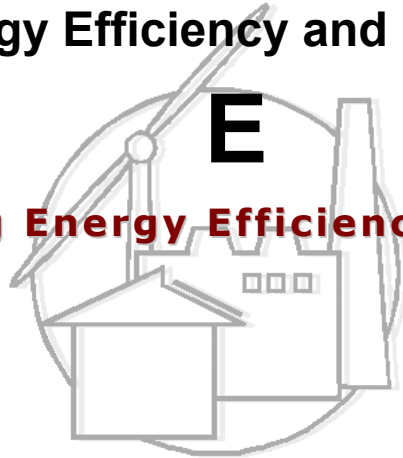


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**INVESTIGATION OF THE EFFECT OF CONSIDERING NFRC  
STANDARD SIZE U FACTOR FOR THE FENESTRATION SYSTEMS ON  
THE ENERGY PERFORMANCE OF A TYPICAL COMMERCIAL  
BUILDING**

September 25, 2002



This report is an addendum to the previous report entitled “ Investigation of effects of fenestration systems on the energy performance of a typical commercial building”.

### Effect of considering NFRC standard size U factor

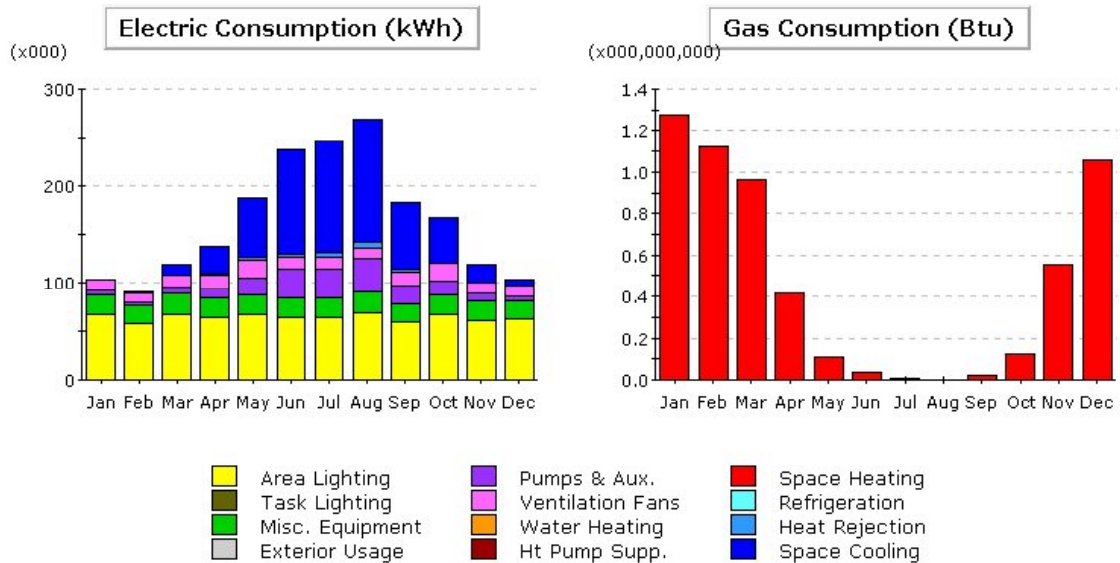
As per current NFRC procedure the commercial site built products are tested at the standard size of 80”x80”. The results from the testing are then applied to the actual size of the windows in any building. The effect of applying this procedure has also been investigated in this study. Incidentally the average window area in this particular building is very close to the area of standard size, therefore, the calculations have also be performed for the size 40”x40”. Table A1 shows the effect of considering the equivalent frame U factors based on the standard size U factors. The detailed monthly electric and gas consumption data are given in Figs A1-A3. These U factors have been applied to all the windows with area more than 2% (major windows) and the rest of the windows (minor windows) were considered at U=0.5. The actual case here corresponds to the minor windows (U=0.5) case in Table 6.

**Table A1: Load and energy of the building with equivalent U factors corresponding to NFRC sizes 80”x80”0 and 40”x40” applied to the major windows: minor windows <2%**

U factor of frame (Btu/hr.ft <sup>2</sup> .F)		Building Peak Load (kBtu/hr)				Building Energy MBtu			
		Cooling	% Diff	Heating	% Diff	Cooling	% Diff	Heating	% Diff
Major windows (Actual)	Total	2879.36 (1603.15)		1109.76 (1013.96)		6343.77 (3316.14)		933.65 (901.44)	
	Diff.	-	-	-	-	-	-	-	-
Major windows (NFRC size 80”x80”)	Total	2931.27 (1651.36)		1145.91 (1050.11)		6411.42 (3391.99)		971.91 (947.91)	
	Diff.	-48.21	3.0	-36.15	3.6	-75.85	2.29	-46.47	5.5
Major windows (NFRC size 40”x40”)	Total	3052.15 (1772.23)		1264.05 (1194.85)		6597.59 (3602.64)		1075.37 (1057.84)	
	Diff.	-119.08	7.4	-180.89	17.8	-286.5	8.6	-156.4	17.4

Note: Values in parenthesis show the window only contribution and % Diff. is based on the window only contribution

It is evident from the table that considering the U factor based on standard sizes, the energy consumption of whole building changes significantly.



