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Ontology for Life-Cycle Modeling of Electrical Distribution Systems: Application of Model View Definition Attributes

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Abstract

Previous efforts by the US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) to develop a life-cycle building model have resulted in the definition of a "core" building information model that contains general information describing facility assets such as spaces and equipment. To describe how facility assets (i.e., components) function together, information about assemblies of assets and their connections must also be defined. The definitions of assets, assemblies, and connections for the various building-information domains are discipline-specific. Work documented in ERDC/CERL CR-13-2 identified the processes and tasks specifically associated with the design of building electrical systems and the information exchange requirements for every participant in the design. The findings were used to develop an information-exchange Model View Definition (MVD) for building electrical systems.

The objective of the current work was to document the steps needed to identify the electrical MVD attributes in three experimental building information models representing typical low-rise Army facilities, and to update the models. This work also validated the International Foundation Class (IFC) export function from the experimental models against the electrical MVD, and studied the requirements for creating computable open building models that can be utilized for the automated information exchanges.

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Preface

This study was conducted for the US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) and the National Institute of Building Sciences (NIBS) by Kristine Fallon Associates Inc., and Constructivity.com, LLC, under CRADA-07-CERL-02, "Cooperative Research and Development Agreement Between US Army Engineer Research and Development Center–Construction Engineering Laboratory and National Institute Of Building Sciences." The CRADA supports Research, Development, Test, and Evaluation (RDT&E) Program Element 622784 T41, "Military Facilities Engineering Technology"; Project 157249, "Life-Cycle Model For Mission Ready Sustainable Facilities (LCM)." The ERDC-CERL project manager was Dr. E. William East (CEERD-CF-N), and the NIBS project manager was Dominique Fernandez.

The work was supervised and monitored by the Engineering Processes Branch (CF-N) of the Facilities Division (CF), ERDC-CERL. At the time of publication, Donald K. Hicks was Chief, CEERD-CF-N; L. Michael Golish was Chief, CEERD-CF; and Martin J. Savoie, CEERD-CV-ZT, was the Technical Director for Installations. The Deputy Director of ERDC-CERL was Dr. Kirankumar Topudurti and the Director was Dr. Ilker Adiguzel.

COL Kevin J. Wilson was the Commander of ERDC, and Dr. Jeffery P. Holland was the Director.

Unit Conversion Factors

Multiply	By	To Obtain
feet	0.3048	meters
gallons (U.S. liquid)	3.785412 E-03	cubic meters
mils	0.0254	millimeters
pounds (mass)	0.45359237	kilograms
square feet	0.09290304	square meters
yards	0.9144	meters

1 Introduction

1.1 Background

Previous efforts by the US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) to develop a life-cycle building model have resulted in the definition of a "core" building information model that contains general information describing facility assets such as spaces and equipment (East, Love, and Nisbet 2010). To describe how facility assets (i.e., components) function together, information about assemblies of assets and their connections must also be defined. The definitions of assets, assemblies, and connections for the various building-information domains are discipline-specific. Taken together, studies of all essential building-information domains will create a unified framework for developing automatic design checks, ensuring construction compliance, improving operations and maintenance efficiency, and evaluating alternatives for redesign within completed facilities.

COBie (East 2007) was the first step in analyzing information exchanges in the life cycle of a building. Since March 2012, COBie has been part of the National BIM Standard–United States (NBIMS-US). COBie defines the format for providing information about building assets from the planning phase through design, construction, and operations. Properties of these assets may also be captured in the COBie date exchange format. The *COBie Guide*, a commentary on the COBie standard (public draft downloadable at link from http://www.nibs.org/?page=bsa_cobieguide), does not prescribe how to model specific assemblies of components or how components and assemblies are connected. Those aspects of modeling and information exchange require a domain-specific ontology for every system needed to construct a functional building. Subsequent work led to the development of a Model View Design (MVD) for the design of electrical distribution systems in typical Army facilities. That MVD is documented in ERDC/CERL CR-13-2 (Chipman et al. 2013).

In order to provide a foundation for testing and validating research on building life-cycle topics, ERDC-CERL led the development of experimental core building information models for three common facility types widely used on Army installations: a Duplex Apartment, a Medical Clinic, and an Office Building (East 2012a). This report documents the application of the electrical distribution system MVD to those experimental models as part of the effort toward creating formal specifications applicable to open-standards BIM at the coordinated design stage of construction.

1.2 Objectives

The objective of this work was to document the steps needed to identify the electrical MVD attributes in the three experimental BIMs and update the models. This work also validated the International Foundation Class (IFC) export function from the experimental models against the MVD, and studied the requirements for creating computable open building models that can be utilized for the automated information exchanges.

1.3 Approach

The present work applies the process flows and data exchanges requirements for the design of interior electrical distribution systems in typical Army facilities. These processes and exchange requirements were used to create a Model View Definition (MVD) procedures (see Chipman et al. 2013) defined by the International Organization for Standardization (ISO) and buildingSmart International (e.g., Hietanen 2008).

The electrical process flow and exchange requirements were applied to a simulated real-world situation to study how the information exchanges can be handled in COTS BIM software using the three experimental models noted above. These “core” BIMs represent typical low-rise facilities commonly built on Army installations. Electrical equipment and systems were updated using commercial off-the-shelf (COTS) BIM software and a native common object library developed in that software. Coordinated IFC models were then generated using the COTS IFC export capability.

The models act as a test bed for the MVD and the COTS tools available at the time the work was performed. While the results will change with time, as software is updated to accommodate this and potentially other new MVDs, the procedures described here can be used by others to evaluate their software and design processes.

2 Experimental Building Models

2.1 Overview

This chapter documents the procedure followed for the design-phase modeling and IFC export of electrical systems equipment found in three typical Army facilities: a Duplex Apartment, an Office Building and a Clinic. The goal of this process is to produce model files in the native COTS BIM-authoring software and IFC formats for the information exchange of electrical system design information. The three example models produced by this process can serve as reference data for future experimentation by ERDC and testing by software developers and end users.

The starting points for the modeling were previously developed architectural and mechanical/electrical/plumbing (MEP) experimental models (East 2012a). These models were initially developed using Revit 2011, which was current at the time the models were created. In the present work, Revit 2013, Update Release 2, build 20121003_2115(x64), was used. As Revit versions are not backward compatible, the models produced for the current project cannot be used within Revit 2011.

It should be noted at the outset that this MVD is based on IFC4, which had not been officially approved at the time this work was undertaken. As stated in Chipman et al. 2013 (p 61),

> While most product geometry information was already well-defined within IFC version 2x3 and implemented by many vendors, there were many concepts that required some of the lesser-supported IFC data structures and some that required the expanded MEP scope in IFC version 4 to achieve adequate levels of detail... While realizing that many of these concepts were not supported by existing COTS software, the MVD has been defined to allow partial compliance for now, but with allowances to later relax or replace some requirements after testing models produced by existing software .

Therefore, one cannot fault Revit 2013 (the selected COTS software, which was designed to use IFC2x3) for not handling the IFC4 concepts. Indeed, as noted below (section 2.6), the tests used to validate conformance to the MVD were relaxed to take account of the IFC4 concepts.

The Revit models were edited to remove non-electrical system interior elements so that the tests of the electrical system MVD would not contain extraneous information. Families and groups not related to testing the electrical system MVD were deleted from the model.

The following sections describe creating the Revit 2013 electrical system design models and exporting these models to IFC. Details on the modeling of each building type are given below in separate sections.

Table 1 provides statistical information for each of the three models.

Table 1. Model statistics.

Model Statistics	Duplex	Office	Clinic
Native file size	14.5MB	16MB	18.6MB
IFC file size	1.6MB	6.3MB	11.6MB
Building Area	3,372 sq ft	40,053 sq ft	49,571 sq ft
No. of Spaces	21	99	266
No. of types	15	14	57
No. of Components	103	887	2,118

2.1 Determination of additional electrical system properties

In order to meet the requirements of the Electrical System MVD, additional properties must be added to those already on the electrical system elements in the experimental Revit models. That additional properties are needed is not a fault in the software used or the original models – it simply underscores the notion that, as new information exchanges are defined, additional properties can be added to the models to accommodate the new uses that the new MVD provides.

To determine what properties were needed:

1. Using the schedules in the Revit models, a spreadsheet listing the electrical system element types was created and the occurrence of each type in the three models was noted (Appendix A). For some elements,

such as the M_Elevator-Hydraulic, the IFC classification was assigned to reflect the electrical system components of the element.

2. A list of the property sets and properties for these element types was extracted from the MVD and added to the spreadsheet for each type.
3. The list of properties needed by the Electrical System MVD was compared to the list of properties already in the Revit models to create a list of the properties that needed to be added to the element types in the model. This list is shown in Appendix B.

The time needed to identify the needed properties will depend on the complexity of the model, but can take a day or two.

2.2 Addition of the electrical system properties to the Revit experimental building models

The base architectural and MEP Revit models, which are documented in ERDC/CERL CR-11-2 (Johnson and Fallon 2011), were downloaded from buildingSmartAlliance (East 2012a).

The following steps were followed to update and expand these models:

1. Non-electrical system elements were removed from the models so that the IFC export would include only the target electrical system elements and the building architectural elements necessary to define the floors, rooms and spaces.
2. Some existing types were subdivided into multiple types.
3. Additional electrical system elements were added as needed. Since the electrical system models in these buildings are relatively completely developed, so little additional modeling was needed.
4. Additional properties were added to the electrical system elements as needed. This process can take a day or two, depending on the complexity of the model. It is recommended that a copy of the original model be retained, since if errors are made, it is often easier to revert to the original model than it is to remove the incorrect properties.
5. Default values were assigned to element parameters.
6. Project parameters were updated.

2.3.1 Removing non-essential elements from the models

Building interior features, such as furniture, casework, plumbing and heating elements and piping, were deleted from the model. Plumbing and heating elements that have electrical connections (such as the water heaters and roof-top ventilators) were retained.

