

PREFER- RSEG Module

Single DoE RSE Analysis

Spreadsheet Instructions

(Template_RSEG.xls Instructions)

Installation Requirements

- Java 5.0 Runtime Environment (JRE 1.5 or JRE 5.0) needs to be installed.
- Design Expert 7.x version needs to be installed.
 - This spreadsheet works with either the stand-alone version of Dx7 or the network installed version of Dx7.
- All RSEG module spreadsheets require Microsoft's MSXML4.0 libraries. These libraries are typically included with Windows XP and newer versions of Excel (Excel XP and Excel 2003).
 - msxml4.msi is the installer for the MSXML4.0 libraries.
 - Installing msxml4.msi may require an upgrade to the Microsoft installer, InstMsiW.exe will upgrade the Microsoft installer.
- Template_RSEG.xls requires the Microsoft VBScript Regular Expressions 5.5 library. This library are typically included with Windows XP and newer versions of Excel (Excel XP and Excel 2003).
 - scripten.exe is the installer for the VBScript 5.5 package.
- Contact Jack Zentner (jack.zentner@asdl.gatech.edu) or Waylon Webbon (waylon.webbon@ps.ge.com) to get a zip file containing the necessary Excel upgrades.

To determine whether or not you need to install the msxml4.msi or the scripten.exe packages, open up the Template_RSEG.xls in Excel. Hit [alt+F11] to start the VBA macro editor. From the upper menu, select Tools>References. This will bring up a dialog box that contains all of the packages that can be referenced from an Excel VBA macro that are currently installed on you computer. If the MSXML4.0 and VBScript 5.5 Regular Expressions packages have been installed, they should be in the initial list of packages with a check in front of their names. If, they are not checked, scroll down through the list and search for Microsoft XML, v4.0 and Microsoft VBScript Regular Expressions 5.5. If you do not find one or both of these packages, install the proper packages with via the installers listed above.

Overview

The Excel spreadsheet, Template_RSEG.xls, provides the user with streamlined way to create Response Surface Equations (RSE) from preexisting data and from data created using the PREFER tool in Ansys. The resultant RSEs can then be used in a Monte Carlo simulation via Crystal Ball, for optimization via Excel's built in Solver or simply as a calculator to see how changes in the input variable values map to changes in the output response values.

The Template_RSEG.xls spreadsheet is composed of six worksheets, the VariableData sheet, the ResponseData sheet, the RegressionControls sheet, the RSEsSummary sheet, the RSEs sheet and the ValidationSummary sheet. The VariableData sheet is where the user stores the variable or input data to be analyzed. In addition, the VariableData sheet is where the user defines the install location of the RSEG module, working directory, and XML data file name to conduct the analysis. Figure 1 shows the empty layout of the VariableData sheet. The ResponseData sheet is where the user stores the response or output data to be analyzed. Figure 2 shows the empty layout of the ResponseData sheet. The RegressionControls sheet allows the user to customize the regression analysis performed during a batch analysis of all the response data. Figure 3 shows the empty layout of the RegressionControls page.

The RSEsSummary sheet contains a summary of the RSE input factors and output responses. Figure 4 shows the empty layout of the RSEsSummary sheet. The RSEs sheet contains all of the imported response surface equations that are created from analyzing the variable and response data defined in the VariableData and ResponseData sheets, respectively. Figure 5 shows the empty layout of the RSEs sheet. The ValidationSummary sheet summarizes the statistics of validating the RSEs against a set of off design-point data. Figure 6 shows the empty layout of the ValidationSummary sheet.

