AUTODESK® GREEN BUILDING STUDIO

Regression Test Validation of Autodesk Green Building Studio

Regression Test Validation Results: Build Version 2014.2.32.3978, Release Date February 2014

Green Building Studio (GBS) Version 2014.2.32.3978, released February 2014, has passed the regression testing. This release now uses the newest version of DOE-2.2 (48r), which includes Autodesk code enhancements. Results of the regression testing have differing, but expected energy usage results compared to the previous release dated October 2013. These differences are all resulting from revisions to the DOE-2.2 software.

Changes to the DOE-2-2 software now require models to have building coordinates less than ten miles from the BIM model's site coordinates. The number of surfaces has differing, but expected, counts—again as a result of the DOE-2.2 revisions.

Some of the main computational changes to DOE-2.2, which impact the GBS energy results, include modifications of window convective calculations per NREL documentation, and the addition of an ASHRAE enhanced infiltration correction. Other significant changes to DOE-2.2 version 48r include conversion to Intel Fortran and C compilers; replacement of triangular or rectangular shapes for shading surfaces with rich polygons (up to a maximum of 128 vertices); and the increase in the number of limits of many model parameters. This will enable the energy analysis of more complex Revit models that may have previously been exceeding the lower limits.

Refer to the DOE-2.2 New Features documentation, and the Description of Cumulative DOE-2.2 Version 48r Bug Fixes documentation for more details.

	Baseline limits	New DOE-2.2 version 48r limits
Number of spaces	4096	9999
Number of exterior walls	8192	64,000
Number of windows	8192	64,000
Number of interior walls	8192	64,000
Number of Underground wall	8192	10,000
Number of doors	1024	4096
Number of building shades	1024	10,000
Number of polygons	32,768	120,000

Table 1. Increased building limits

Summary of Test Cases

The current iteration runs 464 energy analysis simulations, using 464 different GBS projects and 4 different conceptual models. The main purposes of the regression testing are:

1. Exercise different model configurations and building types in 16 ASHRAE climate zones for pass/fail
2. Compare energy usage results between previous release and current release candidate.

	Weather data source	Number of Building Types	Number of locations	Number of models	number of test cases
Test Suite A	Autodesk Climate Server	29	16 U.S.	4	464
Test Suite B	TMY2	1	1 U.S.	201	201

Table 2. Test Cases

Regression Test Cases

Test Suite A

The current iteration runs 464 energy analysis simulations, using 464 different projects & 4 different xml files.

Main purposes

1. Exercise building types in 16 ASHRAE climate zones for pass/fail
2. Tracks Energy results

Test Suite B

Currently runs 201 xml files under one GBS project.

Main purposes:

1. Previous blocked files should still be blocked. Failing files should trigger appropriate error message. Successful runs should still succeed.
2. Tracks pre- and post-GBS processing surface count and surface area and opening area
3. Tracks Energy results

Results Summary

	Successful simulation	Check for errors	energy results differences	Pre Surface Count	Post Surface Count	Pre Surface Area	Post Surface Area	Pre Opening Count	Post Opening Count	Pre Opening Area	Post Opening Area
Test Suite A	PASS	N/A	expected & PASS	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Test Suite B	PASS	PASS	expected & PASS	expected & PASS	expected & PASS	expected & PASS	expected & PASS	expected & PASS	expected & PASS	expected & PASS	expected & PASS

Table 3. Results Summary

Typical Meteorological Year (TMY2) Weather Data

TMY2 weather data sets are a collation of selected weather data for a specific location, generated from the 1961-1990 National Solar Radiation Data Base. The data is selected so that it presents the range of weather conditions for the location, which are consistent with the long-term averages for the location.

Autodesk Climate Server Weather Data

GBS has 1.3 million weather station locations worldwide at a spatial resolution of approximately 20 km. For some locations ASHRAE climate zone assignments using GBS weather may differ from ASHRAE Climate Zone assignments usingTMY2 weather because the weather data used by GBS represents observed and/or derived data from one calendar year while TMY2 weather data, used by most energy analyses, is a compiled dataset of weather spanning thirty years.

Locations

The locations chosen for the regression test suite covers sixteen representative locations of ASHRAE Climate Zones in the U.S.

Representative ASHRAE Climate Zones Locations in the U.S

1A	Miami, FL United States
2A	Mobile, AL United States
2B	Phoenix, AZ United States
3A	Oklahoma City, OK United States
3B	Las Vegas, NV United States
3B	Los Angeles, CA United States
3C	Santa Rosa, CA United States
4A	Philadelphia, PA United States
4B	Briscoe, TX United States
4C	Seattle, WA United States
5A	Columbus, OH United States
5B	Burns, OR United States
6A	South Burlington, VT United States
6B	Dillon, MT United States
7	Fargo, ND United States
8	Fairbanks, AK United States

GBS Building Types

Twenty nine GBS Building Types, which are based upon ASHRAE building type categories, are used in the regression tests.

1. Automotive Facility	10. Gymnasium	19. Performing Arts Theater	28. Transportation
2. Convention Center	11. Health Care Clinic	20. Police Station	29. Warehouse
3. Courthouse	12. Hospital	21. Post Office	
4. Dining: Bar Lounge/Leisure	13. Hotel	22. Religious Building	
5. Dining: Cafeteria/ Fast Food	14. Library	23. Retail	
6. Dining: Family	15. Motel	24. School/University	
7. Dormitory	16. Motion Picture Theatre	25. Single Family	
8. Exercise Center	17. Office	30. Sports Arena	
9. Fire Station	18. Penitentiary	31. Town Hall	

Models

Models used for the energy simulations include: 4 simplified schematic models to fully exercise all GBS energy setting defaults and 201 previously failed models and intentionally blocked models (obtained with users' permission). GBS automatically applies intelligent energy setting defaults to models where the parameters necessary for energy analysis have not been specified. These default values vary by building type, building size, and location. The Autodesk Building Performance Analysis Help topic, Assumptions and Default Values in GBS, provides more information on these defaults.

Regression Test Criteria

Regression test criteria determine whether or not energy usage results of the new release are within an acceptable tolerance range with the results of the previous release. Tests are passed where differences are expected due to DOE-2.2 revisions and GBS code enhancements.