2.3.2 Subdividing types

The original experimental BIMs combined some related fixture types into a single Revit element type. For example, in the Clinic model, a total of only 7 light fixture types were used to represent what should have been 42 separate fixture types. The original Revit families were edited to include the actual number of types required. The COBie spreadsheets for the three buildings (East 2012a) were used to identify the separate fixture types and their locations in the model, which were updated accordingly.

2.2.1 Modeling additional electrical system elements

There were no additional electrical system elements added to the experimental BIMs.

2.2.2 Adding additional properties to elements in the models

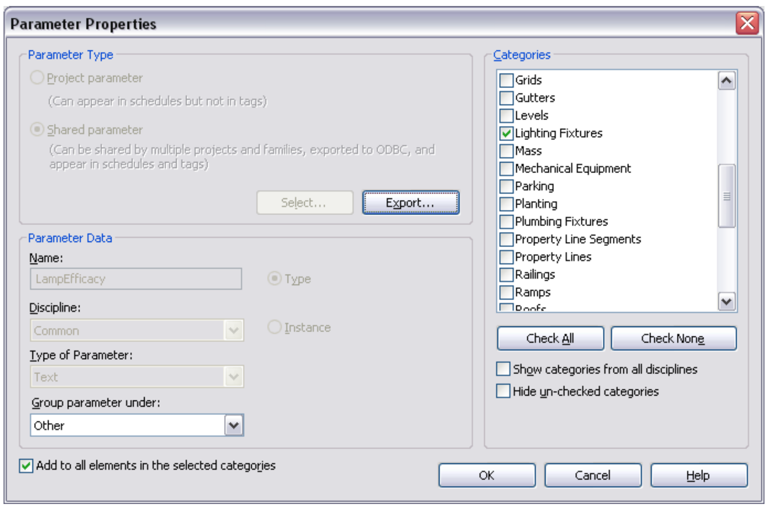
In order to include the electrical properties that were identified in Section 1.2 on the families in the building model, it was necessary to directly update the families in Revit with the new parameters.

The following procedure was used to add the additional parameters to the models:

1. The Revit MEP model for the Duplex Apartment—Duplex_MEP.rvt — was opened in Revit 2013.
2. New Revit Shared Parameters for each of the new electrical properties were added to the COBieSharedParameters.txt file using the Revit Manage tab > Shared Parameters command. The resulting shared parameter file was saved as COBieSharedParameters - Ontologies MVD-Electrical.txt.
3. The new Shared Parameters were added to selected element categories using a proprietary custom add-in program. (Steps 2 and 3 can also be done using the Revit Manage tab > Project Parameters > Add command.)
4. A copy was made of the existing electrical schedules in the Duplex Apartment Model file, re-named where necessary based on the corresponding Revit Category and updated to include the new parameters.

5. The new parameters were edited in the Schedule Properties dialog box to apply the parameters to the appropriate element categories in the model (Figure 1).
6. For the other models and the Revit Experimental BIM template (.RTE) files, each file was opened in Revit 2013 and the electrical schedules created were copied into it from the first model. Copying the schedules into the model applies the shared parameters to the building elements in the model.

Figure 1. Parameter Properties dialog box showing
the lamp efficiency property applied to lighting fixtures.



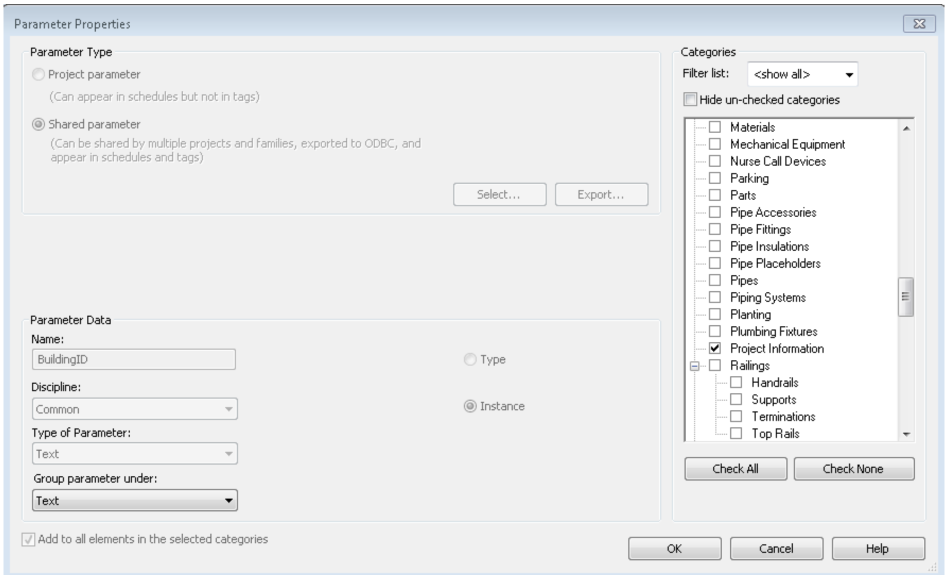
2.3.5 Assigning default values

Revit does not export to IFC custom parameters that do not have assigned values. Therefore, in order to be able to export all of the additional electrical parameters to IFC, default values (such as 0, UNSET, or N/A) were set using a proprietary custom add-in program. (Values could also have been set by editing the Revit schedules of the electrical system elements.)

2.3.6 Updating project parameters

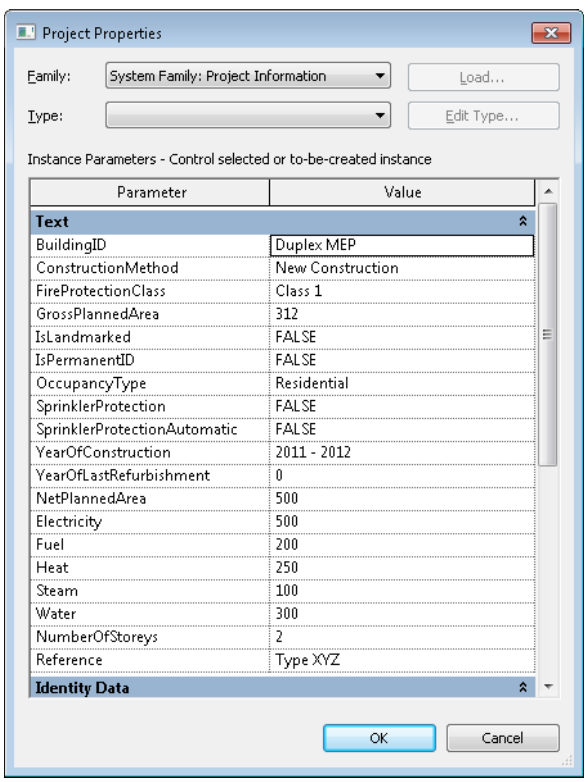
The procedure for adding additional properties to the overall project were similar to the steps outlined in section 2.3.4, Adding Additional Properties to Elements in the Models. All shared parameters associated with the overall project were added as Project Parameters and associated with the Project Information category (see Figure 2).

Figure 2. Parameter Properties dialog box showing the Building ID property applied to project information.



This category cannot be scheduled. Updating these parameters with the correct values was completed by navigating to the project properties dialog box (**Revit Manage tab > Project Information)** then typing the values in the fields provided.

Figure 3: Project Properties dialog box showing the building parameters.



2.3 Export of the models to IFC

Once the building models had been edited to expand the electrical system model and remove extraneous elements, new properties added to the models and applied to the building elements in the models and default values assigned, the models were ready to export to IFC files.

2.3.1 Revit IFC export

The basic procedures for successfully exporting the Revit model to IFC are outlined in ERDC/CERL CR-11-2 9 (Johnson and Fallon 2011). Because of changes in Revit's IFC export between the 2011 and 2013 releases, some of the values of the IfcExportAs and IfcExportType override parameters needed to be changed. (The Revit 2011 settings from the original Table 2-15 from ERDC/CERL CR-11-2 are reproduced here for electrical elements as Table 2. See Table 3 for the changed settings for the Revit 2013.) All three of the elements in Table 3 had their value for the IfcExportAs parameter set to IfcElectricDistributionPoint for Revit 2011.

Table 2. IFC export override parameter settings.

Revit Family	IfcExportAs	IfcExportType
M_Air Handling Unit - Split System - Horizontal.rfa	IfcFanType	CENTRIFUGALAIRFOIL
M_Air Handling Unit - Vertical Packaged - DX - 21-35 kW.rfa	IfcFanType	CENTRIFUGALAIRFOIL
M_Centrifugal Fan - Rooftop - Upblast.rfa	IfcFanType	CENTRIFUGALAIRFOIL
M_Duplex Receptacle.rfa	IfcOutletType	POWEROUTLET
M_Fire Alarm Control Panel.rfa	IfcElectricDistributionPoint	CONTROLPANEL
M_Hot Water Boiler - 59-440 kW.rfa	IfcBoilerType	WATER
M_Inline Pump - Circulator.rfa	IfcPumpType	CIRCULATOR
M_Lighting and Appliance Panelboard - 208V MLO.rfa	IfcElectricDistributionPoint	DISTRIBUTIONBOARD
M_Microwave.rfa	IfcElectricApplianceType	MICROWAVE
M_Range.rfa	IfcElectricApplianceType	ELECTRICCOOKER
M_Refrigerator.rfa	IfcElectricApplianceType	FRIDGE_FREEZER
M_Screw Chiller - Air Cooled - 1406-1758 kW.rfa	IfcChillerType	AIRCOOL
M_Screw Chiller - Air Cooled - 281-1231 kW.rfa	IfcChillerType	AIRCOOL
M_Telephone Terminal Board.rfa	IfcElectricDistributionPoint	DISTRIBUTIONBOARD
M_Thermostat.rfa	IfcControllerType	TWOPOSITION
M_Transformer Switchboard.rfa	IfcTransformerType	VOLTAGE
M_VAV Unit - Single Duct.rfa	IfcFanType	NOTDEFINED
M_Water Heater.rfa	IfcTankType	PREFORMED

Table 3. Changed IfcExportAs and IfcExportType settings for Revit 2013

Revit Family	IfcExportAs	IfcExportType
M_Fire AlarmControl Panel	IfcControllerPanel	ALARMPANEL
M_Lighting and Appliance Panelboard	IfcProtectiveDeviceType	DISTRIBUTIONBOARD
M_Telephone Terminal Board	IfCElectricApplianceType	FLOWTERMINAL

The Revit model was exported to IFC using the IFC-exportlayers.txt file created for the Experimental BIM project (East 2012a). The IFC-exportlayers.txt file provides additional Revit-to-IFC mappings to enable correct export of the Revit elements and properties to IFC (see the Experimental BIM report for more details).