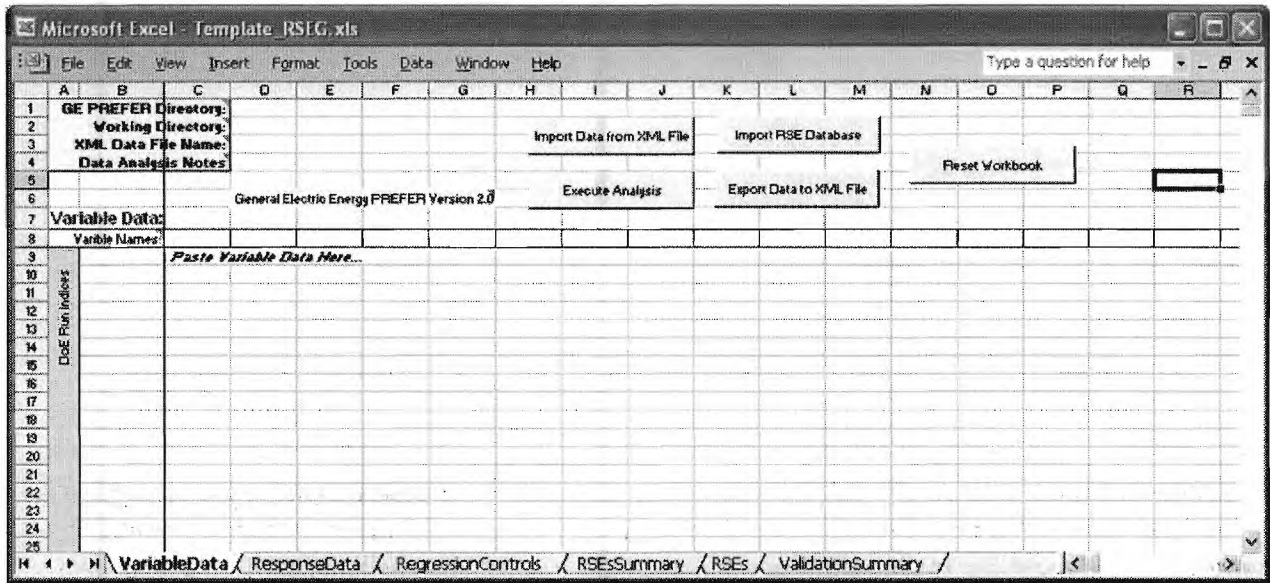


Figure 1: Variable data sheet layout

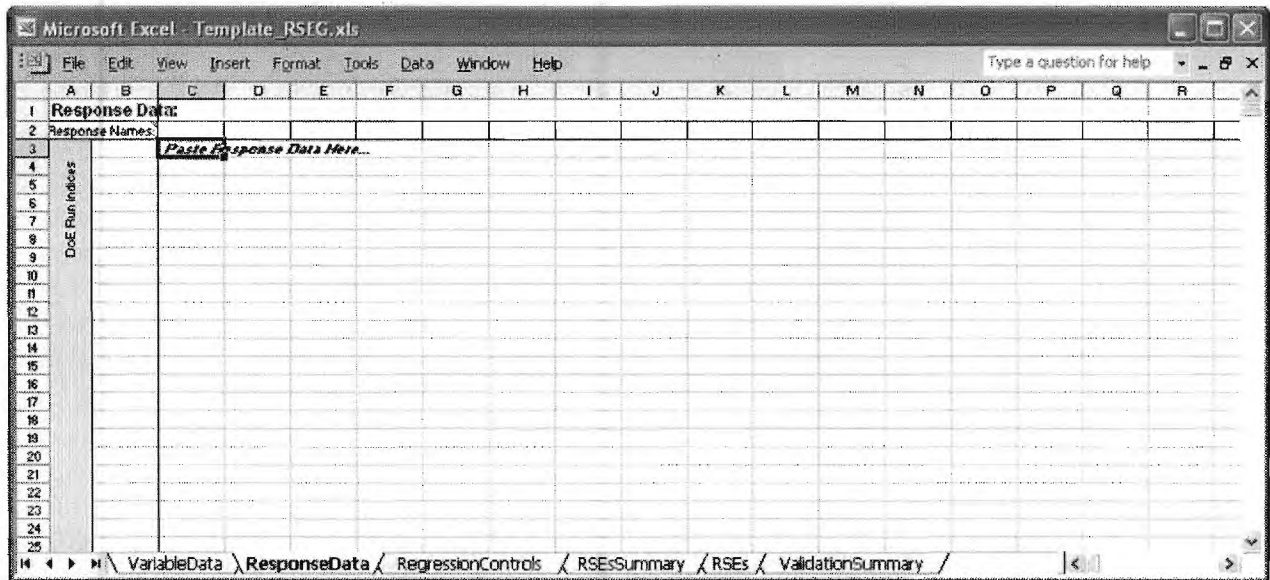


Figure 2: Response data sheet layout

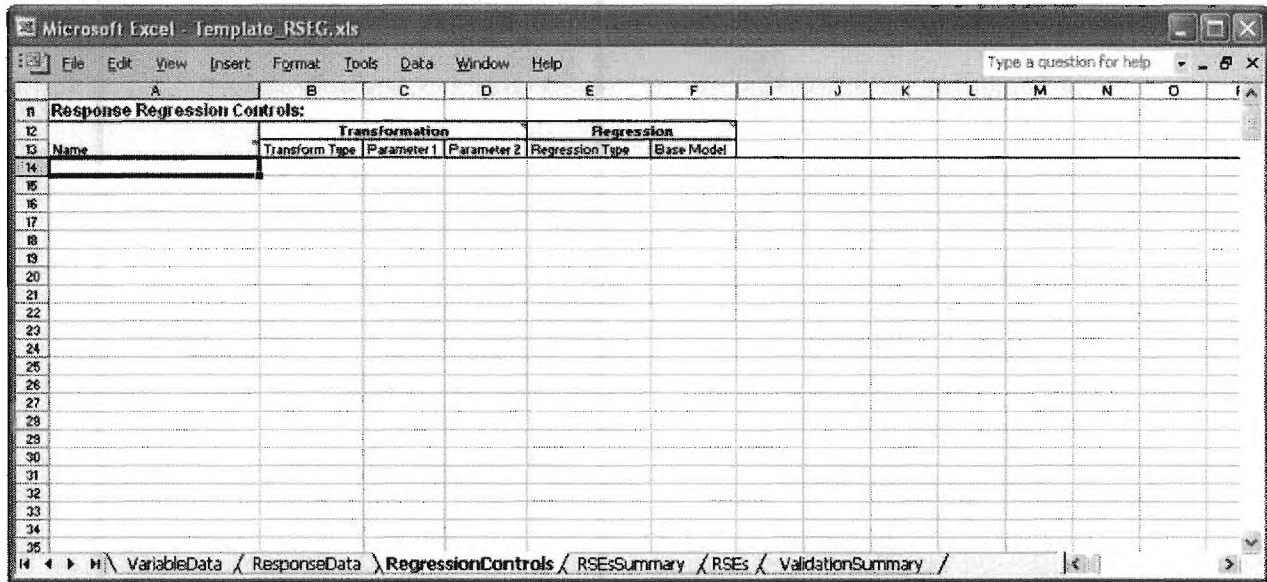


Figure 3: Regression Controls sheet layout

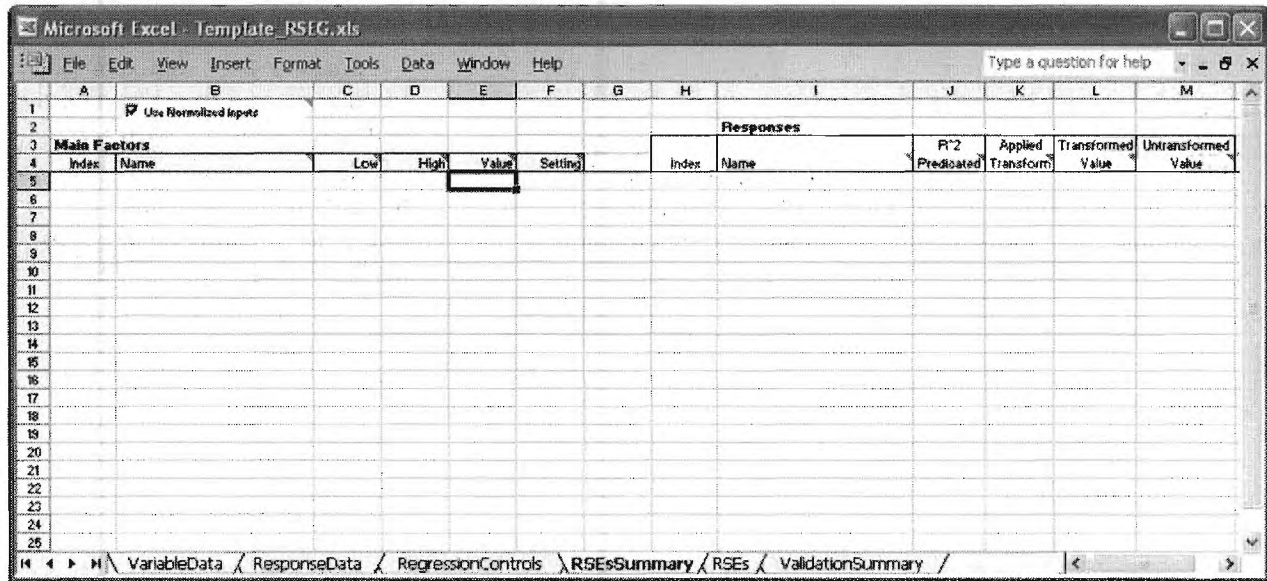


Figure 4: RSEs Summary sheet layout

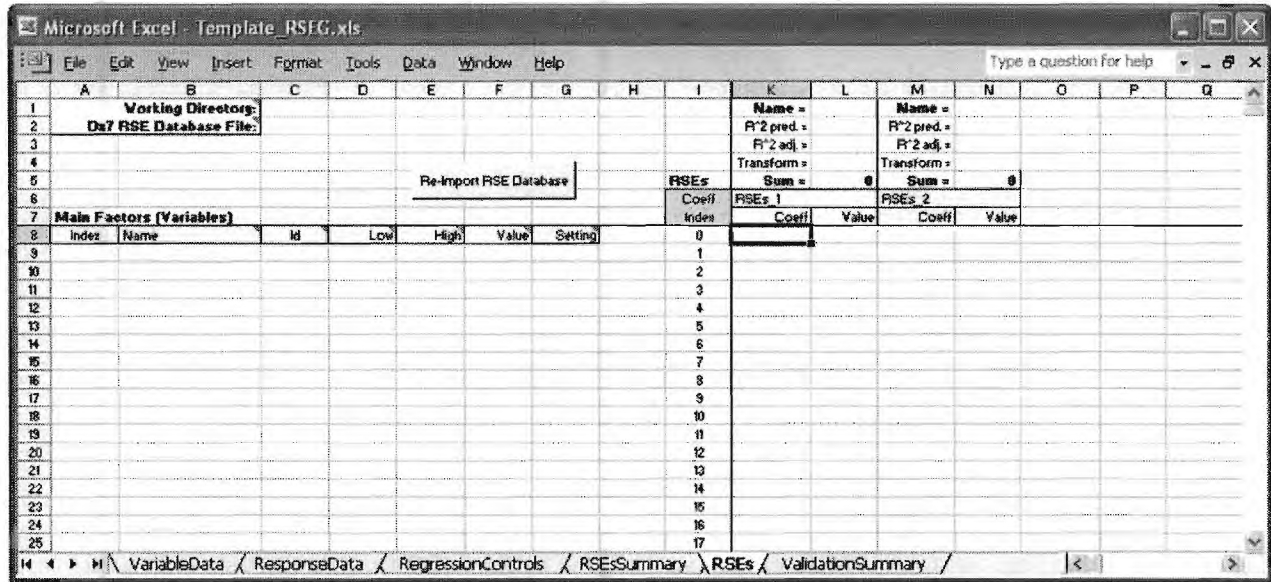


Figure 5: Response surface equations sheet layout

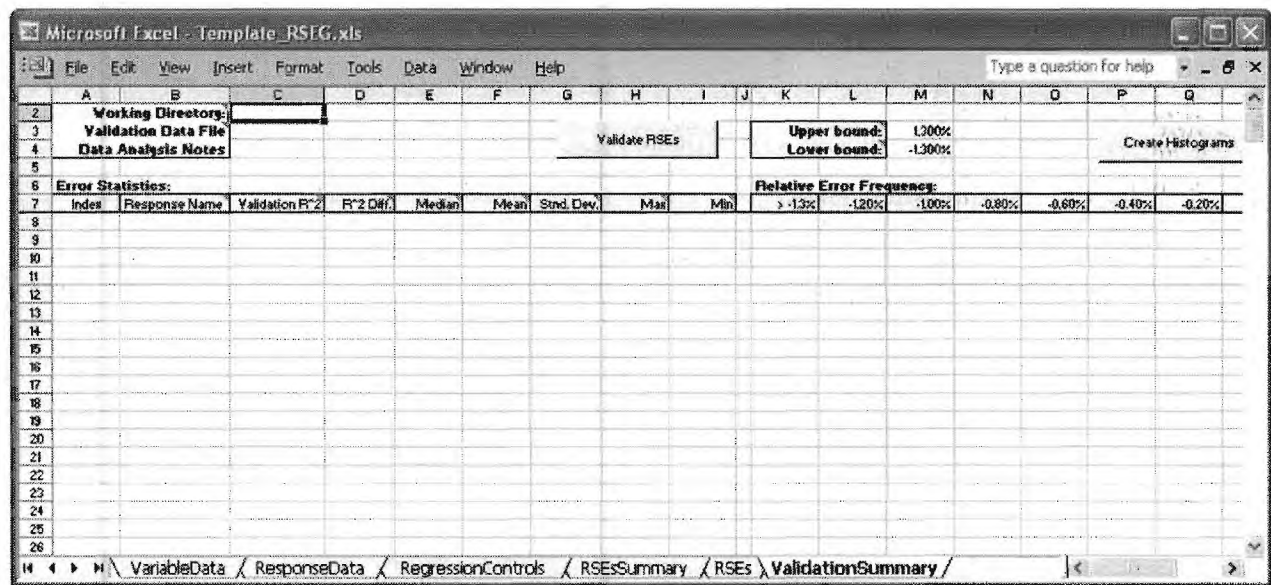


Figure 6: Validation Summary sheet layout

During the analysis of the variable and response data resulting from a click of the “Execute Analysis” button on the VariableData sheet, three files will be created in the working directory. Namely, a Design Expert XML file that containing the analyzed response surface equations, the Design Expert 7.0 XML DTD file, and a Windows batch file that executes the Java analysis engine. The XML file containing the response surface equations is what will be imported and displayed in the RSEs sheet when the “Import RSE Database” button is clicked on the VariableData sheet.

The Design Expert 7.0 XML file is retained after the analysis for the convenience of the user to allow