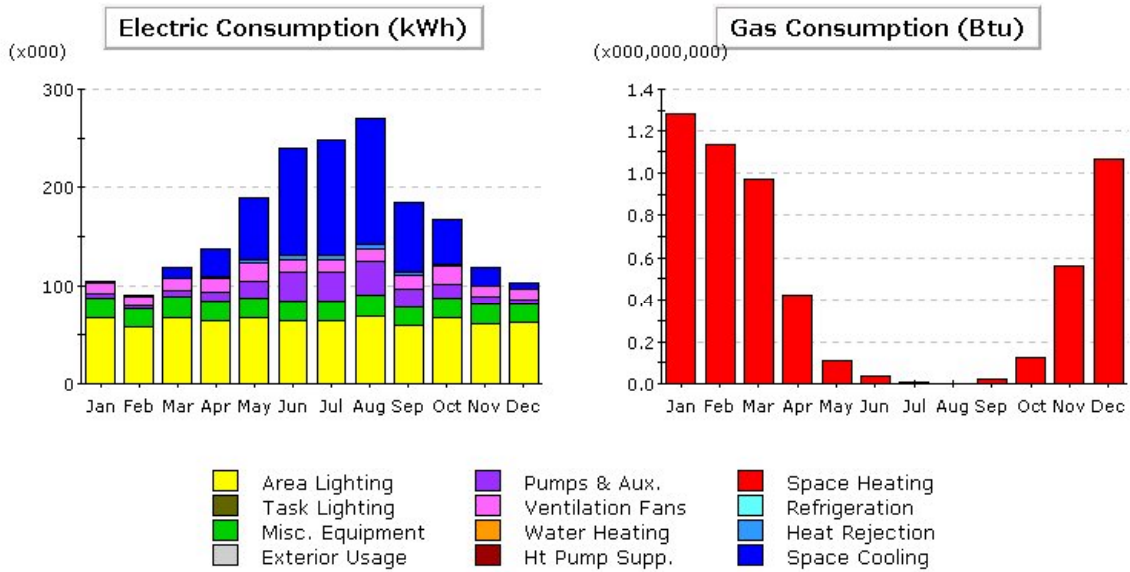
**Electric Consumption (kWh x000)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.2	0.6	12.0	28.9	61.9	107.0	116.0	126.0	69.4	46.6	18.4	5.2	593.3
Heat Reject.	0.0	0.0	0.3	0.9	2.1	4.4	5.0	5.5	2.4	1.4	0.5	0.1	22.7
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	11.2	9.8	12.1	14.1	19.3	12.6	11.8	12.1	15.1	18.2	11.3	10.7	158.2
Pumps & Aux.	3.7	3.2	6.6	9.7	16.8	28.7	29.6	33.7	17.9	13.6	7.7	4.4	175.5
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	21.2	18.6	21.3	20.3	21.2	20.5	20.5	21.8	19.1	21.2	19.6	20.0	245.1
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	66.6	58.1	67.0	63.8	66.6	64.2	64.1	69.1	59.2	66.6	61.3	62.0	768.7
<b>Total</b>	<b>103.9</b>	<b>90.3</b>	<b>119.3</b>	<b>137.7</b>	<b>187.8</b>	<b>237.5</b>	<b>247.0</b>	<b>268.2</b>	<b>183.1</b>	<b>167.6</b>	<b>118.7</b>	<b>102.4</b>	<b>1,963.5</b>

**Gas Consumption (Btu x000,000,000)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.28	1.13	0.96	0.42	0.11	0.04	0.01	-	0.02	0.13	0.56	1.05	5.70
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Total</b>	<b>1.28</b>	<b>1.13</b>	<b>0.96</b>	<b>0.42</b>	<b>0.11</b>	<b>0.04</b>	<b>0.01</b>	<b>-</b>	<b>0.02</b>	<b>0.13</b>	<b>0.56</b>	<b>1.05</b>	<b>5.70</b>

**Fig. A1: Monthly electric and gas consumption by end use for actual case (Major windows framing U factor as per the drawings and Minor windows U=0.5)**