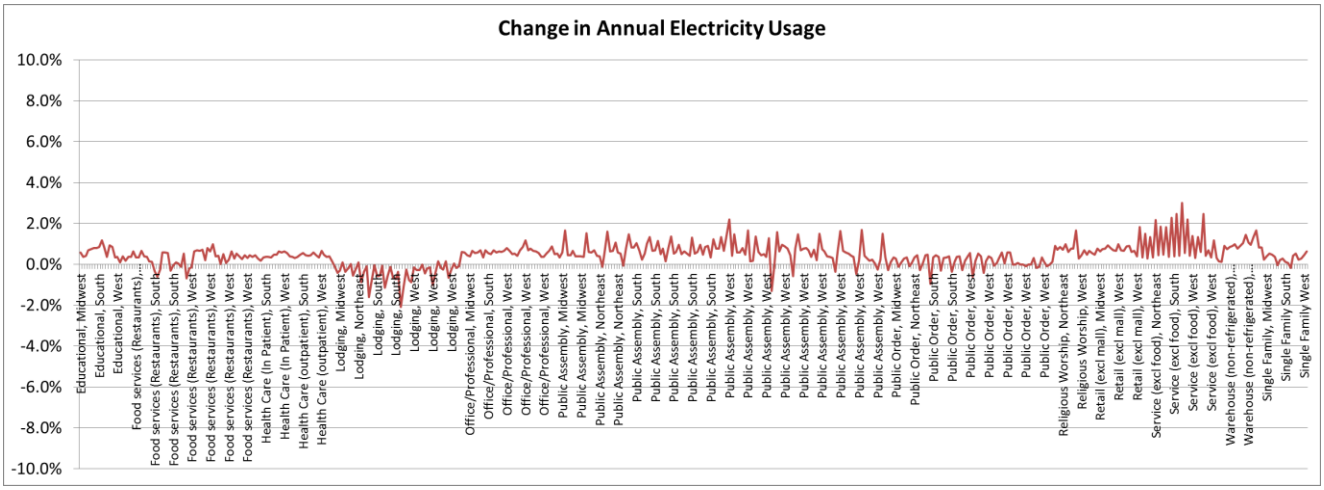
Results Detail:

The following differences are all due to changes in the new DOE-2.2 release, and GBS code-enhancements.

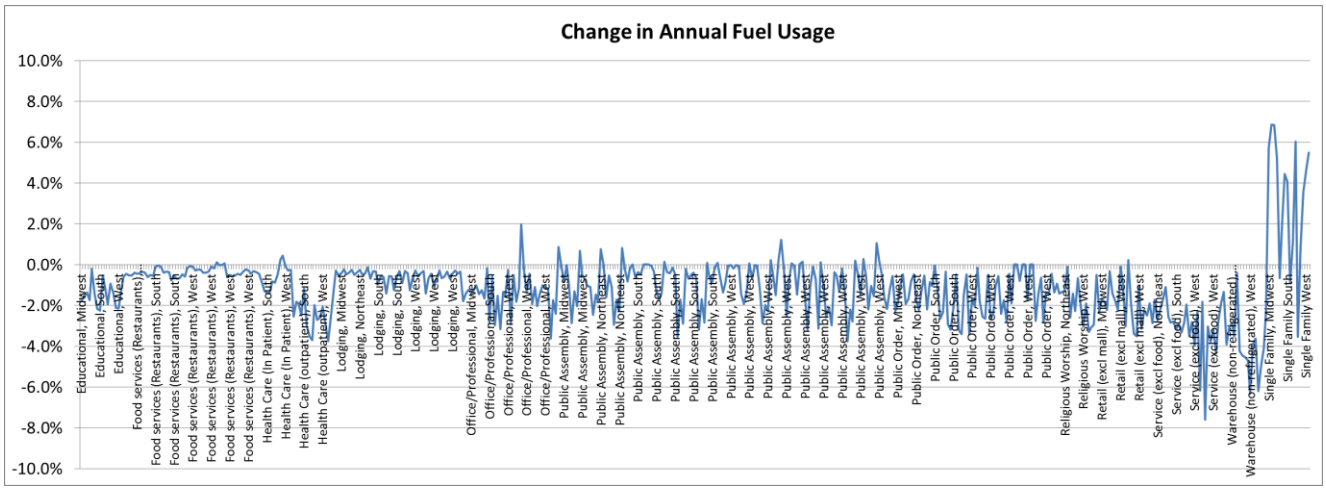
The results below are from GBS Test Suite A. The change in annual electricity consumption ranges between -2.1% to 3.0%, with a median change of 0.4% and an average change of 0.4%. The fuel usage differences range from -7.6% to 6.9%, with a median of -1.0% and an average of -1.2%.

Detailed results

- Electricity usage change:



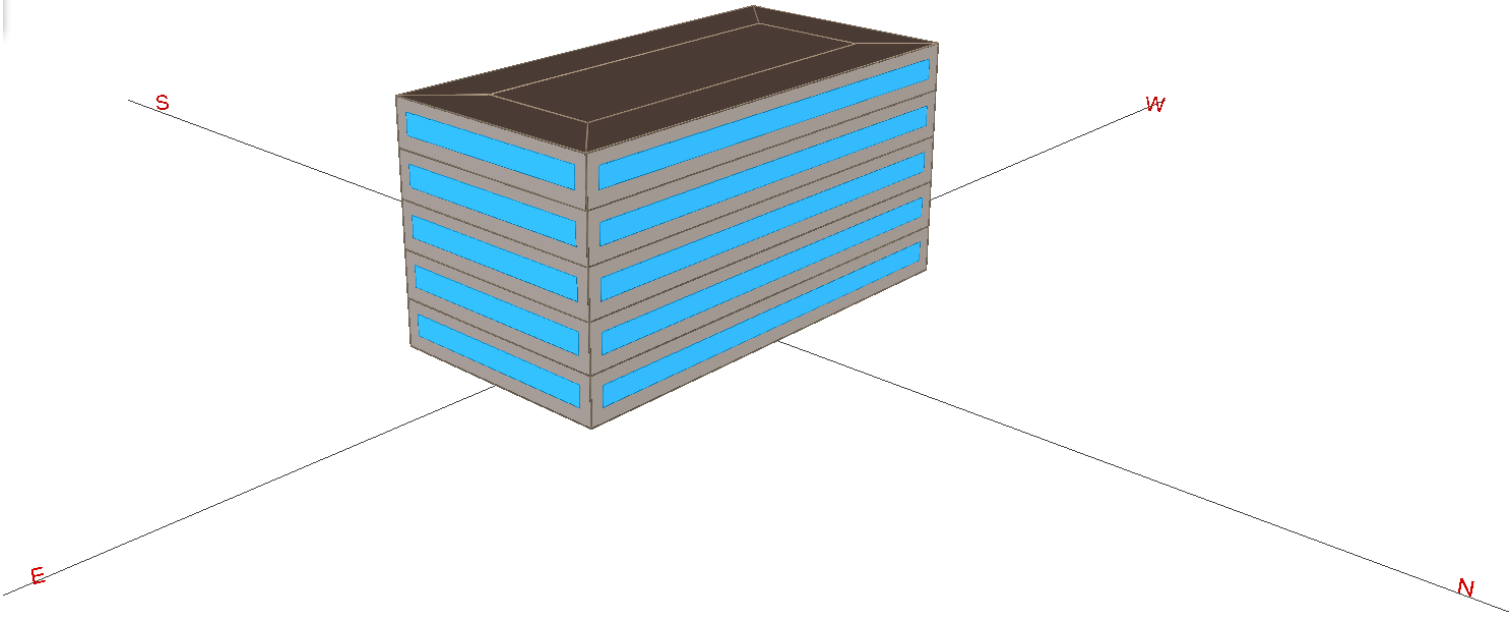
- Fuel usage change:



One of the largest changes in annual fuel usage is is a 7% increase in heating energy in the Fargo ND Single Family test model, which is described below.

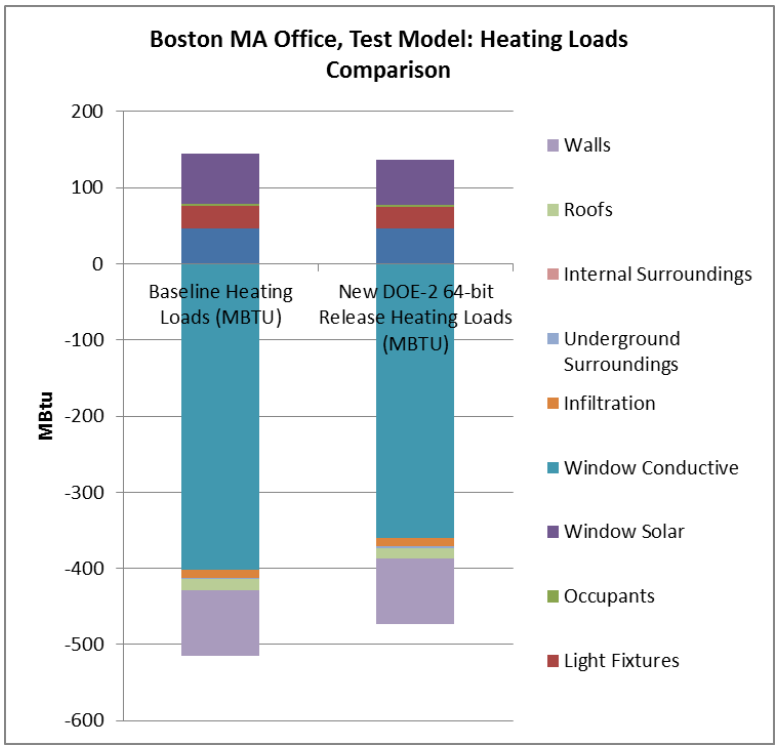
Below is a more detailed review of the energy results changes from two test models.

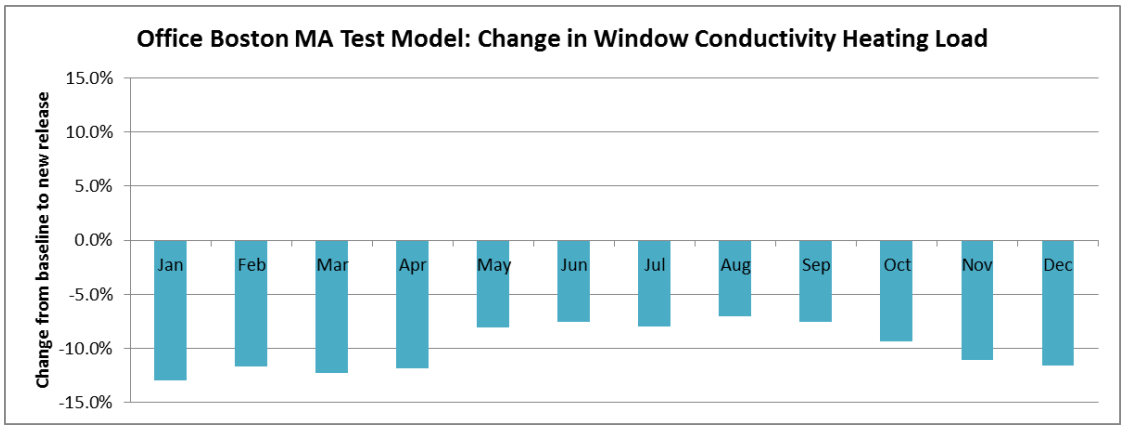
One of the office test models is located in Boston MA, with an area of 25,000 square feet, five floors with approximately 40% window-to-wall ratio. The largest end-use change for this test model is a reduction in HVAC heating energy (11.5%). The largest heating load component of this test model is window conductivity (approximately 60%). One of the changes to version 48r of DOE-2.2 is the modification to window convective calculations, therefore it is expected that this model would have changes in heating energy. The window conductivity heating load is reduced an average of 10% from the baseline to the new release.