the user to manually recreate some or all of the response surface equations if desired. The Design Expert 7.0 XML file is a properly formatted Design Expert XML file that contains all of the necessary variable and response data from the VariableData and ResponseData sheets. Once the user has manually analyzed the data in Design Expert, the RSE Analysis spreadsheet re-import the results of that analysis. To re-import a manually analyzed Design Expert 7.0 XML file, click on the “Re-Import RSE Database” button on the RSEs sheet.

There are three other buttons displayed on the VariableData sheet that add additional functionality to the RSE analysis spreadsheet. The “Reset Worksheets” button will clear all of the data currently stored in the spreadsheet to allow the user to start fresh if needed. The “Export Data to XML File” and “Import Data from XML File” allow the user to easily read and write the variable and response data to an XML file. The XML file format used to store variable and response data is an improvement over the traditional way of storing raw data in a comma separated or tab delimited text file. As an example, the Figures 7 and 8 show data stored in a comma separated text file and the same data stored in the XML data file format.

As is easy to see, the XML data file describes or adds context to each piece of data in the data file. To get this same amount of readability in a standard text file, one would have to create their own data format and create a data file parser to read and write data to that format. The beauty of using an XML format to describe your data is that you then have access to professionally developed XML data parsing and manipulation libraries that would be a significant undertaking to recreate yourself.

XML is a meta-markup language for text documents. The data is included as strings of text marked-up by tags describing the data. There are two important features to XML which make it very useful for data storage and data transfer between programs.

Firstly, portability. XML is non-platform specific since it is merely a text file and can be directly transferred between platforms. Secondly, interoperability. The XML standard specifies the format and structure of an XML file but not the content of the tags, the strings, the attributes, etc. An XML data structure or file can hold analysis data as easily as it can contain a letter to your grandmother, as long as it conforms to the XML formatting standards.

