | R             | R                    | R                | R         | R                   | R              | R                   | R                 | R               | R                    | R                    | R                 | R               | R                | R                | R               | R                        | O                | O               | O                    | O                  |
| Revision Control     | O                  | O                         | O                  | O             | O             | O            | O             | O                 | O             | O                    | O                | O         | O                   | O              | O                   | O                 | O               | O                    | O                    | O                 | O               | O                | O                | O               | O                        | O                | O               | O                    | O                  |
| External Data Constraints | O              | O                         | R                  | R             | R             | R            | R             | R                 | R             | R                    | R                | R         | R                   | R              | R                   | R                 | R               | R                    | R                    | R                 | R               | R                | R                | R               | R                        | O                | O               | O                    | O                  |
| Classification       | O                  | O                         | O                  | R             | R             | R            | R             | R                 | R             | R                    | R                | R         | R                   | R              | R                   | R                 | R               | R                    | R                    | R                 | R               | R                | R                | R               | R                        | O                | O               | O                    | O                  |
| Spatial Composition  | O                  | O                         | O                  | R             | R             | R            | R             | R                 | R             | R                    | R                | R         | R                   | R              | R                   | R                 | R               | R                    | R                    | R                 | R               | R                | R                | R               | R                        | O                | O               | O                    | O                  |
| Quantities on Occurrences | O              | R                         | R                  | R             | R             | R            | R             | R                 | R             | R                    | R                | R         | R                   | R              | R                   | R                 | R               | R                    | R                    | R                 | R               | R                | R                | R               | R                        | R                | O               | O                    | O                  |
### Table 53 IfcBuilding - Concept Applicability

| Concept                  | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | Product Type Template | Bid Issue | System Layout | Product Installation | Construction Issue | Product Type Parts | Product Type Warranty | Product Type Maintenance | System Operation | Space Condition | Space Parts Replacement | Space Parts Placement | Space Occupancy | Space Activity | Remodel | Expand | Demolish |
|-------------------------|------------------|---------------------------|--------------------|---------------|----------------|-------------|-----------------|-------------------|--------------|----------------------|----------|----------------|-----------------------|---------------------|-------------------|------------------------|------------------------|------------------|-----------------|---------------------|------------------------|
| Identity                | R                | R                         | R                  | R             | R             | R           | R               | R                 | R           | R                    | R        | R             | R                     | R                    | R                 | R                      | R                      | R               | R               | R       | R      | R        |
| Revision Control        | O                | O                         | O                  | O             | O             | O           | O               | O                 | O           | O                    | O        | O             | O                     | O                    | O                 | O                      | O                      | O               | O               | O       | O      | O        |
| Classification          | O                | O                         | O                  | O             | O             | O           | O               | O                 | O           | O                    | O        | O             | O                     | O                    | O                 | O                      | O                      | O               | O               | O       | O      | O        |
| Spatial Composition     | R                | R                         | R                  | R             | R             | R           | R               | R                 | R           | R                    | R        | R             | R                     | R                    | R                 | R                      | R                      | R               | R               | R       | R      | R        |

### Table 54 IfcSite - Concept Applicability

| Concept                  | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | Product Type Template | Bid Issue | System Layout | Product Installation | Construction Issue | Product Type Parts | Product Type Warranty | Product Type Maintenance | System Operation | Space Condition | Space Parts Replacement | Space Parts Placement | Space Occupancy | Space Activity | Remodel | Expand | Demolish |
|-------------------------|------------------|---------------------------|--------------------|---------------|----------------|-------------|-----------------|-------------------|--------------|----------------------|----------|----------------|-----------------------|---------------------|-------------------|------------------------|------------------------|------------------|-----------------|---------------------|------------------------|
| Identity                | R                | R                         | R                  | R             | R             | R           | R               | R                 | R           | R                    | R        | R             | R                     | R                    | R                 | R                      | R                      | R               | R               | R       | R      | R        |
| Spatial Composition     | R                | R                         | R                  | R             | R             | R           | R               | R                 | R           | R                    | R        | R             | R                     | R                    | R                 | R                      | R                      | R               | R               | R       | R      | R        |
| Revision Control        | O                | O                         | O                  | O             | O             | O           | O               | O                 | O           | O                    | O        | O             | O                     | O                    | O                 | O                      | O                      | O               | O               | O       | O      | O        |

### Table 55 IfcProject - Concept Applicability

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|-------------------------|------------------|---------------------------|--------------------|---------------|----------------|-------------|-----------------|-------------------|--------------|----------------------|----------|----------------|-----------------------|---------------------|-------------------|------------------------|------------------------|------------------|-----------------|---------------------|------------------------|
| Identity                | R                | R                         | R                  | R             | R             | R           | R               | R                 | R           | R                    | R        | R             | R                     | R                    | R                 | R                      | R                      | R               | R               | R       | R      | R        |
| Revision Control        | O                | O                         | O                  | O             | O             | O           | O               | O                 | O           | O                    | O        | O             | O                     | O                    | O                 | O                      | O                      | O               | O               | O       | O      | O        |
| External Data Constraints| R                | R                         | R                  | R             | R             | R           | R               | R                 | R           | R                    | R        | R             | R                     | R                    | R                 | R                      | R                      | R               | R               | R       | R      | R        |
| Conversion Units        | R                | R                         | R                  | R             | R             | R           | R               | R                 | R           | R                    | R        | R             | R                     | R                    | R                 | R                      | R                      | R               | R               | R       | R      | R        |
| Project Declaration    | R                | R                         | R                  | R             | R             | R           | R               | R                 | R           | R                    | R        | R             | R                     | R                    | R                 | R                      | R                      | R               | R               | R       | R      | R        |
### Table 56 IfcZone - Concept Applicability

| Concept            | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | Product Type Template | Product Template | Bid Issue | Product Type Selection | System Layout | Product Installation | Construction Issue | Product Type Parts | ProductTypeWarranty | ProductTypeMaintenance | System Operation | Space Condition | Space Parts | Space Activity | Remodel | Expand | Demolish |
|--------------------|-------------------|---------------------------|--------------------|---------------|----------------|--------------|-----------------|-------------------|--------------|----------------------|-----------------|-----------|----------------------|----------------|---------------------|-------------------|------------------|---------------------|--------------------|------------------|------------|-------------|---------|--------|---------|
| Identity           | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |
| Revision Control   | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |
| External Data      | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |
| Constraints        | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |
| Classification     | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |
| Group Assignment   | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |

### Table 57 IfcSystem - Concept Applicability

| Concept            | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | Product Type Template | Product Template | Bid Issue | Product Type Selection | System Layout | Product Installation | Construction Issue | Product Type Parts | ProductTypeWarranty | ProductTypeMaintenance | System Operation | Space Condition | Space Parts | Space Activity | Remodel | Expand | Demolish |
|--------------------|-------------------|---------------------------|--------------------|---------------|----------------|--------------|-----------------|-------------------|--------------|----------------------|-----------------|-----------|----------------------|----------------|---------------------|-------------------|------------------|---------------------|--------------------|------------------|------------|-------------|---------|--------|---------|
| Identity           | R                 | R                         | R                  | R             | R              | R            | R               | R                 | R            | R                    | R               | R         | R                    | R             | R                   | R                 | R                | R                   | R                 | R      | R          | R       | R       | R       |
| Revision Control   | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |
| External Data      | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |
| Constraints        | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |
| Classification     | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |
| Group Assignment   | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |
| Classification     | 0                 | 0                         | 0                  | 0             | 0              | 0            | 0               | 0                 | 0            | 0                    | 0               | 0         | 0                    | 0             | 0                   | 0                 | 0                | 0                   | 0                 | 0        | 0          | 0       | 0       | 0       |
### Table 58 IfcElement - Concept Applicability

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### Table 61 IfcActor - Concept Applicability

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### Table 62 IfcActionRequest - Concept Applicability

| Concept                | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | Product Type Template | Product Template | Bid Issue | Product Type Selection | System Layout | Product Installation | Product Inspection | Product Type Issue | Product Type Parts | Product Type Warranty | Product Type Maintenance | System Operation | Product Type O | System Parts Replacement | Space Condition | Space Activity Renovation | Remodel | Expand | Demolish |
|------------------------|-------------------|---------------------------|--------------------|---------------|----------------|--------------|------------------|---------------------|--------------|----------------------|-----------------|-----------|-----------------------|---------------|----------------------|----------------------|---------------------|------------------|----------------------|----------------------|-----------------|----------------------|---------|--------|----------|
| Identity               |                   |                           |                    |               |                |              | R                | R                   | R            | R                     | O               | O         | O                     | O              | O                    | O                     | O                   | O                | O                     | O                   | O              | O                    | O       | O      | O        |
| Revision Control       |                   |                           |                    |               |                |              |                  | O                   | O            | O                     | O               | O         | O                     | O              | O                    | O                     | O                   | O                | O                     | O                   | O              | O                    | O       | O      | O        |
| External Data Constraints |                 |                           |                    |               |                |              |                  | R                   | R            | R                     | R               | R         | R                     | R              | R                    | R                     | R                   | R                | R                     | R                   | R              | R                    | R       | R      | R        |
| Property Sets for Occurrences |               |                           |                    |               |                |              |                  | O                   | O            | O                     | O               | O         | O                     | O              | O                    | O                     | O                   | O                | O                     | O                   | O              | O                    | O       | O      | O        |
| Control Assignment     |                   |                           |                    |               |                |              |                  | O                   | O            | O                     | O               | O         | O                     | O              | O                    | O                     | O                   | O                | O                     | O                   | O              | O                    | O       | O      | O        |

### Table 63 IfcPropertySet - Concept Applicability

| Concept                | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | Product Type Template | Product Template | Bid Issue | Product Type Selection | System Layout | Product Installation | Product Inspection | Product Type Issue | Product Type Parts | Product Type Warranty | Product Type Maintenance | System Operation | Product Type O | System Parts Replacement | Space Condition | Space Activity Renovation | Remodel | Expand | Demolish |
|------------------------|-------------------|---------------------------|--------------------|---------------|----------------|--------------|------------------|---------------------|--------------|----------------------|-----------------|-----------|-----------------------|---------------|----------------------|----------------------|---------------------|------------------|----------------------|----------------------|-----------------|----------------------|---------|--------|----------|
| Identity               |                   |                           |                    |               |                |              | R                | R                   | R            | R                     | O               | O         | O                     | O              | O                    | O                     | O                   | O                | O                     | O                   | O              | O                    | O       | O      | O        |
| Revision Control       |                   |                           |                    |               |                |              |                  | O                   | O            | O                     | O               | O         | O                     | O              | O                    | O                     | O                   | O                | O                     | O                   | O              | O                    | O       | O      | O        |
| External Data Constraints |                 |                           |                    |               |                |              |                  | R                   | R            | R                     | R               | R         | R                     | R              | R                    | R                     | R                   | R                | R                     | R                   | R              | R                    | R       | R      | R        |
| Classification         |                   |                           |                    |               |                |              |                  | O                   | O            | O                     | O               | O         | O                     | O              | O                    | O                     | O                   | O                | O                     | O                   | O              | O                    | O       | O      | O        |

### Table 64 IfcAnnotation - Concept Applicability

| Concept                | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | Product Type Template | Product Template | Bid Issue | Product Type Selection | System Layout | Product Installation | Product Inspection | Product Type Issue | Product Type Parts | Product Type Warranty | Product Type Maintenance | System Operation | Product Type O | System Parts Replacement | Space Condition | Space Activity Renovation | Remodel | Expand | Demolish |
|------------------------|-------------------|---------------------------|--------------------|---------------|----------------|--------------|------------------|---------------------|--------------|----------------------|-----------------|-----------|-----------------------|---------------|----------------------|----------------------|---------------------|------------------|----------------------|----------------------|-----------------|----------------------|---------|--------|----------|
| Identity               |                   |                           |                    |               |                |              | R                | R                   | R            | R                     | O               | O         | O                     | O              | O                    | O                     | O                   | O                | O                     | O                   | O              | O                    | O       | O      | O        |
| Revision Control       |                   |                           |                    |               |                |              |                  | O                   | O            | O                     | O               | O         | O                     | O              | O                    | O                     | O                   | O                | O                     | O                   | O              | O                    | O       | O      | O        |
| External Data Constraints |                 |                           |                    |               |                |              |                  | R                   | R            | R                     | R               | R         | R                     | R              | R                    | R                     | R                   | R                | R                     | R                   | R              | R                    | R       | R      | R        |
### Table 65 IfcRelConnectsPorts - Concept Applicability

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### Table 66 IfcWorkSchedule - Concept Applicability

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### Table 67 IfcRelAssociatesDocument - Concept Applicability

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### Table 68 ifcRelConnectsWithRealizingElements - Concept Applicability

| Concept                  | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | Product Type Template | Product Template | Bid Issue | Product Type Selection | Product Installation | Product Inspection | Construction Issue | System Operation | System Layout | Product Type Parts | Product Type Warranty | Product Type Maintenance | Product Type Operation | Product Type Repairs | Space Condition | Space Occupancy | SpaceActivityRenovation | Remodel | Expand | Demolish |
|--------------------------|------------------|---------------------------|--------------------|---------------|----------------|--------------|------------------|-------------------|---------------|---------------------|-------------------|-----------|----------------------|----------------------|----------------------|-------------------|-------------------|----------------|------------------|-------------------|---------------------|----------------------|------------------------|---------------------|----------------|----------------|-------------------------|---------|-------|----------|
| Identity                 |                  |                           |                    |               |                |              |                  |                   |              |                     |                   |           |                      |                      |                      |                  |                  |                |                 |                  |                     |                      |                       |                     |                 |               |                         |         |       |          |
| Revision Control         |                  |                           |                    |               |                |              |                  |                   |              |                     |                   |           |                      |                      |                      |                  |                  |                |                 |                  |                     |                      |                       |                     |                 |               |                         |         |       |          |
| External Data Constraints|                  |                           |                    |               |                |              |                  |                   |              |                     |                   |           |                      |                      |                      |                  |                  |                |                 |                  |                     |                      |                       |                     |                 |               |                         |         |       |          |

