

BIM and the U.S. General Services Administration

The U.S. General Services Administration (GSA) now requires the delivery of building information models (BIMs) – in both the native format of the BIM authoring application and as an IFC (Industry Foundation Classes) file – for major federal building projects. This white paper takes a closer look at the IFC standard and how it's being used to facilitate data exchange for U.S. federal government projects.

GSA BIM Program

In October 2006, the U.S. GSA – the government agency that builds and manages federal facilities – began requiring the delivery of building information models for major federal building projects. For those of you unfamiliar with GSA, this is noteworthy because GSA is the U.S. government's "landlord," meeting office and other space requirements of the federal workforce. GSA owns, operates, and manages over 340 million square feet of space in approximately 8,700 owned and leased buildings across the United States. GSA properties include border stations, courthouses, office buildings, laboratories, data processing centers, and notable facilities such as the White House.

GSA hires and manages private sector professionals (architects, engineers, contractors, etc.) to design, renovate, and construct their properties. GSA's new rule for BIM delivery applies to all their major projects receiving design funding in fiscal year 2007 and beyond. For architects and engineers working on one of these projects, this means that their concept design needs to be submitted to the GSA in both the native format of the BIM authoring application and as an IFC (Industry Foundation Classes) file. As the largest owner of commercial space in the country, GSA's mandate constitutes a watershed event for the acceptance of IFC as a data exchange standard in the building industry.

Many Standards for Data Exchange

A host of vehicles exist to move building data between software applications. There's STEP, IGES, ODBC, XML, DWG™, DWF™, DXF™, and PDF - to name just a few. This alphabet soup of data exchange mechanisms has evolved over time, with various standards developed and advanced by different organizations, vendors, or consortiums to suit particular requirements.

IFC is an open standard for building data exchange, developed by the International Alliance for Interoperability (IAI) - a global consortium of commercial companies and research organizations. The IAI was started in 1994 when Autodesk led a group of

twelve companies to examine the potential for making different software applications work together. Autodesk is a founding member of the IAI, holds a board level position in the IAI's North American chapter, and participates actively in the IAI worldwide.

IFCs and the other standards mentioned above are mechanisms for moving data from one software application to another but are not themselves building information models. In turn, BIM is not a file format or data schema. The coordinated, consistent, and reliable information delivered by BIM, however, is the foundation for the value these standards have the potential to deliver.

Interoperability and IFC

A 2004 NIST study¹ was undertaken to estimate the efficiency losses in the U.S. capital facilities industry (i.e., commercial, institutional buildings, and industrial facilities). The study calculated the cost of inefficiencies caused by inadequate interoperability among computer-aided design, engineering, and software systems.

IFC strives to increase interoperability by providing a data exchange standard for sharing building data across various applications used for building design, construction and facility management. Unlike some of the "generic" data standards mentioned above, the IFC standard was specifically created to share building information, and can represent building-specific elements like walls as well as abstract elements such as spaces.

Its format is open and available to commercial software vendors to build the necessary IFC import and export capabilities into their authoring applications. Applications are deemed IFC-compliant - i.e., capable of importing and exporting IFC files - after going through a multi-stage certification process conducted by the IAI.

Note: You may start to hear the name BuildingSMART used in conjunction with the IAI and/or IFC. With the overall architecture of the IFC standard under its belt, the IAI is broadening its scope of interest - seeking alliances with other organizations to promote the use of building information modeling and IFC to achieve beneficial change in the building industry. They are branding this initiative "BuildingSMART."

Revit, IFC and BIM

Revit[®] Architecture software is IFC-certified²; having received its stage 1 IFC2x3 (shorthand for IFC2x Edition 3) certification for the Extended Coordination View for both import and export in June of 2006, and full certification for the IFC2x2 Code Checking View (that expands the IFC Coordination View to additionally support architectural code checking) in November of 2005.