VariableData.txt					
1	1500,	785.1851852,	833.3333333,	711.1111111,	0.277777778
2	1377.777778,	740.7407407,	870.3703704,	814.8148148,	0.268518519
3	1600,	792.5925926,	818.5185185,	822.2222222,	0.296296296
4	1477.777778,	770.3703704,	914.8148148,	703.7037037,	0.240740741
5	1555.555556,	733.3333333,	900,	800,	0.189814815
6	1355.555556,	866.6666667,	937.037037,	881.4814815,	0.24537037
7	1511.111111,	851.8518519,	966.6666667,	748.1481481,	0.273148148
8	1466.666667,	800,	803.7037037,	777.7777778,	0.310185185
9	1455.555556,	711.1111111,	855.5555556,	829.6296296,	0.208333333
10	1544.444444,	844.4444444,	974.0740741,	874.0740741,	0.25462963
11	1522.222222,	881.4814815,	811.1111111,	896.2962963,	0.236111111
12	1368.888889,	777.7777778,	988.8888889,	844.4444444,	0.291666667
13	1588.888889,	762.962963,	848.1481481,	888.8888889,	0.259259259
14	1633.333333,	718.5185185,	951.8518519,	762.962963,	0.212962963
15	1577.777778,	755.5555556,	944.4444444,	851.8518519,	0.231481481
16	1566.666667,	748.1481481,	929.6296296,	837.037037,	0.203703704
17	1622.222222,	814.8148148,	959.2592593,	755.5555556,	0.305555556
18	1444.444444,	829.6296296,	981.4814815,	740.7407407,	0.226851852
19	1433.333333,	807.4074074,	877.7777778,	807.4074074,	0.194444444
20	1611.111111,	888.8888889,	892.5925926,	866.6666667,	0.263888889
21	1422.222222,	725.9259259,	862.962963,	859.2592593,	0.282407407
22	1411.111111,	896.2962963,	907.4074074,	785.1851852,	0.222222222
23	1400,	874.0740741,	825.9259259,	770.3703704,	0.217592593
24	1366.666667,	703.7037037,	885.1851852,	733.3333333,	0.287037037
25	1488.888889,	822.2222222,	922.2222222,	725.9259259,	0.199074074
26	1533.333333,	837.037037,	996.2962963,	792.5925926,	0.300925926
27	1644.444444,	859.2592593,	840.7407407,	718.5185185,	0.25

Figure 7: Variable data in comma separated text file

```

1      <?xml version="1.0" encoding="US-ASCII"?>
2      <root>
3      <variables>
4      <variable name="External Temp">
5      <values>
6      <value index="1">1500.0</value>
7      <value index="2">1377.7777777777778</value>
8      <value index="3">1600.0</value>
9      <value index="4">1477.7777777777778</value>
10     <value index="5">1555.5555555555554</value>
11     <value index="6">1355.5555555555557</value>
12     <value index="7">1511.1111111111111</value>
13     <value index="8">1466.6666666666667</value>
14     <value index="9">1455.5555555555557</value>
15     <value index="10">1544.4444444444443</value>
16     <value index="11">1522.2222222222222</value>
17     <value index="12">1388.8888888888889</value>
18     <value index="13">1588.8888888888887</value>
19     <value index="14">1633.3333333333333</value>
20     <value index="15">1577.7777777777776</value>
21     <value index="16">1566.6666666666665</value>
22     <value index="17">1622.2222222222222</value>
23     <value index="18">1444.4444444444446</value>
24     <value index="19">1433.3333333333335</value>
25     <value index="20">1611.1111111111111</value>
26     <value index="21">1422.2222222222224</value>
27     <value index="22">1411.1111111111113</value>
28     <value index="23">1400.0</value>
29     <value index="24">1366.6666666666667</value>
30     <value index="25">1488.8888888888889</value>
31     <value index="26">1533.3333333333333</value>
32     <value index="27">1644.4444444444443</value>
33     </values>
34     </variable>
35     <variable name="External Heat Trans Coef">
66     <variable name="Internal Temp">
97     <variable name="Internal Heat Trans Coef">
128    <variable name="Wall Thickness">
159    </variables>
160    <responses>
534    </root>
535

```

Figure 8: Variable data in an XML file

Note – Figure 8 depicts only a limited view of the data shown in Figure 7. To see all of the data stored in the XML file, open the `geps_example_data.xml` file in your favorite text editor or in Internet Explorer. The `geps_example_data.xml` will be one of the files created during the step-by-step instructions in the next section.

Step-by-Step Analysis Instructions

The following instructions will guide the user through a typical analysis that can be done with the RSE analysis spreadsheet. The analysis will start by assuming that the user has some variable and response data stored in several text files. These instructions will show the user the proper methods for inserting the data into the spreadsheet and then analyzing that data.

The actual variable and response data for this example is located in two text files in the “<RSEG_Install_Directory>\RSEG\example\SingleDoeExampleData” directory that came in the RSEG.zip file. The variable data is stored in Example_Variable_Data.txt and the response data is stored in Example_Response_Data.txt.

- The <RSEG_Install_Directory> is the directory that the RSEG module is installed in. For the GE PREFER system, this is usually V:\AEAPPS\
- To use the Template_RSEG.xls spreadsheet, it does not have to be located in the “<RSEG_Install_Directory>\RSEG\spreadsheets” directory, it can be copied or moved to any directory on the user's computer.
- The working directory where the analysis XML data files will be created and the directory that contains the analysis spreadsheet do not have to be the same directory.

Step 1. Insert the name of the working directory and the desired name of the XML data file into the cells D2 and D3, respectively, in the VariableData Sheet.

- The XML data file name is the name of the XML file that the variable and response data will be stored in. This file name will be used to create the names of each of the analysis files generated when the “Execute Analysis” button is pressed.
- The little red triangles in the upper right hand corner of the cells labeled “Working Directory” and “XML Data file” indicate that the cells can be hovered over and a cell comment will pop up. The pop up comments indicate what type of information is expected in the cells. Many cells in the spreadsheet have this feature.

Step 1. Open the Example_Variable_Data.txt file located in the “<RSEG_Install_Directory>\RSEG\example\SingleDoeExampleData” directory and paste the contents into cell C9 in the VariableData sheet.

- Normally when one pastes comma separated or tab delimited data into Excel from a text file, all the data will be placed in a single column of cells.
- To expand the data into individual cells:
 1. Highlight the data to be expanded
 2. Go to the “Data” pull down menu on Excel's main tool bar and select “Text to Columns...”
 3. The “Convert Text to Columns Wizard” will pop up, hit the “Next >” button
 4. Select the radio buttons associated with the delimiters that describe your data. In our case, un-select the “Tab” option and select the “Comma” option.