2.3.2 Special considerations regarding Revit IFC export

Several special considerations that apply to Revit's IFC export functionality affect the completeness of the IFC file and its validation against the MVD. It should be noted that since the version of Revit 2013 selected for this project (20121003_2115 [x64]) was released, changes have been made to the open source Revit IFC export code. Users who wish to use the latest Revit IFC export code should get the latest version of the open source Revit exporter plug-in, either from SourceForge (http://sourceforge.net/projects/ifcexporter/files/2013) or from the Autodesk Exchange App Store (http://apps.exchange.autodesk.com/RVT/Home/Index).

Revit MEP elements contain connector sub-elements that identify the ports and flow direction. As of the version of Revit 2013 used in this study, however, Revit does not export electrical ports. The IFC export source code (ConnectorExporter.cs, line 46 and line 61, version 2.4.0.0 of the source code, dated 2012-10-23, downloaded from http://sourceforge.net/projects/ifcexporter/) states in two comments that the export of connection ports "Works only for HVAC and Piping for now."

Property values that should be numeric but that have a unit text, such as '208 V' for 208 volts, get incorrectly converted in the IFC export. For example, '208 V' exports as '2238.89'. This is a known issue in Revit. The Revit API GetParameter function returns values in a mixture of imperial units for length and metric units for everything else. So volts, which can be expressed as (kg * m2) / (A * s3), get returned as (kg * ft2) / (A * s3). Note that 2238.89/208 is approximately 10.76, or in other words 1 m2/1 ft2 (Valdez 2012). This problem has reportedly been fixed in the Open Source code.

At the time Revit 2013 was released, IFC4 had not been approved, so it is not supported. Because the Electrical System MVD is written to take advantage of IFC4, adjustments were made to the validation tests to account for the fact that Revit exports to IFC 2x3.

2.4 Validation of the Revit 2013 IFC export

The exported IFC files for the three BIMs were checked against the Electrical System MVD using the ifcDoc tool (downloaded from http://www.buildingsmart-tech.org/specifications/specification-tools/ifcdoc-tool). IfcDoc is a Microsoft Windows program that automates IFC documentation generation for both baseline IFC documentation as well as Model View Definitions. It supports generating boilerplate text from templates, hyperlinks, EXPRESS definitions, figures, tables, contents, and indices. It can also import MVD-XML and file and validate IFC files for conformance to that MVD. Additional information on out validation methodology is presented in Appendix C. Additional information on using the ifcDoc tool can be found at http://www.buildingsmart-tech.org/specifications/specification-tools/ifcdoc-tool/ifcdoc-help-page.

Because the Electrical System MVD was based on IFC4, which was unofficial at the time this work was undertaken, Revit 2013 does not support IFC4 concepts. Adjustments to the requirements of the MVD were made in ifcDoc to make some IFC4 concepts optional. Other modifications were made to simplify the report format and combine similar error reports into single line items.

As model view definitions have historically been defined by their documentation only (no computer interpretable rules), validation has typically been a manual process requiring human interpretation of documentation and authoring of programming code to test IFC files.

BuildingSmart International established the mvdXML format as a way to automate the validation process such that future model view definitions may be validated without custom programming. The Electrical System model view definition presented here was one of the first to leverage mvdXML. At the time this MVD was authored, mvdXML 1.0 had been finalized and approved, but validation tools were not readily available.

The Global Testing Documentation Server tool (gtds.buildingsmart.com; registration required) was scheduled to support mvdXML validation at the time of IFC4 final release (previously slated for July 2012), however the IFC release schedule was extended to accommodate ISO approval, with the result that the mvdXML validation tools were not yet integrated into GTDS as of late 2012, when the work reported here was completed.

The Open Source Building Information Modelserver (bimserver.org) also indicated intentions of supporting mvdXML validation, yet that support was delayed due to resource availability. As of February 2013, the researchers have been in contact with a developer actively working on mvdXML integration.

While mvdXML support from either of these tools is expected in the near future, the project timeline necessitated validation tools in late Fall of 2012. To accommodate this schedule, several alternatives were considered: (a) exclude validation efforts; (b) postpone validation until tools are available; or (c) invest resources out-of-pocket in creating such tools. The latter option was selected, and the team worked with buildingSmart International to expand the IfcDoc tool to support integrated validation of model view definitions. To help streamline other efforts, the utility was adapted to support integration with server tools such as the above.

The report in Appendix C (Table C-3) was generated by the IfcDoc validation tool, an open-source utility available at buildingsmart-tech.org/mvd. The report is organized by IFC entity, with concepts underneath each entity. Columns are shown for on the right for each exchange, identified by number (see Table C-1). The symbols in the column indicate the status of each test (see Table C-2).

Some of the concepts tested relied on IFC4. The team attempted to leverage IFC2x3 where possible but it lacked the detail for various concepts deemed critical for MEP systems. Ultimately, the goal of these model view definitions is to provide the necessary information to actually build a building. For example, port typing in particular is necessary to understand how equipment is connected, and to analyze systems for required capacity and conformance to building code; IFC4 supports identifying port types and system types unambiguously. Another such critical concept was classification. While that is also possible in IFC2x3, IFC4 provides an enforceable syntax to ensure that classifications are interoperable across files. Additionally, there were some specific IFC4 concepts leveraged for certain exchanges, such as occupancy schedules, projected energy usage, and resource allocations. To distinguish between IFC2x3 and IFC4 concepts, each IFC4-dependent concept is noted in Table C-3 and overall statistics were calculated for both IFC2x3 and IFC4.

It was found that software already on the market in 2012 was able to produce files that were in 100% conformance with some of the exchanges for IFC2x3. The more advanced concepts that failed the validation provide room to push the industry forward toward greater detail and better interoperability.

An overall summary of the MVD Validation report is provided below in Table 4 and a detailed summary in Table C-4. The percentages of noncompliant items are also provided and associated with the possible cause. Appendix C, Table C-3, presents the validation results broken down by the specific exchange and Table C-4 presents a summary of the numbers. The summary in Table 4 identifies the applicable concepts, number of passing concepts, and the percentage of concepts that passed the validation check, based on all of the object instances in the model. Table C-3 shows the validation results based on each separate information exchange and presents percentages passing based on the number of rules checked, not the number of instances.

Table 4. IfcDoc validation report summary.

Electrical Systems MVD Validation	Duplex	Office	Clinic
Tests Applicable	214	214	214
Tests Passing All Exchanges	172	170	172
Optional Tests Failing Any Exchange (number)	22	22	22
Optional Tests Failing Any Exchange (percent)	10.3%	10.3%	10.3%
Mandatory Tests Failing Any Exchange (number)	20	22	20
Mandatory Tests Failing Any Exchange (percent)	9.3%	10.3%	9.3%
Overall Percent of Tests Passing (IFC4)	97-99%	97-99%	97-99%
Overall Percent of Tests Passing (IFC2x3)	97-100%	97-100%	97-100%
Causes of Non-Compliance, as a percentage of total non-compliant concepts:			
IFC4	61%	55%	56%
Revit IFC Export hard-coded to null	17%	15%	16%
Values not assigned in the code	22%	30%	28%

As indicated in Table 4, about 10% of the 214 tests failed for at least one optional exchange for the three buildings; about 9% failed at least one mandatory test for the Duplex Apartment and Clinic and about 10% for the Office Building. The overall failure rate for all tests, looked at for each exchange separately, ranged from 1% to 3% for IFC4 tests and from 0% to 3% for IFC2x3 tests. Not unexpectedly, none of the 29 exchanges passed all of the IFC4-related tests, but 19 of the 29 exchanges passed all of the IFC2x3 tests.

Overall, the Entities (Item), Concepts (Sub-Items), and Problems related to the possible Causes of non-compliance are listed below in Table 5. Refer to Chapter 3 of the companion MVD report (Chipman et al. 2013) for discussion of Entities and Concepts as related to MVDs.

Table 5. IfcDoc MVD non-compliance items.

Item	Sub-Item	Problem	Cause
IfcProject	Project Context	'Plan' context is not defined for 2D layout	Revit puts the information in the 'Annotation' context rather than the 'Plan' context
IfcSite	Site Location	Physical address is needed for determining applicable building codes	Hard-coded to null in Revit IFC export
IfcBuilding	Classification	OmniClass address needed for classifying building to determine code requirements	IFC4
IfcBuilding	Building Location	Elevations needed to determine utility connectivity	Hard-coded to null in Revit IFC export
IfcSpace	Classification	OmniClass address needed for classifying space to determine designed electrical usage per square foot	IFC4
IfcLightFixtureType	Property Sets for Types	Manufacturer type information necessary to identify, order, and price products	Variable created in Revit IFC export code, but no values are assigned
IfcDistributionPort	Property Sets	Cable property sets required to size, order, and price cabling	IFC4. Electrical ports not exported by Revit
IfcPumpType	Property Sets for Types	Manufacturer type information necessary to identify, order, and price products	Variable created in Revit IFC export code, but no values are assigned
IfcCableCarrierFittingType	Property Sets for Types	Manufacturer type information necessary to identify, order, and price products	Variable created in Revit IFC export code, but no values are assigned
IfcCableCarrierSegmentType	Property Sets for Types	Manufacturer type information necessary to identify, order, and price products	Variable created in Revit IFC export code, but no values are assigned
IfcCableCarrierSegmentType	Material Profile Set	Required to determine capacity, placement, sizing, and interference	IFC4
IfcOutletType	Property Sets for Types	Manufacturer type information necessary to identify, order, and price products	Variable created in Revit IFC export code, but no values are assigned
IfcProtectiveDeviceType	Property Sets for Types	Manufacturer type information necessary to identify, order, and price products	Variable created in Revit IFC export code, but no values are assigned

3 Conclusions and Recommendations

While the subject matter experts interviewed in the first stage of this project (Chipman et al. 2013) showed a diversity of project delivery methods and specific workflows, it was possible to define role-based information exchanges that were broadly applicable. The information exchanges identified in these workflows established the basis for developing the Electrical Systems MVD. Although at the time of this report IFC2x3 is the currently adopted standard, the Electrical Systems MVD was written for IFC4. IFC4 was used due to its expanded capabilities for describing electrical schemas. The final version of IFC4 is scheduled to be released in 2013 and it is anticipated that the issues identified in this report related to IFC4 will be addressed once IFC4 is officially released and adopted by software vendors.