### Table 69 ifcConstructionProductResource – Concept Applicability

| Concept                  | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | Product Type Template | Product Template | Bid Issue | Product Type Selection | Product Installation | Product Inspection | Construction Issue | System Operation | System Layout | Product Type Parts | Product Type Warranty | Product Type Maintenance | Product Type Operation | Product Type Repairs | Space Condition | Space Occupancy | SpaceActivityRenovation | Remodel | Expand | Demolish |
|--------------------------|------------------|---------------------------|--------------------|---------------|----------------|--------------|------------------|-------------------|---------------|---------------------|-------------------|-----------|----------------------|----------------------|----------------------|-------------------|-------------------|----------------|------------------|-------------------|---------------------|----------------------|------------------------|---------------------|----------------|----------------|-------------------------|---------|-------|----------|
| Identity                 |                  |                           |                    |               |                |              |                  |                   |              |                     |                   |           |                      |                      |                      |                  |                  |                |                 |                  |                     |                      |                       |                     |                 |               |                         |         |       |          |
| Revision Control         |                  |                           |                    |               |                |              |                  |                   |              |                     |                   |           |                      |                      |                      |                  |                  |                |                 |                  |                     |                      |                       |                     |                 |               |                         |         |       |          |
| External Data Constraints|                  |                           |                    |               |                |              |                  |                   |              |                     |                   |           |                      |                      |                      |                  |                  |                |                 |                  |                     |                      |                       |                     |                 |               |                         |         |       |          |
| Property Sets for Occurrences |            |                           |                    |               |                |              |                  |                   |              |                     |                   |           |                      |                      |                      |                  |                  |                |                 |                  |                     |                      |                       |                     |                 |               |                         |         |       |          |

### Table 70 ifcConstructionProductResourceType – Concept Applicability

| Concept                  | Facility Criteria | Discipline Specifications | Project Definition | Space Program | Product Program | Design Early | Design Schematic | Design Coordinated | Design Issue | Product Type Template | Product Template | Bid Issue | Product Type Selection | Product Installation | Product Inspection | Construction Issue | System Operation | System Layout | Product Type Parts | Product Type Warranty | Product Type Maintenance | Product Type Operation | Product Type Repairs | Space Condition | Space Occupancy | SpaceActivityRenovation | Remodel | Expand | Demolish |
|--------------------------|------------------|---------------------------|--------------------|---------------|----------------|--------------|------------------|-------------------|---------------|---------------------|-------------------|-----------|----------------------|----------------------|----------------------|-------------------|-------------------|----------------|------------------|-------------------|---------------------|----------------------|------------------------|---------------------|----------------|----------------|-------------------------|---------|-------|----------|
| Identity                 |                  |                           |                    |               |                |              |                  |                   |              |                     |                   |           |                      |                      |                      |                  |                  |                |                 |                  |                     |                      |                       |                     |                 |               |                         |         |       |          |
| Revision Control         |                  |                           |                    |               |                |              |                  |                   |              |                     |                   |           |                      |                      |                      |                  |                  |                |                 |                  |                     |                      |                       |                     |                 |               |                         |         |       |          |
| External Data Constraints|                  |                           |                    |               |                |              |                  |                   |              |                     |                   |           |                      |                      |                      |                  |                  |                |                 |                  |                     |                      |                       |                     |                 |               |                         |         |       |          |
| Property Sets for Types  |                  |                           |                    |               |                |              |                  |                   |              |                     |                   |           |                      |                      |                      |                  |                  |                |                 |                  |                     |                      |                       |                     |                 |               |                         |         |       |          |
4.2.7.9 Related existing concept list

The table below demonstrates the re-use of COBie MVD concepts in related NBIMS-US™ V3 standards, and other buildingSMART alliance® projects. In the table, each row corresponds to a concept used within this model view, each column corresponds to another model view, and each cell indicates usage of the concept within the corresponding model view.

Table 71 Exchange Requirement Reuse Analysis

<table>
<thead>
<tr>
<th>Exchange</th>
<th>COBie</th>
<th>BPie</th>
<th>BAMie</th>
<th>HVACie</th>
<th>SPARKie</th>
<th>WSie</th>
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<tr>
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<td>X</td>
<td>X</td>
<td>X</td>
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<td>PropertySetsforOccurrences</td>
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</table>

4.2.7.10 Concept business rule list

The tables below identify the application of each concept business rule to the specific IFC entity or parameters to which that rule apply. The values for applicable parameters are either “As-defined” meaning that the rules contained in the underlying IFC model apply or as noted in the table.

Table 72 Identity Concept Business Rule List

<table>
<thead>
<tr>
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<th>Parameter</th>
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<tbody>
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<tr>
<td>\IfcRoot.GlobalId\IfcGloballyUniqueid</td>
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</tr>
<tr>
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<td>As-specified</td>
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<tr>
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</tr>
<tr>
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### Table 73 Revision Control Concept Business Rule List

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<th>Reference</th>
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</thead>
<tbody>
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<td>\IfcRoot.OwnerHistory</td>
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<tr>
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<td>As-specified</td>
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<td>As-specified</td>
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<td>As-specified</td>
</tr>
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<td>\IfcRoot.OwnerHistory\IfcOwnerHistory.OwningUser\IfcPersonAndOrganization-ThePerson-IfcPerson</td>
<td>As-specified</td>
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<td>As-specified</td>
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### Table 74 Revision Control Concept Business Rule List (cont.)

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### Table 75 External Data Constraints Concept Business Rule List

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### Table 76 External Data Constraints Concept Business Rule List (cont.)

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Table 77 Classification Concept Business Rule List

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<tr>
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**Table 78 Spatial Composition Concept Business Rule List**

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<tr>
<td><code>IfcRelDefinesByProperties</code></td>
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<tr>
<td><code>IfcObject.IsDefinedByIfcRelDefinesByProperties.RelatingPropertyDefinition</code></td>
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<td><code>IfcObject.IsDefinedByIfcRelDefinesByProperties.RelatingPropertyDefinition.IfcElementQuantity</code></td>
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**Table 74 Quantities on Occurrences Concept Business Rule List**

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<td><code>IfcRelDefinesByProperties</code></td>
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<td><code>IfcObject.IsDefinedByIfcRelDefinesByProperties.RelatingPropertyDefinition</code></td>
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</tr>
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<tr>
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### Table 75 Conversion Units Concept Business Rule List

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</thead>
<tbody>
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</tr>
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<td>IfcContext.UnitsInContext\IfcUnitAssignment.Units</td>
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### Table 81 Project Declaration Concept Business Rule List

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<td>IfcContext.Declares\IfcRelDeclares</td>
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</tr>
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### Table 762 Group Assignment Concept Business Rule List

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<tr>
<td>IfcGroup.IsGroupedBy\IfcRelAssignsToGroup</td>
<td>As-specified</td>
</tr>
<tr>
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<td>Type</td>
</tr>
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### Table 77 Object Typing Concept Business Rule List

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<td>As-specified</td>
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</tr>
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### Table 784 Spatial Containment Concept Business Rule List

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### Table 85 Property Sets for Occurrences Concept Business Rule List

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<tr>
<td><code>IfcObject.IsDefinedBy.IfcRelDefinesByProperties</code></td>
<td>As-specified</td>
</tr>
<tr>
<td><code>IfcObject.IsDefinedBy.IfcRelDefinesByProperties.RelatingPropertyDefinition</code></td>
<td>As-specified</td>
</tr>
<tr>
<td><code>IfcObject.IsDefinedBy.IfcRelDefinesByProperties.RelatingPropertyDefinition.IfcPropertySet</code></td>
<td>As-specified</td>
</tr>
<tr>
<td><code>IfcObject.IsDefinedBy.IfcRelDefinesByProperties.RelatingPropertyDefinition.IfcPropertySet.Name</code></td>
<td>Name</td>
</tr>
</tbody>
</table>

### Table 86 Property Sets for Types Concept Business Rule List

<table>
<thead>
<tr>
<th>Reference</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>IfcTypeObject.HasPropertySets</code></td>
<td>As-specified</td>
</tr>
<tr>
<td><code>IfcTypeObject.HasPropertySets.IfcPropertySet</code></td>
<td>As-specified</td>
</tr>
<tr>
<td><code>IfcTypeObject.HasPropertySets.IfcPropertySet.Name</code></td>
<td>Name</td>
</tr>
<tr>
<td><code>IfcTypeObject.HasPropertySets.IfcPropertySet.Name.IfcLabel</code></td>
<td>As-specified</td>
</tr>
<tr>
<td><code>IfcTypeObject.HasPropertySets.IfcPropertySet.HasProperties</code></td>
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</tr>
<tr>
<td><code>IfcTypeObject.HasPropertySets.IfcPropertySet.HasProperties.IfcProperty</code></td>
<td>As-specified</td>
</tr>
</tbody>
</table>
### Table 797 Task Scheduling Concept Business Rule List

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime</td>
</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring</td>
</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.ScheduleStart</td>
</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.ScheduleStart\IfcDateTime</td>
</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.ScheduleFinish</td>
</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.ScheduleFinish\IfcDateTime</td>
</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.ScheduleDuration</td>
</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.ScheduleDuration\IfcDuration</td>
</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.Recurrence</td>
</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.Recurrence\IfcRecurrencePattern</td>
</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.Recurrence\IfcRecurrencePattern.RecurrenceType</td>
</tr>
<tr>
<td>As-specified</td>
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</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.Recurrence\IfcRecurrencePattern.WeekdayComponent</td>
</tr>
<tr>
<td>As-specified</td>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.Recurrence\IfcRecurrencePattern.MonthComponent</td>
</tr>
<tr>
<td>As-specified</td>
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</tr>
<tr>
<td>As-specified</td>
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</tr>
<tr>
<td>As-specified</td>
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</tr>
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</table>
Table 88 Task Scheduling Concept Business Rule List (cont.)

<table>
<thead>
<tr>
<th>Reference</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.Recurrance\IfcRecurrencePattern.Occurrences</td>
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</tr>
<tr>
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<td>As-specified</td>
</tr>
<tr>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.Recurrance\IfcRecurrencePattern.TimePeriods</td>
<td>As-specified</td>
</tr>
<tr>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.Recurrance\IfcRecurrencePattern.TimePeriods\IfcTimePeriod</td>
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</tr>
<tr>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.Recurrance\IfcRecurrencePattern.TimePeriods\IfcTimePeriod.StartTime\IfcTime</td>
<td>As-specified</td>
</tr>
<tr>
<td>IfcTask.TaskTime\IfcTaskTimeRecurring.Recurrance\IfcRecurrencePattern.TimePeriods\IfcTimePeriod.EndTime\IfcTime</td>
<td>As-specified</td>
</tr>
</tbody>
</table>

Table 89 Sequential Connectivity Concept Business Rule List

<table>
<thead>
<tr>
<th>Reference</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>IfcProcess.IsPredecessorTo</td>
<td>As-specified</td>
</tr>
<tr>
<td>IfcProcess.IsPredecessorTo\IfcRelSequence</td>
<td>As-specified</td>
</tr>
<tr>
<td>IfcProcess.IsPredecessorTo\IfcRelSequence.RelatedProcess</td>
<td>As-specified</td>
</tr>
<tr>
<td>IfcProcess.IsPredecessorTo\IfcRelSequence.RelatedProcess\IfcProcess</td>
<td>As-specified</td>
</tr>
<tr>
<td>IfcProcess.IsSuccessorFrom</td>
<td>As-specified</td>
</tr>
<tr>
<td>IfcProcess.IsSuccessorFrom\IfcRelSequence</td>
<td>As-specified</td>
</tr>
<tr>
<td>IfcProcess.IsSuccessorFrom\IfcRelSequence.RelatingProcess</td>
<td>As-specified</td>
</tr>
<tr>
<td>IfcProcess.IsSuccessorFrom\IfcRelSequence.RelatingProcess\IfcProcess</td>
<td>As-specified</td>
</tr>
<tr>
<td>Reference</td>
<td>Parameter</td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>IFCActor. TheActor</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses\IfcPostalAddress</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses\IfcPostalAddress.AddressLines</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses\IfcPostalAddress.AddressLines\IfcLabel</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses\IfcPostalAddress.PostalBox</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses\IfcPostalAddress.PostalBox\IfcLabel</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses\IfcPostalAddress.Town</td>
<td>As-specified</td>
</tr>
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<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses\IfcPostalAddress.Region</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses\IfcPostalAddress.Region\IfcLabel</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses\IfcPostalAddress.PostalCode</td>
<td>As-specified</td>
</tr>
<tr>
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<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses\IfcPostalAddress.Country</td>
<td>As-specified</td>
</tr>
<tr>
<td>IFCActor. TheActor\IfcPersonAndOrganization. ThePerson\IfcPerson.Addresses\IfcPostalAddress.Country\IfcLabel</td>
<td>As-specified</td>
</tr>
</tbody>
</table>
4.2.7.11 Concept Business Rule Definition

4.2.7.11.1 Identity Concept Business Rule

An object needs to be identifiable for accurate processing by both human and automated processes. Identification may be through several attributes such as Identification, Name, or GUID. The GUID is compressed for the purpose of being exchanged within an IFC data set - the compressed GUID is referred to as "IFC-GUID". While the IFC-GUID is normally generated automatically and has to be persistent, the Identification may relate to other informal registers but should be unique within the set of objects of the same type. The Name and Description should allow any object to be identified in the context of the project or facility being modelled.

Various objects may have additional identifications that may be human-readable and/or may be structured through classification association.

Various file formats may use additional identifications of instances for serialization purposes; however there is no requirement or guarantee for such identifications to remain the same between revisions or across applications. For example, the IFC-SPF file format lists each instance with a 64-bit integer that is unique within the particular file.
For specific entities information the entity name MUST be unique. Other entities must be uniquely identified by a combination of Name and other required information. Constraints related to compound keys are not described in this paragraph.

### 4.2.7.11.2 Revision Control Concept Business Rule

While objects may reflect a final state, they may also be continually revised over the course of a project lifecycle and reflect transient state. For scenarios of multiple users making updates to the same information, there is a concept of local copies of information based upon a shared repository supporting multiple users. Such shared repository is often referred to as a model server. A model server is similar in concept to a document revision server, but is able to identify changes declared on a per-object basis rather than inferring changes from differences in text. A model server has a concept of revisions on a per-project basis, where each revision consists of a set of changes to contained objects by a particular user at a particular time.