The support for IFCs in Revit enable compliance with the GSA's IFC delivery requirements. In fact, Autodesk is currently working with GSA to develop best practices and BIM guidelines for architectural and engineering firms conducting federal civilian design and construction projects. GSA has published the guidelines on their BIM website (www.gsa.gov/bim).

All of this boils down to the ability to export IFC files from Revit and import IFC files into Revit. In the near term, exporting IFC files will be more typical. Design information created in an authoring application like Revit will be exported to an IFC file for building data *consumers* (owner/operators, municipalities, construction firms) to use in other applications.

¹ Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry, Gallaher, M. P.; O'Connor, A. C.; Dettbarn, J. L., Jr.; Gilday, L. T. (NIST GCR 04-867; 194 p. August 2004.)

² Autodesk[®] Revit[®] Building 9.1 was the certified version of the software. The product was renamed Revit Architecture in 2007.

For example, the initial goal of GSA's BIM requirement is to better manage their space by automating spatial validation of A/E designs. In the past, GSA validated space requirements using manually-created 2D polygons in plan drawings during early design stages. This process was both time-consuming and led to discrepancies when the GSA team measured and reported on the actual building spaces (the basis for their rent calculations). By requiring building data delivered in IFC files for all future projects, GSA will be able to import building data directly into a checking program that calculates rentable and usable areas and ensure that all designs adhere to their spatial requirements.

With the goal of easing interoperability between software platforms, several other federal & municipal government agencies (notably Denmark and Norway) require or will soon be requiring IFC data exchange for publicly funded building projects. The Singapore Building and Construction Authority already uses IFC-based building data to automate the checking of building plans for code compliance. No doubt, as the use of BIM grows and the maturity of the IFC standard is established, there will be many more examples of real world IFC-based data exchange.

Sample IFC Export Workflow for GSA Submittal

Below is a typical step by step workflow to create the IFC export to meet the GSA standard using Revit.

- 1) A GSA spatial BIM model is created in Revit Architecture with custom GSA spatial project parameters assigned to room objects, including GSA STAR Space Type.

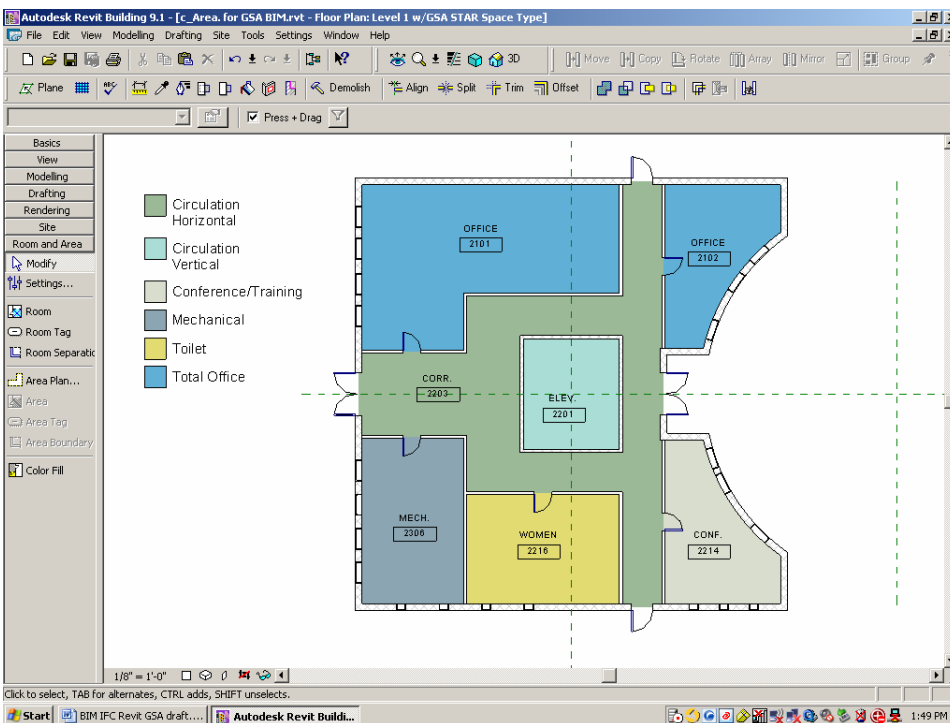


Figure 1:

GSA requires spaces greater than 9 sq. ft. to have a specific set of non-graphic data attributes (described in Section 2.1.1 of the GSA BIM Guide For Spatial Program Validation).

