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IMPACTS ASSESSMENT
ARMENIA WEATHERIZATION PROGRAM

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I. EXECUTIVE SUMMARY

The Armenia Weatherization Program, funded by the U.S. Agency for International Development, (USAID) has taken place in three separate phases, roughly corresponding to the years 1994, 1995, and 1996. All phases of the work were managed and implemented by Resource Management Associates of Madison, Inc. (RMA). Over forty buildings have been weatherized in the three years, including schools, hospitals, orphanages, residential buildings, and other buildings of strategic or historic importance. The impact assessment, which is the subject of this report, is focused on the third phase of the project, where there was an emphasis on making the weatherization cost-effective and marketable. In this phase, the monitoring and evaluation of project results were included in the scope of the work.

A detailed evaluation of the weatherization program was conducted to determine the impacts and effectiveness. The program sponsor (USAID), the recipient (Government of Armenia), and the direct beneficiaries (participants) all have an interest in the impacts. Other funding agencies who are considering programs of a similar type will also find the results interesting and useful in designing additional programs in Armenia and elsewhere.

The impacts of the weatherization are both quantitative and qualitative. To determine quantitative impacts, a data collection and analysis plan was developed which included measurement of temperature and air infiltration over a monitoring period. Four buildings were selected to implement the quantitative assessment. The qualitative assessment was done largely through the use of surveys and interviews with program participants, non-participants, and weatherization workers. A persistence survey and follow-up visit were also designed for selected buildings which had been weatherized in earlier program years.

Quantitative Results

A quantitative assessment was done on four of the buildings which were weatherized in 1995/96: The results of each of the assessments is summarized below:

MATERNITY HOSPITAL #4, YEREVAN

Quantitative Results

Actual

- ✓ Temperatures in weatherized room higher by 5° - 10° C
- ✓ Heat losses from infiltration at windows reduced by 84.5%
- ✓ Energy savings for monitoring period = 1.55 billion BTUs
- ✓ Cost savings for monitoring period = $8,359
- ✓ Payback period = 292 heating days
- ✓ Monitoring period = 101 heating days

Theoretical

- ✓ Heat losses from infiltration at window reduced by 88%
- ✓ Energy savings for monitoring period = 3.4 billion BTUs
- ✓ Cost savings for monitoring period = $18,331
- ✓ Payback period = 139 heating days

TRAUMATOLOGICAL HOSPITAL #6, YEREVAN

Quantitative Results

Actual

- ✓ Temperatures in weatherized room higher by 5° - 10° C
- ✓ Heat losses from infiltration at windows reduced by 43%
- ✓ Energy savings for monitoring period = 260 million BTU s
- ✓ Cost savings for monitoring period = $1,395
- ✓ Payback period = 346 heating days
- ✓ Monitoring period = 38 heating days

Theoretical

- ✓ Heat losses from infiltration at window reduced by 51%
- ✓ Energy savings for monitoring period = 543 million BTUs
- ✓ Cost savings from monitoring period = $2,909
- ✓ Payback period = 166 heating days

SCHOOL #8, YEREVAN

Quantitative Results

Actual

- ✓ Temperatures in weatherized room higher by 5° - 10° C
- ✓ Heat losses from infiltration at windows reduced by 60%
- ✓ Energy savings for monitoring period = 560 million BTUs
- ✓ Cost savings for monitoring period = $3,001
- ✓ Payback period = 823 heating days
- ✓ Monitoring period = 58 heating days

Theoretical

- ✓ Heat losses from infiltration at window reduced by 66%
- ✓ Energy savings for monitoring period = 1.06 billion BTUs
- ✓ Cost savings for monitoring period = $5,684
- ✓ Payback period = 434 heating days

SCHOOL #20, YEREVAN

Quantitative Results

Actual

- ✓ Temperatures in weatherized room higher by 5° - 10° C
- ✓ Heat losses from infiltration at windows reduced by 73%
- ✓ Energy savings for monitoring period = 6.5 million BTUs
- ✓ Cost savings for monitoring period = $1,502
- ✓ Payback period = 425 heating days
- ✓ Monitoring period = 44 heating days

Theoretical

- ✓ Heat losses from infiltration at window reduced by 77%
- ✓ Energy savings for monitoring period = 7.5 million BTUs
- ✓ Cost savings for monitoring period = $4,071
- ✓ Payback period = 157 heating days

Qualitative Results

Participant Surveys:
Participants were asked in surveys about five different categories. A summary of the responses are presented below.

* Weatherization Impacts - The most important impacts, according to participants, were either those which are highly visible (e.g. more attractive building) or led to greater physical comfort (e.g. better working environment). Energy-related impacts such as higher energy efficiency and lower energy costs rated lower in importance to participants. Participants did not believe that weatherization had any negative affects, such as increased moisture problems or poorer indoor air quality.

* Quality of the Weatherization Work - The quality of the work was rated very high by all respondents, including the skills of the workers, the materials used, and the responsiveness of the local staff in addressing any problems in the conduct of the work.

* Perception of the Cost of the Work - Participants were not generally aware of the cost of the weatherization for one door or window. Only 11% responded with the right range for windows, and 27% for doors. However, since the cost is quite near the cut-off point of two of the cost ranges, if the two categories are combined, 56% of participants are correct for windows and 59% for doors.

* Achievable Energy Savings - The largest category of respondents was in the category of " more than 20% of energy savings is possible from weatherization."

* General Comments - Participants mentioned such additional impacts as an increased number of days that the schools could remain open and an increase in school attendance.

Non-Participants Surveys

Non-participants were asked questions regarding their perception of the impacts of weatherization, costs, and achievable energy savings. Their responses on the impacts were quite similar to those of the participants. A substantial majority of the non-participants underestimated the cost of weatherization, and they were more conservative on the possible energy savings.

Workers Survey

Workers on the weatherization crews were also asked their opinion on the impacts of weatherization. Unlike the participants or non-participants, their highest ranking impact was lower energy cost, followed by greater productivity, more comfortable working conditions, and saving money through lower energy costs. Workers were unanimous in their opinion that high quality in the work was stressed.

Persistence Survey

For eight of the sites which had been weatherized in previous years of the program, a reviewer was sent out to interview personnel and to visually assess the condition of the work which had been done. In all of the institutional sites visited, the condition of the weatherized windows was assessed as "good" to "very good". One of the residential sites was reported to have moisture problems. Many comments were offered which were favorable of the work and demonstrated the recipients gratitude to USAID and RMA.

Other Program Impacts

1. Multiple economic benefits have accrued to the Armenian economy through wages paid and local procurement purchases. A standard economic multiplier effect in the U.S. might be 2-3. In the third phase of the project alone, approximately $300,000 was spent on local wages and local procurement. Many bilateral projects are criticized by the host governments because most of the funds stay in the country which is providing the assistance, i.e., providing work for consultants. This project can be used as an example of one which has successfully enhanced the livelihood of people in the country receiving the assistance.

2. Other donor organizations have recognized the benefits of this type of program, and have committed funds to similar programs in other parts of Armenia. While the programs may not contain the same elements, the weatherization project demonstrated that a large number of local personnel can be mobilized and trained to do high quality weatherization and construction-related work.

3. The demand for weatherization supplies has assisted in the development of two small local manufacturers.

4. The awareness of the benefits of building weatherization is increasing, contributing to the beginning of a market demand for such services. Several private companies will be starting up within the next few months, formed from the crews who were trained to do the weatherization work.

The Armenia Weatherization Project has been widely regarded throughout the country as a successful project. This is largely due to the grassroots nature of the project. It is highly visible and has an immediate effect on people's lives. Skills which are marketable and transferable to other types of work (e.g., general construction) were taught. One indication of the project's success is that two other donor agencies have designed and implemented similar projects, with a third considering this for next year.