- Note – sometimes you may need to select several delimiters to properly expand your data.

5. At this point the “Data Preview” window should show the data divided into individual columns, hit the “Finish” button.

Step 2. In each column heading above the expanded variable data, supply a name to describe each column of data.

- Figure 9 shows the VariableData sheet after completing Steps 1 to 3.

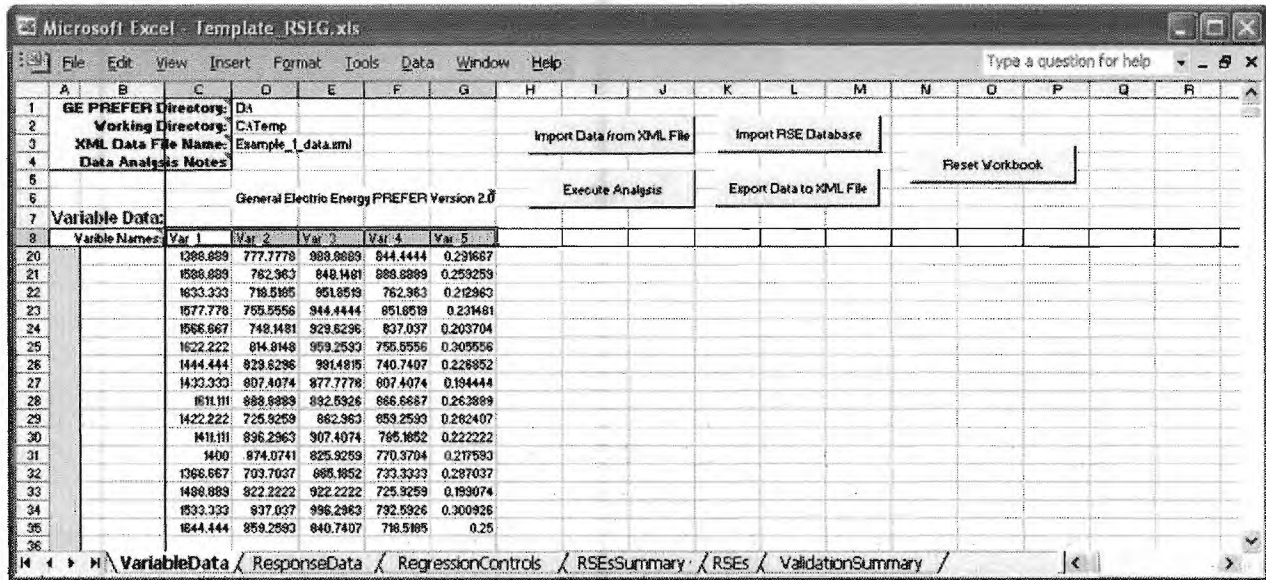


Figure 9: VariableData sheet after completing Steps 1 to 3

Step 3. Open the Example_Response_Data.txt file located in the “<RSEG_Install_Directory>\RSEG\example\SingleDoeExampleData\” directory and paste the contents into cell C3 in the ResponseData sheet.

- Typically for a given Excel session, once you have used the “Text to Columns Wizard”, Excel will apply the same parsing rules to any subsequent text data that you paste into a group of cells, thus you probably won't have to expand out the response data.
- However if necessary, follow the same instructions in Step 2 for expanding the pasted text data to columns.

Step 4. In each column heading above the expanded response data, supply a name to describe each column of data.

- Figure 10 shows the ResponseData sheet after completing Steps 4 and 5.

Response Names:	Resp 1	Resp 2	Resp 3	Resp 4	Resp 5	Resp 6	Resp 7	Resp 8	Resp 9	Resp 10	Resp 11	Resp 12
1	150894	167153	184800	200445	145462	152810	964.71	1018.44	1310.19	1326.29	1016.87	1376.52
2	144049	170396	177874	204472	144982	149841	1448.56	1018.44	1339.31	1326.29	1017.57	1376.52
3	172204	164242	205869	196774	145946	155497	1038.92	1018.44	1318.45	1326.29	1018.8	1376.52
4	217284	156473	261025	187111	142237	163460	1058.89	1018.44	1322.31	1326.29	1017.8	1376.52
5	166878	164479	200278	187071	145691	155300	1015.9	1018.44	1280.58	1326.29	1017.94	1376.52
6	154259	167506	184265	200978	149527	152303	1072	1018.44	1337.46	1326.29	1020.73	1376.52
7	134821	170863	172112	205062	143909	149475	1345.35	1018.44	1324.19	1326.29	1016.39	1376.52
8	195981	163931	238918	191282	144647	163956	982.853	1018.44	1283.5	1326.29	1016	1376.52
9	185378	165938	195427	198890	148051	153845	1076.34	1018.44	1366.5	1326.29	1020.52	1376.52
10	179600	164457	211314	187046	146370	155343	950.189	1018.44	1321.35	1326.29	1018.71	1376.52
11	143239	166816	176680	202243	144438	151420	1053.43	1018.44	1323.14	1326.29	1019.95	1376.52
12	191134	167091	192317	200334	146323	152824	979.518	1018.44	1347.84	1326.29	1017.4	1376.52
13	197480	160557	234839	182177	145031	159107	1100.15	1018.44	1385.65	1326.29	1020.27	1376.52
14	181041	163301	216640	185538	145989	156384	1068.3	1018.44	1351.22	1326.29	1019.63	1376.52
15	203622	159004	244687	190250	144125	160750	1064.64	1018.44	1336.18	1326.29	1018.78	1376.52
16	144409	170489	174702	204983	144363	149686	1495.8	1018.44	1353.93	1326.29	1021.72	1376.52
17	183427	162085	218380	194082	145394	157587	1083.41	1018.44	1316.75	1326.29	1020.1	1376.52
18	209194	157240	254563	188064	142821	162680	1011	1018.44	1283.78	1326.29	1016.48	1376.52
19	166891	167501	196837	200845	146245	152409	1024.1	1018.44	1375.32	1326.29	1019.13	1376.52
20	143413	168535	180430	202145	145801	151541	958.576	1018.44	1316.13	1326.29	1016.78	1376.52
21	184883	161740	223083	193648	145321	158011	1019.71	1018.44	1295.22	1326.29	1017.73	1376.52
22	168309	161333	228084	192152	145254	158437	958.894	1018.44	1276.3	1326.29	1015.43	1376.52