Using the Electrical Systems MVD, additional required properties were identified for the electrical elements in the BIMs and add these properties to the models. Based on the results received after updating each of the BIMs with the additional MVD attributes, converting the BIMs to IFC, and analyzing the data utilizing the ifcDoc tool, it can be concluded that the current COTS version of Revit 2013, Update 2 is capable of capturing and managing the necessary information within the BIMs.

Although the Electrical Systems MVD is new and still preliminary, and thus not supported by COTS software, and Revit does not claim to have extensive IFC 2X3 export support for MEP systems, the validation reports generated by the ifcDoc tool indicated that more than half of the included concepts were successfully exported to IFC. The validation reports indicated that the three main causes for non-compliance were:

- concepts and properties introduced in IFC4
- property values that are hard-coded to null in Revit IFC export
- property values are not assigned in the Revit IFC export code.

In the process of conducting this research, it has become clear that describing and maintaining the systems and connections between elements in the BIM is essential to extracting useful data for the information exchanges described by this MVD. This requirement has implications both for the way some electrical elements are defined in the COTS software and for the way a typical BIM design project subdivides the model.

- Some BIM families (e.g., a water heater) can belong to different systems and even different disciplines and might be better modeled if broken into separate components. For the water heater, this means that the electrical heating element is part of an electrical supply system, while the water input connects to a cold water system and the output feeds the hot water system.
- The common method of subdividing large projects by floors or even by parts of floors can sever the system connections between elements in different parts of the model. Without these system connections, some of the information needed for the information exchanges in the MVD is lost. New ways of subdividing large models are need that will preserve both the system and the contextual information.

The modeling work described in this report demonstrates that it is possible, recognizing some limitations in the current software, to use the new MVD to add properties to the BIM and extract that information to IFC, where it can be used for further analyses. If future software releases address these issues, the BIMs will have the ability to achieve greater interoperability by providing the additional information that teams require during the design phase.

Looking to the future, although the IFC2x3 Coordination View has been sufficient for BIM use in the industry to date, it is time for vendors to support the entire IFC data model more fully. In that way, the ability of the software to handle new MVDs would be increased. Further, the software development tools and techniques accompanying IFC4, particularly mvdXML, make the incorporation of new MVDs much easier for software vendors.

In order to reduce the problems of identifying additional properties that need to be applied to product categories, methods are needed to align proprietary types, hierarchies and inheritance with the IFC data model. These problems would also be reduced and user experience and predictability of outcome would be enhanced, if the BIM content included in authoring software products and provided by manufacturers contained the relevant IFC property sets.

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Appendix A: Electrical System Building Component Occurrences in the Revit Models

Table A1. Electrical system building component occurrences in the Revit models.

- - - COMPONENT - - -		TYPE	BUILDING OCCURRANCE		
FAMILY:TYPE	IFC	IFC	Duplex	Clinic	Office
M_Plain Recessed Lighting Fixture:600x1200 - 120	IfcFlowTerminal	IfcLightFixtureType			*
M_Plain Recessed Lighting Fixture:600x600 - 120	IfcFlowTerminal	IfcLightFixtureType			*
M_Pendant Light - Linear - 2 Lamp:1200mm - 120V	IfcFlowTerminal	IfcLightFixtureType		*	*
M_Pendant Light - Linear - 2 Lamp:2400mm - 120V	IfcFlowTerminal	IfcLightFixtureType		*	*
M_Troffer Light - Parabolic Rectangular:0600x1200mm(2 Lamp) - 120V	IfcFlowTerminal	IfcLightFixtureType		*	
M_Troffer Light - Parabolic Rectangular:0600x0600mm(2 Lamp) - 120V	IfcFlowTerminal	IfcLightFixtureType		*	
M_Pendant Light - Linear - 2 Lamp:1200mm - 120V_ 1m Drop	IfcFlowTerminal	IfcLightFixtureType		*	
M_Downlight - Recessed Can:203mm Incandescent - 120V	IfcFlowTerminal	IfcLightFixtureType		*	
M_Sconce Light - Sphere:100W - 120V	IfcFlowTerminal	IfcLightFixtureType	*	*	
M_Pendant Light - Hemisphere:150W - 120V	IfcFlowTerminal	IfcLightFixtureType	*		
M_Lighting Switches:Single Pole	IfcFlowTerminal	IfcLightFixtureType	*	*	*
M_Lighting Switches:Three Way	IfcFlowTerminal	IfcLightFixtureType		*	*
M_Duplex Receptacle:Standard	IfcFlowTerminal	IfcOutletType		*	*
M_Duplex Receptacle:Duplex Receptacle	IfcFlowTerminal	IfcOutletType	*		
M_Duplex Receptacle:GFCI	IfcFlowTerminal	IfcOutletType		*	
M_Elevator-Hydraulic:2000 lbs	IfcFlowTerminal	IfcElectricApplianceType		*	
M_Smoke Detector:Smoke Detector	IfcFlowController	IfcProtectiveDeviceType	*		

- - - COMPONENT - - -		TYPE	BUILDING OCCURRANCE		
M_Fire Alarm Control Panel:400x475	IfcFlowTerminal	IfcUnitaryControlElementType	*		
M_Microwave:760 x 400 x 450mm	IfcFlowTerminal	IfcElectricApplianceType	*		
M_Range:760 x 650mm	IfcFlowTerminal	IfcElectricApplianceType	*		
M_Refrigerator:850 x 760mm	IfcFlowTerminal	IfcElectricApplianceType	*		
M_Thermostat:Thermostat	IfcDistributionControlElement	IfcUnitaryControlElementType	*		
M_Lighting and Appliance Panelboard - 208V MLO:225 A	IfcFlowTerminal	IfcElectricApplianceType		*	*
M_Lighting and Appliance Panelboard - 208V MLO:400 A	IfcFlowTerminal	IfcElectricDistributionBoardType	*		
M_Transformer Switchboard: 914mmx673mm_120	IfcEnergyConversionDevice	IfcTransformerType		*	*
M_Telephone Terminal Board:TTB 300x300	IfcElectricDistributionBoard	IfcElectricApplianceType	*		
M_Centrifugal Fan - Rooftop - Upblast:991-1905 LPS	IfcFlowMovingDevice	IfcFanType	*	*	*
M_Inline Pump – Circulator:3.9 LPS – 0.8 Meter Head	IfcFlowMovingDevice	IfcPumpType	*	*	*
M_Hot Water Boiler – 59-440 kW:147kW	IfcEnergyConversionDevice	IfcBoilerType	*		
M_Water Heater:380 L	IfcFlowStorageDevice	IfcTankType		*	*
M_Screw Chiller – Air Cooled – 281 – 1231 kW:633 – 703 kW	IfcEnergyConversionDevice	IfcChillerType		*	*
M_Air Handling Unit – Split System – Horiz:63300000 J	IfcFlowMovingDevice	IfcFanType		*	*

Appendix B: Additional Electrical System Properties for Revit Families and Model

Table B1. Additional electrical system properties of the Revit families.

Family:Type	Revit Category	Ifc Category – MVD	Attributes *Pset_ElectricalDeviceCommon*
M_Lighting Switches:Three Way	Lighting Devices	IfcSwitchingDevice	RatedCurrent RatedVoltage NominalFrequencyRange PowerFactor ConductorFunction NumberOfPoles HasProtectiveEarth IP_Code InsulationStandardClass
M_Lighting Switches:Single Pole			

Family:Type	Revit Category	Ifc Category – MVD	Attributes *Pset_LightFixtureTypeCommon*
M_Sconce Light - Sphere:100W - 120V	Lighting Fixtures	IfcLightFixture	Reference Status (instance) NumberOfSources TotalWattage LightFixtureMountingType LightFixturePlacingType MaintenaceFactor SensibleLoadToRadiant
M_Pendant Light - Hemisphere:150W - 120V			
M_Pendant Light - Linear - 2 Lamp:1200mm - 120V			
M_Pendant Light - Linear - 2 Lamp:2400mm - 120V			
M_Plain Recessed Lighting Fixture:600x1200 - 120			
M_Plain Recessed Lighting Fixture:600x600 - 120			
M_Troffer Light - Parabolic Rectangular:0600x1200mm(2 Lamp) - 120V			
M_Troffer Light - Parabolic Square:0600x0600mm(2 Lamp) - 120V			
M_Pendant Light - Linear - 2 Lamp:1200mm - 120V_ 1m Drop	Lighting Fixtures	IfcLightFixture	MaximumPlenumSensibleLoad MaximumSpaceSensibleLoad
M_Downlight - Recessed Can:203mm Incandescent - 120V			
			Pset_ElectricalDeviceCommon
			Same as Above
			Pset_LightFixtureTypeSecurityLighting
			SecurityLightingType FixtureHeight SelfTestFunction BackupSupplySystem PictogramEscapeDirectiom Addressability

Family:Type	Revit Category	Ifc Category – MVD	Attributes ***Pset_ProtectiveDeviceTypeCommon***
M_Smoke Detector: Smoke Detector	Fire Alarm Devices	IfcProtectiveDevice	Reference Status (instance)