2. INTRODUCTION

2.1 Description of the Weatherization Program

The Armenia Weatherization Program, funded by the U.S. Agency for International Development, has taken place in three separate phases, roughly corresponding to the years 1994, 1995, and 1996. All phases of the project were managed and implemented by Resource Management Associates of Madison, Wisconsin, and Yerevan, Armenia. The objective of the first phase was to demonstrate weatherization techniques and materials in a small number residential and municipal buildings (schools and hospitals). The second phase focused on weatherizing buildings which were used to provide critical services to vulnerable segments of the Armenian population, such as maternity hospitals, orphanages and schools. The third phase of the project is trying to develop the business skills of key personnel and to make the weatherization more cost-effective, with the objective of privatizing the workforce and making the weatherization activity self-sustaining. The third phase is scheduled to end September 30, 1996.

To date, over forty buildings throughout Armenia have been weatherized during the three years in which RMA has been active. This has included five residential buildings, three refugee centers, nineteen hospitals/clinics (or portions thereof), one orphanage, seven schools, and five other buildings of various historic or strategic importance. RMA has trained over 120 workers in weatherization and carpentry skills, including workers from the cities of Yerevan, Gyumri, and Vanadzor. The work has included door and window repair and replacement, weatherstripping and caulking. Because of poor construction and maintenance practices, windows have often required considerable refurbishment to reduce or eliminate thermal loss. Materials used for weatherization were either purchased locally or imported from the U.S. RMA has also worked with the Armenian Relief Society and the United Nations High Commission for Refugees, training their workers to perform weatherization.

The project which will be described in this assessment will concentrate on phase three, where the monitoring and evaluation of project results were included in the scope of the work. The project provided technical assistance (overall project management and expatriate weatherization specialist), training in weatherization techniques, and the materials/supplies to complete the work. The labor assigned to the project in this phase was overwhelmingly local, with a ratio of about 60 person months local labor to 1 person month of expatriate labor. Roughly one-third of the project budget of $600,000 was spent for materials; one-half for local labor; and the remainder for technical assistance, training, travel, and other direct costs.

The project beneficiaries fall into several groups:

- Administrators and employees who work in the weatherized buildings
- Recipients of services provided in the buildings (students and patients)
- Municipalities/hospital administration who experience lower energy costs
- Local Armenians employed by the project
- Vendors of products purchased for the project

Financing was initially on a completely grant basis, although as the demand for weatherization services has increased, a cost share has been requested of sites being considered for weatherization. The cost share has been a low percentage of the total cost of the work at each location; however, this requirement has provided a stronger stake in the project.

2.2 Purpose of the Impact Assessment

A detailed evaluation of the benefits of weatherization was conducted to determine the impacts and effectiveness of the program. The program sponsor (USAID), the recipient (Government of Armenia) and the direct beneficiaries (participants) who have been involved in the program all have an interest in the impacts. Other funding agencies who are considering programs of a similar type will also find the results interesting and useful in designing additional programs in Armenia and other locations with similar problems.

The specific evaluation objectives are as follows:

- Estimate energy savings resulting from weatherization, using data collected in winter 1995
- Compare measured savings to engineering calculations of projected savings
- Measure "customer satisfaction" with the weatherization program
- Assess benefits to workers performing weatherization
- Assess increased awareness of benefits of weatherization

2.3 Impact Assessment Plan

The impacts of the weatherization project are both quantitative and qualitative, impacts which require different measurement techniques. To estimate the quantitative impacts, a data collection and analysis plan was developed. First, as a routine part of job estimation and for tracking the costs of the weatherization, background information on each building was gathered. This data was used to select four sites (two schools and two hospitals) for the quantitative assessment. Data loggers were purchased to record the temperature differences between weatherized and unweatherized rooms at each of the locations. Temperature was logged on an hourly basis, twenty-four hours per day. Air infiltration measurements were recorded on a daily basis in both the weatherized and the control room. Data collection was done over the winter of 1995-96, in the period January through April 1996. The data was used to determine the increase in average room temperature, heat loss reduction, and to calculate energy savings and payback periods. Data collection and analysis was the responsibility of RMA subcontracted staff in Yerevan, with assistance from RMA Madison.

To measure the qualitative impacts, surveys were developed for different project beneficiary groups to determine impacts beyond energy savings (increased hours of operation, better working conditions, longer patient stays, etc.). Surveys were developed for participants in the program (buildings which were weatherized), non-participants, and weatherization workers. Each of the

surveys was field-tested on a small number of persons in the target group and revised, based on their responses and understanding of the questions. A survey of the persistence of weatherization measures was also developed and implemented. RMA staff in Yerevan was responsible for implementing the surveys. Responses to the surveys were compiled and analyzed by the RMA Yerevan and Madison offices.

3. IMPACT ASSESSMENT RESULTS

3.1 Quantitative Results

Quantitative assessment was done on four of the buildings which were weatherized in 1995/96:

- Maternity Hospital #4
- Traumatological Hospital #6
- School #8
- School #20

Profiles for each of the buildings, energy use data and a breakdown of the weatherization costs is contained in *Appendix A*. This section summarizes the quantitative results of the evaluation.

3.1.1 Description of the Work

The weatherization work in general included the following elements:

- Caulking
- Weatherstripping
- Replacing missing glass in windows
- Filling gaps between window frame and wall
- Replacing missing hardware on windows and doors
- Installing new doors and door sweeps

The general condition of most of the windows in the buildings weatherized was very bad, as a result of little or no maintenance for many years. Gaps between the window sash and frame were 4-8 mm and 5-12 mm between the window frame and building. The average size of the gap between the door sash and frame ranged from 4-10 mm and between the door frame and building 3-12 mm. All of the windows were designed to be double-pane, but many of them were missing glass panes. The fit of the windows was also poor because of missing hardware.

Two grades of weatherization work on windows was completed. All activities relevant to windows from the above list were performed on all of the windows. In addition, in some sites considerable repair and rebuilding work was done on the windows. This work included stripping and repainting the windows and carpentry repair of windows' frames and sills. This level of weatherization work was termed "full repair," because following the work, the condition of the windows was "like new." Of the sites evaluated in the quantitative assessment, only School #8 underwent full repair of the windows.

3.1.2 Actual and Theoretical Results

This section presents the results of the quantitative assessment. Data is presented for each of the four sites, followed by selected graphical representations.

MATERNITY HOSPITAL #4, YEREVAN

- Constructed in 1984; concrete block with tufa plates
- 7 floors/180 rooms (48 patient rooms, 21 operating rooms, 2 critical care rooms)
- Operational Capacity = 140 patients
- Serves a population of 400,000
- Low-temperature district heating supplemented by electric space heating