To support a model server scenario, each object may be marked with a change action indicating the object was added, modified, deleted, or has no change since the project was retrieved from the server at a particular revision sequence. Given an object's identity (IFC-GUID) and change action, the state of the object may be merged when submitted to a model server. An object is considered modified when any of its direct attributes change, attributes on a referenced resource definition (any entity not deriving from IfcRoot) change, items are added or removed from sets, or items are added, removed, or reordered within lists.

For cases when multiple users make conflicting changes to the same objects, users may choose to keep their own changes, accept changes from others, merge both changes, and a combination thereof upon submitting to a server. Alternatively, to avoid such merge scenario and coordinate work, objects may be locked such that a particular user has exclusive access to read and/or write a particular object at the current time.
Project libraries may also be retrieved from model servers having particular revision, and potentially different server URI than the referencing Project. As a project may include multiple revisions of the same project library (a common scenario when multiple users are involved using libraries revised by others), the IfcRoot.ObjectIdentifier IFC-GUID is only valid within the scope of the referencing project, and a separate library reference identifies a project library based object within its originating model server.

Finally, objects may also carry informational attributes indicating when an object was created, who, when, and what application was used to last modify an object, and who currently owns the object, potentially having exclusive use according to its lock state.

### 4.2.7.11.3 External data constraints concept business rule

The constraint model may be used to indicate mappings between data in the IFC model and external documents. This concept template may also be used by software applications to translate data to/from spreadsheets without necessarily instantiating constraint relationships within an IFC data set.

To indicate an explicit mapping to a particular file or database, IFC classes may be mapped to tabular data formats using IfcResourceConstraintRelationship attached to IfcDocumentInformation.

Default mappings may be indicated using the IfcRelAssociatesConstraint relationship, with RelatingConstraint pointing to IfcObjective.

An IfcObjective of type EXTERNAL has ConstraintSource set to the name of the IFC entity (e.g. 'IfcSpace') with Benchmarks containing a single IfcMetric with DataValue set to an IfcTable. On IfcTable, the Name is set to the name of the external database table or worksheet, and the Columns attribute indicates the external table columns in order as IfcTableColumn. For each IfcTableColumn, the Name indicates the field name or column header, and the ReferencePath identifies the corresponding object attribute, for which standard mappings are indicated.

Within this document, attribute paths (as used for IfcReference) are encoded using syntax in the form 'IfcSpace.OwnerHistory\IfcOwnerHistory.CreationDate' with the following conventions:
• The period character dereferences an attribute from an entity.
• The backslash character casts an entity into a subtype, where a backslash without a subtype indications mapping to the type itself.
• A bracket sequence with an asterisk ("[*]"") dereferences a collection into each member.
• A bracket sequence with an encoded string (e.g. "[SerialNumber]"") dereferences a collection into a specific member by name.

Upon import from a spreadsheet, tables shall be identified by worksheet name regardless of order, and columns shall be identified by header name regardless of order. For export to a new spreadsheet, worksheets shall be provided with identifying name for each entity and sequenced in the order specified, and within each worksheet a header row shall be provided with with each column having an identifying name and sequenced in the order specified.

Attributes are mapped to spreadsheet cells, where either NULL, an empty string, or the reserved value 'n/a' indicates a null value. Specific base types are mapped as follows:

• STRING: String types are represented as strings.
• REAL: Real number types are represented as real numbers.
• ENTITY Entity references are represented as strings identifying by name (IfcRoot.Name).
• SET Set-based collections are represented as strings identifying each object by name and separated by a comma.
• Specific mappings are defined at corresponding entities, where the following standard column names are used:
  • Name: Indicates the name of the object, corresponding to IfcRoot.Name.
  • ExtObject: Indicates the IFC type of the object by identifying the IFC entity by name (e.g. 'IfcBoiler'). If omitted upon import, the IFC entity shall be the base type where the concept is indicated (if non-abstract); otherwise no entity shall be imported.
  • ExtSystem: Indicates the application that currently owns the object, mapping to IfcApplication.ApplicationIdentifier.
  • ExtIdentifier: Indicates the GUID of the object encoded in the same format described at IfcGloballyUniqueId, mapping to IfcRoot.GlobalId. If omitted upon import, such GUID shall be constructed dynamically. If merging changes upon import, such identifier shall be used to identify an existing object (i.e. this maintains identity if an object is renamed (the Name attribute changing).

![Figure 64 External Data Constraints Concept - Business Rule](image-url)
4.2.7.11.4 Classification concept business rule

Objects, type objects, properties, and some resource schema entities can be further described by associating references to external sources of information. The source of information can be:

- a classification system;
- a dictionary server;
- any external catalogue that classifies the object further;
- a service that combine the above features.

An individual item within the external source of information can be selected. It then applies the inherent meaning of the item to the object or property.

Figure 65 Classification Concept - Business Rule

4.2.7.11.5 Spatial composition concept business rule

The spatial structure is a hierarchical tree of spatial structure elements (site, building, story, space) ultimately assigned to the project. Composition refers to the relationship to a higher level element (e.g. this story is part of a building). The order of spatial structure elements being included in the concept are from high to low level: IfcProject, IfcSite, IfcBuilding, IfcBuildingStory, IfcSpace. Therefore an spatial structure element can only be part of an element at the same or higher level.

Figure 66 Spatial Composition Concept - Business Rule
4.2.7.11.6 Quantities on occurrences concept business rule

Any specialization of object can be related to multiple quantity set occurrences. A quantity set contains multiple quantity occurrences. The data type of quantity occurrence are count, length, area, volume, weight, time, and combination of quantity occurrences.

![Figure 67 Quantities on Occurrences Concept - Business Rule](image)

4.2.7.11.7 Conversion units concept business rule

Conversion units are defined according to a conversion factor (and conversion offset for temperature) relative to a specified base SI unit.

![Figure 68 Conversion Units Concept - Business Rule](image)

4.2.7.11.8 Project declaration concept business rule

The project provides a directory of objects contained within using declaration relationships.

![Figure 69 Project Declaration Concept - Business Rule](image)
### 4.2.7.11.9 Group assignment concept business rule

Groups may have assignments indicating products that are members of the group. An example of such assignment is an air handler belonging to an air conditioning system.

![Diagram of Group Assignment Concept - Business Rule](image)

### 4.2.7.11.10 Object typing concept business rule

Object Occurrences may be defined by a particular Object Type, where such type describes common characteristics. Such characteristics include common properties, shapes, materials, composition, and other concepts described at particular entities. An object occurrence may have similar state as its object type, overridden state for particular characteristics, or have no defined type object.

A pair of entities are defined for various object occurrences and object types, where such object occurrence entity may only be defined using a particular object type entity. For example, the IfcTank occurrence object entity has a corresponding IfcTankType type object entity.

Many object occurrence and object type entities have an attribute named PredefinedType consisting of a specific enumeration. Such predefined type essentially provides another level of inheritance to further differentiate objects without the need for additional entities. Predefined types are not just informational; various rules apply such as applicable property sets, part composition, and distribution ports.

For scenarios of object types having part compositions, such parts may be reflected at object occurrences having separate state. For example, a wall type may define a particular arrangement of studs, a wall occurrence may reflect the same arrangement of studs, and studs within the wall occurrence may participate in specific relationships that do not exist at the type such as being connected to an electrical junction box.
4.2.7.11.11 Spatial containment concept business rule

Spatial structures may contain physical elements, including building elements, distribution elements, and furnishing elements.
4.2.7.11.12 Property sets for occurrences concept business rule

Any specialization of object can be related to multiple property set occurrences. A property set contains multiple property occurrences. The data types of property occurrences are single value, enumerated value, bounded value, table value, reference value, list value, and combination of property occurrences.

![Figure 73 Property Sets for Occurrences Concept - Business Rule](image)

4.2.7.11.13 Property sets for types concept business rule

For object types, property sets are defined directly.

![Figure 74 Property Sets for Types Concept - Business Rule](image)
4.2.7.11.14 Task scheduling concept business rule

Tasks may be scheduled to run continuously, at a single period in time, or multiple recurring periods in time.

4.2.7.11.15 Sequential connectivity concept business rule

Processes that occur in time use this relationship to indicate the order of occurrence, such as for tasks, procedures, and events.
4.2.7.11.16 Contact Concept Business Rule

Project participants are indicating using IfcActor. The Name must indicate a human-readable unique identifier of the actor, such as their email address, which enables automatic association of authoring information based on login credentials.

![Figure 77 Contact Concept - Business Rule](image)

4.2.7.11.17 Control assignment concept business rule

Controls may have assignments indicating objects that must observe the established requirements. An example of such assignment is a labor resource assigned to a calendar.

![Figure 78 Control Assignment Concept - Business Rule](image)

4.2.7.12 MVD schema listing

The schema encapsulating the data definitions for this model view is published in multiple representations as shown in the list below:

- COBie.exp - EXPRESS schema definition
- COBie.xsd - XML schema definition (XSD)
- COBie.mvdxml - MVDXML schema transform
- COBie.ifc - IFC dynamic schema definition

An MVDXML file defines the referenced entities and rules for this model view. This file may be used to validate instance data (in IFC-SPF or IFC-XML files), filter instance data to include entities and attributes within scope of this model view, or generate sub-schemas (including the EXP and XSD representations).

An EXP file represents the schema in EXPRESS format (ISO 10303-11) which adapts the referenced Industry Foundation Classes schema (ISO 16739) by including a subset of data definitions and a subset of attributes within each data definition. The EXP file may be used by software development tools for generating programming languages schemas (e.g. C++, C#, Java), database definitions (e.g. SQL DDL), and data transport schema definitions (e.g. XSD).

An XSD file represents the schema in XML Data Definition Language (XSD) which adapts the referenced subset of data definitions. The XSD file may be used by software development tools (e.g. Eclipse, Microsoft Visual Studio) to validate XML files and generate language-specific classes.

An IFC file represents the dynamic portions of the schema in the form of property sets within an SPF (ISO 10303-21) instance file.

The rationale for publishing multiple representations is to provide the richest level of integration for different implementations; while XSD is often used in defining web standards replacing document-based exchanges (e.g. invoices), it lacks data model information needed for type safety, data integrity, indexing, and optimization; all of which may be derived from the EXPRESS representation.

4.2.7.13 MVD format description

Each supported format is listed by name, with Extension indicating the default file extension to use on applicable platforms (e.g. Windows), MIME type for indicating the HTTP header when transmitting over the Internet, and Reference standard indicating the presentation layer encoding format. This standard contains all information necessary for transformation between these formats. These transformations have been demonstrated to fully maintain all information that is within the scope of this MVD.

<table>
<thead>
<tr>
<th>Format</th>
<th>Extension</th>
<th>MIME Type</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>SpreadsheetML</td>
<td>.xml</td>
<td>application/xmlspreadsheet</td>
<td>Microsoft Office 2003</td>
</tr>
<tr>
<td>COBieLite</td>
<td>.xml</td>
<td>application/xml</td>
<td>U.S. Department of Homeland Security</td>
</tr>
<tr>
<td>IFC-SPF</td>
<td>.ifc</td>
<td>application/step</td>
<td>ISO 10303-21</td>
</tr>
<tr>
<td>IFC-XML</td>
<td>.ifcxml</td>
<td>application/xml</td>
<td>ISO 10303-28</td>
</tr>
</tbody>
</table>

SpreadsheetML is an XML format that presents COBie data in an easy to understand and digest format for members of the COBie user community who are not computer programmers.

COBieLite is a United States National Information Exchange Model (NIEM) compliant-XML schema. The use of this format is expected for system-to-system exchanges of COBie data in domains other than architectural and engineering design. This is because the exchanges needed by non-architectural and engineering design software need not carry the overhead and file size associated with STEP (or ifcXML) data formats.
IFC-SPF (ISO 10303-21) is a text format optimized to carry data with complex relationships, supporting human readability yet more compact representation (typically around 10% of size of equivalent XML).

IFC-HDF (ISO 10303-26) is a binary file format encapsulating data in a compact, indexable encoding optimized for quick retrieval and minimal memory usage. NOTE As this file type is not yet widely implemented, it is not officially part of this model view, however implementations may prefer such format for internal use.

IFC-XML (ISO 10303-28) is a hierarchical markup format with wide support from software development tools and platforms, supporting greater human readability at the expense of larger representation. NOTE As typical buildings contain millions of elements with graphs of relationships resulting in gigabytes of data, XML is not yet suitable for representing complete buildings from a pragmatic standpoint of data size, transmission cost, and loading time. However, using derived formats along with MVDXML to filter data sets may enable more efficient exchanges to take place.

IFC-ZIP (ISO 21320-1) is a compressed file format encapsulating one of the above formats to minimize data size. NOTE As this model view is primarily intended for web-based exchange, zip compression may be selected by other means according to the client and server; therefore, the IFC-ZIP format is not officially part of this model view.

4.2.7.14 MVD dynamic schema analysis

Portions of data definitions are defined dynamically, to allow software applications to support extensible definitions while minimizing implementation overhead. Each property set is shown within a subsection as follows, with rows corresponding to properties. See IfcPropertySet for usage information.