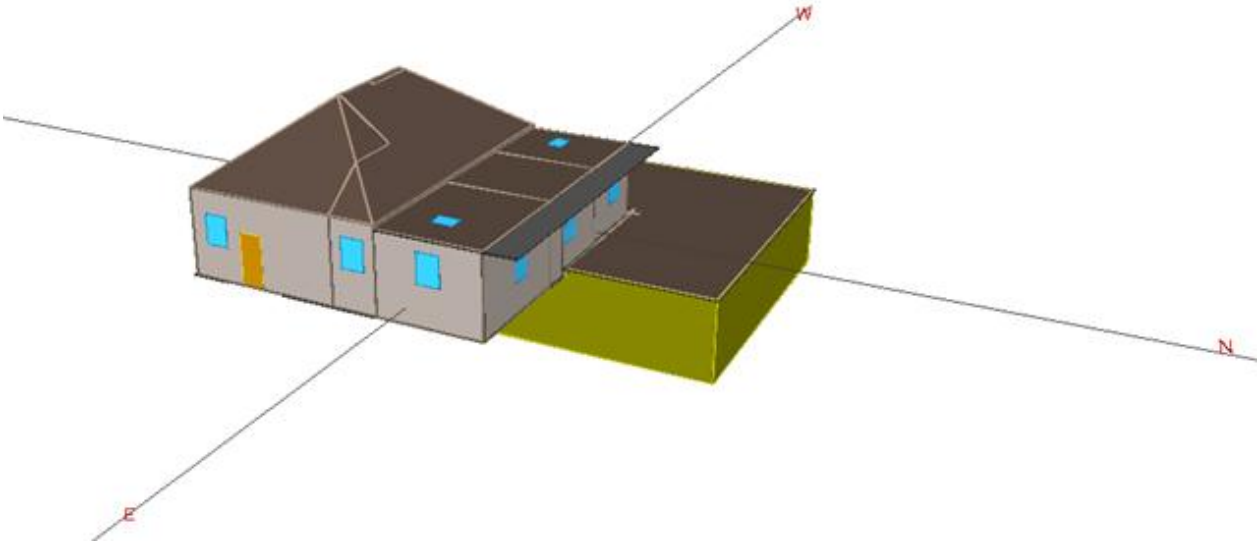
Office Test Model Annual Electricity Use (kWh)	HVAC	Lighting	Misc Equipment	Total
Baseline	115,183	82,451	124,837	322,471
February 2014 Release	117,446	82,451	124,837	324,734
Change	1.9%	0.0%	0.0%	0.7%

Office Test Model Annual Fuel Use (Therms)	HVAC	DHW	Total
Baseline	2,801	476	3,277
February 2014 Release	2,513	476	2,989
Change	-11.5%	0.0%	-9.6%


Boston MA Office, Test Model: Heating Loads Comparison
200
100
0
-100
-200
-300
-400
-500
-600
MBtu
Baseline Heating Loads (MBTU)
New DOE-2 64-bit Release Heating Loads (MBTU)
Walls
Roofs
Internal Surroundings
Underground Surroundings
Infiltration
Window Conductive
Window Solar
Occupants
Light Fixtures

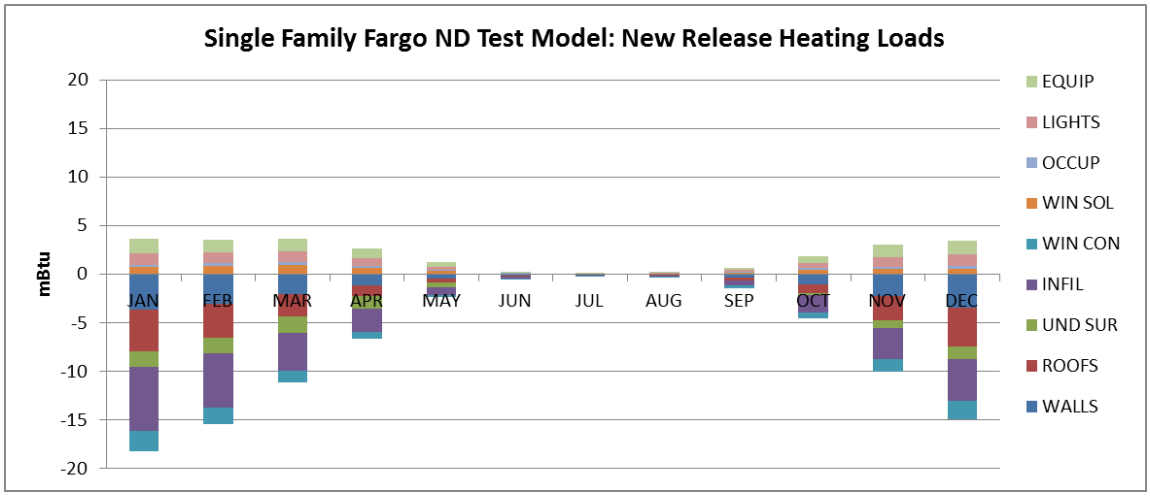

Office Boston MA Test Model: Change in Window Conductivity Heating Load
Change from baseline to new release
15.0%
10.0%
5.0%
0.0%
-5.0%
-10.0%
-15.0%
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec

The Fargo ND Single Family test model is 3000 square feet, including a conditioned underground level. The largest change is a 7% increase in heating energy, with the largest heating load component being infiltration. One of the changes to version 48r of DOE-2.2 is the infiltration correction, therefore it is expected that this model would have changes in heating energy.