- In this model, Mechanical Room 2306 has been created as a room in Revit (bounded by walls) and assigned several GSA specific non-graphic data attributes. Within Revit these attributes are implemented as project parameters using schedule keys that provide automatic lookup tables for entering the data automatically.

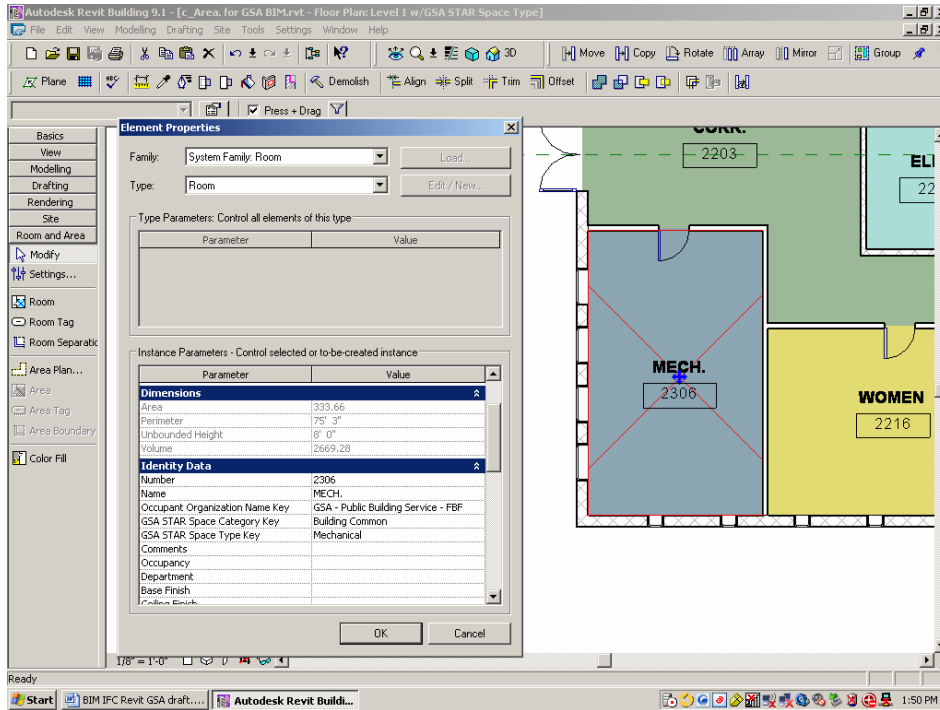


Figure 2:

Revit schedule keys provide automatic lookup tables for entering GSA-specific attribute data automatically.

- A further examination of the parameters in Revit assigned to this Mechanical Room 2306 illustrates the kind of GSA Spatial data that is being tracked with these rooms.