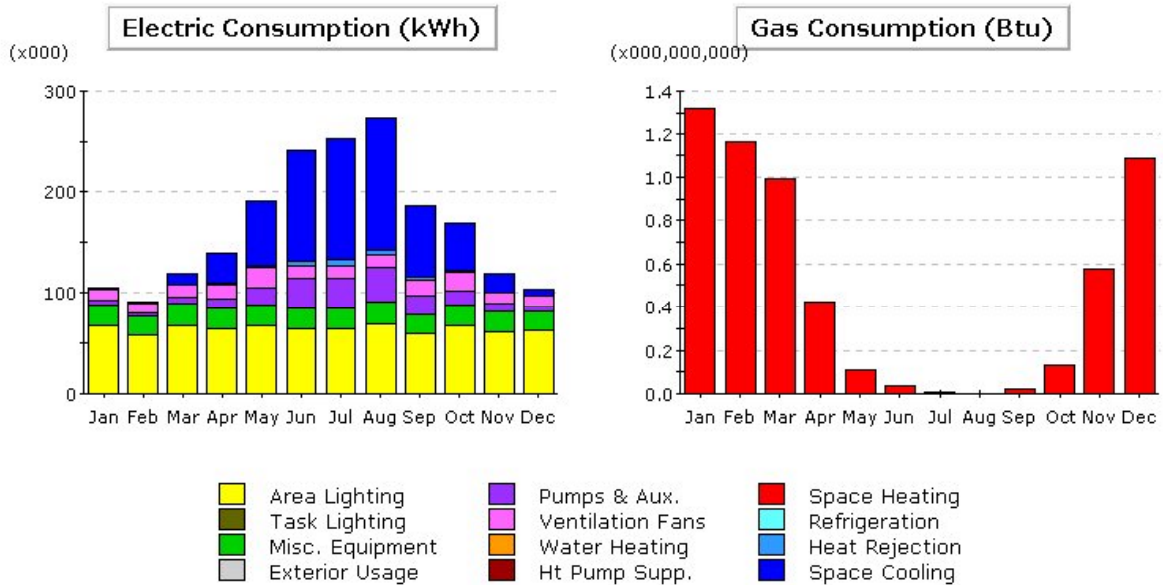
**Electric Consumption (kWh x000)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.2	0.6	12.0	29.0	62.2	108.1	117.3	127.4	70.0	46.8	18.4	5.2	598.3
Heat Reject.	0.0	0.0	0.3	0.9	2.1	4.5	5.0	5.6	2.5	1.4	0.5	0.1	22.9
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	11.2	9.8	12.1	14.3	19.6	12.7	12.0	12.2	15.4	18.4	11.3	10.7	159.7
Pumps & Aux.	3.7	3.2	6.6	9.7	16.8	28.8	29.6	33.7	17.9	13.6	7.7	4.4	175.7
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	21.2	18.6	21.3	20.3	21.2	20.5	20.5	21.8	19.1	21.2	19.6	20.0	245.1
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	66.6	58.1	67.0	63.8	66.6	64.2	64.1	69.1	59.2	66.6	61.3	62.0	768.7
<b>Total</b>	<b>103.9</b>	<b>90.3</b>	<b>119.4</b>	<b>138.0</b>	<b>188.4</b>	<b>238.8</b>	<b>248.6</b>	<b>269.7</b>	<b>184.2</b>	<b>167.9</b>	<b>118.8</b>	<b>102.4</b>	<b>1,970.4</b>

**Gas Consumption (Btu x000,000,000)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.29	1.14	0.97	0.42	0.11	0.04	0.01	-	0.02	0.13	0.56	1.06	5.74
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Total</b>	<b>1.29</b>	<b>1.14</b>	<b>0.97</b>	<b>0.42</b>	<b>0.11</b>	<b>0.04</b>	<b>0.01</b>	<b>-</b>	<b>0.02</b>	<b>0.13</b>	<b>0.56</b>	<b>1.06</b>	<b>5.74</b>

**Fig. A2: Monthly electric and gas consumption by end use for actual case (Major windows framing U factor based on NFRC standard size 80"x80"; Minor windows frame U=0.5)**



**Electric Consumption (kWh x000)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	1.2	0.6	12.1	29.4	63.2	110.0	121.4	130.5	71.2	47.3	18.5	5.2	610.5
Heat Reject.	0.0	0.0	0.3	0.9	2.1	4.6	5.2	5.7	2.5	1.4	0.5	0.1	23.3
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	11.2	9.8	12.2	14.5	20.4	13.0	12.7	12.4	16.2	18.9	11.3	10.7	163.4
Pumps & Aux.	3.7	3.2	6.6	9.7	16.8	28.8	29.6	33.6	17.9	13.6	7.7	4.4	175.5
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	21.2	18.6	21.3	20.3	21.2	20.5	20.5	21.8	19.1	21.2	19.6	20.0	245.1
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	66.6	58.1	67.0	63.8	66.6	64.2	64.1	69.1	59.2	66.6	61.3	62.0	768.7
<b>Total</b>	<b>103.9</b>	<b>90.3</b>	<b>119.5</b>	<b>138.6</b>	<b>190.2</b>	<b>241.0</b>	<b>253.5</b>	<b>273.1</b>	<b>186.1</b>	<b>169.0</b>	<b>118.9</b>	<b>102.4</b>	<b>1,986.6</b>

**Gas Consumption (Btu x000,000,000)**

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	1.32	1.17	0.99	0.42	0.11	0.03	0.01	-	0.02	0.13	0.57	1.09	5.85
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Total</b>	<b>1.32</b>	<b>1.17</b>	<b>0.99</b>	<b>0.42</b>	<b>0.11</b>	<b>0.03</b>	<b>0.01</b>	<b>-</b>	<b>0.02</b>	<b>0.13</b>	<b>0.57</b>	<b>1.09</b>	<b>5.85</b>

**Fig. A3: Monthly electric and gas consumption by end use for actual case (Major windows framing U factor based on NFRC standard size 40”x40”; Minor windows frame U=0.5)**