Family:Type	Revit Category	Ifc Category – MVD	Attributes ***Pset_ElectricalDeviceCommon***
M_Fire Alarm Control Panel:400x475	Electrical Equipment	IfcElectricDistributionBoard	Same as Above
M_Lighting and Appliance Panelboard - 208V MLO:400 A			
M_Lighting and Appliance Panelboard - 208V MLO:225 A			***Pset_ElectricDistributionBoardOccurrence***
M_Telephone Terminal Board			IsMain IsSkilledOperator
			Pset_ElectricDistributionBoardTypeCommon
			Reference Status

Family:Type	Revit Category	Ifc Category – MVD	Attributes ***Pset_ElectricalDeviceCommon***
M_Transformer Switchboard:914mmx673mm_120	Electrical Equipment	IfcTransformer	Same as Above

Family:Type	Revit Category	Ifc Category – MVD	Attributes ***Pset_ElectricalDeviceCommon***
M_Duplex Receptacle:Standard	Electrical Fixtures	IfcOutlet	Same as Above
M_Duplex Receptacle:GFCI			
M_Duplex Receptacle:Duplex Receptacle			
			Pset_OutletTypeCommon
			Reference Status IsPluggableOutlet

Family:Type	Revit Category	Ifc Category – MVD	Attributes ***Pset_ElectricalDeviceCommon***
M_Microwave:760 x 400 x 450mm M_Range:760 x 650mm M_Refrigerator:850 x 760mm M_Thermostat:Thermostat	Electrical Fixtures	IfcDistributionElement	Same as Above

Family:Type	Revit Category	Ifc Category – MVD	Attributes ***Pset_ElectricalDeviceCommon***
M_Centrifugal Fan - Rooftop - Upblast:991-1905 LPS	Mechanical Equipment	IfcElectricMotor	Same as Above

Family:Type	Revit Category	Ifc Category – MVD	Attributes ***Pset_ElectricalDeviceCommon***
M_Inline Pump – Circulator:3.9 LPS – 0.8 Meter Head	Mechanical Equipment	IfcPump	Same as Above

Family:Type	Revit Category	Ifc Category – MVD	Attributes ***Pset_BoilerPHistory***
M_Hot Water Boiler – 59-440 kW:147kW	Mechanical Equipment	IfcBoiler	EnergySourceConsumption OperationalEfficiency CombustionEfficiency WorkingPressure CombustionTemperature PartLoadRatio Load PrimaryEnergyConsumption AuxiliaryEnergyConsumption
			Pset_BoilerTypeCommon

Family:Type	Revit Category	Ifc Category – MVD	Attributes *Pset_BoilerPHistory*
M_Hot Water Boiler – 59-440 kW:147kW (cont'd)	Mechanical Equipment (cont'd)	IfcBoiler (cont'd)	Status PressureRating OperatingMode HeatTransferSurfaceArea NominalPartLoadRatio WaterInletTemperatureRange WaterStorageCapacity IsWaterStorageHeater PartialLoadEfficiencyCurves OutletTemperatureRange NominalEnergyConsumption EnergySource
			Pset_BoilerTypeWater
			NominalEfficiency HeatOutput

Family:Type	Revit Category	Ifc Category – MVD	Attributes *Pset_BoilerPHistory*
M_ Water Heater:380 L	Mechanical Equipment	IfcBoiler	Same as Above
			Pset_BoilerTypeCommon
			Same as Above
			Pset_BoilerTypeWater
			Same as Above

Family:Type	Revit Category	Ifc Category – MVD	Attributes *Pset_ElectricalDeviceCommon*
M_Screw Chiller – Air Cooled – 281-1231 kW:633-703 kW	Mechanical Equipment	IfcChiller	Same as Above

Family:Type	Revit Category	Ifc Category - MVD	Attributes *Pset_ElectricalDeviceCommon*
M_Air Handling Unit – Split System – Horiz:63300000 J	Mechanical Equipment	IfcUnitaryEquipment	Same as Above

Table B2. Additional project properties not associated with individual elements.

Revit Category	Ifc Category - MVD	Attributes *Pset_BuildingCommon*
N/A	*IfcBuiliding*	Reference
		BuildingID
		IsPermanentID
		ConstructionMethod
		FireProtectionClass
		SprinklerProtection
		SprinklerProtectionAutomatic
		OccupancyType
		GrossPlannedArea
		NetPlannedArea
		NumberOfStoreys
		YearOfConstruction
		YearOfLastRefurbishment
		IsLandmarked

Appendix C: Sample Validation Report

Table C1. Electrical system exchanges.

Number	Exchange Name
1	Facility Occupancy Model
2	Electrical Project Requirements
3	Equipment Room Requirements
4	Space Program
5	Coordinate Concept Design
6	Electrical System Types
7	Electrical Basis of Design
8	Electrical Source of Supply
9	Electrical Space Requirements
10	Energy Performance
11	Document Concept Design
12	Locate Electrical Loads
13	Electrical Equipment Requirements
14	Electrical Equipment Rooms
15	Lighting Layout
16	Size Electrical System
17	Raceway Layout
18	Electrical Schematic Design
19	Coordinate with Other Building Systems
20	Estimate Energy Usage
21	Facility Spatial Configuration
22	Electrical Supply Requirements
23	System Loads
24	Cabling Schematic
25	Redistribute Circuits
26	Cabling and Equipment Size
27	Architectural Light Fixtures
28	Product Type Specifications
29	Document Coordinated Design

Table C2. Validation test results symbols used in Table C-3.

Symbol	Meaning	Flag Column
-	The test was inapplicable for the particular exchange	A "-" indicates that the test does not apply to any of the exchanges
+	The entity or concept passed the test for the given exchange	A "+" indicates that the test passes for all applicable exchanges
*	An optional rule for the particular exchange failed the test	An "*" indicates that the optional test failed at least one of the applicable exchanges
F	A mandatory rule for the particular exchange failed the test	An "F" indicates that the mandatory test failed at least one of the applicable exchanges
R	Required concept (Req column)	
O	Optional concept (Req column)	
#<number>	The number identifies the first object instance that violates the rule – the numbers correspond to those in the IFC file. (Errors column)	
<number>	Number of instances subject to the rule (Count column)	

Table C3. Clinic Electrical System MVD IFC Validation.

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
IfcProject			1																														
Identity	-		1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Decomposition	R																																
Spatial Parts=IfcSite;			1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Project Units	O																																
NamedUnitType=LENGTHUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=ELECTRICCURRENTUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=ELECTRICVOLTAGEUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=ELECTRICRESISTANCEUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=ENERGYUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=POWERUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=TIMEUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=FREQUENCYUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=ILLUMINANCEUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=LUMINOUSFLUXUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=LUMINOUSINTENSITYUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=AREAUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
NamedUnitType=THERMODYNAMICTEMPERATUREUNIT;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Project Context	O	#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Project Declaration [IFC4]	O																																
Type=IfcSpaceType;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Type=IfcOccupant;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Type=IfcActor;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Type=IfcSpace;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Type=IfcWorkPlan;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Type=IfcDistributionElementType;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
Type=IfcDistributionSystem;		#53	0	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
IfcSite			1																														
Identity	R		1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Site Location	R	#266768	0	F	*	*	*	*	*	*	*	F	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	F
Spatial Decomposition	R																																
Spatial Parts=IfcBuilding;			1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Footprint Geometry	R																																
RepresentationType=GeometricCurveSet;Geometry=IfcGeometricCurveSet;		#266768	0	F	-	-	-	F	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F
RepresentationType=Annotation2D;Geometry=IfcAnnotationFillArea;		#266768	0	F	-	-	-	F	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F
IfcSpaceType			0																														
Identity	R		0	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Classification [IFC4]	R																																
Source=CSI;Name=OmniClass;Tokens=13-00 00 00;			0	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets for Types	R																																
Name=Pset_SpaceCommon;			0	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Pset_SpaceOccupancyRequirements;			0	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Pset_SpaceLightingRequirements;			0	+	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcBuilding			1																														
Identity	R		1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Classification [IFC4]	R																																

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Source=CSI;Name=OmniClass;Tokens=11-00-00-00;		#57	0	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F	F
Property Sets	R																																
PredefinedType=;Name=Pset_BuildingCommon;		#57	0	F	*	*	*	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=;Name=Pset_UtilityConsumptionPHistory;		#57	0	F	*	*	*	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Decomposition	-																																
Spatial Parts=IfcBuildingStorey;			1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Building Location	R	#57	0	F	-	-	-	*	-	-	-	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F
IfcDistributionSystem			0																														
Identity	R		0	+	-	+	-	-	-	+	+	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	+	+	+	-	-	+
Property Sets	R																																
PredefinedType=;Name=Pset_DistributionSystemCommon;			0	+	-	+	-	-	-	+	+	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	+	-	+	+	-	-	-
PredefinedType=ELECTRICAL;Name=Pset_DistributionSystemTypeElectrical;			0	+	-	+	-	-	-	+	+	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	+	-	+	+	-	-	-
PredefinedType=ELECTRICAL;Name=SPARKie_DistributionSystemTypeElectrical;			0	+	-	+	-	-	-	+	+	-	-	-	-	-	-	-	-	+	-	+	-	-	-	-	+	-	+	+	-	-	-
Object Aggregation	R																																
PredefinedType=;RelatedObjects=IfcDistributionCircuit;			0	+	-	-	-	-	-	-	-	-	-	-	+	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	-	-	+
Group Assignment	-																																
Type=IfcElectricDistributionBoard;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcLightFixture			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	R																																
Type=IfcLightFixtureType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+
Property Sets	-																																