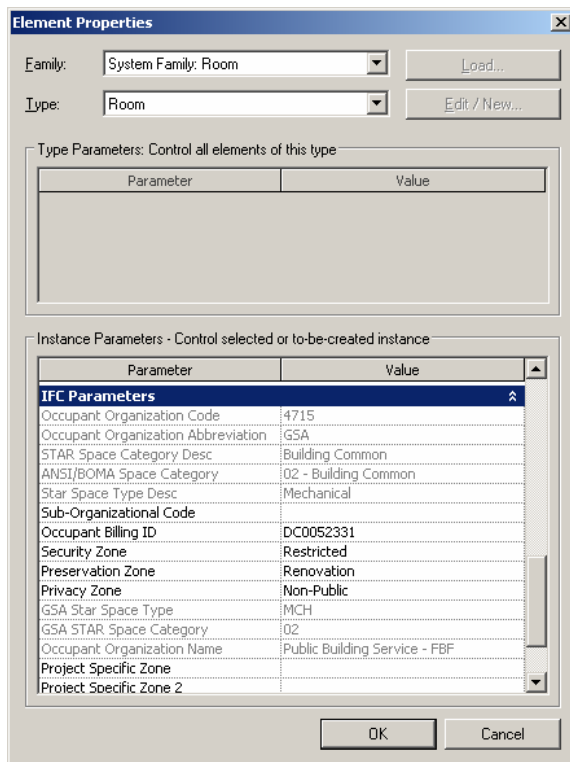


Figure 3:

Parameters shown in gray were automatically populated using Revit schedule keys.

- 4) The Revit building information model is then exported as IFC using the built-in IFC Import/Export capability of Revit (shown in Figure 4). The IFC export in Revit Architecture has been enhanced to export GSA-specific non-graphic spatial data to the IFC file.

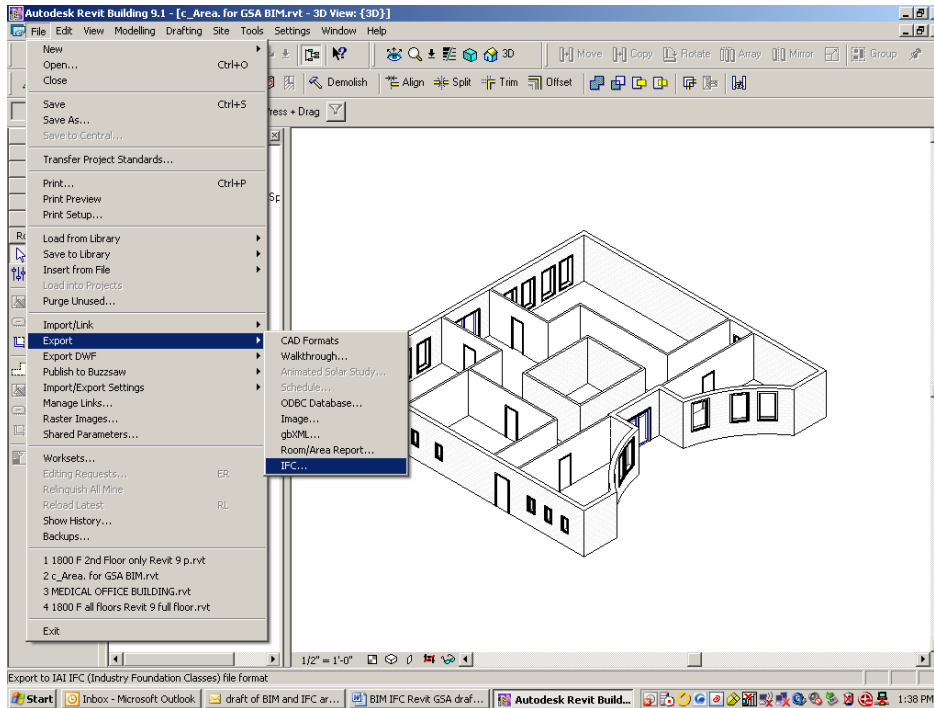


Figure 4:

Revit provides built-in IFC import/export capability.

- 5) Revit Architecture can export IFC version 2x2, 2x3, and the BCA ePlan Check view (as required by the Singapore government code checking initiative described earlier). For the GSA IFC export requirements, 2X2 is the minimal requirement - but the other versions will export the GSA-specific IFC space parameters as well.