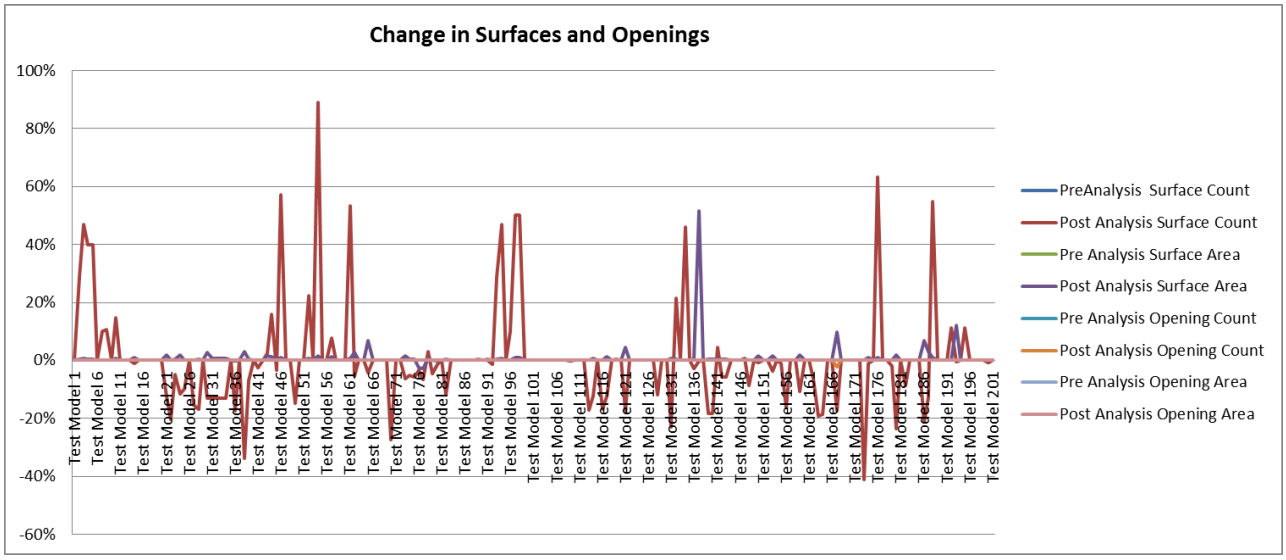
Single Family Test Model Annual Electricity Use (kWh)	HVAC	Lighting	Misc Equipment	Total
Baseline	3,416	4,512	5,246	13,174
February 2014 Release	3,486	4,512	5,246	13,244
Change	2.0%	0.0%	0.0%	0.5%

Single Family Test Model Annual Fuel Use (Therms)	HVAC	DHW	Total
Baseline	1077	149	1226
February 2014 Release	1161	149	1310
Change	7.2%	0.0%	6.4%



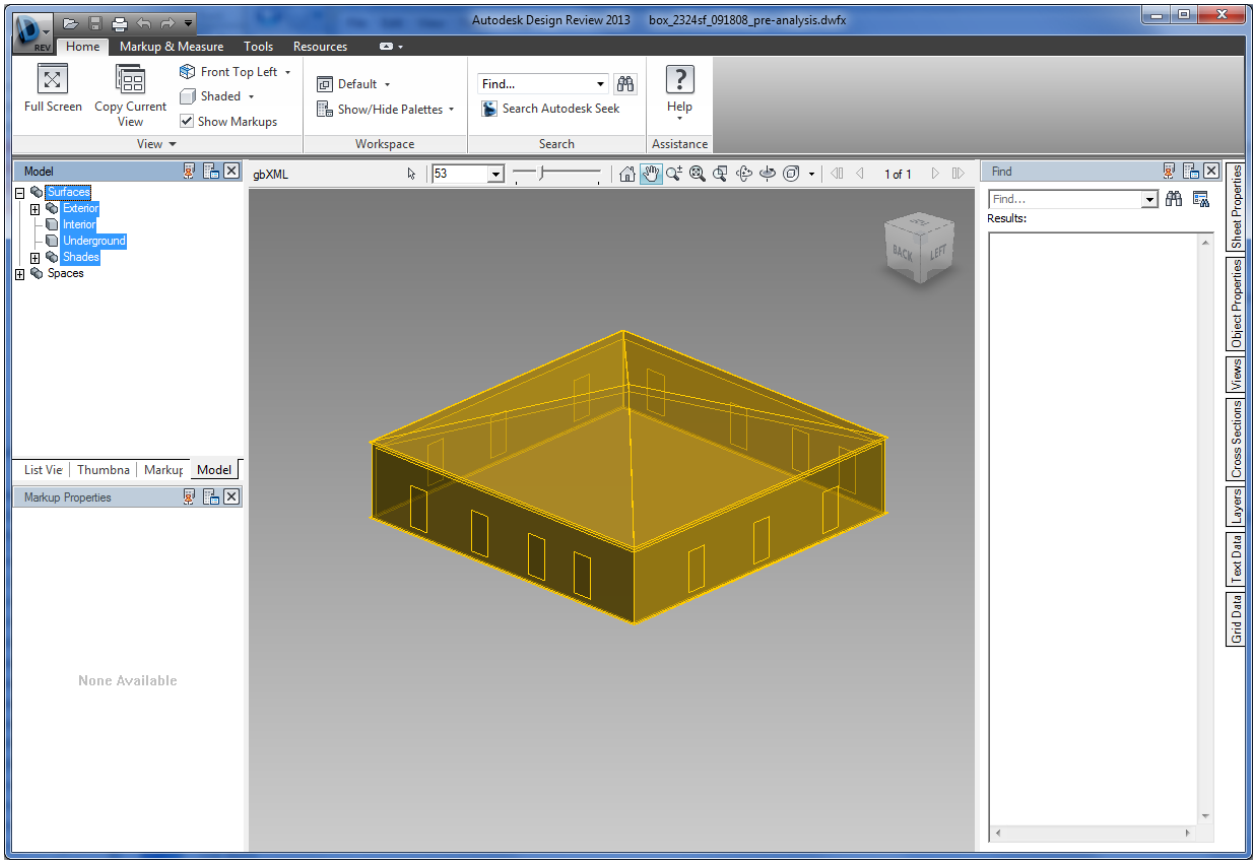
Below is a more detailed review of the surface count changes from two test models

Results of Test Suite B, percent change between the current and the previous release all of the surface counts and areas, and the opening counts and areas between pre- and post-processed gbXML file. The change in post-analysis surface counts ranges between -41.0% to 88.9%, with a median change of 0% and an average change of 0.9%. These changes are expected and are attributed to improved shading polygon support of instead of simplified rectilinear shapes.