Figure 10: ResponseData sheet after completing Steps 4 and 5

Step 5. Click on the “Execute Analysis” button on the VariablesData sheet.

- This will bring up a MSDOS Command Window indicating that the Java analysis engine is running – DO NOT close this window, the window will close automatically when the the analysis is finished.
- The analysis will create four files in the working directory with the following formats:
`<XML data file base name>.xml`
`<XML data file base name>_dx7.xml`
`dex7XmlDoc.DTD`
`rseGenerator.bat`
- The `dex7XmlDoc.DTD` file is copied from the “<RSEG_Install_Directory>\RSEG\jarfiles\” directory to the working directory. This file is necessary for the importing of response surface equations from an analyzed Design Expert 7.0 XML file.
- Figure 11 is a picture of the command window that pops up.
- Note – for some installations of Design Expert 7.0, it may be necessary for the user to click the “OK” button on the Design Expert 7.0 splash screen to complete the data analysis.

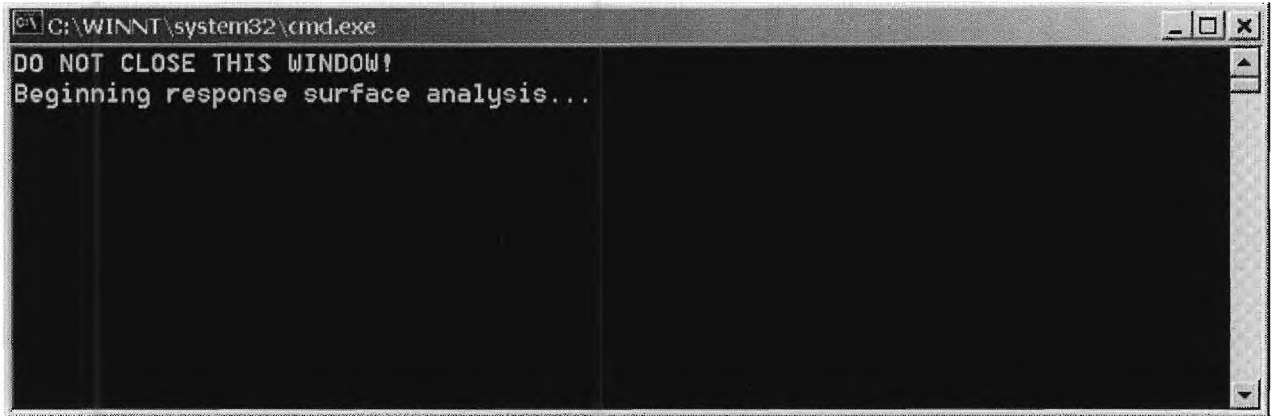


Figure 11: Java analysis engine MSDOS command window

Step 6. Click on the “Import RSE Database” button on the VariableData sheet.

- This imports in the Dx7 XML file containing the analyzed response surface equations into the RSEs sheet and creates the RSEsSummary sheet data.
- Figure 12 shows the RSEsSummary sheet after the RSEs have been imported.
- Figure 13 shows the RSEs sheet after all of the response surfaces from the *geps_example_data_rse.xml* file are imported.

Main Factors							Responses				
Index	Name	Low	High	Value	Setting	Index	Name	R ² Predicted	Applied Transform	Transformed Value	Untransformed Value
1	Var_1	1355.556	1644.444	1500	0	1	Resp_1	0.990423	NONE()	165673.019	165673.0187
2	Var_2	703.7037	896.2963	800	0	2	Resp_2	0.9965219	NONE()	165364.251	165364.2511
3	Var_3	803.7037	896.2963	800	0	3	Resp_3	0.8374734	NONE()	198763.984	198763.984
4	Var_4	703.7037	896.2963	800	0	4	Resp_4	0.9966152	NONE()	198184.005	198184.0048
5	Var_5	0.189815	0.310185	0.25	0	5	Resp_5	0.7497389	NONE()	145494.731	145494.7305
						6	Resp_6	0.996217	NONE()	154546.593	154546.5934
						7	Resp_7	-0.555275	NONE()	1063.30857	1066.30857
						8	Resp_8	n/a	NONE()	1018.44	1018.44
						9	Resp_9	0.6785793	NONE()	1326.40537	1326.405373
						10	Resp_10	n/a	NONE()	1326.29	1326.29
						11	Resp_11	0.8999507	NONE()	1018.36261	1018.362608
						12	Resp_12	n/a	NONE()	1376.52	1376.52

Figure 12: Summary Sheet after RSEs have been imported.

