Documentation of the BEMCmpMgr (CEC Compliance Manager) DLL
For Analysis of Commercial Buildings
SAC 5/28/2015 (v12) (latest changes in Red font)

The purpose of this document is to provide information needed to develop software interfaces to the CEC Compliance engine DLL(s). The primary library third party tools will interface with is BEMCmpMgr_os.dll. This DLL manages the compliance analysis processing, including:

- Evaluation of compliance rules on user input building models (via BEMProc.dll),
- Simulation of the proposed and standard building models (via OpenStudio/EnergyPlus (and soon to be T24DHW.dll for recirculating hot water systems)), and
- Generation of compliance reports (informal reports internal to compliance manager, certified reports via web-based report generator).

Ultimately, the analysis engine DLLs will have only open source dependencies (primarily boost, Qt C++, OpenSSL, cURL and OpenStudio libraries), but for the time being there are still dependencies on Microsoft (Windows) libraries. As of the release of version 3a in late November 2014, the Windows dependencies include both Viausal Studio 2008 & 2013 redistributables (2013 for OpenStudio, CBECC-Com and the compliance manager and 2008 for some other libraries). We anticipate some, but not substantial, changes to the software interfacing routines documented here as we migrate the compliance manager toward open source dependencies in the coming months.

There are only a handful of exports needed to perform compliance analysis and retrieve analysis results/reports. One initializes the DLLs, one performs the analysis (and potentially generates a report), another to generate a draft report from an existing analysis results file, three more are designed to retrieve data (inputs and/or results) from the building model following analysis, a couple more to retrieve error messages and the last is used to clean-up following exit.

The overall analysis data model is broken into a few subsets, one of which is the “Input Data Model”. This is the version of most interest to third party tools wishing to generate files that can be analyzed for compliance using this tool. The Input Data Model is documented in a text file contained in each release of CBECC-Com, residing in the “Data” directory of the install, at:

<CBECC-Com xxx Data>\Documents\RulesetSource\CEC 2013 NonRes - Input Data Model.txt

There is one variation associated with the input data model that is important to understand, and that has to do with the ability to describe buildings using either “Detailed” or “Simplified” geometry. There are certain limitations on building and analysis features when using the simplified approach, while any/all features and analysis can be performed on detailed geometry projects. For more information on this topic, refer to the CBECC-Com User’s Manual.
A new feature of the Input Data Model text file is the ability to specify whether or not certain building object properties should or should not be included in detailed vs. simplified building model files submitted for analysis. This is denoted in the highlighted excerpt from the Input Data Model text:

```
Spc                Space                              #Props:109/340  MaxDefinable: 1000
                                  Parent(s):  Story
                                  Children:  IntLtgSys  /  DayltgCtrl  /  Ceiling  /  ExtFlr...
   ...
    Area    ...    Float    ...   Units: ft2  ...   (see next line)     Error if not:  Value >= 0.01
            ...             ...                ...   Compulsory when Proj:GeometryInpType = 'Simplified', else NotInput
```

One data model variation that is NOT documented in the Input Data Model text file (described above) is the inclusion of PolyLp (PolyLoop) objects in project files. Detailed geometry projects should include PolyLp children for Spc (Space) objects and all types of surfaces & shading devices (Ceiling, ExtFlr, ExtWall, IntFlr, IntWall, Roof, UndgrFlr, UndgrWall, Win, Skylt, Dr & ExtShdgObj). Simplified geometry projects should include NO PolyLp objects. If PolyLp objects are included in simplified geometry projects, they will be removed and not considered during analysis.

Recommended sequence of events (assuming use of Visual Studio & C++) for a scenario where direct linking to the compliance manager DLLs is not required:

1. Load the pertinent DLLs via LoadLibrary() -->> "libeay32.dll", "ssleay32.dll", "QtCore5.dll", "QtXml5.dll", "QtGui5.dll", "BEMProc.dll", and "BEMCmpMgr_os.dll"
   This step MAY not be required if the third party application and these referenced DLLs are located in the same directory.

2. Call GetProcAddress() to retrieve function pointers to each DLL function you plan to call.

3. Call `InitBEMProcAndCmpMgrDLLs()` to initialize the BEMProc & BEMCmpMgr_os DLLs with the desired building data model.

4. For each building model to be simulated:
   - Call `CMX_PerformAnalysis_CECNonRes()` to perform the compliance analysis.
   - Call `CMX_GenerateReport_CEC()` to generate a PDF compliance report based on the results contained in an XML file identified by the calling application.
   - Call `CMX_GetDataString()`, `CMX_GetDataInteger()`, &/or `CMX_GetDataFloat()` any number of times to retrieve building model inputs, calculated defaults or simulation results (anything stored in the building model).
   - Call `CMX_GetRulesetErrorCount()` to retrieve the number of errors encountered during the analysis and `CMX_GetRulesetErrorMessage()` to retrieve individual error message character strings.
   - Call `CMX_ExportCSVHourlyResults_CECNonRes()` to export a CSV file containing hourly simulation results and TDV multipliers for a single analysis run (proposed vs. standard).

5. Call `ExitBEMProcAndCmpMgrDLLs()` following all simulations to clean-up BEMProc & BEMCmpMgr_os data.

6. Unload the loaded DLLS (in reverse order) via FreeLibrary() -->> "BEMCmpMgr_os.dll", "BEMProc.dll", "QtGui5.dll", "QtXml5.dll", "QtCore5.dll", "ssleay32.dll", and "libeay32.dll"
   This step not required if the third party DLLs are not explicitly loaded in step 1.