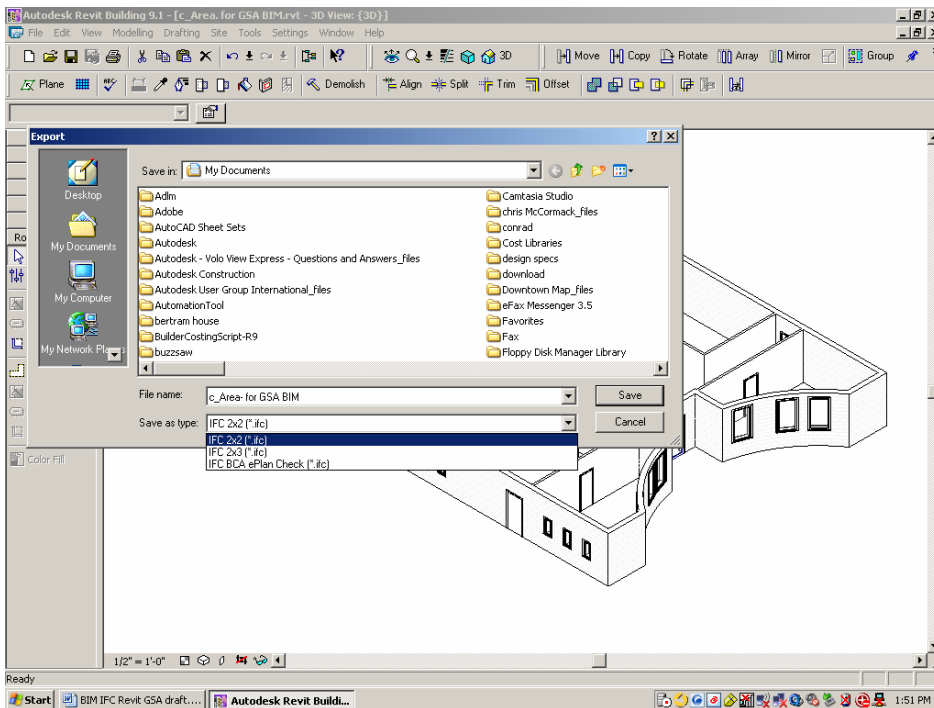


Figure 5:

Revit has been validated against GSA's BIM and IFC delivery requirements.

- 6) If you open the exported IFC file using Notepad, you can see the format of an IFC file. In the figures below, sections relative to Mechanical Room 2306 are highlighted.

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1800 F 2nd Floor only Revit 9 p.ifc - Notepad
File Edit Format View Help
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#107813=IFCAXIS2PLACEMENT3D(#3,$,$);
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#107820=IFCDIRECTION((0.,0.,-0.7854164221527086));
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#107822=IFCPLANE(#107821);
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#107830=IFCCARTESIANPOINT((-176.4185434142746,138.3392861975325,12.));
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#107834=IFCCONNECTIONSURFACEGEOMETRY(#107833,$);
#107835=IFCRELSPACEBOUNDARY('2ofzRzCUjEY8rzbze9T_hc',#30,$,$,#107817,#15150,#107834,.PHYSICAL,.INTERNAL.);
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#107837=IFCDIRECTION((-1.,0.,0.));
#107838=IFCDIRECTION((0.,0.,-0.3430208741791146));
#107839=IFCAXIS2PLACEMENT3D(#107836,#107838,#107837);
#107840=IFCPLANE(#107839);
#107841=IFCCARTESIANPOINT((-157.2102100809412,132.3497160424448,22.));
#107842=IFCCARTESIANPOINT((-173.6120388486235,132.3497160424448,22.));
    