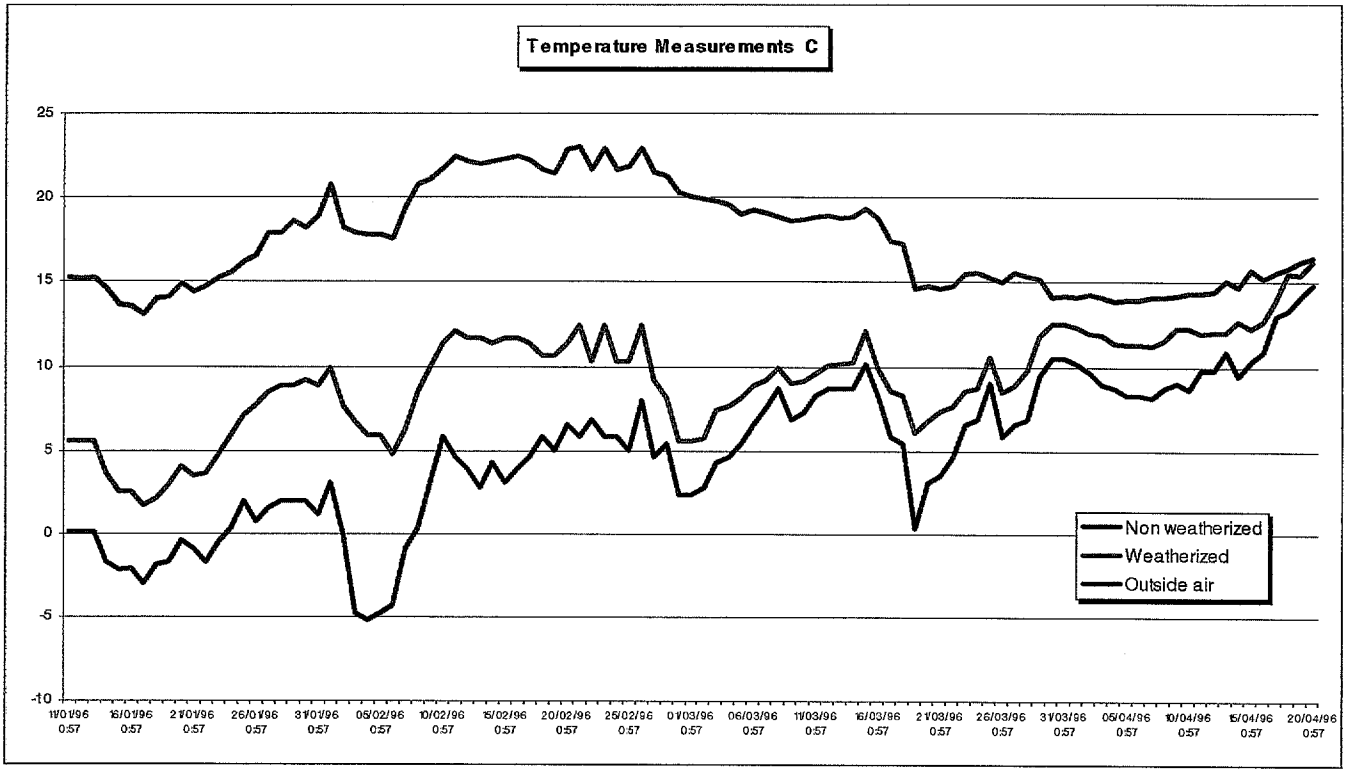
Quantitative Results

Actual

✓ Temperatures in weatherized room higher by 5° - 10° C
✓ Heat losses from infiltration at windows reduced by 84.5%
✓ Energy savings for monitoring period = 1.55 billion BTUs
✓ Cost savings for monitoring period = $8,359
✓ Payback period = 292 heating days
✓ Monitoring period = 101 heating days

Theoretical

✓ Heat losses from infiltration at window reduced by 88%
✓ Energy savings for monitoring period = 3.4 billion BTUs
✓ Cost savings for monitoring period = $18,331
✓ Payback period = 139 heating days


Temperature Measurements C
25
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15
10
5
0
-5
-10
Non weatherized
Weatherized
Outside air
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18/01/96 0:57
21/01/96 0:57
26/01/96 0:57
31/01/96 0:57
05/02/96 0:57
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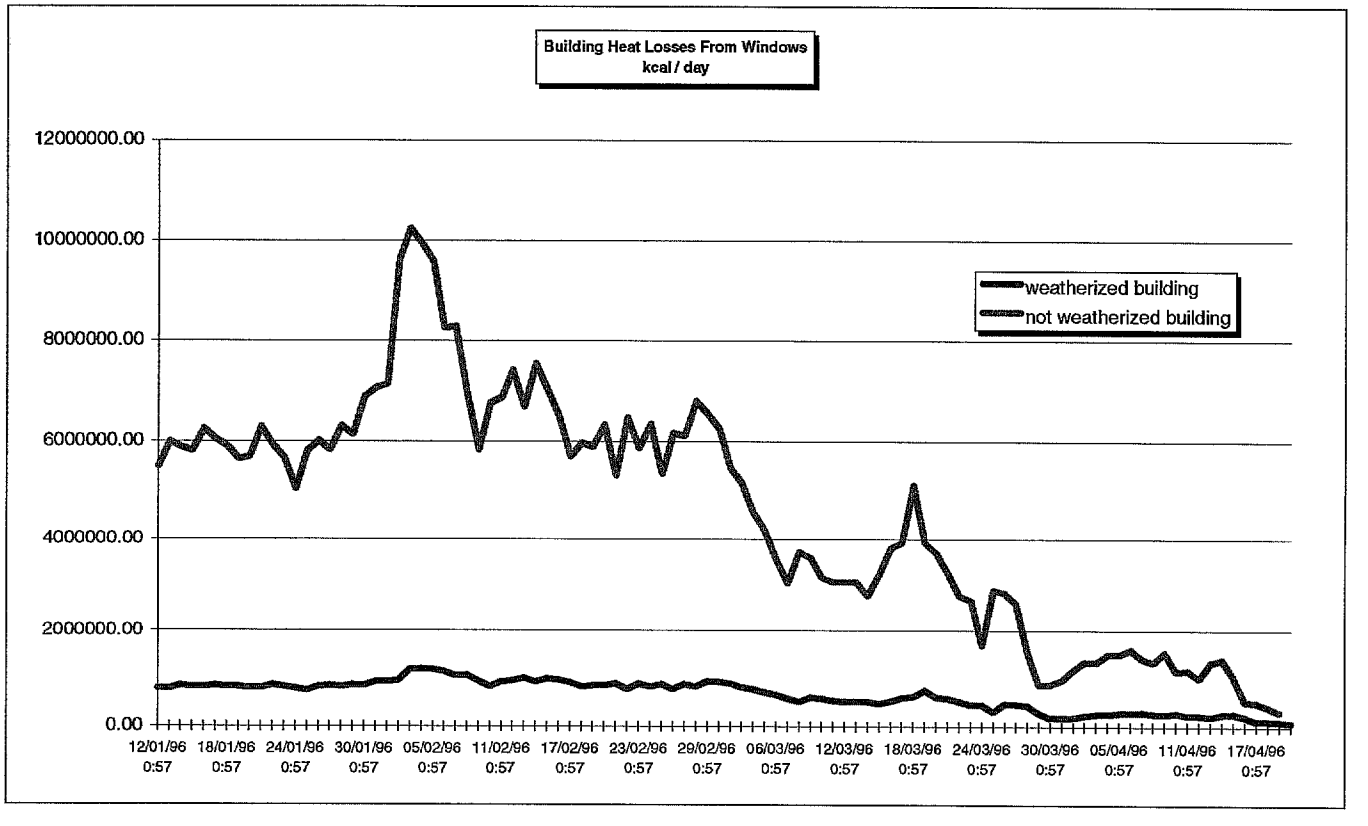
Building Heat Losses From Windows
kcal / day
12000000.00
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6000000.00
4000000.00
2000000.00
0.00
weatherized building
not weatherized building
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17/04/96 0:57

TRAUMATOLOGICAL HOSPITAL #6, YEREVAN

- Constructed in 1963; tufa block
- 4 floors/190 rooms (93 patient rooms, 11 operating rooms, 6 critical care rooms)
- Operational Capacity = 350 patients (served by 60 doctors)
- District heating backed-up by wood-burning stoves