Function Reference

The following are names and documentation pertaining to the compliance manager routines referenced above

---

```
void InitBEMProcAndCmpMgrDLLs( const char* psBEMProcFileName,
                               int iBEMType,
                               const char* psInitLogFileName );

      // typedef void (__cdecl *PInitBEMProcAndCmpMgrDLLs)( const char*, int,
```

```
//                                                      const char* );
// _InitBEMProcAndCmpMgrDLLs
```
(note: No longer using mangled names as of version 1c (500) / v2 of this document)

where:

- psBEMProcFileName is a null terminated string containing the path and filename of the data model definitions file. In the CBECC-Com installer, this would be: '<Data directory>\Rulesets\CEC 2013 Nonres\CEC 2013 NonRes BEMBase.bin'.
- iBEMType is an enumeration describing the data model type. For CBECC-Com (or -Res) processing this should be set to 0.
- psInitLogFileName is a null terminated string containing the path and filename of a file used to log messages. This is something that gets re-set with each project file read, so we tend to ignore this – passing in NULL for this argument.

Call this routine once following the loading of the BEMProc & BEMCmpMgr_os DLLs.

note – all path/filename arguments can be either complete or relative to the path in which the calling executable resides.

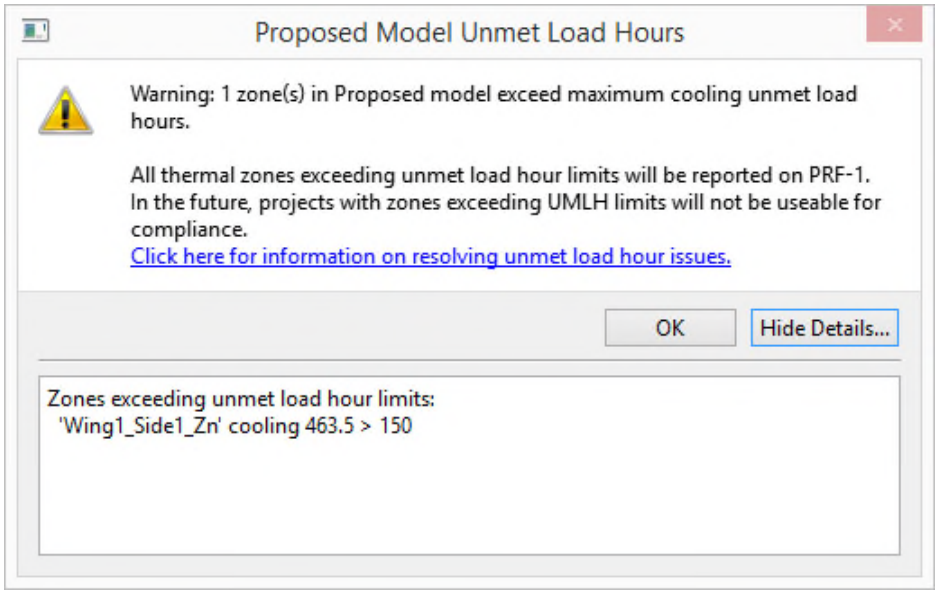
```
int CMX_PerformAnalysis_CECNonRes(              const char* pszBEMBasePathFile,
            const char* pszRulesetPathFile,     const char* pszSimWeatherPath,
            const char* pszCompMgrDLLPath,      const char* pszDHWWeatherPath,
            const char* pszProcessingPath,      const char* pszModelPathFile,
            const char* pszLogPathFile,         const char* pszUIVersionString,
            bool bLoadModelFile,                const char* pszAnalysisOptionsCSV,
            char* pszErrorMessage,              int iErrorMsgLength,
            bool bDisplayProgress,              HWND hWnd,
            char* pszResultsSummary,            int iResultsSummaryLen );

      // typedef int  (__cdecl *PCMX_PerformAnalysis_CECNonRes)(  const char*,
      //                      const char*, const char*, const char*,
      //                      const char*, const char*, const char*,
      //                      const char*, const char*, bool,
      //                      const char*, char*, int, bool, HWND, char*, int );
      // _CMX_PerformAnalysis_CECNonRes
```

where:

- pszBEMBasePathFile is a null terminated string containing the path and filename of the data model definitions file. This should not be specified (pass in NULL) unless the run being performed uses a different data model as the one previously used to initialize the DLLs or perform a simulation.
- pszRulesetPathFile is a null terminated string containing the path and filename of the ruleset file used to process the building model. This should be specified for each run when switching building models, as it re-initializes both the building model and ruleset data. In the CBECC-Com installer, this would be: '<Data directory>\Rulesets\CEC 2013 NonRes.bin'.
  If a simulation is to be performed on a building model already loaded into memory, then you can specify NULL for this argument.