```

Figure 6:

A room in Revit is exported as an “IFCSPACE” with its Revit Project Parameters assigned as IFC Property Sets to the IFC Space (top). GSA-specific spatial data is also exported to the IFC file (bottom).

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1800 F 2nd Floor only Revit 9 p.ifc - Notepad
File Edit Format View Help
#107950=IFCRELSPACEBOUNDARY('11fb5nXHD9Xwye19tEVS0H',#30,$,$,#107817,#12468,#107949,.PHYSICAL,.EXTERNAL.);
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#107952=IFCPROPERTYSET('3YtkFB5UndI9_wWU_TsIR9',#30,'Pset_SpaceCommon',$,#107951);
#107953=IFCRELDEFINESBYPROPERTIES('09Mvg8pXr16wD7k_LUHYOU',#30,$,$,#107817,#107952);
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#107961=IFCPROPERTYSINGLEVALUE('Occupant organization Name',$,IFCLABEL('Public Building Service - FBF'),$);
#107962=IFCPROPERTYSINGLEVALUE('Occupant Billing ID',$,IFCLABEL('dc0052331'),$);
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#107964=IFCRELDEFINESBYPROPERTIES('3PYivGLDFDeouZK5pc0YNA',#30,$,$,#107817,#107963);
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#107966=IFCPROPERTYSINGLEVALUE('Preservation Zone',$,IFCLABEL('Renovation'),$);
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#107969=IFCRELDEFINESBYPROPERTIES('2E5MUveJ1Eh9VTcbt6XaJt',#30,$,$,#107817,#107968);
#107970=IFCPROPERTYSINGLEVALUE('Number',$,IFCLABEL('2306'),$);
#107971=IFCPROPERTYSINGLEVALUE('Name',$,IFCLABEL('MECH.'),$);
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#107973=IFCPROPERTYSINGLEVALUE('Area',$,IFCAREAMEASURE(416.3928696047947),$);
#107974=IFCPROPERTYSINGLEVALUE('Perimeter',$,IFLENGTHMEASURE(91.99997333333411),$);
#107975=IFCPROPERTYSINGLEVALUE('Unbounded Height',$,IFLENGTHMEASURE(11.916666666666666),$);
#107976=IFCPROPERTYSINGLEVALUE('Volume',$,IFCOLUMEASURE(4163.928696047942),$);
#107977=IFCPROPERTYSET('23WbF55pb4eAA0Ja6E7Dl',#30,'Pset_Revit_Identity Data',$,#107970,#107971);
#107978=IFCRELDEFINESBYPROPERTIES('1utZiUyrz8sXBRR0b5JBQT',#30,$,$,#107817,#107977);
    
```

- 7) There are a variety of viewers capable of viewing IFC files directly, such as the one shown in the figure below from Data Design Systems.

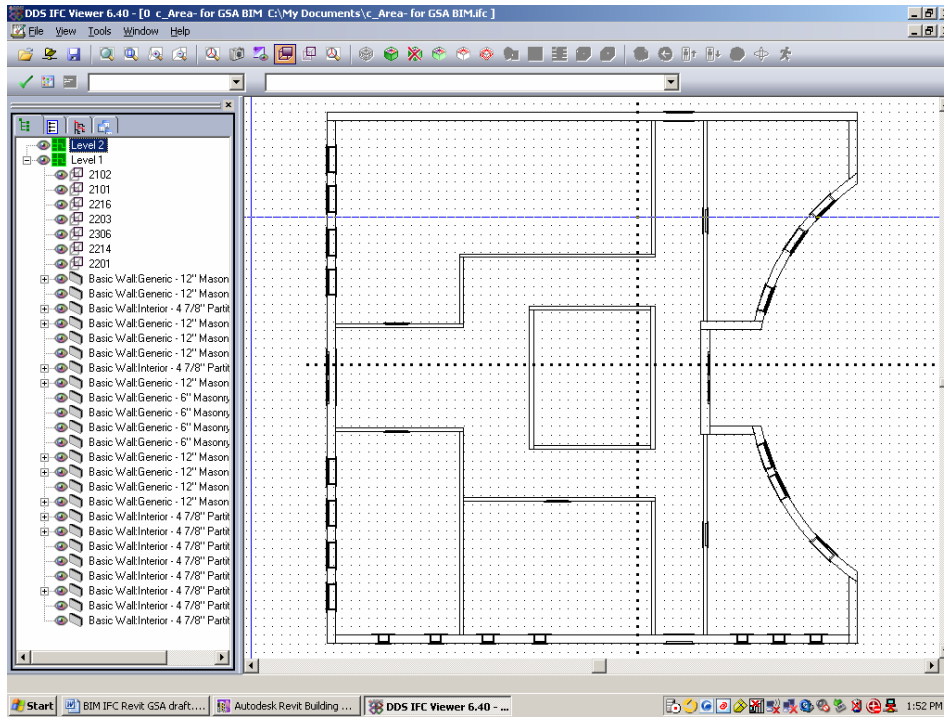


Figure 7:

Revit Building 9.1 IFC file, displayed by an IFC viewer (from DDS).