The screenshot shows an Excel spreadsheet titled "Microsoft Excel - Template_RSEG.xls". The main data area is divided into several sections:

- Working Directory:** C:\Temp
- Da7 RSE Database File:** Example_1_data_da7.xml
- Re-import RSE Database** button
- Main Factors (Variables):** A table with columns: Index, Name, Id, Low, High, Value, Setting. It lists 5 variables (Var_1 to Var_5) with their respective ranges and current values.
- RSEs:** A table with columns: Name, R² pred., R² adj., Transform, Sum. It lists four response surface equations (Resp_1 to Resp_4) with their statistical metrics.
- Validation Summary:** A table with columns: RSEs 1, RSEs 2, RSEs 3, RSEs 4. It lists the coefficients and values for each RSE.

Figure 13: RSEs sheet with imported response surface equations

Using the Summary and RSEs Sheets

After the data has been analyzed and the resultant RSEs imported into the Single DoE Analysis Spreadsheet, the user will primarily interact with the RSEsSummary sheet for doing any subsequent analysis with the created RSEs. The RSEsSummary sheet contains direct linkages to the main factor input and the response surface equation output cells on the RSEs sheet. These linkages are created when the RSEs are imported from the XML file after the “Import RSE Database” button is pressed. As such it is best not to directly modify any of the values on the RSEs sheet but do so via the Summary sheet.

The Summary sheet is divided into two main parts. The Main Factors columns summarizes the input variables that the response data was regressed against and are linked to the Main Factors columns in the RSEs sheet.. The Responses columns on the right summarize the current values of the actual response surface equations from the RSEs sheet.

To use the Summary sheet to do calculations, one simply has to change the values in either the “Settings” column or the “Values” column for each of the main factors. Use of either the “Values” or “Settings” column depends on how the “Use Normalized Inputs” check box is checked. If the check box is checked, then the user should use the “Settings” column to change the inputs to the RSEs.

- Each cell in the settings column should be a value in the range of [-1, 1], where a setting of -1 corresponds to the low or lower bound in the range for that factor.
- As the setting for a factor changes, the value of the cell in the “Values” column will also change. The values in the “Values” column are the true values for the actual factor based on the high and low values.

If the check box is unchecked, then the user should use the “Values” column to change the inputs to the RSEs.

- Each cell in the values column should be a value in the range of upper and lower bound, as defined in the high and low columns for the factor.
- As the setting for a factor changes, the value of the cell in the “Settings” column will also change. The values in the “Settings” column reflect the normalized settings for the factor.

Note – If you accidentally enter a value in the wrong column, just select the “Use Normalized Inputs” check box to reset the underlying equations.

As the settings for each factor are changed, the resultant values for each of the response surface equations are automatically updated. The output value for a given response surface equation will be reflected in the appropriate row in the Responses table.. For instant, in Figure 12 the value for the response surface associated with the “Resp1” output is “165673”. That value corresponds to the case where the main factor settings are all set to “0” or their nominal value. In Figure 14, the main factors settings have been changed to [1, 0, 0.5, 0, -1] and the resulting output value for the “Resp1” response surface equation is “217484.4”.

Main Factors							Responses				
Index	Name	Low	High	Value	Setting	Index	Name	F ² Predicted	Applied Transform	Transformed Value	Untransformed Value
1	Var_1	1365.956	1644.444	1644.444	1	1	Resp_1	0.990423	NONE()	217484.403	217484.4027
2	Var_2	703.7037	896.2963	800	0	2	Resp_2	0.9985219	NONE()	156425.606	156425.6056
3	Var_3	803.7037	896.2963	948.1481	0.5	3	Resp_3	0.9974734	NONE()	259325.153	259325.1531
4	Var_4	703.7037	896.2963	800	0	4	Resp_4	0.9986152	NONE()	167051.906	167051.9057
5	Var_5	0.189815	0.310185	0.189815	-1	5	Resp_5	0.7497389	NONE()	142011.197	142011.1965
						6	Resp_6	0.896217	NONE()	163534.789	163534.7887
						7	Resp_7	-0.555275	NONE()	701.002558	701.0025576
						8	Resp_8	n/a	NONE()	1018.44	1018.44
						9	Resp_9	0.8785793	NONE()	1395.588938	1395.588977
						10	Resp_10	n/a	NONE()	1328.29	1328.29
						11	Resp_11	0.9898507	NONE()	1019.87029	1019.870289
						12	Resp_12	n/a	NONE()	1376.52	1376.52

Figure 14: New setting of main factor values

In addition to being able to import in the automatically created Dx7 RSE database generated from hitting the “Execute Analysis” button on the VariablesData sheet, the RSEs sheet can also be used to import response surfaces from a manually analyzed Design Expert 7.0 XML file. As was stated before, when the user hits the “Execute Analysis” button one of the four files that is created in the working directory is a Design Expert 7.0 XML input file. The Design Expert 7.0 file will contain all of the variable and response data contained in the VariableData and ResponseData sheets plus any analysis results that were performed during the batch analysis of that data. This allows the user to open the Design Expert 7.0 XML file in Design Expert and manually reanalyze the data. Design Expert will save the resultant response surface equations to the Design Expert XML file when the user selects the save command in Design Expert.