- pszSimWeatherPath is a null terminated string containing path (including trailing '\') of the directory where the EnergyPlus CEC weather files reside. The default CBECC-Com installer location for these files is: '<Data directory >\EPW\'.
- pszCompMgrDLLPath is a null terminated string containing path (including trailing '\') of the directory where the CEC compliance manager DLLs reside. If NULL or a zero-length path is specified for this argument, then the path to the executable file which loaded & called this analysis routine will be used. The analysis mechanism assumes that other required exedcutables are located as follows in relation to the directory identified by this argument:
  - EnergyPlus simulation executable & DLLs located in 'EPlus\' subdirectory, and
  - CEC DHW engine DLLs located in 'T24DHW\' subdirectory.
- pszDHWWeatherPath is a null terminated string containing path (including trailing '\') of the directory where the CEC DHW simulation weather files reside. In the CBECC-Res installer, this would be: '<Program directory>\CSE\'.
  This argument is NOT YET IMPLEMENTED and should always be NULL (for the time being). The DHW simulation engine IS currently compatible with TMY(2) files, but the BEMCmpMgr_os interface to the DHW engine is currently available only for the California Climate Zones.
- pszProcessingPath is a null terminated string containing the path (including trailing '\') of the directory where the simulation inputs and outputs will be written.
- pszModelPathFile is a null terminated string containing the path and filename of the building model input (.cibd or .xml) file. The model input file identified by this argument may or may not be loaded into memory during the analysis processing depending on a subsequent argument.
- pszLogPathFile is a null terminated string containing the path and filename of a file to write processing messages to. If specified as NULL (which it typically is), then the log file will be equivalent to the pszModelPathFile specified in the previous argument, but with the file extension replaced with '.log'.
- pszUIVersionString is a null terminated string containing the name and version/ID of the application that is calling this function. This information is stored in the data model for later reporting in results export and final compliance reports.
- bLoadModelFile is a boolean indicating whether or not to read the building model (pszModelPathFile) into memory prior to analysis. This should be specified as 'true' (non-zero) unless the calling application has already loaded the building model into memory via a previous call.
- pszAnalysisOptionsCSV is a null terminated, comma separated value (CSV) formatted string defining any/all of the following analysis options:
  - StoreBEMDetails: boolean (0/1 – default 0): whether or not to store detailed building energy model ('.ibd-detail') files during the course of the model defaulting and analysis. Typically set to 1 in testing/debugging phases and turned off (value of 0, the default) for distribution to users (reducing processing time and file I/O).
  - Verbose: boolean (0/1 – default 0): whether or not to write messages to the log file for each rule evaluated on the model and identifying each step in the analysis sequence. Typically set to 1 in certain testing/debugging phases and turned off (value of 0, the default) for distribution to users (reducing processing time and file I/O – can result in very large analysis log files).
  - Silent: boolean (0/1 – default 0): whether or not dialog boxes are permitted to be presented during the analysis. One example is a dialog indicating that a file needing to be written during/following the analysis cannot be written to, prompting the user to close the file in another application it is opened in so that the file can be re-written. A value of '1' will prevent user prompts and issues such as files unable to be written may cause the analysis to be aborted.

- PromptUserUMLHWarning: boolean (0/1 – default 0): whether or not to prompt user with a dialog following simulation of the Proposed model if any thermal zones are found to exceed the unmet load hour (UMLH) limits as prescribed in the compliance ruleset. The dialog looks like this:



  where the "Click here…" link opens the CBECC-Com HVAC FAQ page at the UMLH section in the user's default web browser.
- WriteUMLHViolationsToFile: boolean (0/1 – default 1): whether or not to write a text file with details of any Proposed model unmet load hours (similar to the information provided in the above dialog). If selected, this information is written to the file:
  <Input file path>\<Input filename> - UMLH Zones.txt
- QuickAnalysis (-1/0/1 – default -1): whether to perform QuickAnalysis, processes much faster but may vary from the results of a full annual analysis and therefore cannot be used to generate final compliance documentation. There is no difference in the sizing simulations, but annual simulations consist of 4 1-week run periods, one period simulated in each season of the year. Values of 0/1 will override the QuickAnalysis setting defined in the model input data and the default value of -1 will activate QuickAnalysis only if specified in the model.
- ParallelSimulations: boolean (0/1 – default 1): whether or not simulations should be grouped by type (sizing vs. annual) and performed at the same time (in parallel). This feature has been shown to reduce the overall analysis duration by 30-40% (depending on model details). This feature can be toggled off by specifying a '0' for this analysis option.
- LogWritingMode: integer (0-2 – default 2): the method used to write messages to project log files.
  0. log file flushed and closed following each write (slower, but ensures complete log file)
  1. log file populated in memory and only flushed/refreshed periodically (faster writing)
  2. causes use of method '1' if any detailed logging activated (when VerboseInputLogging, LogRuleEvaluation, or DebugRuleEvalCSV are specified), otherwise '0'
- AnalysisThruStep: integer (0-100 – default 100): an indication of the last analysis step to be executed before aborting the analysis. Steps of the analysis (and their corresponding integer values) include:
  1. Analysis initialization (DEFAULT/CHECKSIM/CHECKCODE rules)
  2. Prepare Proposed & Baseline Sizing models (if applicable)

3. Generate Proposed & Baseline Sizing model OSM (OpenStudio Model) and IDF (EnergyPlus Input) files (if applicable)
4. Simulate Proposed & Baseline Sizing models and retrieve results (possible iteration of sizing runs)
5. Generate Annual Proposed & Baseline models
6. Generate Annual Proposed & Baseline model OSM (OpenStudio Model) and IDF (EnergyPlus Input) files
7. Simulate Annual Proposed & Baseline models, retrieve results and perform UMLH (unmet load hours) check
8. Generation of compliance report

- DontAbortOnErrorsThruStep: integer (0-100 – default 0): an indication of how far the analysis sequence (based on the steps listed above) should be executed, regardless of the number or types of errors encountered through that point.
- BypassInputChecks: boolean (0/1 – default 0): whether or not numeric range and required input checks should be bypassed during the course of performing the analysis. This is typically activated (set to 1) only when performing software testing/debugging and a certified compliance report cannot be generated when set to 1.
- BypassUMLHChecks: boolean (0/1 – default 0): whether or not UMLH (unmet load hour) checks should be bypassed during the course of performing the analysis. This is typically activated (set to 1) only when performing software testing/debugging and a certified compliance report cannot be generated when set to 1.
- BypassCheckSimRules: boolean (0/1 – default 0): whether or not CheckSim rules (designed to ensure that the building model as input can be simulated) should be bypassed during the course of performing the analysis. This is typically activated (set to 1) only when performing software testing/debugging and a certified compliance report cannot be generated when set to 1.
- BypassCheckCodeRules: boolean (0/1 – default 0): whether or not CheckCode rules (designed to ensure that mandatory code requirements are present in the building model) should be bypassed during the course of performing the analysis. This is typically activated (set to 1) only when performing software testing/debugging and a certified compliance report cannot be generated when set to 1.
- BypassOpenStudio_zp / BypassOpenStudio_zb / BypassOpenStudio_ap / BypassOpenStudio_ab: boolean (0/1 – default 0): whether or not OpenStudio (and the EnergyPlus simulation) is to be bypassed for the proposed sizing ('_zp'), baseline sizing ('_zb'), proposed ('_ap') and/or baseline ('_ab') models. This is typically activated (set to 1) only when performing software testing/debugging and a certified compliance report cannot be generated when set to 1.
- OverrideAutosize_zp / OverrideAutosize_bz / OverrideAutosize_ap / OverrideAutosize_ab: integer (-1/0/1 – default -1): whether to force the simulation to automatically size (autosize) the HVAC equipment ('1'), to not autosize the equipment ('0') or to simulate using the default autosizing setting ('-1' => off for Annual Proposed & Baseline, on for Proposed & Baseline Sizing). This is typically activated (set to 0 or 1) only when performing software testing/debugging and a certified compliance report cannot be generated when set to a value other than -1.
- IgnoreFileReadErrors: boolean (0/1 – default 0): whether or not the analysis should ignore (continue analysis following) errors encountered when reading and parsing the input building model.