Quantitative Results

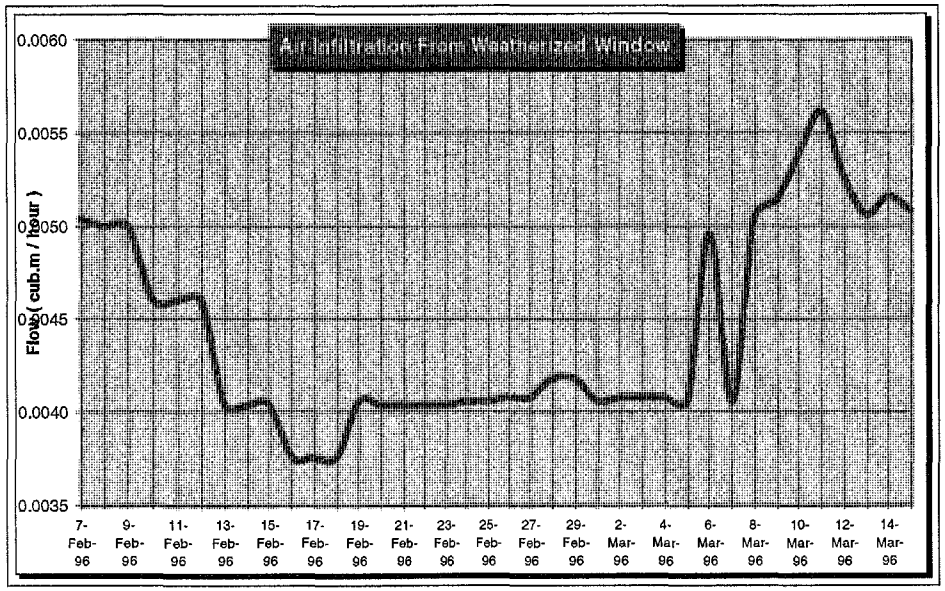
Actual

✓ Temperatures in weatherized room higher by 5° - 10° C
✓ Heat losses from infiltration at windows reduced by 43%
✓ Energy savings for monitoring period = 260 million BTUs
✓ Cost savings for monitoring period = $1,395
✓ Payback period = 346 heating days
✓ Monitoring period = 38 heating days

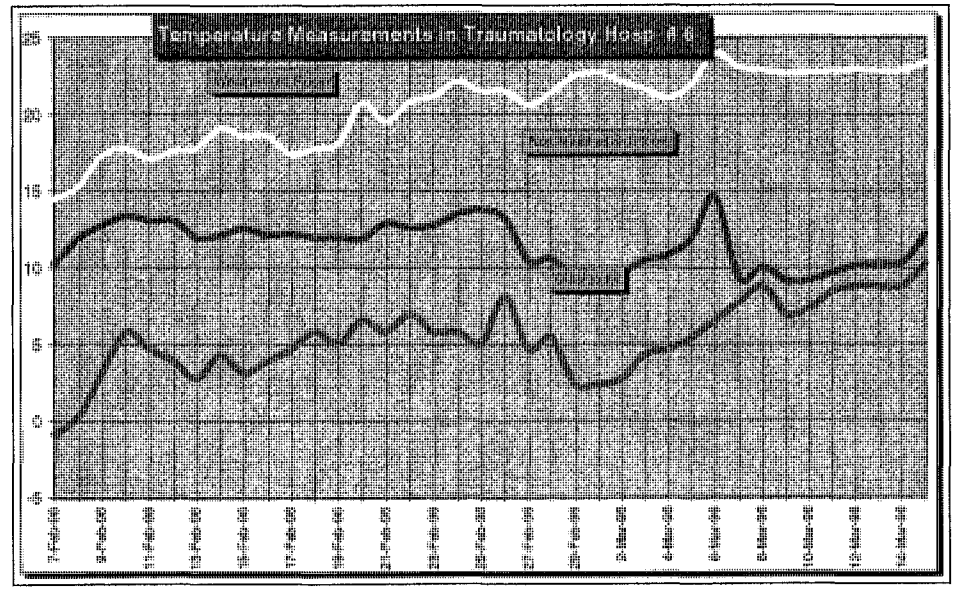
Theoretical

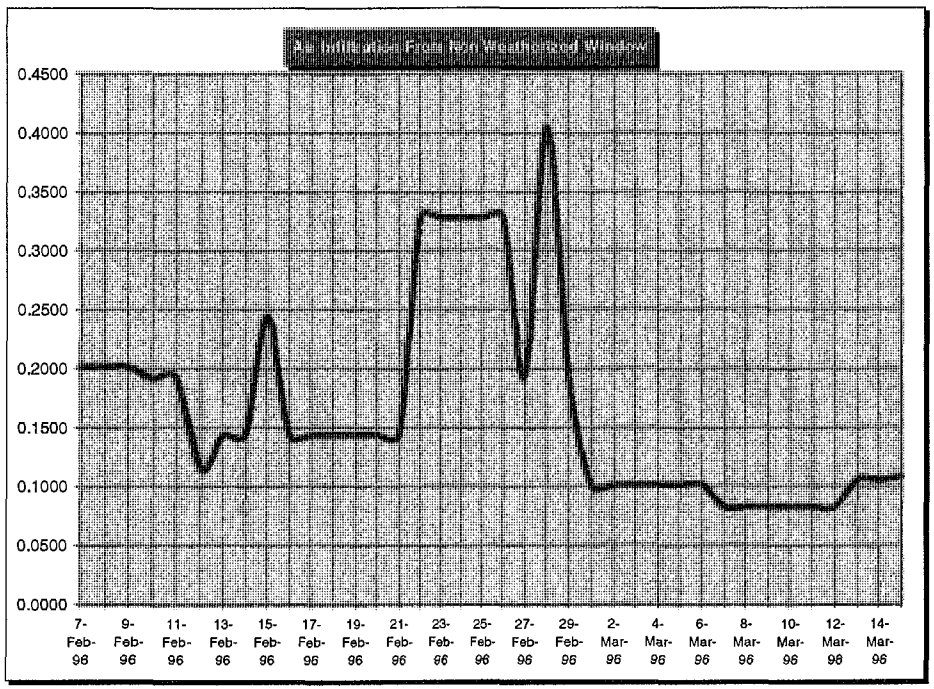
✓ Heat losses from infiltration at window reduced by 51%
✓ Energy savings for monitoring period = 543 million BTUs
✓ Cost savings from monitoring period = $2,909
✓ Payback period = 166 heating days