**Table 82 COBie_Task Dynamic Schema Definition**

<table>
<thead>
<tr>
<th>Property</th>
<th>Property Type</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>P_ENUMERATEDVALUE</td>
<td>/PEnum_TaskCategory:Adjustment,Calibration,Emergency,Inspection,Operation,PM,SAFETY,SHUTDOWN,STARTUP,TESTING,TROUBLE</td>
</tr>
<tr>
<td>Status</td>
<td>P_ENUMERATEDVALUE</td>
<td>/PEnum_TaskStatus:NOT YET Started,STARTED,COMPLETED</td>
</tr>
<tr>
<td>Property</td>
<td>Property Type</td>
<td>Data Type</td>
</tr>
<tr>
<td>-----------------------</td>
<td>---------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>AssetType</td>
<td>P_ENUMERATEDVALUE</td>
<td>PENumb_AssetType:Fixed,Moveable</td>
</tr>
<tr>
<td>ReplacementCost</td>
<td>P_SINGLEVALUE</td>
<td>IfcMonetaryMeasure</td>
</tr>
<tr>
<td>NominalLength</td>
<td>P_SINGLEVALUE</td>
<td>IfcPositiveLengthMeasure</td>
</tr>
<tr>
<td>NominalWidth</td>
<td>P_SINGLEVALUE</td>
<td>IfcPositiveLengthMeasure</td>
</tr>
<tr>
<td>NominalHeight</td>
<td>P_SINGLEVALUE</td>
<td>IfcPositiveLengthMeasure</td>
</tr>
<tr>
<td>Shape</td>
<td>P_SINGLEVALUE</td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>P_SINGLEVALUE</td>
<td></td>
</tr>
<tr>
<td>Color</td>
<td>P_SINGLEVALUE</td>
<td></td>
</tr>
<tr>
<td>Finish</td>
<td>P_SINGLEVALUE</td>
<td></td>
</tr>
<tr>
<td>Features</td>
<td>P_SINGLEVALUE</td>
<td>IfcText</td>
</tr>
<tr>
<td>AccessibilityPerfor-</td>
<td>P_SINGLEVALUE</td>
<td>IfcLabel</td>
</tr>
<tr>
<td>CodePerformance</td>
<td>P_SINGLEVALUE</td>
<td>IfcLabel</td>
</tr>
<tr>
<td>SustainabilityPerfor-</td>
<td>P_SINGLEVALUE</td>
<td>IfcLabel</td>
</tr>
<tr>
<td>Grade</td>
<td>P_SINGLEVALUE</td>
<td>IfcLabel</td>
</tr>
<tr>
<td>Material</td>
<td>P_SINGLEVALUE</td>
<td></td>
</tr>
<tr>
<td>Constituents</td>
<td>P_SINGLEVALUE</td>
<td>IfcText</td>
</tr>
<tr>
<td></td>
<td>P_SINGLEVALUE</td>
<td>IfcText</td>
</tr>
</tbody>
</table>
### Table 84 Pset_ManufacturerOccurrence Dynamic Schema Definition

<table>
<thead>
<tr>
<th>Property</th>
<th>Property Type</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AcquisitionDate</td>
<td>P_SINGLEVALUE</td>
<td>IfcDate</td>
<td>The date that the manufactured item was purchased.</td>
</tr>
<tr>
<td>BarCode</td>
<td>P_SINGLEVALUE</td>
<td>IfcIdentifier</td>
<td>The identity of the bar code given to an occurrence of the product.</td>
</tr>
<tr>
<td>SerialNumber</td>
<td>P_SINGLEVALUE</td>
<td>IfcIdentifier</td>
<td>The serial number assigned to an occurrence of a product.</td>
</tr>
<tr>
<td>BatchReference</td>
<td>P_SINGLEVALUE</td>
<td>IfcIdentifier</td>
<td>The identity of the batch reference from which an occurrence of a product is taken.</td>
</tr>
<tr>
<td>AssemblyPlace</td>
<td>P_ENUMERATEDVALUE</td>
<td>IfcLabel/PEnum_AssemblyPlace:FACTORY,OFFSITE,SITE,OTHER,NOTKNOWN,UNSET</td>
<td>Enumeration defining where the assembly is intended to take place, either in a factory, other offsite location or on the building site.</td>
</tr>
</tbody>
</table>

### Table 85 Pset_ManufacturerTypeInfoInformation Dynamic Schema Definition

<table>
<thead>
<tr>
<th>Property</th>
<th>Property Type</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>GlobalTradeItemNumber</td>
<td>P_SINGLEVALUE</td>
<td>IfcIdentifier</td>
<td>The Global Trade Item Number (GTIN) is an identifier for trade items developed by GS1 (<a href="http://www.gs1.org">www.gs1.org</a>).</td>
</tr>
<tr>
<td>ArticleNumber</td>
<td>P_SINGLEVALUE</td>
<td>IfcIdentifier</td>
<td>Article number or reference that is be applied to a configured product according to a standard scheme for article number definition as defined by the manufacturer. It is often used as the purchasing number.</td>
</tr>
<tr>
<td>ModelReference</td>
<td>P_SINGLEVALUE</td>
<td>IfcLabel</td>
<td>The model number or designator of the product model (or product line) as assigned by the manufacturer of the manufactured item.</td>
</tr>
<tr>
<td>ModelLabel</td>
<td>P_SINGLEVALUE</td>
<td>IfcLabel</td>
<td>The descriptive model name of the product model (or product line) as assigned by the manufacturer of the manufactured item.</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>P_SINGLEVALUE</td>
<td>IfcLabel</td>
<td>The organization that manufactured and/or assembled the item.</td>
</tr>
<tr>
<td>ProductionYear</td>
<td>P_SINGLEVALUE</td>
<td>IfcLabel</td>
<td>The year of production of the manufactured item.</td>
</tr>
<tr>
<td>AssemblyPlace</td>
<td>P_ENUMERATEDVALUE</td>
<td>IfcLabel/PEnum_AssemblyPlace:FACTORY,OFFSITE,SITE,OTHER,NOTKNOWN,UNSET</td>
<td>Enumeration defining where the assembly is intended to take place, either in a factory or on the building site.</td>
</tr>
</tbody>
</table>

### Table 86 Pset_ActionRequest Dynamic Schema Definition

<table>
<thead>
<tr>
<th>Property</th>
<th>Property Type</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RequestSourceLabel</td>
<td>P_SINGLEVALUE</td>
<td>IfcLabel</td>
<td>A specific name or label that further qualifies the identity of a request source. In the event of an email, this may be the email address.</td>
</tr>
<tr>
<td>RequestSourceName</td>
<td>P_REFERENCEVALUE</td>
<td>IfcPerson</td>
<td>The person making the request, where known.</td>
</tr>
<tr>
<td>RequestComments</td>
<td>P_SINGLEVALUE</td>
<td>IfcText</td>
<td>Comments that may be made on the request.</td>
</tr>
<tr>
<td>Property</td>
<td>Property Type</td>
<td>Data Type</td>
<td></td>
</tr>
<tr>
<td>--------------</td>
<td>----------------------</td>
<td>---------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Type</td>
<td>P_ENUMERATEDVALUE</td>
<td>/PEnum_ActionRequestType:Change,Claim,Coordination,Environmental,Function,InDoorAirQuality,Installation,RFI,Safety,Specification</td>
<td></td>
</tr>
<tr>
<td>Risk</td>
<td>P_ENUMERATEDVALUE</td>
<td>/PEnum_ActionRequestRisk:Very High,High,Moderate,Low,Unknown</td>
<td></td>
</tr>
<tr>
<td>Chance</td>
<td>P_ENUMERATEDVALUE</td>
<td>/PEnum_ActionRequestChance:Has Occurred,High,Moderate,Low,Unknown</td>
<td></td>
</tr>
<tr>
<td>Impact</td>
<td>P_ENUMERATEDVALUE</td>
<td>/PEnum_ActionRequestImpact:Very High,High,Moderate,Low,Unknown</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Property</th>
<th>Property Type</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>P_ENUMERATEDVALUE</td>
<td>/PEnum_ConstructionProductResourceTypeCategory:Part,PartSet,Lubricant,Other,Spare,SpareSet</td>
</tr>
<tr>
<td>SetNumber</td>
<td>P_SINGLEVALUE</td>
<td></td>
</tr>
<tr>
<td>PartNumber</td>
<td>P_SINGLEVALUE</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Property</th>
<th>Property Type</th>
<th>Data Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>P_ENUMERATEDVALUE</td>
<td>/PEnum_ConstructionProductResourceCategory:Labor,Material,Tools,Training</td>
</tr>
</tbody>
</table>

### 4.2.7.15 Entity exclusion set

As the number of established MVD’s grows, software companies will be required to implement exports to each of these MVD’s. Furthermore, the information content of such MVD’s within a specific contractual context will also require software companies to filter the information exported within that MVD. To date, software companies who have provided COBie data in IFC format have done so by extending the Coordination MVD specification. As a result the information content, and size, of such files is significantly greater than that required for COBie.

To assist software companies to respond to the NBIMS-US™ COBie MVD, the tables below list IFC entities to be be filtered when producing the generic COBie data sets for use in the United States. The exclusion lists are expressed as entities excluded from the COBie spreadsheet implementation format.

The Appendix to this standard provides an alternative view of the Entity Exclusion lists, showing the IFC inheritance graphs. These graphs may also be useful to fully understand the context of these exclusion lists.

Within the United States, specific owners may also extend the specification of COBie to non-managed facility assets. As a result software vendors should consider implementation of flexible exclusion lists that support both the generic standard and contract-specific exclusion lists. In addition, as COBie is internationally adopted standard software vendors may also wish to implement exclusion lists based on regional requirements that are outside of the scope of NBIMS-US™.
### Table 101 Entities Excluded from Type and Component

<table>
<thead>
<tr>
<th>Entity Name</th>
<th>Entity Name</th>
<th>Entity Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>IfcAnnotation</td>
<td>IfcJunctionBox</td>
<td>IfcFlowSegment</td>
</tr>
<tr>
<td>IfcBeam</td>
<td>IfcJunctionBoxType</td>
<td>IfcFlowSegmentType</td>
</tr>
<tr>
<td>IfcBeamStandardCase</td>
<td>IfcMechanicalFastener</td>
<td>IfcSpatialZone</td>
</tr>
<tr>
<td>IfcBeamType</td>
<td>IfcMember</td>
<td>IfcStair</td>
</tr>
<tr>
<td>IfcBuilding</td>
<td>IfcMemberStandardCase</td>
<td>IfcStairFlight</td>
</tr>
<tr>
<td>IfcBuildingElementPart</td>
<td>IfcMemberType</td>
<td>IfcStairFlightType</td>
</tr>
<tr>
<td>IfcBuildingStory</td>
<td>IfcOpeningElement</td>
<td>IfcStairType</td>
</tr>
<tr>
<td>IfcCableCarrierFitting</td>
<td>IfcOpeningStandardCase</td>
<td>IfcStructuralAction</td>
</tr>
<tr>
<td>IfcCableCarrierFittingType</td>
<td>IfcPile</td>
<td>IfcStructuralActivity</td>
</tr>
<tr>
<td>IfcCableCarrierSegment</td>
<td>IfcPipeFitting</td>
<td>IfcStructuralConnection</td>
</tr>
<tr>
<td>IfcCableCarrierSegmentType</td>
<td>IfcPipeFittingType</td>
<td>IfcStructuralCurveAction</td>
</tr>
<tr>
<td>IfcCableFitting</td>
<td>IfcPipeSegment</td>
<td>IfcStructuralCurveConnection</td>
</tr>
<tr>
<td>IfcCableFittingType</td>
<td>IfcPipeSegmentType</td>
<td>IfcStructuralCurveMember</td>
</tr>
<tr>
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<td>IfcPlate</td>
<td>IfcStructuralCurveMemberVarying</td>
</tr>
<tr>
<td>IfcCableSegmentType</td>
<td>IfcPlateStandardCase</td>
<td>IfcStructuralCurveReaction</td>
</tr>
<tr>
<td>IfcColumn</td>
<td>IfcProcedureType</td>
<td>IfcStructuralItem</td>
</tr>
<tr>
<td>IfcColumnStandardCase</td>
<td>IfcProjectionElement</td>
<td>IfcStructuralLinearAction</td>
</tr>
<tr>
<td>IfcColumnType</td>
<td>IfcRailing</td>
<td>IfcStructuralMember</td>
</tr>
<tr>
<td>IfcCurtainWall</td>
<td>IfcRailingType</td>
<td>IfcStructuralPlanarAction</td>
</tr>
<tr>
<td>IfcCurtainWallType</td>
<td></td>
<td>IfcStructuralPointAction</td>
</tr>
<tr>
<td>IfcDistributionPort</td>
<td>IfcRamp</td>
<td>IfcStructuralPointConnection</td>
</tr>
<tr>
<td>IfcDuctFitting</td>
<td>IfcRampFlight</td>
<td>IfcStructuralPointReaction</td>
</tr>
<tr>
<td>IfcDuctFittingType</td>
<td>IfcRampFlightType</td>
<td>IfcStructuralReaction</td>
</tr>
<tr>
<td>IfcDuctSegment</td>
<td>IfcRampType</td>
<td>IfcStructuralSurfaceAction</td>
</tr>
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<td>IfcReinforcingBar</td>
<td>IfcStructuralSurfaceConnection</td>
</tr>
<tr>
<td>IfcElementAssembly</td>
<td>IfcReinforcingMesh</td>
<td>IfcStructuralSurfaceMember</td>
</tr>
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<td>IfcElementType</td>
<td>IfcRoof</td>
<td>IfcStructuralSurfaceMemberVarying</td>
</tr>
<tr>
<td>IfcEventType</td>
<td>IfcSite</td>
<td>IfcStructuralSurfaceReaction</td>
</tr>
<tr>
<td>IfcExternalSpatialElement</td>
<td>IfcSlab</td>
<td></td>
</tr>
<tr>
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<td>IfcSlabElementedCase</td>
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</tr>
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<td>IfcSlabType</td>
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</tr>
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<td>IfcTypeProduct</td>
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<td>IfcSpaceType</td>
<td>IfcVirtualElement</td>
</tr>
<tr>
<td>IfcFeatureElementSubtraction</td>
<td>IfcSpatialElement</td>
<td>IfcVoidingFeature</td>
</tr>
<tr>
<td>IfcFlowFitting</td>
<td>IfcSpatialElementType</td>
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<tr>
<td></td>
<td></td>
<td>IfcWallType</td>
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</tbody>
</table>
Table 102 Entities Excluded From All Sheets