- PurgeUnreferencedObjects: boolean (0/1 – default 1): whether or not purge (delete) building objects from the model that have no effect on the analysis during the early stages of rule processing.
- EnableRptGenStatusChecks: boolean (0/1 – default 1): whether or not to check for report generator website access prior to initiating report generation.
  This feature is known to have problems in some network/proxy server scenarios, in which case it is important to disable this option in order to ensure that reports are generated.
- ComplianceReportPDF: boolean (0/1 – default 0): whether or not a PDF compliance report will be generated at the conclusion of the analysis, assuming no errors have occurred and no checks or simulation runs were bypassed. In the event a compliance PDF is generated, the file will be located in the project directory and named:
  <project file name> - AnalysisResults-BEES.pdf
  This option can also be toggled on by setting Proj:CompReportPDF to '1' in the input building model.
- ComplianceReportXML: boolean (0/1 – default 0): whether or not a full (XML) compliance report will be generated at the conclusion of the analysis, assuming no errors have occurred and no checks or simulation runs were bypassed. Full XML compliance reports include all analysis inputs and results as well as an imbedded PDF report. In the event a XML compliance report is generated, the file will be located in the project directory and named:
  <project file name> - AnalysisResults-BEES.xml
  This option can also be toggled on by setting Proj:CompReportXML to '1' in the input building model.
- SimulationStorage: integer (0-7 – default 1): determines which, if any, simulation input and/or output files are to be retained following each building model simulation. Valid options include:
  0. ALL simulation sub-directories and files deleted
  1. Only the input (.idf) files are retained
  2. (#1 above) + summary output (.htm) retained
  3. (#2 above) + limited additional output (.csv|.eio|.err|.rdd) retained
  4. (#3 above) + SQL output (.sql) retained
  5. (#3 (not 4) above) + both SQL & other standard output files retained
  6. (#4 & 5 above) +
  7. ALL simulation input and output files retained
- AnalysisStorage: integer (0-3 – default 2): determines which, if any, (non-simulation) files generated during analysis are to be retained following each round of analysis. Valid options include:
  0. ALL analysis files deleted
  1. Only simulation SDD XML (.xml) files are retained
  2. (#1 above) + OpenStudio model (.osm) files are retained
  3. ALL files produced during analysis are retained
- ExportHourlyResults: a series of integer options that will cause the export of 1-2 hourly results CSV files during analysis, one for each individual annual simulation.
  ExportHourlyResults_ap = 1 - exports results of annual proposed simulation
  ExportHourlyResults_ab = 1 - exports results of annual baseline simulation
  ExportHourlyResults_All = 1 - exports results of all annual simulations
- ProxyServerAddress: character string: The address (i.e. "site.site:port") of the proxy server to be used in accessing the report generator (via the internet).

- ProxyServerCredentials: character string: Username and password credentials (i.e. "username:password") needed to access the internet via the proxy server (only needed for report generation).
- ModelRpt_ALL (or specific model report options): boolean (0/1 – default 0): whether or not certain CSV report files are to be written by the ruleset for each model generated during the analysis. Such CSV files are used primarily for testing/debugging, but can be informative in comparing certain aspects of the analysis models. The ModelRpt_ALL can be specified to activate all defined reports, or individual report options can be specified as:
  ModelRpt_Space_InteriorLoadsElec (self explanatory)
  ModelRpt_Space_InteriorLoadsFuel

Multiple analysis options can be concatenated into the pszAnalysisOptionsCSV string, for instance, if you wanted to perform a run with the Verbose & BypassOpenStudio_p flags activated (and all other defaults used), then this function argument would include the string "Verbose,1,BypassOpenStudio_p,1,".
Searches for options in this string argument are case insensitive and if a single flag is repeated multiple times, the value associated with its first occurrence will drive the analysis.

- pszErrorMessage is a pointer to a character string that can be populated by this function to describe error(s) encountered during the analysis. Pass in a value of 0/NULL if no return of error messaging is desired.
- iErrorMsgLength is an integer describing the number of characters present in the error message character string (previous argument). Pass in a value of 0 if no return of error messaging is desired.
- bDisplayProgress is a boolean indicating whether or not to display the analysis progress dialog as the processing is executed.
- hWnd is a HANDLE to a MS Windows application window. This argument is not currently used.
- pszResultsSummary is a pointer to a character string of length (iResultsSummaryLen) that is to be populated with a summary of the analysis performed. If no results summary string is desired, pass NULL for this argument.
- iResultsSummaryLen is the length of the character string (pszResultsSummary argument) to be populated (2056 is recommended length), or 0 if no summary string desired.
  Refer to information below for the CMX_PopulateResultsHeader_CECNonRes() function for information about populating column titles for this data.

Return value is 0 if simulation successful and > 0 if errors occurred (listed below).

Call this routine once for each compliance analysis to be performed.