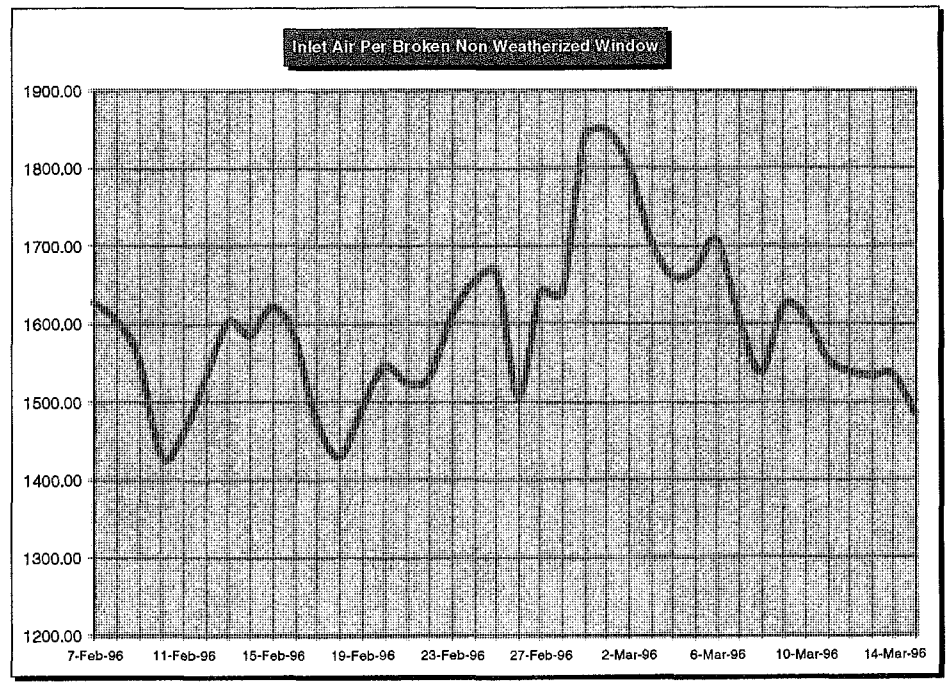
Traumatology Hospital # 6



Traumatology Hospital # 6

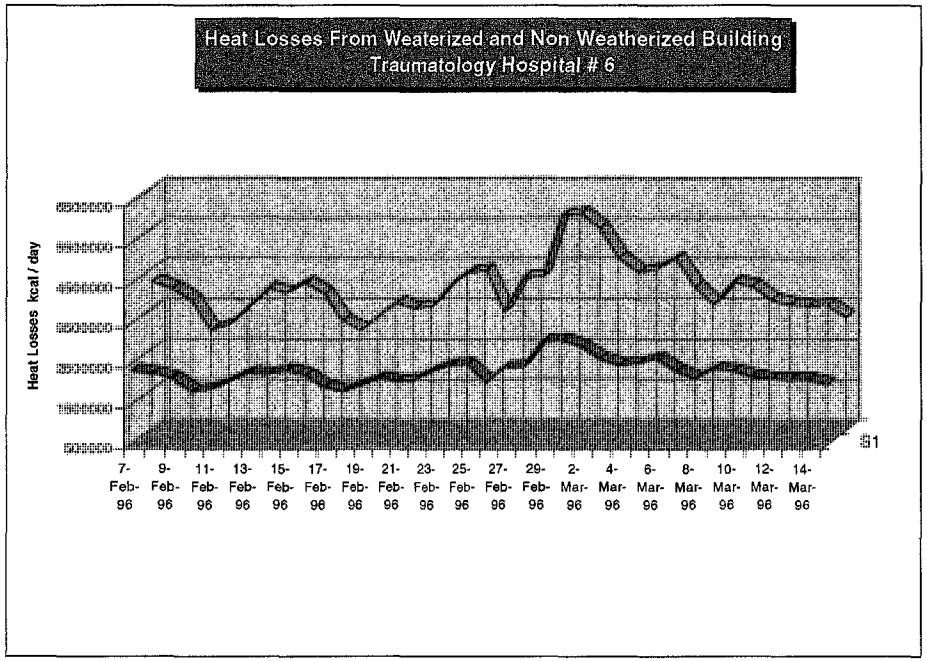


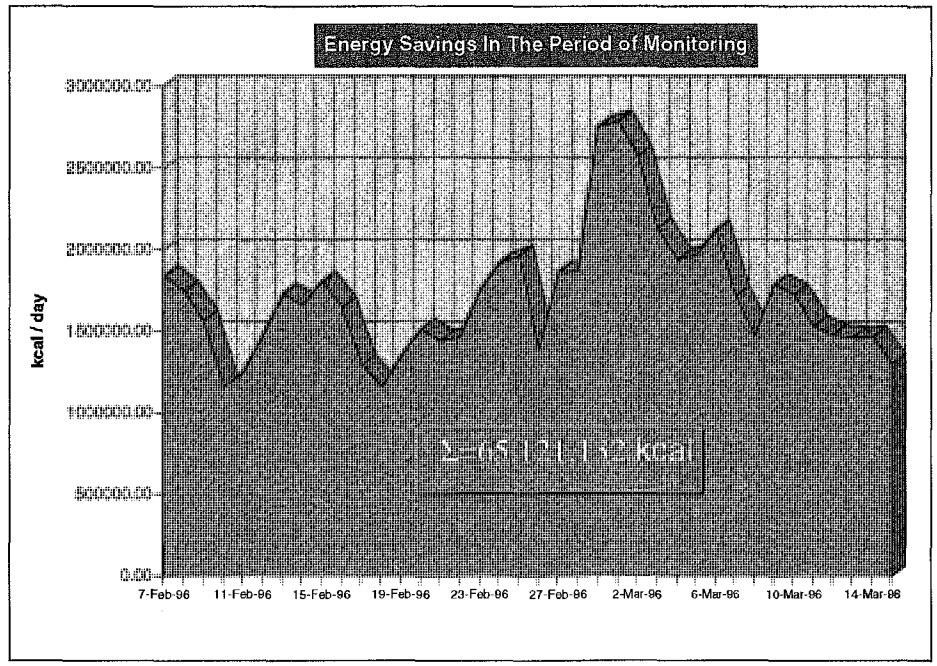


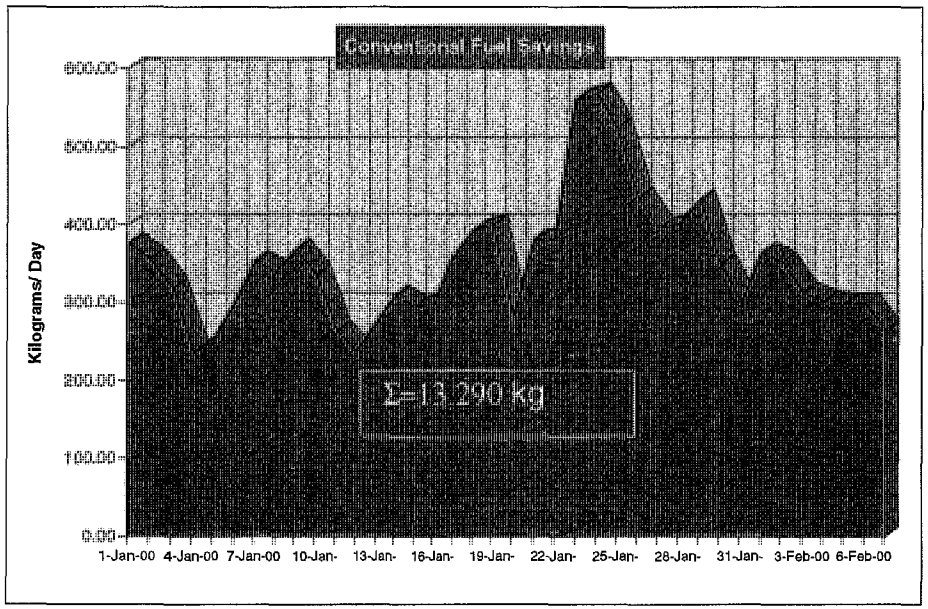


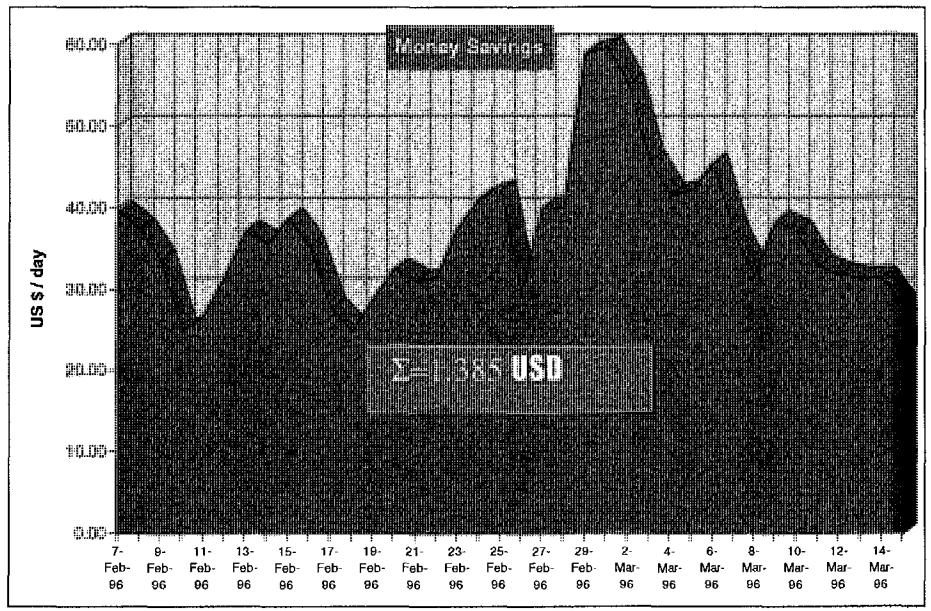
Traumatology Hospital # 6

Traumatology Hospital # 6









SCHOOL #8, YEREVAN

- Constructed in 1923; tufa, concrete block with tufa plates, and glass block. One of the oldest and largest schools in Yerevan, central city.
- 4 floors/82 rooms (46 classrooms serving grades kindergarten - 8)
- Operational Capacity = 1,124 students and 120 teachers
- District heating system shut down in this district. Heating source is kerosene, backed-up/supplemented by electric space heating.