<table>
<thead>
<tr>
<th>IFC Class</th>
<th>IFC Class</th>
<th>IFC Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>IfcAnnotation</td>
<td>IfcJunctionBox</td>
<td>IfcStair</td>
</tr>
<tr>
<td>IfcBeam</td>
<td>IfcJunctionBoxType</td>
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</tr>
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<td>IfcBeamStandardCase</td>
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<td>IfcStairFlightType</td>
</tr>
<tr>
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<td>IfcMember</td>
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</tr>
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<td>IfcMemberType</td>
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<td>IfcStructuralConnection</td>
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<tr>
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<td>IfcOpeningStandardCase</td>
<td>IfcStructuralCurveAction</td>
</tr>
<tr>
<td>IfcCableCarrierSegmentType</td>
<td>IfcPipeFitting</td>
<td>IfcStructuralCurveConnection</td>
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<td>IfcPipeFittingType</td>
<td>IfcStructuralCurveMember</td>
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<td>IfcCableFittingType</td>
<td>IfcPipeSegment</td>
<td>IfcStructuralCurveMemberVarying</td>
</tr>
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<td>IfcStructuralCurveReaction</td>
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<td>IfcColumn</td>
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<td>IfcStructuralReaction</td>
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<td>IfcReinforcingMesh</td>
<td>IfcStructuralSurfaceAction</td>
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<td>IfcRoof</td>
<td>IfcStructuralSurfaceConnection</td>
</tr>
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<td>IfcStructuralSurfaceMember</td>
</tr>
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<td>IfcStructuralSurfaceMemberVarying</td>
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<td>IfcElementType</td>
<td>IfcReinforcingBar</td>
<td>IfcStructuralSurfaceReaction</td>
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<td>IfcTypeFeature</td>
</tr>
<tr>
<td>IfcExternalSpatialElement</td>
<td>IfcSite</td>
<td>IfcTaskType</td>
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<td>IfcTypeObject</td>
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<td>IfcVirtualElement</td>
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<td>IfcFeatureElement</td>
<td>IfcSlabType</td>
<td>IfcVoidingFeature</td>
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<td>IfcSpaceType</td>
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<td>IfcSpatialElementType</td>
<td>IfcWallStandardCase</td>
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</tr>
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<td>IfcFlowSegmentType</td>
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</tr>
<tr>
<td>IfcFooting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.2.8 Conformance testing procedures

Author’s Editorial Comment: The NBIMS-US™ V2 COBie standard Part D provided general information pertaining to COBie conformance testing conducted in 2007-2008. This standard updates that information based on the experience of over a dozen public events including thirty software vendors. The conclusion reached during these sessions is that for NBIMS-US™ standard to be used in contracts, testing must evaluate the format, content, and associated workflows. As a result, buildingSMART alliance® testing is conducted as a “Challenge” and not a “Certification” event. Two types of testing have evolved as part of the buildingSMART alliance® Challenge. The “Quality Control Test” is used on COBie files produced at specific phases of the project life-cycle. The “Quality Assurance Test” is applied for software consuming COBie data files.

buildingSMART alliance® Quality Control Testing begins with “verification” testing. Automated verification testing demonstrates that the data file provided is technically correct. Invalid files are not permitted to participate in the second stage testing. The second stage testing is a “validation” test to see if the information provided in the file could be used, ultimately, to replace the equivalent document-based contract deliverable. The criteria used to validate the information provided is to determine if the information provided would be acceptable in-lieu of the corresponding contract deliverable. An objective measure of time to manually correct data files is the objective metric that can be reported based on Quality Control Testing.

buildingSMART alliance® Quality Assurance Testing begins with the verification of the import of COBie data into a given software system. Validation of that information is evaluated, in the context of the workflows of a given software system, to determine if the information is consistently applied in all appropriate locations within that specific software. The output of Quality Assurance Testing is the identification of the information that was correctly imported into the tested software, and what information was not imported correctly.

The buildingSMART alliance® cannot predict the ultimate impact of its standards across a United States construction industry that comprises a notable percent of the Gross Domestic Product of the country.

The objective of delivering accurate and timely COBie data at the least cost on the widest number of projects is the goal of the COBie project. While buildingSMART alliance standards must be rooted in IFC to ensure that all MVD’s have a common ancestry and unambiguous mapping, the ultimate implementation format for COBie data, across all use cases, may not be IFC. To this end any approved COBie mapping: IFC, ifcXML, SpreadsheetML, and COBieLite are allowed to be submitted as part of COBie testing. The selection of the implementation format is left to the software vendor.

To insure impartiality in the testing test models and expected output are publically available (East 2012a). The Medical Clinic Model at the Architectural Design and Construction Documents stage has been used as the basis for the Challenge. Specific spot checks of model content are identified as part of the checking process and then verified during the Challenge process.

Based on the rules NBIMS-US™ V3 Technical Subcommittee Evaluation Criteria for Revised Information Exchange standards, the information provided in this section should be considered a Moderate Change.

4.2.8.1 Format and content requirements

4.2.8.1.1 Quality control test rule list

For software that produces COBie files, an automated Quality Control test procedure has been adopted and used in each of the Challenge events to evaluate the format and content of that COBie file. The rules are used to evaluate the integrity of the format and cardinality of a COBie test file.
In accordance with the COBie Guide publication, the criteria for evaluation of the content of a COBie deliverable is that the information provided in a COBie file match the information that would be found in the equivalent drawing or document set.

4.2.8.1.2 Quality control test rule definition

The following general rules are applied for Quality Control testing of submitted COBie files:

- **NotNull** - Must have a text value that is not n/a or empty
- **NotEmpty** - Must have a text value (n/a is acceptable)
- **Unique** - Must be unique within the scope of the worksheet
- **CrossReference** - Must match a referenced Name column in another worksheet
- **OneAndOnlyOneFacilityFound** - Only one facility is allowed
- **ValidNumber** - Must represent a valid number - n/a is not acceptable
- **ValidNumberOrNA** - If text is provided it must represent valid number or 'n/a'
- **AtLeastOneRowPresent** - Worksheet must have at least one row
- **ZeroOrGreaterOrNA** - If text is provided it must represent a valid number greater than zero or n/a

The following sections describe the full application of these rules to a given COBie file that is tested. This description is organized in a specific format to assist the reader of this standard to understand and evaluate these rules. First the rules are based on the COBie SpreadsheetML representation of COBie data. The first of the rules in each set applies to number of rows in a given COBie entity. Following rules in each set apply to specific fields within that worksheet. These tests are applied regardless of the format of the COBie test file tested (IFC, ifcXML, SpreadsheetML, COBieLite).

4.2.8.1.3 Quality control test rule application

Rules applied to COBie.Contacts:

- Contact.AtLeastOneRowPresent
- Contact.Email.Unique
- Contact.Email.NotNull
- Contact.Email.Format
- Contact.CreatedBy.CrossReference
- Contact.CreatedBy.NotNull
- Contact.CreatedOn.NotNull
- Contact.ExternalSystem.NotEmpty
• Contact.ExternalObject.NotEmpty
• Contact.ExternalIdentifier.NotEmpty
• Contact.Category.NotNull
• Contact.Company.NotNull
• Contact.Phone.NotNull
• Contact.Department.NotEmpty
• Contact.OrganizationCode.NotEmpty
• Contact.GivenName.NotEmpty
• Contact.FamilyName.NotEmpty
• Contact.Street.NotEmpty
• Contact.PostalBox.NotEmpty
• Contact.Town.NotEmpty
• Contact.StateRegion.NotEmpty
• Contact.PostalCode.NotEmpty
• Contact.Country.NotEmpty

Rules applied to COBie.Facility:

• Facility.OneAndOnlyOneFacilityFound
• Facility.Name.NotNull
• Facility.Name.Unique
• Facility.CreatedBy.CrossReference (ToContact)
• Facility.CreatedBy.NotNull
• Facility.CreatedOn.NotNull
• Facility.CreatedOn.Valid (Valid Email Address)
• Facility.Category.NotNull
• Facility.Description.NotEmpty
• Facility.ProjectName.NotNull
• Facility.SiteName.NotNull

• Facility.LinearUnits.NotNull
• Facility.AreaUnits.NotNull
• Facility.VolumeUnits.NotNull
• Facility.Currency.NotNull
• Facility.AreaMeasurement.NotNull
• Facility.ExternalSystem.NotEmpty
• Facility.ExternalProjectObject.NotEmpty
• Facility.ExternalProjectIdentifier.NotEmpty
• Facility.ExternalSiteObject.NotEmpty
• Facility.ExternalSiteIdentifier.NotEmpty
• Facility.ExternalFacilityObject.NotEmpty
• Facility.ExternalFacilityIdentifier.NotEmpty

Rules applied to COBie.Floor:

• Floor.AtLeastOneRowPresent
• Floor.Name.NotNull
• Floor.Name.Unique
• Floor.CreatedBy.CrossReference (ToContact)
• Floor.CreatedBy.NotNull
• Floor.CreatedOn.NotNull
• Floor.CreatedOn.Valid (Valid Email Address)
• Floor.ExternalSystem.NotEmpty
• Floor.ExternalObject.NotEmpty
• Floor.Extidentifier.NotEmpty
• Floor.Category.NotNull
• Floor.Elevation.ValidNumberOrNA

Floor.Height.ZeroOrGreaterOrNA

Rules applied to COBie.Space:

• Space.AtLeastOneRowPresent
• Space.CreatedBy.CrossReference (ToContact)
• Space.CreatedBy.NotNull
• Space.CreatedOn.NotNull
• Space.CreatedOn.Valid (Valid Email Address)
• Space.ExternalSystem.NotEmpty
• Space.ExternalObject.NotEmpty
• Space.ExtIdentifier.NotEmpty
• Space.Category.NotNull
• Space.Name.NotNull
• Space.PrimaryKey.Unique.Warning (Name)
• Space.PrimaryKey.Unique.Error (Name, FloorName)
• Space.FloorName.NotNull, FloorName.CrossReference
• Space.Description.NotNull
• Space.RoomTag.NotEmpty
• Space.UsableHeight.ZeroOrGreaterOrNA
• Space.GrossArea.ZeroOrGreaterOrNA

Space.NetArea.ZeroOrGreaterOrNA

Rules applied to COBie.Zone:

• Zone.CreatedBy.CrossReference (ToContact)
• Zone.CreatedBy.NotNull
• Zone.CreatedOn.NotNull
• Zone.CreatedOn.Valid (Valid Email Address)
• Zone.Category.NotNull
• Zone.Description.NotEmpty
• Zone.ExternalSystem.NotEmpty
• Zone.ExternalObject.NotEmpty
• Zone.ExtIdentifier.NotEmpty
• Zone.Name.NotNull
• Zone.PrimaryKey.Unique (Name, Category, SpaceNames)
• Zone.SpaceNames.NotNull, SpaceNames.CrossReference
Rules applied to COBie.Type:

- Type.AtLeastOneRowPresent
- Type.Name.NotNull
- Type.Name.Unique
- Type.CreatedBy.CrossReference (ToContact)
- Type.CreatedBy.NotNull
- Type.CreatedOn.NotNull
- Type.CreatedOn.Valid (Valid Email Address)
- Type.Category.NotNull
- Type.ExternalSystem.NotEmpty
- Type.ExternalObject.NotEmpty
- Type.Extidentifier.NotNull
- Type.Type.Component.AComponentForEachType
- Type.AssetType.NotNull
- Type.Manufacturer.NotNull
- Type.Manufacturer.CrossReference (Contact Sheet)
- Type.ModelNumber.NotNull
- Type.WarrantyGuarantorParts.NotNull
- Type.WarrantyGuarantorParts.CrossReference (Contact Sheet)
- Type.WarrantyDurationParts.validNumberZeroOrGreaterOrNA
- Type.WarrantyGuarantorLabor.NotNull
- Type.WarrantyGuarantorLabor.CrossReference (Contact Sheet)
- Type.WarrantyDurationLabor.ZeroOrGreaterOrNA
- Type.WarrantyDurationUnit.NotNull
- Type.ReplacementCost.ZeroOrGreaterOrNA
- Type.ExpectedLife.ZeroOrGreaterOrNA
- Type.DurationUnit.NotNull
- Type.WarrantyDescription.NotEmpty
- Type.NominalLength.ZeroOrGreaterOrNA
- Type.NominalWidth.ZeroOrGreaterOrNA
- Type.NominalHeight.ZeroOrGreater
- Type.ModelReference.NotEmpty
- Type.Shape.NotEmpty
- Type.Size.NotEmpty
- Type.Color.NotEmpty
- Type.Finish.NotEmpty
- Type.Grade.NotEmpty
- Type.Material.NotEmpty
- Type.Constituents.NotEmpty
- Type.Features.NotEmpty
- Type.AccessibilityPerformance.NotEmpty
- Type.CodePerformance.NotEmpty
- Type.SustainabilityPerformance.NotEmpty

Rules applied to COBie.Component:

- Component.AtLeastOneRowPresent
- Component.CreatedBy.CrossReference (ToContact)
- Component.CreatedBy.NotNull
- Component.CreatedOn.NotNull
- Component.CreatedOn.Valid (Valid Email Address)
- Component.ExternalSystem.NotEmpty
- Component.ExternalObject.NotEmpty
- Component.Extidentifier.NotNull
- Component.Name.NotNull
- Component.PrimaryKey.Unique.Warning (Name)
- Component.PrimaryKey.Unique.Error (Name, Space)
- Component.TypeName.NotNull
• Component.TypeName.CrossReference (Type Worksheet)
• Component.Space.NotNull
• Component.Space.CrossReference (Component Worksheet)
• Component.Description.NotNull
• Component.InstallationDate.NotNull
• Component.WarrantyStartDate.NotNull
• Component.TagNumber.NotEmpty
• Component.BarCode.NotEmpty

Rules applied to COBie.System:

• System.CreatedBy.CrossReference (ToContact)
• System.CreatedBy.NotNull
• System.CreatedOn.NotNull
• System.CreatedOn.Valid (Valid Email Address)
• System.Category.NotNull
• System.ExternalSystem.NotEmpty
• System.ExternalObject.NotEmpty
• System.ExtIdentifier.NotEmpty
• System.Description.NotEmpty
• System.PrimaryKey.Unique (Name, Category, ComponentNames)
• System.Name.NotNull
• System.ComponentNames.NotNull
• System.ComponentNames.CrossReference

Rules available for COBie.Assembly, if information is present:

• Assembly.CreatedBy.CrossReference (ToContact)
• Assembly.CreatedBy.NotNull
• Assembly.CreatedOn.NotNull
• Assembly.CreatedOn.Valid (Valid Email Address)
• Assembly.ExternalSystem.NotEmpty
• Assembly.ExternalObject.NotEmpty
• Assembly.ExtIdentifier.NotEmpty
• Assembly.Description.NotEmpty
• Assembly PRIMARY_KEY. UNIQUE
• Assembly.Name.NotNull
• Assembly.SheetName.NotNull
• Assembly.SheetName.CrossReference
• Assembly.ParentName.NotNull
• Assembly.ParentName.Reference
• Assembly.ChildNames.NotNull
• Assembly.ChildNames.CrossReference
• Assembly.AssemblyType.NotNull