All path/filename arguments can be either complete or relative to the path in which the calling executable resides.

Error return value mapping:

1 : pszBEMBasePathFile doesn't exist
2 : pszRulesetPathFile doesn't exist
3 : pszSimWeatherPath doesn't exist
4 : pszCompMgrDLLPath specified, but doesn't exist
5 : Invalid project log file name (too long)

6 : Error writing to project log file
7 : Building model input/project file not found
8 : Error reading/initializing model input/project file
9 : Errors encountered evaluating input model defaulting rules
10 : Errors encountered evaluating input model defaulting rules (multiple times)
11 : Error(s) encountered performing required data & numeric range checks
12 : Error(s) encountered checking input model for simulation compatibility
13 : Error(s) encountered checking input model for code requirements
14 : Error encountered initializing weather file locations and/or names
15 : Error creating or accessing the analysis processing directory
16 : Error generating Proposed Sizing model
17 : Error generating Proposed (final) model
18 : Error generating Standard Sizing model
19 : Error generating Standard (final) model
20 : Error initializing Standard Sizing model
21 : Error initializing Standard (final) model
22 : Analysis aborted - user chose not to overwrite SDD XML file
23 : Error: Unable to write SDD XML file
24 : Error(s) encountered simulating Proposed model
25 : Error(s) encountered simulating Standard Sizing model
26 : Error(s) encountered simulating Standard (final) model
27 : Error(s) encountered retrieving Proposed model simulation results
28 : Error(s) encountered retrieving Standard Sizing model simulation results
29 : Error(s) encountered retrieving Standard (final) model simulation results
30 : Proposed model zone(s) exceed unmet load hours limits
31 : Error initializing building model database
32 : Error loading analysis ruleset
33 : User aborted analysis via progress dialog 'Cancel' button
34 : Invalid results object types
35 : Error copying results objects from a previous model
36 : Error copying equipment sizes/flows from source model
37 : Error(s) encountered reading building model (input/project) file
38 : Error: EnergyPlus simulation engine not found.
39 : Error: Version of EnergyPlus installed not compatible with analysis.
40 : Error setting up check of weather & design day file hashes
41 : DHW simulation not successful
42 : Error encountered in creating building geometry
43 : Error encountered initializing building geometry DBIDs
44 : Error initializing Proposed model
45 : Error(s) encountered simulating Proposed Sizing model
46 : Error(s) encountered retrieving Proposed Sizing model simulation results
47 : Error encountered in generating window shades
48 : UseExcptDsgnModel flag set but no path/filename specified by UseExcptDsgnModel
49 : IDF path/filename specified by Proj:UseExcptDsgnModel not found
50 : Exceptional Design IDF specification and the Quick Analysis feature cannot both be activated
51 : Window(s) and/or Door(s) are overlapping on ExtWalls with window shades defined
52 : Analysis aborted via callback function in calling application

(return values in the range 101-200 describe issues encountered during/by simulation)
101 : SDD XML simulation input file not found
102 : Simulation weather file not found
103 : Simulation processing path not valid
104 : Simulation executable path not valid
105 : Simulation error output path/file not valid
106 : User aborted analysis
107 : SDD XML simulation input file for second of run pair not found
108 : Simulation weather file for second of run pair not found
109 : Simulation error output path/file for second of run pair not valid
131 : Error encountered in OpenStudio loading SDD XML file
132 : Error encountered in OpenStudio saving model to OSM file
133 : Unable to locate EnergyPlus simulation SQL output file
134 : OpenStudio Model not valid following simulation
135 : OpenStudio Facility not valid following simulation
136 : Error creating OpenStudio Model object
137 : Error encountered in OpenStudio loading SDD XML file (second of run pair)
138 : Error encountered in OpenStudio saving model to OSM file (second of run pair)
139 : Unable to locate EnergyPlus simulation SQL output file (second of run pair)
140 : OpenStudio Model not valid following simulation (second of run pair)
141 : OpenStudio Facility not valid following simulation (second of run pair)
142 : Error creating OpenStudio Model object (second of run pair)
143 : Error encountered in OpenStudio saving (forward translated) IDF file
144 : Error encountered in OpenStudio saving (forward translated) IDF file (second of run pair)
161 : Fatal error(s) ocurred in EnergyPlus simulation
162 : EnergyPlus simulation did not complete successfully
163 : Fatal error(s) ocurred in EnergyPlus simulation (second of run pair)
164 : EnergyPlus simulation did not complete successfully (second of run pair)
181 : User aborted analysis during building model simulation

```
int CMX_PerformAnalysisCB_NonRes(                const char* pszBEMBasePathFile,
            const char* pszRulesetPathFile,      const char* pszSimWeatherPath,
            const char* pszCompMgrDLLPath,       const char* pszDHWWeatherPath,
            const char* pszProcessingPath,       const char* pszModelPathFile,
            const char* pszLogPathFile,          const char* pszUIVersionString,
            bool bLoadModelFile,                 const char* pszAnalysisOptionsCSV,
            char* pszErrorMessage,               int iErrorMsgLength,
            bool bDisplayProgress,
            char* pszResultsSummary,             int iResultsSummaryLen,
            PAnalysisProgressCallbackFunc pAnalProgCallbackFunc );

      // typedef int  (__cdecl *PCMX_PerformAnalysisCB_NonRes)(  const char*,
      //                      const char*, const char*, const char*,
      //                      const char*, const char*, const char*,
      //                      const char*, const char*, bool,
      //                      const char*, char*, int, bool, char*, int,
      //                      PAnalysisProgressCallbackFunc );
      // _CMX_PerformAnalysisCB_NonRes
```

This is an alternative compliance analysis routine as the one listed above (CMX_PerformAnalysis_CECNonRes). The function arguments are identical to the above routine with the exception of HWND* removed and a new final argument which is a pointer to a callback function. The return value is also the same as above.