- 8) From within the viewer, clicking on Mechanical Room 2306 displays the IFC property sets resident in the IFC file.

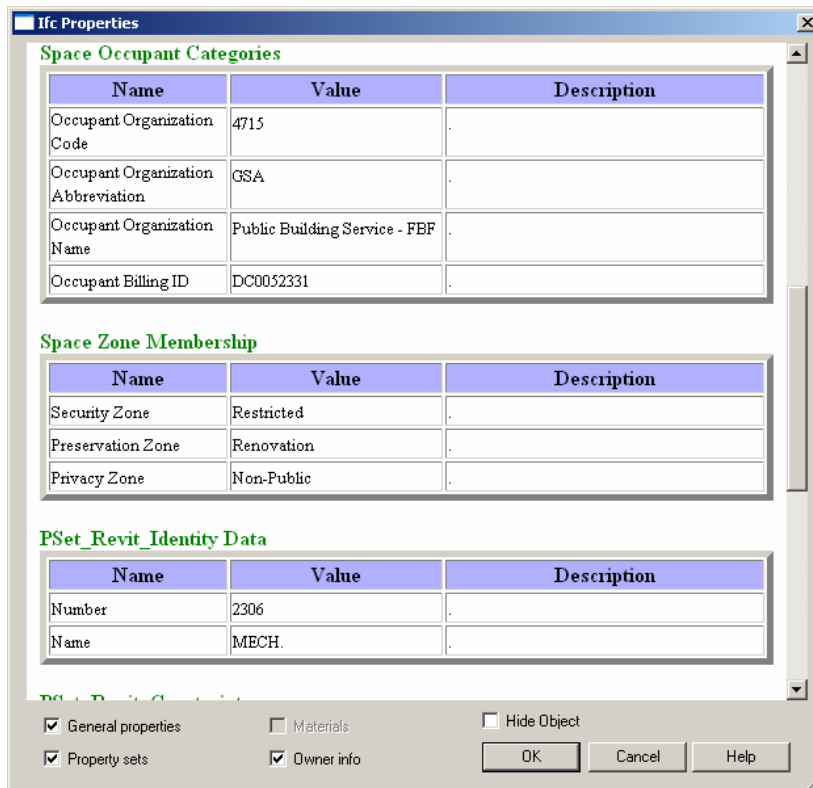


Figure 8:

Attributes of Mechanical Room 2306, transferred from the Revit model to the IFC file, can be displayed by the IFC viewer.

Summary

GSA's new requirement for BIM is one more (very prominent) example of the growing acceptance and importance of BIM within the building industry. In parallel, Revit IFC certification is the latest example of Autodesk's commitment to open, standards-based data exchange mechanisms in its products. Combined, they are especially good news for firms using Revit on federal building projects funded by the GSA.

About Revit

The Revit platform is Autodesk's purpose-built solution for building information modeling. Applications such as Revit Architecture, Revit® Structure, and Revit® MEP software products built on the Revit platform are complete, discipline-specific building design and documentation systems supporting all phases of design and construction documentation. From conceptual studies through the most detailed construction drawings and schedules, applications built on Revit help provide immediate competitive advantage, better coordination and quality, and can contribute to higher profitability for architects and the rest of the building team.

At the heart of the Revit platform is the Revit parametric change engine, which automatically coordinates changes made anywhere — in model views or drawing sheets, schedules, sections, plans... you name it.

For more information about building information modeling please visit us at <http://www.autodesk.com/bim>. For more information about Autodesk Revit and the discipline-specific applications built on Revit please visit us at <http://www.autodesk.com/revit>.

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