Rules available for COBie.Connection, if information is present:
• Connection.CreatedBy.CrossReference (ToContact)
• Connection.CreatedBy.NotNull
• Connection.CreatedOn.NotNull
• Connection.CreatedOn.Valid (Valid Email Address)
• Connection.ExternalSystem.NotEmpty
• Connection.ExternalObject.NotEmpty
• Connection.Description.NotEmpty
• Connection.PrimarkyKey.Unique
• Connection.Name.NotNull

• Connection.ConnectionType.NotNull
• Connection.SheetName.NotNull
• Connection.SheetName.CrossReference
• Connection.RowName1.NotNull
• Connection.RowName1.CrossReference
• Connection.RowName2.NotNull
• Connection.RowName2.CrossReference
• Connection.RealizingElement.NotNull
• Connection.PortName1.NotNull
• Connection.PortName2.NotNull

Rules applied to COBie.Spare:

• Spare.CreatedBy.CrossReference (ToContact)
• Spare.CreatedBy.NotNull
• Spare.CreatedOn.NotNull
• Spare.CreatedOn.Valid (Valid Email Address)
• Spare.ExternalSystem.NotEmpty
• Spare.ExternalObject.NotEmpty
• Spare.Description.NotEmpty

• Spare.Name.NotNull
• Spare.Name.Unique
• Spare.Category.NotNull
• Spare.TypeName.NotNull
• Spare.TypeName.CrossReference
• Spare.Suppliers.NotNull
• Spare.Suppliers.CrossReference (Contact Sheet)
• Spare.SetNumber.NotEmpty
• Spare.PartNumber.NotEmpty

Rules applied to COBie.Resource:

• Resource.Name.NotNull
• Resource.Name.Unique
• Resource.CreatedBy.CrossReference (ToContact)
• Resource.CreatedBy.NotNull
• Resource.CreatedOn.NotNull
• Resource.CreatedOn.Valid (Valid Email Address)
• Resource.ExternalSystem.NotEmpty
• Resource.ExternalObject.NotEmpty
• Resource.Description.NotEmpty
Resource.Category.NotNull

Rules applied to COBie.Job:

- Job.CreatedBy.CrossReference (ToContact)
- Job.CreatedBy.NotNull
- Job.CreatedOn.NotNull
- Job.CreatedOn.Valid (Valid Email Address)
- Job.ExternalSystem.NotEmpty
- Job.ExternalObject.NotEmpty
- Job.ExtIdentifier.NotEmpty
- Job.Description.NotEmpty
- Job.Category.NotNull
- Job.Name.NotNull
- Job.PrimaryKey.Unique (Name, TypeName, TaskNumber)
- Job.Status.NotNull
- Job.TypeName.NotNull
- Job.TypeName.CrossReference
- Job.Duration.NotEmpty
- Job.DurationUnit.NotEmpty
- Job.Start.NotEmpty
- Job.TaskStartUnit.NotEmpty
- Job.Frequency.NotEmpty
- Job.FrequencyUnit.NotEmpty
- Job.TaskNumber.NotEmpty
- Job.Priors.NotEmpty
- Job.ResourceNames.NotEmpty

Rules applied to COBie.Document:

- Document.CreatedBy.CrossReference (ToContact)
- Document.CreatedBy.NotNull
- Document.CreatedOn.NotNull
- Document.CreatedOn.Valid (Valid Email Address)
- Document.ExternalSystem.NotEmpty
- Document.ExternalObject.NotEmpty
- Document.ExtIdentifier.NotEmpty
- Document.Description.NotEmpty
- Document.Category.NotNull
- Document.PrimaryKey.Unique (Name, Stage, SheetName, RowName)
- Document.Name.NotNull
- Document.ApprovalBy.NotEmpty
- Document.Stage.NotNull
- Document.SheetName.NotNull
- Document.SheetNameRowName.CrossReference
- Document.RowName.NotNull

Rules applied to COBie.Attribute:

- Attribute.CreatedBy.NotNull
- Attribute.CreatedOn.NotNull
- Attribute.CreatedOn.Valid (Valid Email Address)
- Attribute.ExternalSystem.NotEmpty
- Attribute.ExternalObject.NotEmpty
- Attribute.ExtIdentifier.NotEmpty
- Attribute.Description.NotEmpty
- Attribute.Category.NotNull
- Attribute.PrimaryKey.Unique (Name, SheetName, RowName)
- Attribute.Name.NotNull
- Attribute.SheetNameRowName.CrossReference
- Attribute.Value.NotEmpty
- Attribute.Unit.NotEmpty
- Attribute.AllowedValues.NotEmpty
4.2.8.1.4 Test rule formatting

COBie Quality Control testing rules, described above, have been implemented in a variety of formats by different organizations and companies. The checking tool of record in previous COBie Challenge events, the COBie Tool Kit has implemented these rules in an ISO rule checking format called Schematron. Widespread use of these rules has been made possible through the simplicity of the description of the rules and the distribution of these rules as an open-source project. The COBie Tool Kit is an open source product optimized to support both the verification of the content of COBie data and the validation of that information against the expected contract deliverable.

4.2.8.1.5 Deliverable testing coverage

The COBie Tool Kit implements to testing reports to evaluate the COBie exchanges at two points during the project: design and construction. The table below identifies the information required for design-phase COBie file submissions. The information is provided based on the COBie SpreadsheetML format to simplify understanding of the requirements, although the application is consistent regardless of the file format tested.

Under the buildingSMART alliance® Challenge events conducted to date the COBie.Assembly, COBie.Connection, COBie.Coordinate, and COBie.Issue worksheets are not required since these worksheets contain information that is currently outside the scope of the capture and exchange of information required for facility and asset management within the United States. Use of these worksheets for other purposes is possible, but is outside the scope of this standard. As a result, testing of these worksheets is only accomplished if information is provided as part of the test.

The COBie Tool Kit implements to testing reports to evaluate the COBie exchanges at two points during the project: design and construction. The table below identifies the information required for handover-phase COBie file submissions. As before, the information is provided based on the COBie SpreadsheetML format to simplify understanding of the requirements, although the application is consistent regardless of the file format tested.

<table>
<thead>
<tr>
<th>Information Content</th>
<th>Required</th>
<th>Optional</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>COBie.Contacts</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Facility</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Floor</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Space</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Zone</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Type</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Component</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.System</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Spare</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Resource</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Job</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Document</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Attribute</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Information Content</td>
<td>Required</td>
<td>Optional</td>
<td>N/A</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------</td>
<td>----------</td>
<td>-----</td>
</tr>
<tr>
<td>COBie.Contacts</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Facility</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Floor</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Space</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Zone</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Type</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Component</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.System</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Spare</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Resource</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Job</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Document</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>COBie.Attribute</td>
<td>X</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2.8.2 Examples & mappings

4.2.8.2.1 Example file list

The following examples are provided at the buildingSMART alliance® Common BIM File repository (East 2012a).

Duplex Apartment
- Planning – Space Programming
- Design - Coordinated Design
- Construction – Handover

Office Building
- Design - Coordinated Design

Medical Clinic
- Planning – Space Programming
- Design - Coordinated Design
- Construction – Handover

In the summer of 2013, one additional model entitled “Barracks 101” was also been added to the set of Common BIM Files.
4.2.8.2.2 Example file description

**Duplex Apartment.** The duplex apartment model was originally created by a student who developed this building as part of a design competition. This model was used at the Dec 2009 COBie Challenge event.

**Office Building.** The two-story office building model was developed based on the published sample floor plans for a specific type of mid-size office building built in the United States.

**Medical Clinic.** The Clinic Model project is based on a medical and dental clinic building at a location in the South-West United States. The model also comes with a set of redacted construction documents stage design drawings and operations and maintenance manuals. This model was used in buildingSMART alliance® Challenge events starting in 2011.

**Barracks 101.** The Barracks 101 project is based on a standard barrack building. Standard drawings in PDF format and associated design-stage COBie files have been provided. CADD files are currently being redacted for public release as of the time of preparation of this standard.

4.2.8.2.3 Common BIM file reuse

The buildingSMART alliance Common BIM Files are used for all COBie testing.

The files used for the testing at buildingSMART alliance® Challenge events since 2011 have been based on the Medical Clinic project. This project was selected for several reasons: (1) it is a real project that has been designed and built, (2) a full set of redacted construction drawings and operations and maintenance manuals have been provided, and (3) it is of significant size and scope to address the majority of practical implementation issues likely to appear in practice.

4.2.8.2.4 Implementers’ agreements

As part of COBie Challenge events implementers’ agreements have been developed and documented in a supplemental reference document called the “COBie Responsibility Matrix”. This document is provided for public use and describes all implementers’ agreements required and includes specific vendors’ agreements. These agreements are required to support vendors with legal alternative implementations of IFC SPFF. These agreements are aimed at having most use of COBie with IFC data provided by vendors. The link to the COBie Responsibility Matrix may be found through the COBie Means and Methods website.

Implementers’ agreements are not been required for submissions of SpreadsheetML and COBieLite formats since such formats are specified so that they do not allow multiple valid alternative implementations.

4.2.8.2.5 SpreadsheetML transform

Detailed technical information required to transform COBie data between IFC and SpreadsheetML formats are provided in Annex A.

The use of SpreadsheetML format for COBie data is optional in this specification. It is the requirement of the implementing software companies to determine the most appropriate use of their software and resources within the context of their specific markets.

4.2.8.2.6 COBieLite transform
Detailed technical information required to transform COBie data from SpreadsheetML and COBieLite schema are provided in Annex A.

The use of COBieLite is optional in this specification. It is the requirement of the implementing software companies to determine the most appropriate use of their software and resources within the context of their specific markets.

4.2.8.3 Testing tools and procedures

4.2.8.3.1 Testing Tool List

The following tools are available for testing COBie files. Information about the use of these tools and their availability of these tools is found in a later sub-section of this standard.

- COBie ToolKit
- bimServer.org
- bimServices
- EcoDomus PM
- Onuma System
- Google Docs

COBie data submitted in COBieLite format may also be validated by any number of free and commercial XML schema checking programs. The fact that COBieLite may be validated by a wide range of programmer-oriented tools reflects the overall goal of COBieLite to open use of COBie data outside the traditional buildingSMART alliance® community. These XML checking programs include, but are not limited to, the following:

- Component Assembly Mechanism (CAM) Checker
- XMLSpy
- Saxson XML Parser
- NetBeans Java Code
- MS Visual Studio

4.2.8.3.2 Testing algorithm

The testing of information exchanges must include both the testing of the export of COBie files, at the identified major project milestones, and the importation of COBie files by those who use COBie data in their products. Quality Control Tests describe the testing of exported COBie files. Quality Assurance Testing describes the process of manually checking that imported COBie data is accurate and has been used correctly within the context of the importing system. The algorithms for Quality Control and Quality Assurance testing are provided in this section.

4.2.8.3.2.1 Quality control testing algorithm

Quality control testing begins with the specification of the specific Common BIM Files needed for to test a given exchange. Recent testing has focused on the Medical Clinic model files. During a series of monthly team meetings software firms are able to ask questions pertaining to the specified files and the mapping of information between the test files and the specific data structures and workflows within their products. After meetings each software company produces the file based on the software that is
available for production use as of the date of the Challenge. Testing of beta software is allowed, by exception only.

The following components comprise the COBie Tool Kit algorithm for testing COBie 2.4 formatted files:

- Transformations necessary to normalize IFC, SpreadsheetML, and COBieLite formatted files
- A rule-set for testing COBie design phase files
- A rule-set for testing COBie construction/handover phase files

Transformation rules are described in Annex A. The rule sets themselves have been developed based on the Schematron ISO-based reference standard: ISO/IEC 19757-3:2006 "Information technology -- Document Schema Definition Language (DSDL) -- Part 3: Rule-based validation – Schematron". The full implementation of the COBie rules, described earlier in this standard, into Schematron and associated implementation code (as needed) is available for inspection since the COBie ToolKit is an open-source project.

Automated testing of COBie files verifies that required fields are provided, business rules met, and proper data cardinality is found. Such a test does not, however, validate that the data is of any value to the user. For validation testing the information provided in the COBie file must match that provided on the equivalent drawing or submittal. The use of the Medical Clinic building is important in that the actual, redacted design and construction handover information on the real project is available for this purpose.

To validate the content quality of an exported COBie file buildingSMART alliance® testing publishes the overall statistics for the submitted files expected for design and construction phases. The software companies provide that information to their designers or data-entry personnel and develop the overall models. In addition to the overall model object counts, a limited number of specific spaces within the facility is to be modelled in detail. The collation of information found across all disciplines is provided to the companies to provide the objective set of detailed objects and associated attributes in specific spaces.

While the objective of buildingSMART alliance® Challenges is not to have the software companies redesign the test facility, it is important that some aspects of a fully designed model be tested. Such testing ensures that the software company producing the design drawings addresses individual software workflow issues in appropriate documentation.

When the number of deviations between the overall object counts and the specific space modelling requirements have been tallied the QC testing computes the amount of time required for a COBie-knowledgeable user to manually update a COBie Spreadsheet to correct these deviations. All models, testing, software instructions, and related materials is made public to allow users of tested software to reproduce the resulting tests at any time.

4.2.8.3.2.2 Quality assurance testing

Unlike testing exported COBie files, the testing of the import of COBie files is highly dependent upon the specific workflows and markets in which the importing software is to use. For example, software that assists a facility maintenance manager will need to import the preventative maintenance schedules from the COBie file to have a complete the set of information. A different type of software, for example one that only supports the management of tenants within a completed facility will not need the COBie data related to maintenance management.

Another difference between testing of exported and imported files, is that the ability to ensure that the relationships contained with the COBie, as well as the needed data, are properly represented. An example of such a test is to ensure that imported COBie components are placed within spaces. Given
that some maintenance management software has a data structure that explicitly represents space, and others do not, careful consideration of the use of the COBie data within the context of each individual software product is needed.