This callback function referenced by the final function argument is called each time the analysis progress is checked/reported, enabling calling applications to monitor analysis progress and abort analysis prior to completion without using the analysis progress dialog available in the compliance engine.

where:

- (refer to the previous routine for information on all arguments prior to pAnalProgCallbackFunc)
- pAnalProgCallbackFunc is a pointer to a callback function declared as:

```
long (CALLBACK* PAnalysisProgressCallbackFunc)(  long lProgressID,
                                                 long lPercent  )
```

  where:

  lProgressID encodes several settings describing the current stage of analysis (see below), and lPercent which indicates the percent progress (0-100)

  A return value of 0 from the callback function will cause analysis to continue and a return value > 0 will cause the analysis to be aborted.

The following source code describes how the lProgressID argument can be decoded to describe the current analysis stage.

```
//     2,147,483,647 - max long int
//       ABB,CCC,CDD - compliance analysis

#define  BCM_NRP_AMult  100000000
#define  BCM_NRP_BMult    1000000
#define  BCM_NRP_CMult        100
#define  BCM_NRP_EMult      10000
#define  BCM_NRP_ComplianceProgressID(  lAnalType, lAnalStep, lModels, lSimProg )
       (long) ( (lAnalType * BCM_NRP_AMult) + (lAnalStep * BCM_NRP_BMult) +
                (lModels   * BCM_NRP_CMult) +  lSimProg )

// A: analysis type
   #define   BCM_NRP_Type_Comp          0      //     0-compliance
   #define   BCM_NRP_Type_Batch         1      //     1-batch processing
   #define   BCM_NRP_Type( lNRP )    (long) (lNRP / BCM_NRP_AMult)
   #define   BCM_NRP_TypeIsComp(  lNRP )
                  (long) (BCM_NRP_Type( lNRP ) == BCM_NRP_Type_Comp  ? 1 : 0)
   #define   BCM_NRP_TypeIsBatch( lNRP )
                  (long) (BCM_NRP_Type( lNRP ) == BCM_NRP_Type_Batch ? 1 : 0)

// B: analysis step - valid range 0-99
   #define   BCM_NRP_Step_None          0      //     0-blank
   #define   BCM_NRP_Step_Init          1      //     1-Initialization
   #define   BCM_NRP_Step_Read          2      //     2-Read/Parse Input
   #define   BCM_NRP_Step_MPrep         3      //     3-Preparing Model(s)
   #define   BCM_NRP_Step_MTrans        4      //     4-Translating Model(s)
   #define   BCM_NRP_Step_MSim          5      //     5-Simulating Model(s)
   #define   BCM_NRP_Step_MSimRes       6      //     6-Simulation Results
   #define   BCM_NRP_Step_Store         7      //     7-Store Model & Result
```

```
   #define   BCM_NRP_Step_Report        8      //     8-Report Generation
   #define   BCM_NRP_Step_Done          9      //     9-Completed
   #define   BCM_NRP_Step( lNRP )  (long) ((lNRP - ((lNRP / BCM_NRP_AMult) *
                                             BCM_NRP_AMult)) / BCM_NRP_BMult)

// C:  bitwise flags for up to 13 individual models
   //                0 - none
   //  0 0000 0000 0001 - u  / user input model       (not used in compliance runs)
   //  0 0000 0000 0010 - zp / sizing proposed model
   //  0 0000 0000 0100 - zb / sizing baseline model
   //  0 0000 0000 1000 - ap / annual proposed model
   //  0 0000 0001 0000 - ab / annual baseline model
   #define   BCM_NRP_Model( lNRP )  (long) ((lNRP - ((lNRP / BCM_NRP_BMult) *
                                              BCM_NRP_BMult)) / BCM_NRP_CMult)
     // int BCM_NRP_NumModels( int iModels )         - defined in .cpp
     // int BCM_NRP_NumProgressModels( long lNRP )   - defined in .cpp
   #define   BCM_NRP_Model_None     0   // 0-none
             // generic models 1-13
   #define   BCM_NRP_Model_1        1
   #define   BCM_NRP_Model_2        2
   #define   BCM_NRP_Model_3        4
   #define   BCM_NRP_Model_4        8
   #define   BCM_NRP_Model_5       16
   #define   BCM_NRP_Model_6       32
   #define   BCM_NRP_Model_7       64
   #define   BCM_NRP_Model_8      128
   #define   BCM_NRP_Model_9      256
   #define   BCM_NRP_Model_10     512
   #define   BCM_NRP_Model_11    1024
   #define   BCM_NRP_Model_12    2048
   #define   BCM_NRP_Model_13    4096
             // model names from CA non-res rules
   #define   BCM_NRP_Model_u        1   // user model
   #define   BCM_NRP_Model_zp       2   // proposed sizing
   #define   BCM_NRP_Model_zb       4   // baseline sizing
   #define   BCM_NRP_Model_ap       8   // proposed annual
   #define   BCM_NRP_Model_ab      16   // baseline annual
```