Quantitative Results

Actual

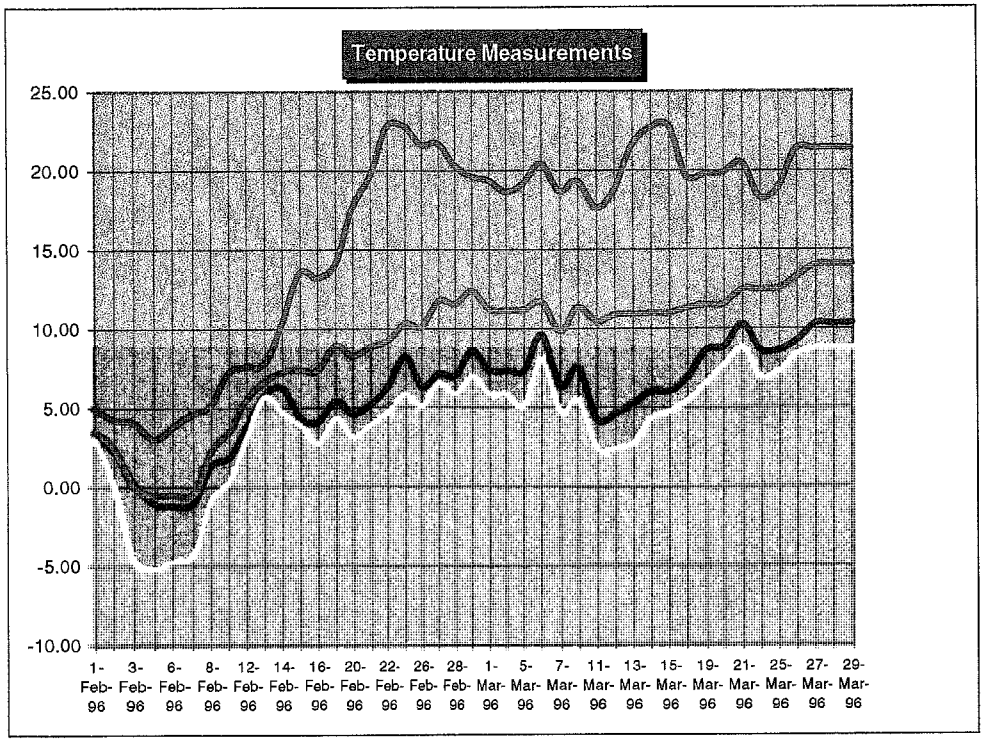
✓ Temperatures in weatherized room higher by 5° - 10° C
✓ Heat losses from infiltration at windows reduced by 60%
✓ Energy savings for monitoring period = 560 million BTUs
✓ Cost savings for monitoring period = $3,001
✓ Payback period = 823 heating days
✓ Monitoring period = 58 heating days

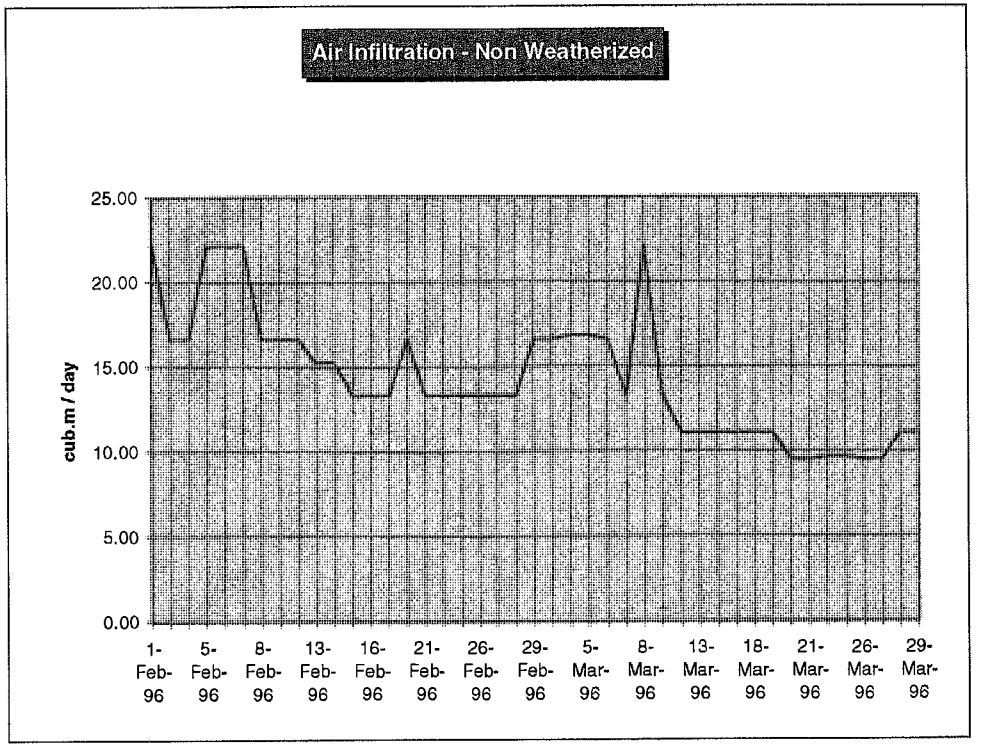
Theoretical

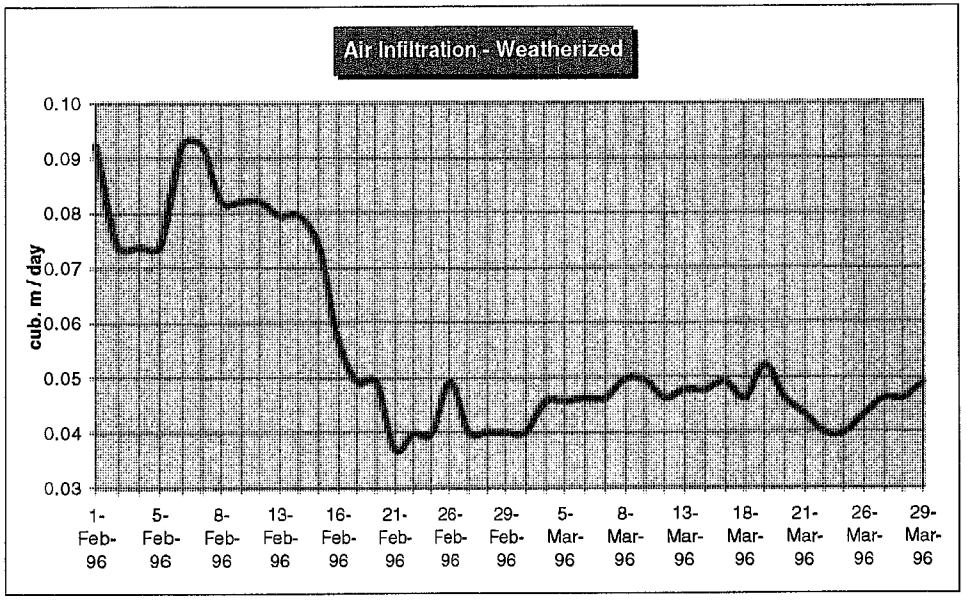
✓ Heat losses from infiltration at window reduced by 66%
✓ Energy savings for monitoring period = 1.06 billion BTUs
✓ Cost savings for monitoring period = $5,684
✓ Payback period = 434 heating days