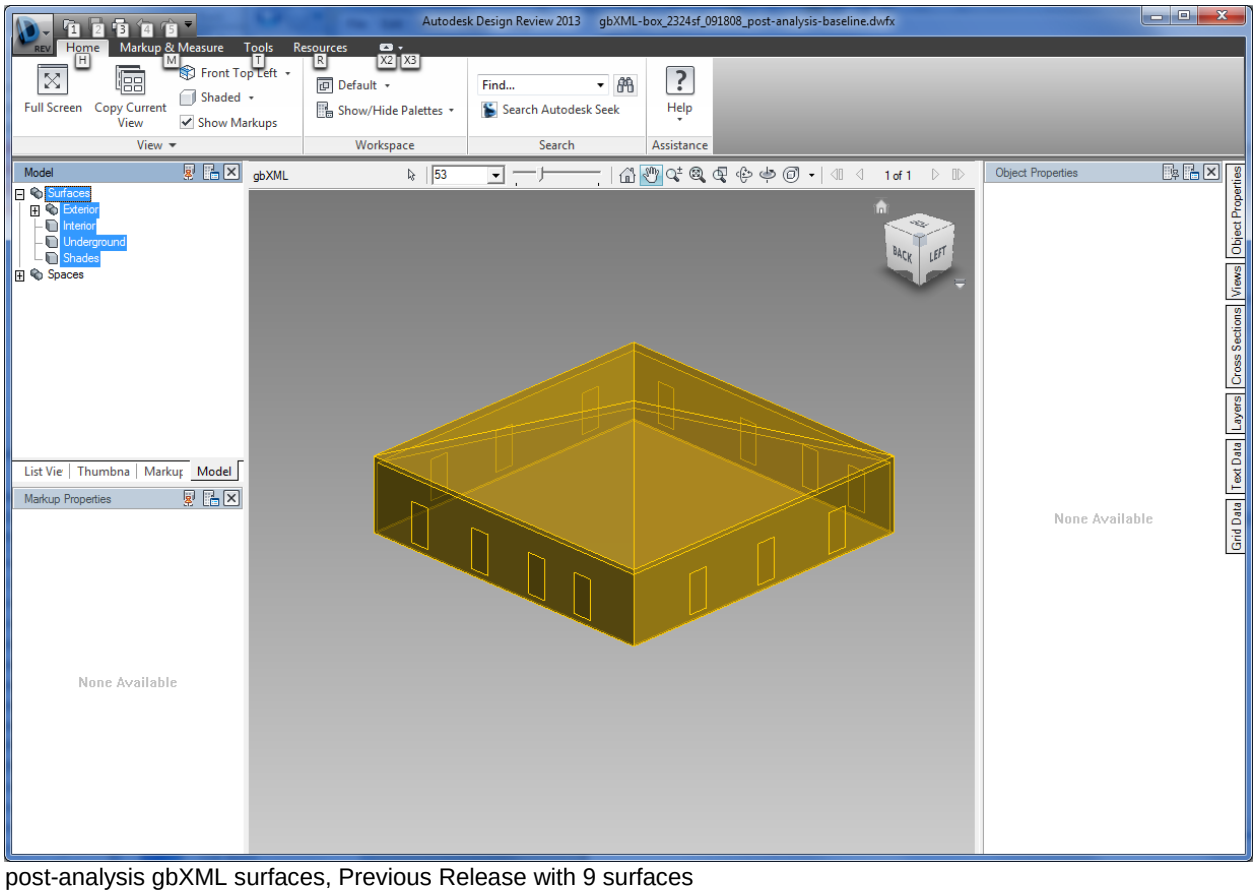


The case with an increase in post-analysis surface counts of 89% has a pre-analysis count of 20 exterior surfaces (the file received by GBS for analysis from the BIM authoring application). Previously the code transformed these 20 exterior surfaces to 9 surfaces; some of the shading surfaces (defined as surfaces not bounded by rooms) were not transformed to separate shade surfaces because of the previous DOE-2.2 limitation of shading surfaces to rectangular shapes. Enhancements to the new code transform the exterior surface count to17 for the analysis—more closely representing the number of surfaces from the pre-analysis file. This is because the revised code now can write the shade surfaces as separate surfaces with the non-rectangular shape.

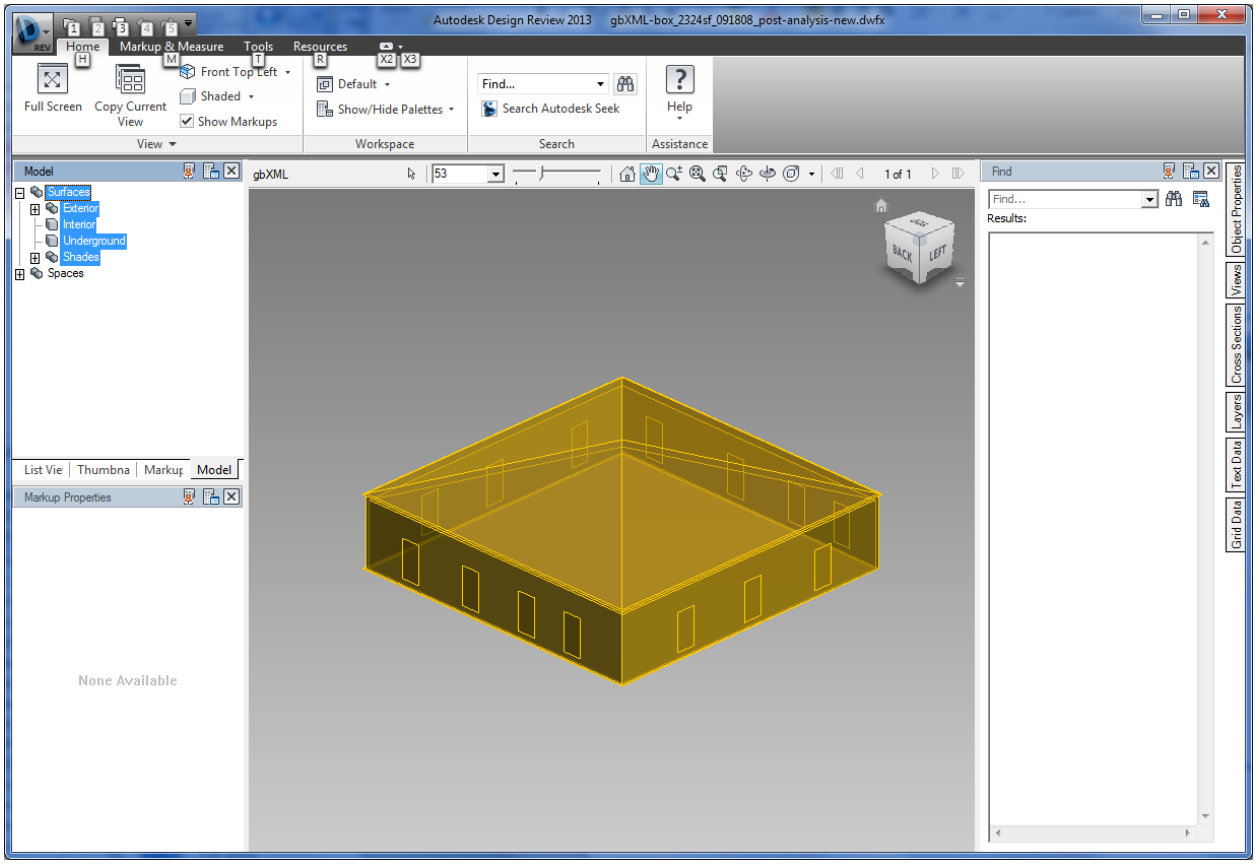
	Number of surfaces
Pre-analysis gbXML file	20
Post-analysis gbXML file (previous release)	9
Post-analysis gbXML file (new release)	17