Mid-simulation progress described below is a placeholder for future progress reporting. These settings are not yet used in the compliance engine.

```
// D:  simulation progress - valid range 0-99
   #define   BCM_NRP_Prog( lNRP )       (long) (lNRP % BCM_NRP_CMult)
   #define   BCM_NRP_Prog_None           0     // blank
   #define   BCM_NRP_Prog_Init           1     // Initialization
   #define   BCM_NRP_Prog_Warmup         2     // Warmup
   #define   BCM_NRP_Prog_Jan            3     // Jan
   #define   BCM_NRP_Prog_Feb            4     // Feb
   #define   BCM_NRP_Prog_Mar            5     // Mar
   #define   BCM_NRP_Prog_Apr            6     // Apr
```

```
#define   BCM_NRP_Prog_May          7     // May
#define   BCM_NRP_Prog_Jun          8     // Jun
#define   BCM_NRP_Prog_Jul          9     // Jul
#define   BCM_NRP_Prog_Aug         10     // Aug
#define   BCM_NRP_Prog_Sep         11     // Sep
#define   BCM_NRP_Prog_Oct         12     // Oct
#define   BCM_NRP_Prog_Nov         13     // Nov
#define   BCM_NRP_Prog_Dec         14     // Dec
#define   BCM_NRP_Prog_Rpt         15     // Reporting
```

```
void CMX_GenerateReport_Proxy_CEC( const char* pszXMLResultsPathFile,
                  const char* pszCACertPath,    const char* pszReportName,
                  const char* pszAuthToken1,    const char* pszAuthToken2,
                  const char* pszSignature,     const char* pszPublicKey,
                  const char* pszProxyAddress,  const char* pszProxyCredentials,
                  const char* pszDebugBool,     bool bVerbose,     bool bSilent,
                  const char* pszCompRptID,     const char* pszRptGetServer,
                  const char* pszRptGenApp,     const char* pszRptGenService,
                  const char* pszSecKeyRLName,  const char* pszOutputPathFile );

      // typedef int (__cdecl *PCMX_GenerateReport_Proxy_CEC(  const char*,
      //                const char*,  const char*,  const char*,  const char*,
      //                const char*,  const char*,  const char*,  const char*,
      //                const char*,  bool,  bool,  const char*,  const char*,
      //                const char*,  const char*,  const char*,  const char*  );
      // _CMX_GenerateReport_Proxy_CEC
```

where:

- pszXMLResultsPathFile is a null terminated string containing the path and filename of the analysis results XML file. This is typically: <Project file directory>\<project file name> - AnalysisResults.xml
- pszCACertPath is a null terminated string containing the path (only) of the CA cert bundle (curl-ca-bundle.crt) used to verify server certificates. For CBECC-Res, this file is distributed in the main program directory.
- pszReportName is a null terminated string containing the name of the report to be generated. Valid report names currently include:
  "NRCC_PRF_01" (Certificate of Compliance - Nonresidential Performance Compliance Method)
- pszAuthToken1 is a null terminated string that, combined with AuthToken2, identifies the calling application. This argument is set to "CBECC-Com" for CBECC-Com and may vary for other certified products.
- pszAuthToken2 is a null terminated string that, combined with AuthToken1, identifies the calling application version. This argument is currently set to "3b" for CBECC-Com (based on release of v3b (717) 3/23/15) but will change with each major software release.
- pszSignature is a null terminated string containing the base-64 ASCII-encoded signature used to sign request data. Signature processing is not yet implemented, so for the time being the string "none" should be supplied for this argument.

- pszPublicKey is a null terminated string containing the base-64 ASCII-encoded public key used to sign request data. Signature processing is not yet implemented, so for the time being the string “none” should be supplied for this argument.
- pszProxyAddress is a null terminated string containing the address (i.e. “site.site:port”) of the proxy server to be used in accessing the report generator (via the internet). If no proxy server is needed/used for internet access, then pass NULL for this argument.
- pszProxyCredentials is a null terminated string containing the username and password credentials (i.e. “username:password”) needed to access the internet via the proxy server. If no proxy server is needed/used for internet access or if no username/password credentials are needed in conjunction with the proxy server, then pass NULL for this argument.
- pszDebugBool is a null terminated string containing either the word “true” or “false”. Passing “true” (the current default) causes the report generator to activate debugging features.
- bVerbose is a boolean flag (not in the form of a character string) indicating whether verbose information should be written to the project processing log file.
- bSilent is a boolean flag (not in the form of a character string) indicating whether or not dialog boxes are permitted to be presented during the report generation. One example is a dialog indicating that the file needing to be written to contain the compliance report cannot be written to, prompting the user to close the file in another application it is opened in or change the file permissions so that the file can be re-written. A value of ‘1’ will prevent user prompts and issues such as files unable to be written may cause the report generation to be aborted.
- pszCompRptID is a null terminated string containing the compliance report ID, currently specified as “BEES”.
- pszRptGetServer is a null terminated string containing the compliance report generator server name, currently specified as “t24docs.com”.
- pszRptGenApp is a null terminated string containing the compliance report generator application, currently specified as “ReportGeneratorCom”.
- pszRptGenService is a null terminated string containing the compliance report generator service, currently specified as “ReportingService.svc”.
- pszSecKeyRLName is a null terminated string containing the compliance report security key rulelist name, currently specified as “rl_SECURITYKEYS”.
- pszOutputPathFile is a null terminated string containing the path and filename of the file to store the compliance report to. If not specified, then the default output file will be used:
  “<analysis results filename>-BEES.PDF” (or .XML, depending on the … argument)

Error return value mapping:

1 : XML file not found
2 : CACert file not found
3 : Error opening and/or reading the analysis results XML file
4 : Error allocating memory for XML file storage
5 : User chose not to overwrite output report file
6 : Error opening report output file
7 : Error reading analysis results XML file
8 : Error reading analysis results XML file
9 : Error initializing CURL (curl_easy_init() returned NULL)
10 : Report generation processing error in send request

11 : Report generation processing error in result retrieval
12 : No Report Name specified
13 : Missing or invalid PDf Only boolean string (must be 'true' or 'false' (case insensitive))
14 : Missing or invalid report generation debug boolean string (must be 'true' or 'false' (case insensitive))
15 : Missing or invalid AuthToken1 string
16 : Missing or invalid AuthToken2 string
17 : Missing or invalid Signature string
18 : Missing or invalid PublicKey string
19 : Error opening output file following report generation
20 : Error reading data from output file following report generation
21 : PDF report contains XML data - likely error messages from web server
22 : XML Path not specified
23 : CACert path not specified
24 : CACertPath not a valid or found directory
25 : Error converting results file signature to hexidecimal

```
int CMX_PopulateResultsHeader_CECNonRes(           char* pszHdr1, int iHdr1Len,
                    char* pszHdr2, int iHdr2Len,   char* pszHdr3, int iHdr3Len  );

      // typedef int  (__cdecl *PCMX_PopulateResultsHeader_CECNonRes)
      //                       (  char*, int, char*, int, char*, int  );
      // _CMX_ PopulateResultsHeader_CECNonRes
```

where:

- pszHdr1, pszHdr2 & pszHdr3 are pointers to character string of length iHdr1/2/3Len that are to be populated with column labels for analysis results summaries returned via the final two arguments of the CMX_PerformAnalysis_CECNonRes() function.
- iHdr1Len, iHdr2Len & iHdr3Len are the lengths of the character string arguments to be populated. Current recommended label string lengths are 512, 1024 & 1536, respectively

Return value is 0 if all header strings are populated successfully and a value of 1-3 if population of one of the three header strings is not successful.

```
int CMX_GetDataString(  char* sReturnStr, int iRetStrLen, const char* pszCompParam,
                        const char* pszCompName,  BOOL bAddCommas,
                        int iPrecision,  const char* pszDefault );

      // typedef int  (__cdecl *PCMX_GetDataString)(  char*, int, const char*,
      //                                   const char*, BOOL, int, const char* );
      // _CMX_GetDataString
```

where:

- sReturnStr is a character string buffer to be populated with data from the building model.
- iRetStrLen is the number of characters allocated in the sReturnStr buffer. The returned string will be null-terminated, so the maximum number of characters written to sReturnStr will be (iRetStrLen-1).
- pszCompParam is a null-terminated string identifying the model object and property to return a string representation of. This argument can reference properties of any type in the data model (float, integer,

object reference, enumeration or string). The object name and property name are separated by a colon, so this argument would contain 'Proj: CondFloorArea' to return a string-representation of the CondFloorArea property of the Proj (Project) object.

- pszCompName is a null terminated string containing the name of the object for which the object/property is to be returned. If there is only a single object of this type in the project (as is the case for Proj, EUseSummary and some other object types), then this argument can/should be set to NULL. If this argument is NULL for objects where multiple are present in the building model, then the property data for the "currently active" object of that type will be returned (not advised).
- bAddCommas is a BOOLean indicating whether or not commas (or related Windows Locale-based numeric separators) are to be included in the returned string. This argument is only referenced when returning string representations of integer or float object properties.
- iPrecision is an integer indicating the decimal precision to be used when populating the return string of float properties. Ignored for non-float properties.
- pszDefault is a null-terminated string containing the desired return string in the event the Object:Property being retrieved is not defined in the building model.

Return value is 0 if data retrieval is successful and > 0 if errors occurred.
<error return value info to be supplied at a later date>

Call this routine each time string data is to be retrieved from the building model.

```
int CMX_GetDataInteger( long* pReturnInt,  const char* pszCompParam,
                        const char* pszCompName,  long lDefault );

      // typedef int  (__cdecl *PCMX_GetDataInteger)( long*,  const char*,
      //                                              const char*, long  );
      // _CMX_GetDataInteger
```

where:

- pReturnInt is a pointer to a (32-bit) integer to be populated with data from the building model.
- pszCompParam is a null-terminated string identifying the model object and property to return the value of. This argument can only reference properties of integer or enumeration types in the data model. The object name and property name are separated by a colon in this string argument.
- pszCompName is a null terminated string containing the name of the object for which the object/property is to be returned. If there is only a single object of this type in the project (as is the case for Proj, EUseSummary and some other object types), then this argument can/should be set to NULL. If this argument is NULL for objects where multiple are present in the building model, then the property data for the "currently active" object of that type will be returned (not advised).
- lDefault is a 32-bit integer value which will be returned (via the pReturnInt argument) in the event the Object:Property being retrieved is not defined in the building model.

Return value is 0 if data retrieval is successful and > 0 if errors occurred.
<error return value info to be supplied at a later date>

Call this routine each time integer data is to be retrieved from the building model.

```
int CMX_GetDataFloat(   float* pReturnFlt,  const char* pszCompParam,
                        const char* pszCompName,  float fDefault );

      // typedef int  (__cdecl *PCMX_GetDataFloat)(   float*, const char*,
      //                                              const char*, float );
      // _CMX_GetDataFloat
```

where:

- pReturnFlt is a pointer to a (32-bit) float to be populated with data from the building model.
- pszCompParam is a null-terminated string identifying the model object and property to return the value of. This argument can reference properties of float, integer, enumeration or object reference types in the data model (returning a float value for an object reference property returns a 1-based index of the referenced object (among all objects of that type)). The object name and property name are separated by a colon in this string argument.
- pszCompName is a null terminated string containing the name of the object for which the object/property is to be returned. If there is only a single object of this type in the project (as is the case for Proj, EUseSummary and some other object types), then this argument can/should be set to NULL. If this argument is NULL for objects where multiple are present in the building model, then the property data for the "currently active" object of that type will be returned (not advised).
- fDefault is a 32-bit float value which will be returned (via the pReturnFlt argument) in the event the Object:Property being retrieved is not defined in the building model.

Return value is 0 if data retrieval is successful and > 0 if errors occurred.
<error return value info to be supplied at a later date>

Call this routine each time float data is to be retrieved from the building model.

```
int CMX_XXX(      <type> argument, …  );

      // typedef int  (__cdecl *PCMX_XXX)(   <type>, … );
      // ?CMX_XXX@@YAHPAMPBD1M@Z
```

where:

- pXXX is a xxx.

```
void ExitBEMProcAndCmpMgrDLLs();

      // typedef void (__cdecl *PExitBEMProcAndCmpMgrDLLs)();
      // _ExitBEMProcAndCmpMgrDLLs
```

Call this routine only once (following all simulations) immediately prior to unloading the DLLs.