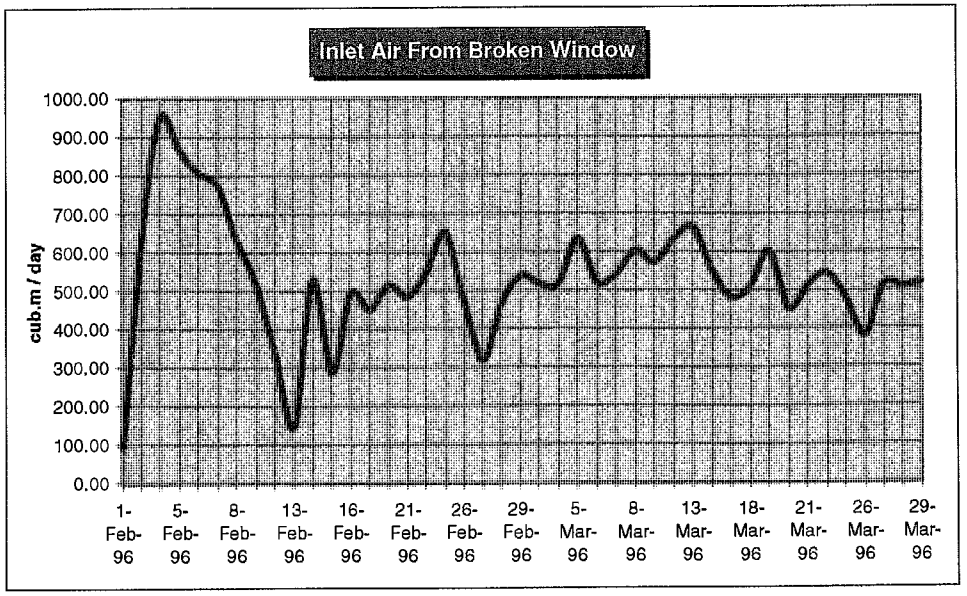
Secondary School # 8

Secondary School # 8



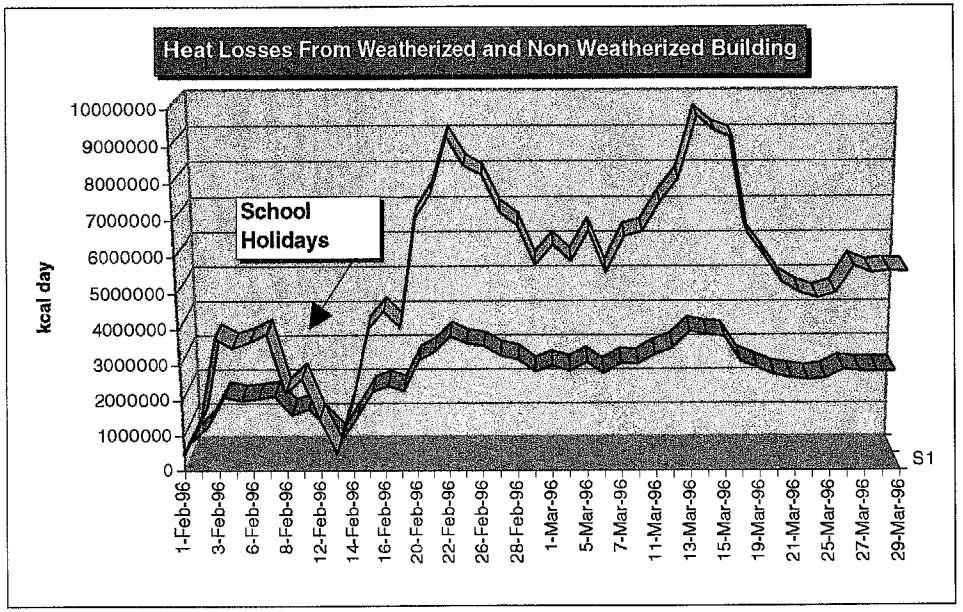


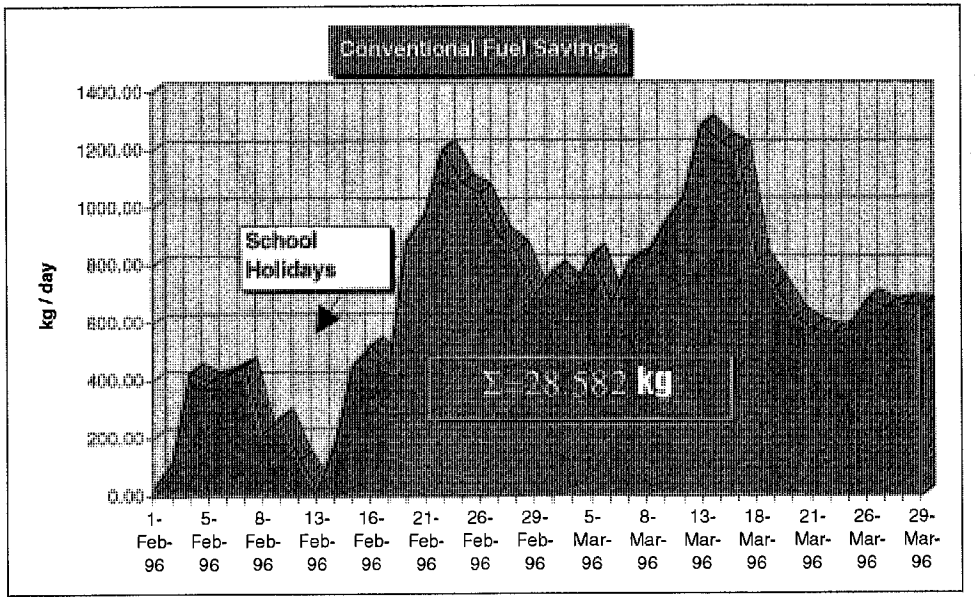


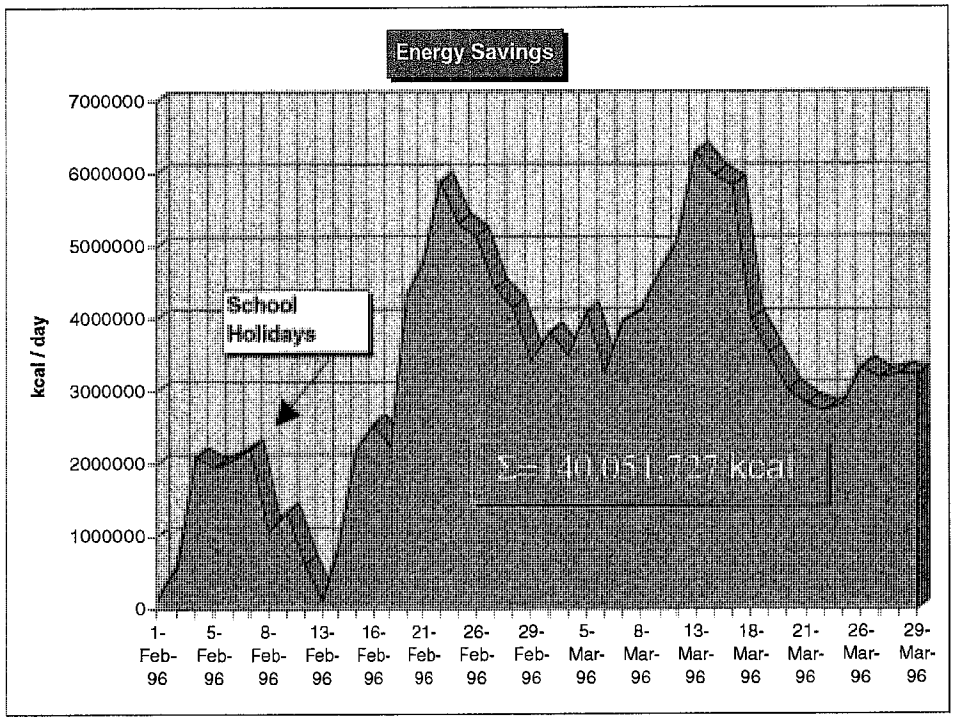


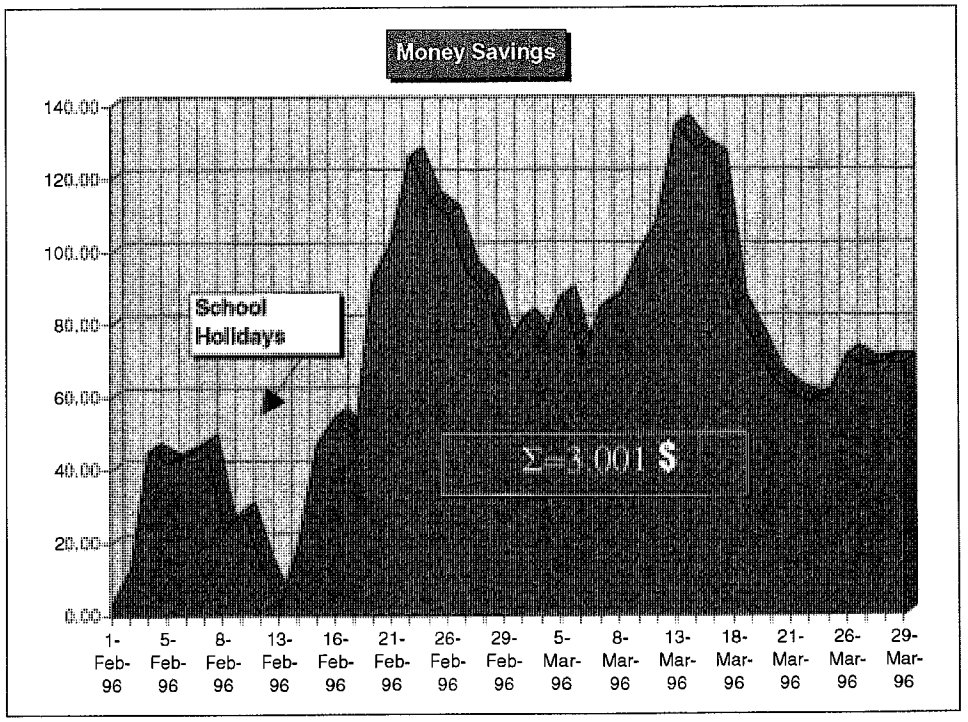
Secondary School # 8

Secondary School # 8









SCHOOL #20, YEREVAN

- Constructed in 1960; tufa and concrete block with tufa plates
- 4 floors/76 rooms (50 classrooms, 10 laboratory rooms, 5 offices, serving grades kindergarten - 8)
- Operational Capacity = 780 students and 90 teachers
- District heating system shut down in this district. Heating source is kerosene, backed-up/supplemented by electric space heating.

Quantitative Results