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=;Name=Pset_LightFixtureTypeCommon;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=SECURITYLIGHTING;Name=Pset_LightFixtureTypeSecurityLighting;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Placement	R																																
Type=IfcGridPlacement;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcLocalPlacement;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Lighting Geometry	R																																
Type=LightSource;Geometry=IfcLightSource;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Ports [IFC4]	R																																
PredefinedType=POINTSOURCE;Name=Line;Type=ELECTRICAL;Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POINTSOURCE;Name=Socket;Type=LIGHTING;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DIRECTIONSOURCE;Name=Line;Type=ELECTRICAL;Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DIRECTIONSOURCE;Name=Socket#1;Type=LIGHTING;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DIRECTIONSOURCE;Name=Socket#2;Type=LIGHTING;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DIRECTIONSOURCE;Name=Socket#3;Type=LIGHTING;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DIRECTIONSOURCE;Name=Socket#4;Type=LIGHTING;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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IfcElectricDistributionBoard			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	R																																
Type=IfcElectricDistributionBoardType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	R																																
PredefinedType=;Name=Pset_ElectricDistributionBoardTypeCommon;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
PredefinedType=;Name=Pset_ElectricDistributionBoardOccurrence;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Body Geometry	R																																
RepresentationType=;Geometry=;			0	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clearance Geometry	R		0	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Element Decomposition	-																																
RelatedObjects=IfcProtectiveDevice;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
PredefinedType=CONSUMERUNIT;Name=Line;Flow=SINK;Type=ELECTRICAL;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CONSUMERUNIT;Name=Ground;Flow=SINK;Type=EARTHING;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CONSUMERUNIT;Name=Circuit#1;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CONSUMERUNIT;Name=Circuit#2;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CONSUMERUNIT;Name=Circuit#3;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=CONSUMERUNIT;Name=Circuit#4;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CONSUMERUNIT;Name=Circuit#5;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CONSUMERUNIT;Name=Circuit#6;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CONSUMERUNIT;Name=Circuit#7;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CONSUMERUNIT;Name=Circuit#8;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	R																																
Structure=IfcSpace;			0	+	-	-	-	+	-	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcCableSegment			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																
Type=IfcCableSegmentType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	-																																
PredefinedType=BUSBARSEGMENT;Name=Pset_CableSegmentTypeBusBarSegment;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CABLESEGMENT;Name=Pset_CableSegmentTypeCableSegment;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Pset_CableSegmentTypeCommon;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=CONDUCTORSEGMENT;Name=Pset_CableSegmentTypeConductorSegment;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CORESEGMENT;Name=Pset_CableSegmentTypeCoreSegment;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=;Name=Pset_CableSegmentOccurrence;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Material Profile Set Usage [IFC4]	R																																
Name=Conductor;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-
Name=Insulation;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-
Name=Screen;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-
Name=Sheath;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-
Product Placement	R																																
Type=IfcLocalPlacement;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Axis Geometry	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Body Geometry	O		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Ports [IFC4]	R																																
PredefinedType=;Name=Head;Flow=SINK;Type=ELECTRICAL;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	+	+	-	-	+
PredefinedType=;Name=Tail;Flow=SOURCE;Type=ELECTRICAL;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	+	+	-	-	+
Spatial Containment	-																																
Structure=IfcSite;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Structure=IfcBuildingStorey;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcJunctionBox			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																
Type=IfcJunctionBoxType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Property Sets	-																																
PredefinedType=;Name=Pset_JunctionBoxTypeCommon;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
PredefinedType=DATA;Name=Line#1;Type=DATA;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DATA;Name=Line#2;Type=DATA;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DATA;Name=Gang#1;Type=DATA;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DATA;Name=Gang#2;Type=DATA;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Line;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Load;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Gang#1;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Gang#2;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Gang#3;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Gang#4;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcOutlet			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	R																																

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Type=IfcOutletType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	-																																
PredefinedType=;Name=Pset_OutletTypeCommon;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
PredefinedType=DATAOUTLET;Name=Line#1;Type=DATA;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DATAOUTLET;Name=Line#2;Type=DATA;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DATAOUTLET;Name=Jack#1;Type=DATA;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DATAOUTLET;Name=Jack#2;Type=DATA;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWEROUTLET;Name=Line#1;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWEROUTLET;Name=Jack#1;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWEROUTLET;Name=Jack#1;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=TELEPHONEOUTLET;Name=Line#1;Type=TELEPHONE;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=TELEPHONEOUTLET;Name=Line#2;Type=TELEPHONE;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=TELEPHONEOUTLET;Name=Jack#1;Type=TELEPHONE;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=TELEPHONEOUTLET;Name=Jack#2;Type=TELEPHONE;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Spatial Containment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcTransformer			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	R																																
Type=IfcTransformerType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	R		0	+	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
Name=Line;Type=ELECTRICAL;Flow =SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Load;Type=ELECTRICAL;Flow =SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	R																																
Structure=IfcSpace;			0	+	-	-	-	+	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcSwitchingDevice			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	R																																
Type=IfcSwitchingDeviceType;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
Name=Line;Type=ELECTRICAL;Flow =SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Load;Type=ELECTRICAL;Flow =SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcProtectiveDevice			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																
Type=IfcProtectiveDeviceType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	-																																

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=;Name=Pset_ProtectiveDeviceBreakerUnitI2TCurve;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Pset_ProtectiveDeviceBreakerUnitI2TFuseCurve;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Pset_ProtectiveDeviceBreakerUnitIPICurve;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CIRCUITBREAKER;Name=Pset_ProtectiveDeviceBreakerUnitTypeMCB;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Pset_ProtectiveDeviceBreakerUnitTypeMotorProtection;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Pset_ProtectiveDeviceTrippingCurve;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CIRCUITBREAKER;Name=Pset_ProtectiveDeviceTypeCircuitBreaker;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Pset_ProtectiveDeviceTypeCommon;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=EARTHLEAKAGECIRCUITBREAKER;Name=Pset_ProtectiveDeviceTypeEarthLeakageCircuitBreaker;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=FUSEDISCONNECTOR;Name=Pset_ProtectiveDeviceTypeFuseDisconnector;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=RESIDUALCURRENTCIRCUITBREAKER;Name=Pset_ProtectiveDeviceTypeResidualCurrentCircuitBreaker;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=RESIDUALCURRENTSWITCH;Name=Pset_ProtectiveDeviceTypeResidualCurrentSwitch;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=VARISTOR;Name=Pset_ProtectiveDeviceTypeVaristor;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
Name=Line;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Load;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcCableCarrierSegment			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																
Type=IfcCableCarrierSegmentType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R																																
PredefinedType=CABLELADDERSEGMENT;Name=Pset_CableCarrierSegmentTypeCableLadderSegment;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
PredefinedType=CABLETRAYSEGMENT;Name=Pset_CableCarrierSegmentTypeCableTraySegment;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=CABLETRUNKINGSEGMENT;Name=Pset_CableCarrierSegmentTypeCableTrunkingSegment;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Name=Pset_CableCarrierSegmentTypeCommon;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
PredefinedType=CONDUITSEGMENT;Name=Pset_CableCarrierSegmentTypeConduitSegment;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-
Material Profile Set Usage [IFC4]	R																																
Name=Casing;Profile=IfcArbitraryClosedProfileDef;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	+	-	-	-
Product Placement	R																																
Type=IfcLocalPlacement;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Axis Geometry	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Body Geometry	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	R																																
Structure=IfcSite;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	+	-	+	-	-	-
Structure=IfcBuildingStorey;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+	-	-	-	-	+	-	+	-	-	-
Interference	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-
Ports [IFC4]	R																																
Name=Head;Type=NOTDEFINED;Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
Name=Tail;Type=NOTDEFINED;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
IfcSpace			266																														
Identity	R		266	+	-	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	O																																
Type=IfcSpaceType;		#275	0	*	-	-	-	*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R																																

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=;Name=SPARKie_SpaceElectricalRequirements;		#275	0	F	-	*	F	F	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=;Name=Pset_SpaceLightingRequirements;		#275	0	F	-	*	F	F	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=;Name=Pset_SpaceOccupancyRequirements;		#275	0	F	-	*	F	F	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=;Name=Pset_SpaceCommon;		#275	0	F	-	*	F	F	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Placement	R																																
Type=IfcLocalPlacement;			266	+	-	-	-	-	-	-	-	-	+	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Space Coverings	R																																
CoveringType=CEILING;		#275	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Classification [IFC4]	R																																
Source=CSI;Name=OmniClass;Tokens=13-00 00 00;		#275	0	F	-	-	F	F	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcActor			0																														
Identity	R		0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R																																
Name=Pset_ActorCommon;TemplateType=PSET_OCCURRENCEDRIVEN;			0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contact	R																																
Role=USERDEFINED;UserDefinedRole=ElectricalUtility;			0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Actor Assignment	R																																
Type=IfcWorkPlan;			0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcCostSchedule			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Nesting	O																																
Type=IfcCostItem;			0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
IfcWorkCalendar			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Nesting	-																																
Type=IfcCostSchedule;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calendar	O		0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Control Assignment	R																																
Type=IfcSpatialStructureElement;			0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcCostItem			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cost	O		0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
IfcElectricGenerator			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																
Type=IfcElectricGeneratorType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R																																
PredefinedType=;Name=Pset_ElectricGeneratorTypeCommon;			0	+	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	R																																
Name=Load;Type=ELECTRICAL;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	-	+
Footprint Geometry	O		0	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Body Geometry	R		0	+	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clearance Geometry	R		0	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcElectricMotor			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																
Type=IfcElectricMotorType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R		0	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Ports [IFC4]	-																																
Name=Line;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Drive;Type=NOTDEFINED;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Footprint Geometry	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Body Geometry	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clearance Geometry	R		0	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcPerformanceHistory			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets for Performance	R																																
Name=Pset_DistributionPortPHistoryCable;			0	+	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Name=Pset_UtilityConsumptionPHistory;			0	+	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Control Assignment	-																																
Type=IfcGroup;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcProduct;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcProcess;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcResource;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcCovering			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Element Decomposition	R																																
RelatedObjects=IfcGrid;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-
RelatedObjects=IfcLightFixture;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-
Spatial Containment	-																																
Structure=IfcSite;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Structure=IfcBuildingStorey;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Structure=IfcBuildingStorey;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcGrid			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Placement	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Grid	R																																
GridType=RECTANGULAR;UCurve=IfcLine;VCurve=IfcLine;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcWallElementedCase			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Placement	R		0	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	+	-	-	-	+	-	-	-	-	-	-	-	+
Axis Geometry	R																																
RepresentationType=Curve2D;Geometry=IfcBoundedCurve;			0	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Surface Geometry	R																																
RepresentationType=Surface3D;Geometry=IfcBoundedSurface;			0	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
Spatial Containment	-																																
Structure=IfcSite;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Structure=IfcBuildingStorey;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Structure=IfcBuildingStorey;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Aggregation	-																																
PredefinedType=;RelatedObjects=IfcMember;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=;RelatedObjects=IfcPlate;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=;RelatedObjects=IfcBuildingElementPart;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=;RelatedObjects=IfcBeam;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcSlabElementedCase			0																														