The conduct of Quality Assurance testing begins with the publication of the sample files by the organizer of the buildingSMART alliance® Challenge event. Typically, the files used will be based on the Medical Clinic Common BIM File example file at design and construction handover. Next, the software vendor identifies those aspects of the COBie data model that are relevant to their specific product. When ready the software vendor demonstrates the import of that COBie data set. The person conducting the QA testing may ask that specific information in the file be changed to verify that this new information is imported. All relevant software screens are reviewed for the presence and quantity of data found in the imported COBie data set. Any deviations are identified by the amount of time required to manually re-enter the data found in the COBie data set.

4.2.8.3.2.3 Support of software development cycles

The buildingSMART alliance® is supportive of software vendors using it standards within vendor’s software development cycles. As a result, extensive efforts have been spent to work with vendors to provide staged approaches for partial implementation of COBie that allow the software company to fit this work within their other priorities. This means that different vendors in the same type of business may not be exporting or importing the same set of COBie data. Regardless of the stage of implementation of COBie, all testing results are made publically.

4.2.8.3.2.4 Testing result format

To reflect the variability in outcomes of various vendors’ tests and the variation in level of implementation from each vendor the results of a buildingSMART alliance® Challenge are published through the buildingSMART alliance® Means and Methods Page. Each vendor has the same set of information to provide and is evaluated the same as any other vendor, within that class of software. Software products are not allowed to compete in sectors in which they are not typically used. For example, software for architectural and coordinated design must also be able to produce the contact deliverables that document the completion of those project phases.

Within a given class of software, results page lists those aspects of COBie relevant to that sector and also those which the vendor has, or has not, implemented as part of a given challenge event. The first buildingSMART alliance® Means and Methods page provides a vendor’s most recent results. Past tests may be found by clicking through to see the detailed test results. The information on each of the vendors’ detailed results pages is formatted to allow buildingSMART alliance® members to distinguish between those vendors with complete, or less complete, implementations of COBie.

Given that a vendor has identified a specific set of COBie data relevant to the users of their product, the number of individual differences between the expected COBie data file (or import data) and that which is provided in the vendor’s export file or software are identified. These differences represent transcription or modeling errors by the software programming in the vendor’s system. If the COBie data is to be corrected on the job site, manual data entry will be required. This manual data entry, for the purpose of a COBie Challenge is assessed at one minute per row of COBie data file that contains an error. If there are multiple errors in a given COBie data row, that is still counted as a single error. The quality score is reported at the number of minutes, or hours, required for a skilled person to correct the COBie file manually.

4.2.8.3.3 Test files

The buildingSMART alliance® Common Building Information Model files website (East 2012a) is the repository for all model files for COBie Challenge testing. COBie sample files for buildings (a duplex housing unit, a two story office building, and a medical/dental clinic) are available for testing. These
sample files are provided free of charge by the buildingSMART alliance® under a creative common licence. The form of that licence, which is not impacted by the reference in this document, allows the unlimited use of these for any purpose. Use of the files must be cited back to the buildingSMART alliance®. Users may change any of these files; however, if the files are changed they may no longer be referred to as one of the set of Common BIM Files.

4.2.8.3.4 Testing tool software availability

The table below provides the list of tools and their associated websites. buildingSMART alliance® Challenge events used in the United States to test conformance of COBie files to NBIMS-US™ standards is the COBie Tool Kit. bimServer.org is provided in the list below since COBie ToolKit code is available either through the buildingSMART alliance® or through the open-source bimServer.org project. The authoritative source for the COBie ToolKit is the link provided through the buildingSMART alliance® provided later in this standard.

Table 105 NBIMS-US™ COBie Testing Tools

<table>
<thead>
<tr>
<th>Product</th>
<th>Type</th>
<th>Description / Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>COBie ToolKit</td>
<td>Open Source</td>
<td>Model transformation, checking, and reporting a custom build of the bimserver.org product used in COBie Challenge events. <a href="http://www.projects.buildingsmartalliance.org/files/?artifact_id=5466">http://www.projects.buildingsmartalliance.org/files/?artifact_id=5466</a></td>
</tr>
<tr>
<td>bimServer.org</td>
<td>Open Source</td>
<td>An IFC-based model server for life-cycle BIM application <a href="http://www.bimserver.org/">http://www.bimserver.org/</a></td>
</tr>
</tbody>
</table>

Additional tools are also listed in table below. These tools may be applicable in regions other than the United States and also by users of specific company’s products. For example, bimServices may be required for use in other regions, such as the United Kingdom. As such, a discussion bimServices is outside the scope of this standard.

Eventually COBie verification tools will be directly embedded within commercial software. These tools would allow those creating or consuming COBie data to identify and fix any errors that may be present in their data before submitting a given file. Two tools (EcoDomusPM, Onuma System) are provided by software companies to pre-check COBie deliverables. Another example of such a tool is one which directly integrates the collection of correct COBie data using the cloud-based Google-docs framework. Since product-based tools are not used as the official source of buildingSMART alliance® Challenge testing, such tools are outside the scope of this standard.

Table 91 Regional and Vendor COBie Tools

<table>
<thead>
<tr>
<th>Product</th>
<th>Type</th>
<th>Description / Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>EcoDomus PM</td>
<td>Commercial – free</td>
<td>Verifies design COBie to deliver construction handover information <a href="http://www.ecodomus.com/index.php/ecodomus-pm/">http://www.ecodomus.com/index.php/ecodomus-pm/</a></td>
</tr>
</tbody>
</table>
4.2.9 Implementation resources

Author’s Editorial Comment: Criteria for Implementation Resources were not included in NBIMS-US™ V2 criteria. The information provided here is an update to what would have been submitted had this requirement been part of the previous standard. Based on the rules NBIMS-US™ V3 Technical Subcommittee Evaluation Criteria for Revised Information Exchange standards, the information provided in this section should be considered a moderate change.

4.2.9.1 Implementation resources list

4.2.9.1.1 COBie guide

The COBie Guide (East 2012c) is a framework for project owners and teams to develop a practical implementation strategy toward COBie. Its function is similar to that of a “commentary” that accompanies a technical standard. Instructions provided in the Guide lead owners to identify their specific requirements and include such requirements directly in design and construction specifications.

Four COBie deliverables identified in the COBie Guide. Two are required during design and two during construction. Design deliverables at the 35% and Construction Documents stage of design are required. Construction Deliverables at the Beneficial Occupancy and Fiscal Completion stage are required.

COBie design deliverables must reflect data about scheduled assets identified in the associated design deliverables. Since scheduled assets appear on drawings in design schedules, the COBie guide provides a suggested minimum requirement for schedule table headers. Owners may adopt these table headers or leave the definition of product properties to the design team at their discretion. The only non-negotiable COBie data quality standard for design COBie files is that the data on the drawings must match the data in the COBie file. COBie construction deliverables must reflect updates to the designed assets and include construction and commissioning information consistent with the submittals that the Contractor is already required to produce in document-centric formats.

Feedback received from many teams has been that owners cannot articulate COBie requirements so the information that is provided to these owners is incomplete. COBie is designed for customization and is fully extensible through the use of owner-specific classifications, commonly required property sets, and specific requirements for space and product properties. The COBie Guide Appendix A tells the owner what should be customized in COBie and allows them to document their requirements.

4.2.9.1.2 COBie Responsibility Matrix

The COBie Responsibility Matrix (East 2013) provides several sets of information to assist project team to define:

- Which team members are required to produce COBie data?
- What information should be found in a COBie file?
- How should that information be formatted?

Specifically, the sections of the COBie Responsibility Matrix include:
Team Responsibility. May be used by project teams to assign responsibility for different elements of the COBie data set to different stakeholders. It would be expected that such a matrix would be useful for those teams preparing a COBie implementation plan.

Deliverable Requirements. Provides a very detailed, life-cycle view, of what COBie information should be delivered when. This list may be used by project teams and owners to determine the expected content of COBie files at different project stages. As such, it is a synopsis of much of the information about exchange requirements identified previously in this standard.

Spreadsheet Schema. Provides the schema for the spreadsheet and IFC 2x3 versions of the same COBie data allowing the mapping between these formats. This list is a synopsis of the COBie Spreadsheet information and IFC mapping requirements found elsewhere in this standard.

Type Assets. Identifies those IFC "type" entities that, for the purpose of COBie are not considered to be "managed assets". This allows the filtering of IFC files when software companies fail to provide their own filters. This list is a synopsis of the MVD Exclusion lists identified in prior sections of this standard.

Component Assets. Identifies those IFC "component" entities that, for the purpose of COBie are not considered to be "managed assets". This allows the filtering of IFC files when software companies fail to provide their own filters. This list is a synopsis of the MVD Exclusion lists identified in prior sections of this standard.

Property Sets. Identifies IFC property sets that should be provided as part of the COBie data set. This allows filtering of IFC files when software companies fail to provide their own filters. This list is a synopsis of the MVD Exclusion lists identified in prior sections of this standard.

4.2.9.1.3 Model merging guide

During design stages that require the coordination of information from multiple disciplines, the decisions regarding merging BIM model data are more complex than simply ensuring that drawings sheets are in the correct order. This is because BIM model files may have similar or overlapping data in many different files. Naively merging all data from all models into one consolidated COBie data set may be problematic since duplicate room numbers, light fixtures, plumbing fixtures and other information could occur.

At the request of software developers participating in the January 2013 buildingSMART alliance® Challenge a complete set of merge rules for all objects for both IFC 2x3 and IFC 4 were developed (East 2012d). This model merging guide was reportedly used by several software vendors who participated in the January 2013 buildingSMART alliance® Challenge.

The philosophy behind the merge rules follows the standard contract interpretation rule of “the more detailed information is likely to be more correct.” A common example of the practical impact of such a rule is that the plumbing fixture schedule in an architect’s model, developed before engaging a plumbing engineer, many not match the more detailed design provided by that plumbing consultant. As a result, the plumbing model data trumps (for specific types of objects) data found in the architect’s model.

4.2.9.1.4 Publication of challenge results

Delivering and using buildingSMART alliance® information exchange standards may be accomplished with existing software used for planning, design, construction, and facility management and operations activities. Software included in the COBie Means and Methods website (East 2012a) have worked directly with the buildingSMART alliance®, through a public process to test and demonstrate their capabilities.

The provided through that page provide the user with the most recent assessment of each products performance. Configuration guides and user manuals are also provided, based on the software at the
time of the testing. The results pages of the software systems may also be directly compared by viewing in separate browser tabs.

4.2.9.1.5 COBie training

A variety of free training videos are currently provided for potential COBie users. This training is available from the main COBie website under “COBie Videos.” Additional training is provided directly by software vendors.

Training may also be available through the buildingSMART alliance®.

4.2.9.1.6 COBie transformation tools

Since COBie data may be found in a variety of different formats, transformation tools may be employed to transform information in a given format to information in a format that is needed. The table below identifies two transformation tools. The first tool, the COBie ToolKit, is authorized for use in the context of NBIMS-US™. The COBie ToolKit has been tested to fully reproduce all information required in the COBie MVD regardless of format.

Another tool kit, bimServices, has been used in the United Kingdom to support its national COBie implementation. Since this tool kit has not been user or tested as part of buildingSMART alliance Challenge events, discussion of this tool is outside the scope of this standard.

<table>
<thead>
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</tr>
<tr>
<td>bimServices</td>
<td>Commercial – free version available</td>
<td>Model transformation, checking, and reporting.</td>
</tr>
</tbody>
</table>

4.2.9.1.7 COBie sample contract specifications

The term “information exchange” as the term used for projects such as COBie originated from the phrase “contracted information exchange” within the IFC community. In order to ensure that two parties would exchange the correct information there has to be some type of contract, either formal or informal, which sets expectations and indicates who is responsible in case something needs to be fixed. To support implementation of COBie a contract specification was created and has been made available through a link found on the primary COBie website: [http://www.wbdg.org/resources/COBie.php](http://www.wbdg.org/resources/COBie.php).

As of the time of submission of this standard the specification provided, Unified Facility Guide Specification 01 79 00, “Construction-Operations Building information exchange,” is expected to be implemented by the U.S. Army, Corps of Engineers in contracts beginning 01-Oct-14.

4.2.9.1.8 LinkedIn group

Social media is being engaged as one of the first lines of support for buildingSMART alliance® information exchange formats. The first place to go for technical feedback on COBie is the Linked-In COBie Group.
This strongly moderated group may be able to help answer some shorter questions. Members of several companies have contributed time and support of buildingSMART alliance® information exchange projects, and related testing activities. These firms, listed below, may also be able to directly assist in your efforts.

4.2.9.1.9 National Information Exchange Model

The National Information Exchange Model (NIEM) is a collaborative network of United States Government entities at federal, state, tribal, and local levels. NIEM’s particular point of view is to support government and public to share information about the world to plan, evaluate, and respond to man-made and natural disasters. Adding a NIEM-compliant information exchange schema to the set of COBie implementation formats provides the foundation to allow those in the disaster planning, mitigation, and response business to access COBie data critical to their enterprise.

4.2.9.2 Business process coverage analysis

Business processes related to the implementation of COBie covered in this standard pertain to the exchange of complete submissions of COBie files at the conclusion of major project milestones. Other workflows not addressed in this standard submission are contained in the section Workflow Coverage Analysis.

4.2.9.2.1 Architectural programming coverage

The requirements for the use of COBie for Architectural Programming have been so accepted that a more specific application of COBie, called the Building Programming information exchange (BPie) project, was begun mid-2012 (East 2012b). The BPie project subsumes many previous proprietary and non-proprietary approaches to capture and exchange architectural programming information.

4.2.9.2.2 Architectural design coverage

Those interested producing COBie data, of the early stage of a design that includes the Architect only, in a format that contains both the scheduled assets and associated geometry have used extensions to the Industry Foundation Class Coordination Model View Definition as well as COBie SpreadsheetML or COBieLite formats. Those interested in producing the COBie asset information only, may use any of the approved COBie data exchange formats.

The buildingSMART alliance® has provided Common BIM Files showing examples of the content of COBie files expected at this stage of a project (East 2012a).

While the COBie format is fixed for all exchanges, the complete set of information needed to be produced at any given deliverable must be specified for that deliverable. The list of objects expected to be included in the Architectural Design deliverable, and the quality criteria upon which such a deliverable is to be judged, is provided in the COBie Responsibility Matrix and COBie Guides. As these documents are considered commentary on the use of COBie, and not directly part of the specification of the COBie format itself, these documents are not included in this standard.