Pre-analysis gbXML surfaces with 20 surfaces



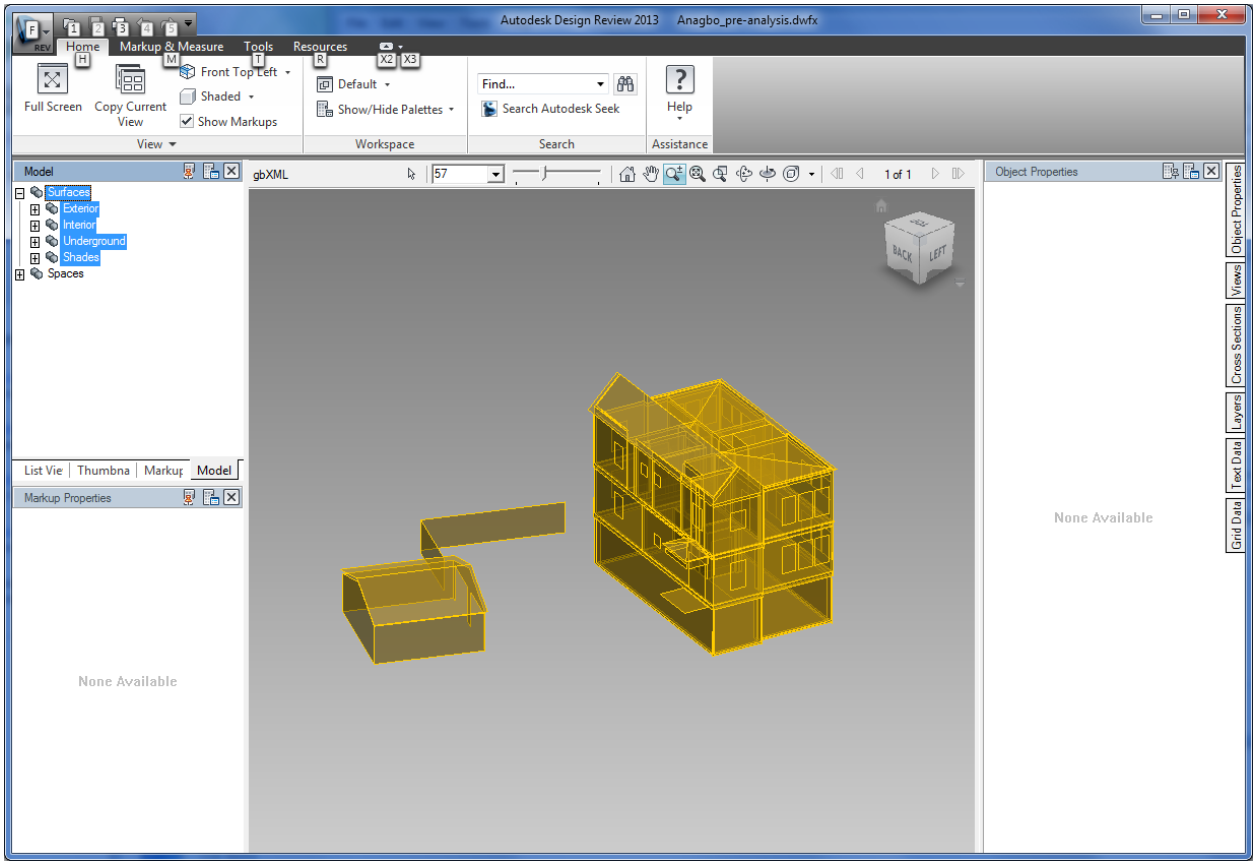
post-analysis gbXML surfaces, Previous Release with 9 surfaces