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Placement	R		0	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	+
Surface Geometry	R																																
RepresentationType=Surface3D;Geometry=IfcBoundedSurface;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	+
Spatial Containment	-																																
Structure=IfcSite;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Structure=IfcBuildingStorey;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Structure=IfcBuildingStorey;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Aggregation	-																																
PredefinedType=;RelatedObjects=IfcBeam;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=;RelatedObjects=IfcPlate;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=;RelatedObjects=IfcBuildingElementPart;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcDistributionCircuit			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Group Assignment	R																																
Type=IfcJunctionBox;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Type=IfcChiller;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Type=IfcUnitaryEquipment;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Type=IfcPump;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Type=IfcLightFixture;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+
IfcLightFixtureType			47																														
Identity	R		47	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+	+
Property Sets for Types	R	#49947	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	F	F
Product Type Assignment	R																																

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Type=IfcLightFixture;		#49947	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F	-
IfcDistributionPort			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R																																
PredefinedType=CABLE;Name=Pset_DistributionPortTypeCable;			0	+	-	-	-	-	-	-	-	-	-	-	-	+	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	+	+
Material Profile Set Usage [IFC4]	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Port Connectivity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Placement	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcElectricFlowStorageDevice			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																
Type=IfcElectricFlowStorageDeviceType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	-																																
PredefinedType=;Name=Pset_ElectricFlowStorageDeviceTypeCommon;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
Name=Line;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Load;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	-																																
Structure=IfcSite;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Structure=IfcBuildingStorey;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Structure=IfcBuildingStorey;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcChiller			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Type=IfcChillerType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R		0	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
PredefinedType=AIRCOOLED;Name=Power;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRCOOLED;Name=Control;Type=CONTROL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRCOOLED;Name=ChilledWaterIn;Type=CHILLEDWATER;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRCOOLED;Name=ChilledWaterOut;Type=CHILLEDWATER;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRCOOLED;Name=VentilationIn;Type=VENTILATION;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRCOOLED;Name=VentilationOut;Type=VENTILATION;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=WATERCOOLED;Name=Power;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=WATERCOOLED;Name=Control;Type=CONTROL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=WATERCOOLED;Name=ChilledWaterIn;Type=CHILLEDWATER;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=WATERCOOLED;Name=ChilledWaterOut;Type=CHILLEDWATER;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=WATERCOOLED;Name=CondenserWaterIn;Type=CONDENSERWATER;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=WATERCOOLED;Name=CondenserWaterOut;Type=CONDENSERWATER;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcUnitaryEquipment			0																														
Identity	R		0	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets	R		0	+	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Ports [IFC4]	-																																
PredefinedType=AIRHANDLER;Name=ReturnAirIn;Type=AIRCONDITIONING;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRHANDLER;Name=SupplyAirOut;Type=AIRCONDITIONING;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRHANDLER;Name=OutsideAirIn;Type=VENTILATION;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRHANDLER;Name=ExhaustAirOut;Type=EXHAUST;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRHANDLER;Name=ChilledWaterIn;Type=CHILLEDWATER;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRHANDLER;Name=ChilledWaterOut;Type=CHILLEDWATER;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRHANDLER;Name=HeatingIn;Type=HEATING;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRHANDLER;Name=HeatingOut;Type=HEATING;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=AIRHANDLER;Name=Power;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=AIRHANDLER;Name=Control;Type=CONTROL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcPump			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																
Type=IfcPumpType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R		0	+	-	-	+	-	-	+	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
Name=Power;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Inlet;Type=NOTDEFINED;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Outlet;Type=NOTDEFINED;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Spatial Containment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcTransportElement			0																														
Identity	O		0	+	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R		0	+	-	+	+	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Placement	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Body Geometry	-																																
RepresentationType=SurfaceModel;Geometry=IfcFaceBasedSurfaceModel;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RepresentationType=Brep;Geometry=IfcFacetedBrep;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RepresentationType=Tessellation;Geo			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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metry=IfcTriangulatedFaceSet;																																	
RepresentationType=MappedRepresentation;Geometry=IfcMappedItem;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcBuildingStorey			3																														
Identity	R		3	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Element Decomposition	R																																
RelatedObjects=IfcSpace;			3	+	-	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Property Sets	R																																
Name=Pset_BuildingStoreyCommon;TemplateType=PSET_OCCURRENCEDRIVEN;		#65	0	F	-	-	-	*	-	-	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F
IfcWorkPlan			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Aggregation	R																																
PredefinedType=;RelatedObjects=IfcWorkCalendar;			0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
PredefinedType=;RelatedObjects=IfcPerformanceHistory;			0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
Control Assignment	R																																
Type=IfcDistributionSystem;			0	+	-	-	-	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-
IfcDistributionElement			2089																														
Object Typing	-																																
Type=IfcDistributionElementType;		#48161	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	-																																
Name=Pset_ElectricalDeviceCommon;TemplateType=PSET_TYPEDRIVENOVERRIDE;		#48161	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Footprint Geometry	-																																
RepresentationType=GeometricCurveSet;Geometry=IfcGeometricCurveSet;			2089	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Body Geometry	-																																
RepresentationType=Brep;Geometry=IfcFacetedBrep;			2089	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RepresentationType=SurfaceModel;Geometry=IfcFaceBasedSurfaceModel;			2089	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RepresentationType=SweptSolid;Geometry=IfcExtrudedAreaSolid;			2089	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RepresentationType=SectionedSpine;Geometry=IfcSectionedSpine;			2089	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RepresentationType=CSG;Geometry=IfcCsgSolid;			2089	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RepresentationType=Tessellation;Geometry=IfcTriangulatedFaceSet;			2089	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RepresentationType=MappedRepresentation;Geometry=IfcMappedItem;			2089	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcFlowMeter			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																
Type=IfcFlowMeterType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R																																
PredefinedType=;Name=Pset_FlowMeterOccurrence;			0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Pset_FlowMeterTypeCommon;TemplateType=PSET_TYPEDRIVENOVERRIDE;			0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=ENERGYMETER;Name=Pset_FlowMeterTypeEnergyMeter;			0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	R																																
PredefinedType=ENERGYMETER;Name=Inlet;Type=ELECTRICAL;Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=ENERGYMETER;Name=Outlet;Type=ELECTRICAL;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+
PredefinedType=GASMETER;Name=Inlet;Type=GAS;Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+
PredefinedType=GASMETER;Name=Outlet;Type=GAS;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+
PredefinedType=OILMETER;Name=Inlet;Type=OIL;Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+
PredefinedType=OILMETER;Name=Outlet;Type=OIL;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+
PredefinedType=WATERMETER;Name=Inlet;Type=DOMESTICCOLDWATER;Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+
PredefinedType=WATERMETER;Name=Outlet;Type=DOMESTICCOLDWATER;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+
Product Placement	O																																
Type=IfcLocalPlacement;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-
Spatial Containment	-																																
Structure=IfcSite;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcOccupant			0																														
Identity	R		0	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Actor Assignment	R																																
Type=IfcSpatialStructureElement;			0	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Type=IfcWorkCalendar;			0	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R		0	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contact	R		0	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcTaskType			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Nesting	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Process Type Assignment	R																																
Type=IfcSubContractResourceType;			0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcSubContractResourceType			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Cost Rate	R		0	+	-	-	-	-	-	-	-	+	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcTask			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Process Assignment	O																																
Type=IfcSubContractResource;			0	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcSubContractResource			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Cost	R		0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Quantity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Assignment	R																																
Type=IfcActor;			0	+	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcConstructionEquipmentResource			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																
Type=IfcConstructionEquipmentResourceType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Cost	O		0	+	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Resource Quantity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcUnitaryEquipmentType			0																														
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
IfcPumpType			1																														
Identity	R		1	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Property Sets for Types	R	#227466	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
IfcFlowMeterType			0																														
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
IfcChillerType			1																														
Identity	R		1	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R	#247646	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
IfcCableCarrierFitting			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Object Typing	-																																
Type=IfcCableCarrierFittingType;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets	R																																
PredefinedType=;Name=Pset_CableCarrierFittingTypeCommon;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-
Ports [IFC4]	R																																
PredefinedType=BEND;Name=Head;Type=NOTDEFINED;Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
PredefinedType=BEND;Name=Tail;Type=NOTDEFINED;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
PredefinedType=CROSS;Name=Head;Type=NOTDEFINED;Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
PredefinedType=CROSS;Name=Tail;Type=NOTDEFINED;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
PredefinedType=CROSS;Name=Left;Type=NOTDEFINED;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
PredefinedType=CROSS;Name=Right;Type=NOTDEFINED;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
PredefinedType=REDUCER;Name=Head;Type=NOTDEFINED;Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+