4.2.9.2.3 Coordinated design coverage

Those interested in producing COBie data, during any design stage that includes both architects and consulting engineers, in a format that contains both the scheduled assets and associated geometry may use extensions to the Industry Foundation Class Coordination Model View Definition as well as COBie SpreadsheetML or COBieLite formats. Those interested in producing the COBie asset information only, may use any of the approved COBie data exchange formats.
The buildingSMART alliance® has provided Common BIM Files showing examples of the content of COBie files expected, at the next stage of the project - the Construction Documents stage (East 2012a). These example files are technically equivalent to the COBie data files produced at this design stage.

While the COBie format is fixed for all exchanges, the complete set of information needed to be produced at any given deliverable must be specified for that deliverable. The list of objects expected to be included in the Architectural Design deliverable, and the quality criteria upon which such a deliverable is to be judged, is provided in the COBie Responsibility Matrix and COBie Guides. As these documents are considered commentary on the use of COBie, and not directly part of the specification of the COBie format itself, these documents are not included in this standard.

Another important guide produced to support software vendors in the January 2013 buildingSMART alliance® Challenge Event was a document that identified the order of precedence of objects in various designer and consultant models. This guide was produced at the direct request of software vendors. As this document should be considered a commentary on the use of COBie, within model servers or model merging software, and not directly part of the specification of the COBie format itself, this document was not included in this standard.

Information provided by the software vendors themselves, for the use of their own customers, has begun to address the variety of workflows that exist at design and consultancies. In addition to the “merge problem” noted a previous section, the problem of equipment schedule development is being addressed directly by the software vendors. This problem occurs when product and equipment schedules found on contract drawings were not created from data on the BIM objects, but pasted-in from another source. As such documents may contain proprietary information that is of interest only to the users of specific software, and not directly part of the specification of the COBie format itself, this document was not included in this standard.

4.2.9.2.4 Construction Documents Coverage

Those interested in producing COBie data, during any design stage that includes both architects and consulting engineers, in a format that contains both the scheduled assets and associated geometry may use extensions to the Industry Foundation Class Coordination Model View Definition as well as COBie SpreadsheetML or COBieLite formats. Those interested in producing the COBie asset information only, may use any of the approved COBie data exchange formats.

The deliverable of the construction documents- stage COBie data follows the same procedure used for any Coordinated Design Deliverable.

The buildingSMART alliance® has provided Common BIM Files showing examples of the content of COBie files at this stage of a project (East 2012a).

4.2.9.2.5 Construction commissioning coverage

Those producing COBie data, during the commissioning stage have, imported COBie Construction Documents stage data, in the SpreadsheetML format, and then exported updated COBie data, again in SpreadsheetML or COBieLite format. Since this is an interim, and likely an internal contractor deliverable, the specific quality criteria for such software is developed based on interviews with commissioning software vendors operating in this niche market.

The buildingSMART alliance® has provided Common BIM Files at the Construction Documents stage that are used as the sample import file (East 2012a).

4.2.9.2.6 Construction handover coverage
Those producing COBie data, at the handover stage have, imported COBie Construction Documents stage data, in the SpreadsheetML or COBieLite format, and then exported updated COBie data, again in SpreadsheetML or COBieLite format. Workflows for the construction processes included in these proprietary software systems are not evaluated during the buildingSMART alliance® Challenge process.

The buildingSMART alliance® has provided Common BIM Files at the Construction Documents stage that are used as the sample import file (East 2012a). In addition, example Construction Handover sample files are provided to assist in the evaluation of the completeness and quality of the construction handover data set.

4.2.9.2.7 Facility start-up coverage

Those consuming COBie data for purposes of maintenance- or asset-management has been accomplished using COBie data in SpreadsheetML, COBieLite, and IFC formats. Due to the differences in specific facility maintenance- and asset-management software systems, the specific quality criteria for such software are developed based on interviews with software system vendors operating in this market.

The buildingSMART alliance® has provided Common BIM Files at the Construction Handover stage that are used as the sample import file (East 2012a).

4.2.9.2.8 Capture of as-built information coverage

The creation of As-built building information using COBie as a data entry template is also a workflow that has been demonstrated. In this workflow a manual take-off of spaces and major equipment schedules is accomplished prior to the on-site visit. During an on-site visit specific name-plate and required spatial data can be directly collected in spreadsheet version of COBie. Rather than reliance on enterprise-wide data systems merging information collected can be accomplished simply by a cut and pasted of the information collected from each survey using the COBie SpreadsheetML format.

4.2.9.3 Related workflow coverage analysis

Workflows supported by the exchange of entire COBie files are only one part of the full set of workflows that pertain to facility asset information. The full set of workflows can be found in the Business Process Model section of this standard submission. The workflows that have been included and tested with regard to COBie 2.4 are the minimum essential workflows to include as contract deliverables in design and construction contracts. This is because these workflows represent specific paid contract milestone deliverables. Thus, the use of COBie for these milestone deliverables mirrors the current practice, and contractual framework, found in design and construction contracts.

The paragraphs below describe workflows that use all or part of the COBie data for different purposes other than the capture of building asset information at major project milestones. While these workflows share significant sets of the same information as COBie, they are not supported solely by the COBie 2.4 format due for two primary reasons. The first reason is that there are differences between COBie information exchanges and those noted in these processes. Some of these workflows require additional specification of COBie attribute data, others of these workflows use COBie data in contexts other than design, construction, and facility operations. The second reason is that many of these processes require persistent COBie data that would be a function of a model server or database. As COBie is an information exchange format, and not a software system or a database, these workflows may be supported by, but are not included as requirements for this standard submission.

Some of these workflows have their own buildingSMART alliance® projects, some do not. Eventually, it would be expected that each of these projects has an information exchange specification of its own.
4.2.9.3.1 Product properties

Many workflows require specific information about product and equipment properties. While COBie has a place for such information, COBie.Type, COBie.Component, and COBie.Attribute, The COBie specification, itself, does not mandate specific properties for different product types. The specification of product properties was created as a separate project called the Specifiers’ Properties information exchange (SPIe, pronounced Spy) project. The reason that COBie and SPIe were split into two projects is that the SPIe effort ultimately requires the participation of many companies, associations, and manufacturers who are not currently members of the buildingSMART alliance®. When those firms are ready with the SPIe data sets, their information may be safely exchanged using the COBie data format that already exists.

4.2.9.3.2 Transaction data

Efforts on COBie prior to this standard submission have concerned the exchanges of entire sets of facility information in a complete COBie formatted file. There are many types of exchanges, however, where exchanging the entire COBie file exchange would not be helpful. An example of such an exchange is a designer’s identification of product type properties based on a product used as a “basis of design.” An example of such an exchange, during construction, is the capture of equipment installation information using a mobile device. In both of these examples it would be inefficient to exchange the entire COBie data set, when only a piece of the COBie data should be enough. A major motivation in the creation of the COBieLite schema was to support the discrete exchange of facility transactions using a variety of different types of devices and using a variety of different transmission protocols.

4.2.9.3.3 Existing facility inventory surveys

Often facility managers are required to survey their facilities to identify some a specific class of asset or identify the properties associated with facility assets. COBie may be used as a consistent format to capture such information. Existing assets and associated properties could be exported for those conducting the survey. Personnel conducting the survey would add, update, or delete the information needed to make the data set current. This updated data set could then be merged from all surveyors and also merged back into the central asset management repository.

4.2.9.3.4 Operations and maintenance history

An interest expressed by software companies providing maintenance and asset management tools is the potential use of COBie for facility operations and maintenance history. COBie assists in facility start-up, by providing a correct snap-shot of the as-built facility information. COBie does not address the workflows needed for facility- and asset-managers to exchange historic information after years of facility operations. It is possible that extensions to COBie’s Job worksheet, and equivalent data structures, could be created to support these extensions.

4.2.9.3.5 Maintaining as-operated COBie data

The question of how to update COBie data during the operations and maintenance phase of a project is a question that often arises in discussion of COBie. The objective in the development of COBie was to create an efficient replacement for paper construction handover deliverables. The business cases associated with maintaining the information once delivered to the facility maintenance, operations, and asset management offices was considered to be in the hands of the commercial software systems used for these purposes. If a buildingSMART alliance® project were to consider the future development of an open standard to exchange such information then there are three workflows where COBie data should be read, updated, or changed during the operational phase of a facility. Each of these cases is described below.
The first case is often referred to as a service call. These calls do not change the information at all, but only use the information provided. An example of such a call would be to change a filter. Since the most important managed equipment must be touched at least once a year, the capture of COBie data as part of that service call could result, within a year or eighteen months, of the capture of all major equipment at a facility.

The second case is often referred to as a work order. These jobs replace one piece of equipment with another. The location of the equipment does not change only the attributes such as manufacturer, model, serial number, and attribute data change. In this case the capture of COBie data could be a requirement needed prior to the completion of the work order.

The third case is often referred to as a facility renovation. In this situation, someone has to make a drawing in which case COBie data that is being removed from an underlying database can be flagged, and the new COBie data provided.

4.2.9.3.6 Energy management

An emerging area of interest in COBie data by several organizations and people outside the buildingSMART alliance® relates to the area of energy management. Energy management related work flows were not included in COBie. The ability of COBie to provide shared-structured information that may be used by energy managers without recollecting the information has been the subject of many conversations with those working in that space. The development that appears to have engaged many in that community is the development of the COBieLite schema. COBieLite allows programmers interested in determining information about buildings not to need to engage a detailed geometric representation but treat COBie data as just another type of data needed by software programmers.

4.2.10 Revision plans

Author’s Editorial Comment: Criteria for Revision Planning were not included in NBIMS-US™ V2 criteria. The information provided here is an update to what would have been submitted had this requirement been part of the previous standard. Based on the rules NBIMS-US™ V3 Technical Subcommittee Evaluation Criteria for Revised Information Exchange standards, the information provided in this section should be considered a moderate change.

4.2.10.1 Revision plans list

4.2.10.1.1 Revision management process

Since its beginning, COBie has been developed using “spiral development model.” The spiral development model is characterized by a process of rapid prototyping and feedback. During each development cycle, improvements are introduced and implemented in software. Since the first version of COBie v1.0 in 2007, this spiral development model is now at the version of COBie, 2.4, that is represented in this standard.

Recent iterations of COBie began with discussion of technical developments during meetings with buildingSMART alliance® Challenge participants. During this meeting changes requested by the user community, through direct request to buildingSMART alliance® or through LinkedIn, are considered. In addition, changes requested by the software developers themselves are discussed. All changes are documented within Challenge meeting minutes and used to propose updates for future COBie versions. During the Challenge events software vendors may, at their discretion, test the agreed upon changes. If a consensus of software developers agree to these changes, then the next version of the standard is updated and documented for the next round of NBIMS-US™ revisions.

The “hands-on” revision management process described above is expected to be needed at the start of virtually all NBIMS-US™ information exchange standards. Once the standard becomes well established, however, the
level of intensity of work required for such a “hands-on” revision management process is not expected to be required. To that end, COBie Project Committees can be formed to systematize COBie revision management.

The COBie CMMS/CAFM Project Group was formed in August 2013 to assist CMMS/CAFM vendors further extend and develop the COBie model for areas beyond design and construction. The importation of COBie construction handover data sets into CMMS/CAFM software is well established.

The COBie Construction Project Group will be formed the first quarter of 2014 to assist Construction and Commissioning (C&C) stage vendors further extend and develop the COBie model for more detailed construction workflows. C&C software is used to import COBie design data, update that data with information gathered during construction, and export that data into COBie construction handover data sets. This process of importation, updating, and exporting COBie data for C&C is well established.

The COBie Project Groups are being formed to support the following functions:

- Identification of Venues for COBie Presentations
- Coordination with Venue Organizers and Speakers
- Development of Consensus-based COBie Standard Updates
- Coordination of COBie verification and validation testing, e.g. COBie Challenges

The charters of each of the COBie project Groups will cover the specifics of revision management for their community, and others who provide or delivery COBie data during the life of the project.

4.2.10.1.2 Revision management notification

To date, public change notifications have been posted on the LinkedIn COBie Group and buildingSMART alliance® COBie revision notification page. An example of the revision notifications between the NBIMS-US™ V2 COBie version 2.26 and the NBIMS-US™ V3 COBie version 2.4 may be found the COBie Version 2.4 update page (Nisbet 2012).

4.2.10.2 Proposed revision deployment methods

4.2.10.2.1 Revision deployment process

Deployment of revisions to COBie occurs through several mechanisms. First, through the software that implements the revisions. This software is then tested as part of an official buildingSMART alliance® Challenge processes. The results of software performance against the baseline any new revisions are documented through the buildingSMART alliance® Means and Methods Page (East 2013).

Parallel with software implementation is the documentation of the exact changes to the standard that have been deployed. The baseline changes to the standard are documented and distributed for all software systems participating in the buildingSMART alliance® Challenge. Since such changes may have slight, but important, variations in individual software systems additional documentation, called the COBie Responsibility Matrix, is also published as part of the Challenge. Once the challenge has been complete, the updated COBie Responsibility Matrix is released through the COBie website.

Parallel with the activities above COBie checking software, called the COBie Tool Kit, is updated to allow the results of the COBie Challenge to be tested. Once the challenge has been complete, the updated COBie Tool Kit is released through the COBie website.
To support the testing of the new revisions testing files, based on the buildingSMART alliance® Common BIM Files, are created. These files demonstrate the changes using the project used as the basis for testing during the Challenge event.

### 4.2.10.2.2 Revision deployment notification

To date, all COBie updates have been presented at the buildingSMART alliance® Challenge event. A presentation that includes the discussion of these changes is included in the conference proceedings. The presentation is available following the meeting as part of the proceedings. Software guidance on any impacts the change may have on the use of specific commercial software is the responsibility of the software vendor. Information regarding vendor implementation of COBie is catalogued on the COBie Means and Methods page (East 2013).

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ISO/IEC 81346-12, Industrial systems, installations and equipment and industrial products — Structuring principles and reference designations — Part 12: Buildings and building services


RFC 3986, Uniform Resource Identifier (URI): Generic Syntax — Network Working Group NWG Standard

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Annex A – COBie Mapping Rules

Annex B – Life Cycle information exchange (LCie) for Product and Product Type data exchanges, a technical Annex to COBie – Version 2.4