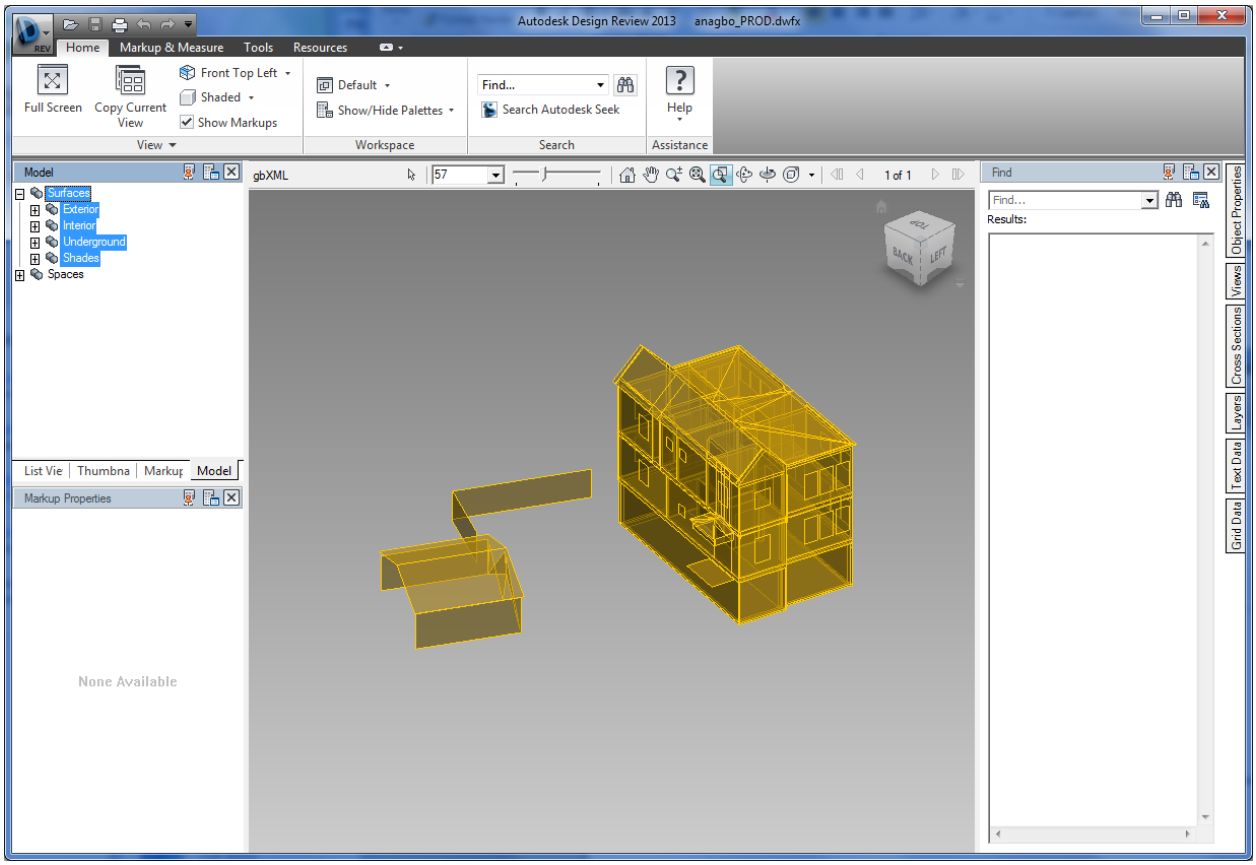
post-analysis gbXML surfaces, New Release with 17 surfaces

The case with a reduction of 43% of post-analysis surfaces is illustrated below. As with the above example, number of surfaces in the post-analysis gbXML file of the new release more closely represents the number of surfaces from the BIM authoring application (the pre-analysis gbXML file).

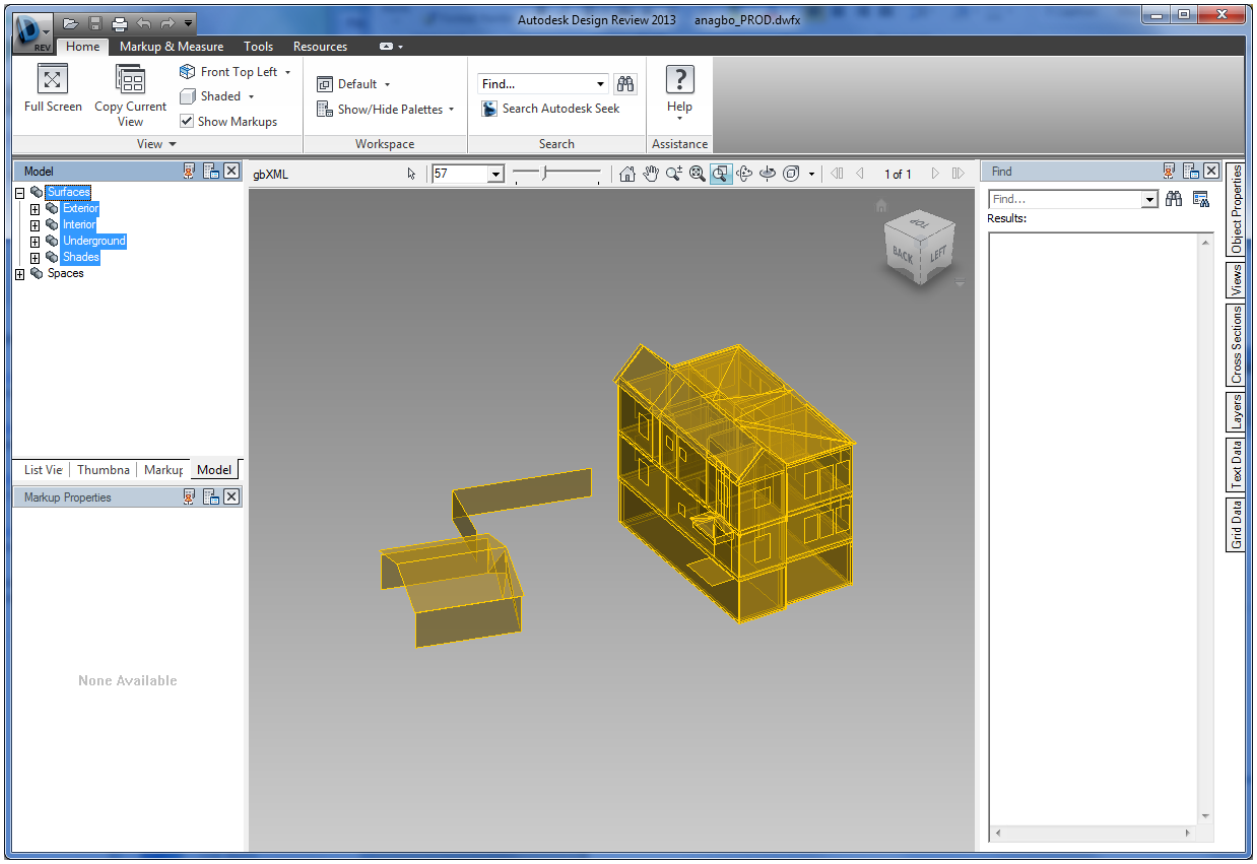
	Number of surfaces
Pre-analysis gbXML file	157
Post-analysis gbXML file (previous release)	236
Post-analysis gbXML file (new release)	156



Pre-analysis gbXML file: 157 Surfaces



Post-analysis gbXML file: Baseline 236 Surfaces



Post-analysis gbXML file: New Release 156 Surfaces