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PredefinedType=REDUCER;Name=Tail;Type=NOTDEFINED;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
PredefinedType=TEE;Name=Head;Type=NOTDEFINED;Flow=SINK			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
PredefinedType=TEE;Name=Left;Type=NOTDEFINED;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
PredefinedType=TEE;Name=Right;Type=NOTDEFINED;Flow=SOURCE			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	+	-	+	-	-	+
Spatial Containment	-																																
Structure=IfcSite;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Structure=IfcBuildingStorey;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Structure=IfcBuildingStorey;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcCableCarrierFittingType			0																														
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Product Type Assignment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
PredefinedType=BEND;Name=Head;Type=NOTDEFINED;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=BEND;Name=Tail;Type=NOTDEFINED;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CROSS;Name=Head;Type=NOTDEFINED;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CROSS;Name=Tail;Type=NOTDEFINED;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CROSS;Name=Left;Type=NOTDEFINED;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=CROSS;Name=Right;Type=NOTDEFINED;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=REDUCER;Name=Head;Type=NOTDEFINED;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=REDUCER;Name=Tail;Type=NOTDEFINED;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=TEE;Name=Head;Type=NOTDEFINED;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=TEE;Name=Left;Type=NOTDEFINED;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=TEE;Name=Right;Type=NOTDEFINED;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcCableCarrierSegmentType			0																														
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Product Type Assignment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Material Profile Set [IFC4]	R																																
Name=Casing;Profile=IfcArbitraryClosedProfileDef;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Ports [IFC4]	-																																
Name=Head;Type=NOTDEFINED;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Tail;Type=NOTDEFINED;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcOutletType			2																														
Identity	R		2	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R	#155210	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
Product Type Assignment	-	#155210	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
PredefinedType=DATAOUTLET;Name=Line#1;Type=DATA;Flow=SINK		#155210	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=DATAOUTLET;Name =Line#2;Type=DATA;Flow=SINK		#1552 10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DATAOUTLET;Name =Jack#1;Type=DATA;Flow=SOURCE		#1552 10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DATAOUTLET;Name =Jack#2;Type=DATA;Flow=SOURCE		#1552 10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWEROUTLET;Na me=Line#1;Type=ELECTRICAL;Flow= SINK		#1552 10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWEROUTLET;Na me=Jack#1;Type=ELECTRICAL;Flow =SOURCE		#1552 10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWEROUTLET;Na me=Jack#1;Type=ELECTRICAL;Flow =SOURCE		#1552 10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=TELEPHONEOUTLE T;Name=Line#1;Type=TELEPHONE;F low=SINK		#1552 10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=TELEPHONEOUTLE T;Name=Line#2;Type=TELEPHONE;F low=SINK		#1552 10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=TELEPHONEOUTLE T;Name=Jack#1;Type=TELEPHONE; Flow=SINK		#1552 10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=TELEPHONEOUTLE T;Name=Jack#2;Type=TELEPHONE; Flow=SINK		#1552 10	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcProtectiveDeviceType			0																														
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Product Type Assignment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
Name=Line;Type=ELECTRICAL;Flow			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
=SINK																																	
Name=Load;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcSwitchingDeviceType			0																														
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Ports [IFC4]	-																																
Name=Line;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Load;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcTransformerType			1																														
Identity	R		1	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R	#154717	0	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	F	F
Product Type Assignment	-	#154717	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
Name=Line;Type=ELECTRICAL;Flow=SINK		#154717	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Load;Type=ELECTRICAL;Flow=SOURCE		#154717	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcJunctionBoxType			0																														
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Product Type Assignment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
PredefinedType=DATA;Name=Line#1;Type=DATA;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DATA;Name=Line#2;Type=DATA;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
PredefinedType=DATA;Name=Gang#1;Type=DATA;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=DATA;Name=Gang#2;Type=DATA;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Line;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Load;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Gang#1;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Gang#2;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Gang#3;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=POWER;Name=Gang#4;Type=ELECTRICAL;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcElectricMotorType			0																														
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Ports [IFC4]	-																																
Name=Line;Type=ELECTRICAL;Flow=SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Drive;Type=NOTDEFINED;Flow=SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Footprint Geometry	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Body Geometry	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clearance Geometry	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcElectricGeneratorType			0																														

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Product Type Assignment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
Name=Load;Type=ELECTRICAL;Flow =SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcElectricFlowStorageDeviceType			0																														
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Product Type Assignment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ports [IFC4]	-																																
Name=Line;Type=ELECTRICAL;Flow =SINK			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Name=Load;Type=ELECTRICAL;Flow =SOURCE			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcElectricDistributionBoardType			0																														
Identity	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Property Sets for Types	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Product Type Assignment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Body Geometry	-																																
RepresentationType=;Geometry=;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Clearance Geometry	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Port Connectivity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcCableSegmentType			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets for Types	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Type Assignment	R		0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Material Profile Set [IFC4]	R																																
Name=Conductor;Profile=IfcCircleProfileDef;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+

Entity/Concept	Req	Errors	Count	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Name=Insulation;Profile=IfcCircleHollowProfileDef;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Name=Screen;Profile=IfcCircleHollowProfileDef;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Name=Sheath;Profile=IfcCircleHollowProfileDef;			0	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+	+
Ports [IFC4]	-																																
PredefinedType=;Name=Head;Flow=SINK;Type=ELECTRICAL;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PredefinedType=;Name=Tail;Flow=SOURCE;Type=ELECTRICAL;			0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IfcTransportElementType			0																														
Identity	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Property Sets for Types	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Product Type Assignment	-		0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUMMARY FOR IFC4					99%	99%	98%	97%	99%	99%	99%	99%	98%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	98%	97%
SUMMARY FOR IFC2X3					100%	100%	99%	98%	99%	100%	100%	99%	99%	100%	99%	100%	100%	100%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	99%	98%	97%

Table C4. Summary of Electrical System MVD IFC Validation.

Duplex Apartment															
		Exchange													
	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Test was inapplicable for the particular exchange (-)	273	448	439	440	436	455	452	450	439	449	456	448	448	456	455
Entity or concept passed the test for the given exchange (+)	172	14	18	16	15	6	11	13	24	9	7	13	15	7	8
Optional rule for the particular exchange failed the test (*)	22	24	28	24	25	22	22	22	21	22	22	23	22	22	22
Mandatory rule for the particular exchange failed the test (F)	20	1	2	7	11	4	2	2	3	7	2	3	2	2	2
Total Tests	487	487	487	487	487	487	487	487	487	487	487	487	487	487	487
Office Building															
		Exchange													
	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Test was inapplicable for the particular exchange (-)	273	448	439	440	436	455	452	450	439	449	456	448	448	456	455
Entity or concept passed the test for the given exchange (+)	170	14	18	16	15	6	11	13	24	9	7	13	15	7	8
Optional rule for the particular exchange failed the test (*)	22	24	28	24	25	22	22	22	21	22	22	23	22	22	22
Mandatory rule for the particular exchange failed the test (F)	22	1	2	7	11	4	2	2	3	7	2	3	2	2	2
Total Tests	487	487	487	487	487	487	487	487	487	487	487	487	487	487	487
Medical Clinic															
		Exchange													
	Flag	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Test was inapplicable for the particular exchange (-)	273	448	439	440	436	455	452	450	439	449	456	448	448	456	455
Entity or concept passed the test for the given exchange (+)	172	14	19	17	16	7	12	14	25	10	8	14	16	8	9
Optional rule for the particular exchange failed the test (*)	22	24	28	24	25	22	22	22	21	22	22	23	22	22	22
Mandatory rule for the particular exchange failed the test (F)	20	1	1	6	10	3	1	1	2	6	1	2	1	1	1
Total Tests	487	487	487	487	487	487	487	487	487	487	487	487	487	487	487

Duplex Apartment															
	Exchange														
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Test was inapplicable for the particular exchange (-)	442	446	430	442	447	447	448	437	446	423	440	419	444	403	369
Entity or concept passed the test for the given exchange (+)	20	17	33	21	16	16	15	26	17	40	23	44	17	55	86
Optional rule for the particular exchange failed the test (*)	22	22	22	22	22	22	22	22	22	22	22	22	23	22	21
Mandatory rule for the particular exchange failed the test (F)	3	2	2	2	2	2	2	2	2	2	2	2	3	7	11
Total Tests	487	487	487	487	487	487	487	487	487	487	487	487	487	487	487

Office Building															
	Exchange														
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Test was inapplicable for the particular exchange (-)	442	446	430	442	447	447	448	437	446	423	440	419	444	403	369
Entity or concept passed the test for the given exchange (+)	20	17	33	21	16	16	15	26	17	40	23	44	17	53	84
Optional rule for the particular exchange failed the test (*)	22	22	22	22	22	22	22	22	22	22	22	22	23	22	21
Mandatory rule for the particular exchange failed the test (F)	3	2	2	2	2	2	2	2	2	2	2	2	3	9	13
Total Tests	487	487	487	487	487	487	487	487	487	487	487	487	487	487	487

Medical Clinic															
	Exchange														
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
Test was inapplicable for the particular exchange (-)	442	446	430	442	447	447	448	437	446	423	440	419	444	403	369
Entity or concept passed the test for the given exchange (+)	21	18	34	22	17	17	16	27	18	41	24	45	18	55	86
Optional rule for the particular exchange failed the test (*)	22	22	22	22	22	22	22	22	22	22	22	22	23	22	21
Mandatory rule for the particular exchange failed the test (F)	2	1	1	1	1	1	1	1	1	1	1	1	2	7	11
Total Tests	487	487	487	487	487	487	487	487	487	487	487	487	487	487	487

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14. ABSTRACT

Previous efforts by the US Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL) to develop a life-cycle building model have resulted in the definition of a "core" building information model that contains general information describing facility assets such as spaces and equipment. To describe how facility assets (i.e., components) function together, information about assemblies of assets and their connections must also be defined. The definitions of assets, assemblies, and connections for the various building-information domains are discipline-specific. Work documented in ERDC/CERL CR-13-2 identified the processes and tasks specifically associated with the design of building electrical systems and the information exchange requirements for every participant in the design. The findings were used to develop an information-exchange Model View Definition (MVD) for building electrical systems.

The objective of the current work was to document the steps needed to identify the electrical MVD attributes in three experimental building information models representing typical low-rise Army facilities, and to update the models. This work also validated the International Foundation Class (IFC) export function from the experimental models against the electrical MVD, and studied the requirements for creating computable open building models that can be utilized for the automated information exchanges.

15. SUBJECT TERMS
information exchange, electrical systems, product data templates, guide specifications, Construction Operations Building information exchange (COBie), Building Information Modeling (BIM)

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