Actual

✓ Temperatures in weatherized room higher by 5° - 10° C
✓ Heat losses from infiltration at windows reduced by 73%
✓ Energy savings for monitoring period = 6.5 million BTUs
✓ Cost savings for monitoring period = $1,502
✓ Payback period = 425 heating days
✓ Monitoring period = 44 heating days

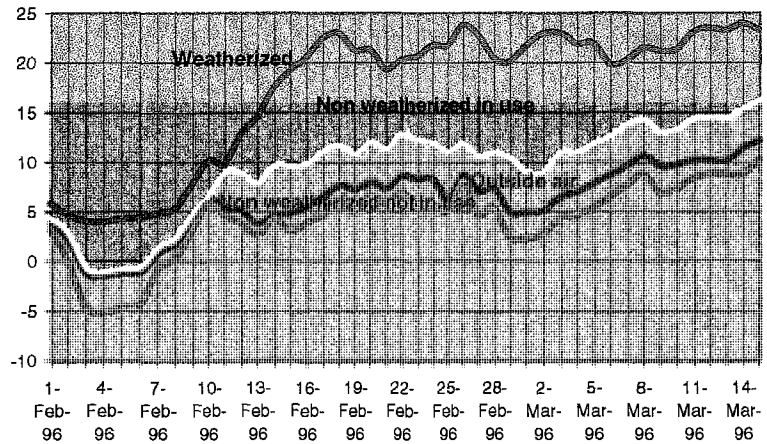
Theoretical

✓ Heat losses from infiltration at window reduced by 77%
✓ Energy savings for monitoring period = 7.5 million BTUs
✓ Cost savings for monitoring period = $4,071
✓ Payback period = 157 heating days

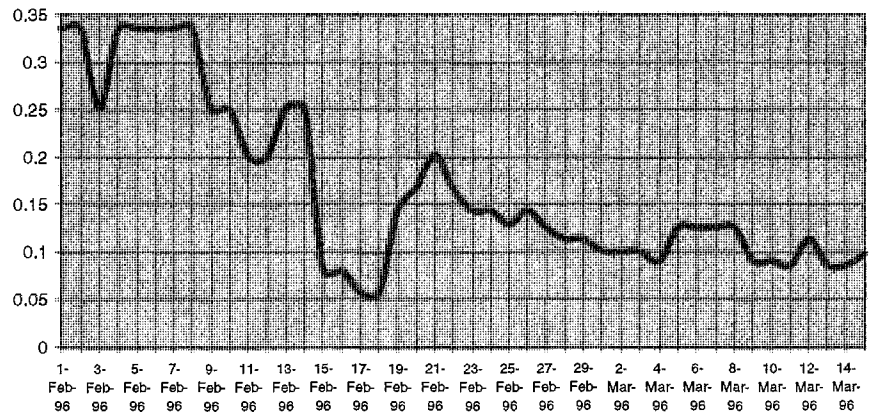
Secondary School # 20

Secondary School # 20

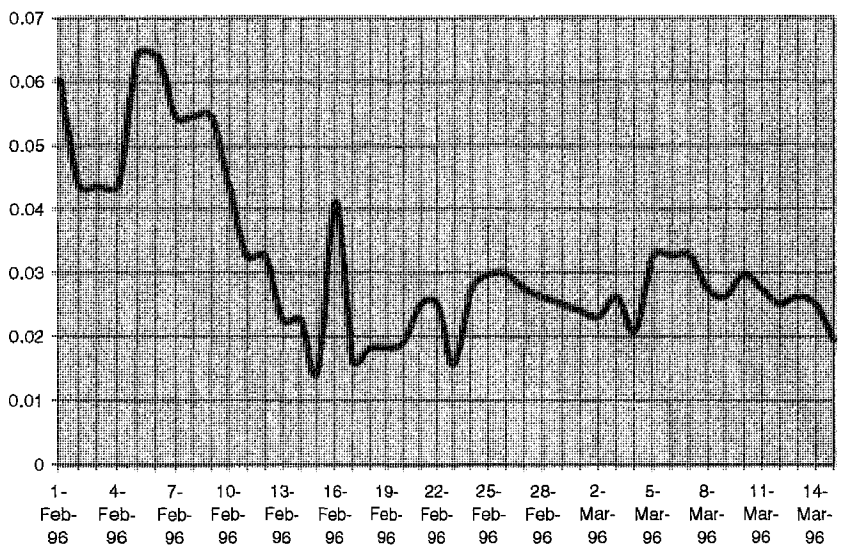
Temperature Measurements



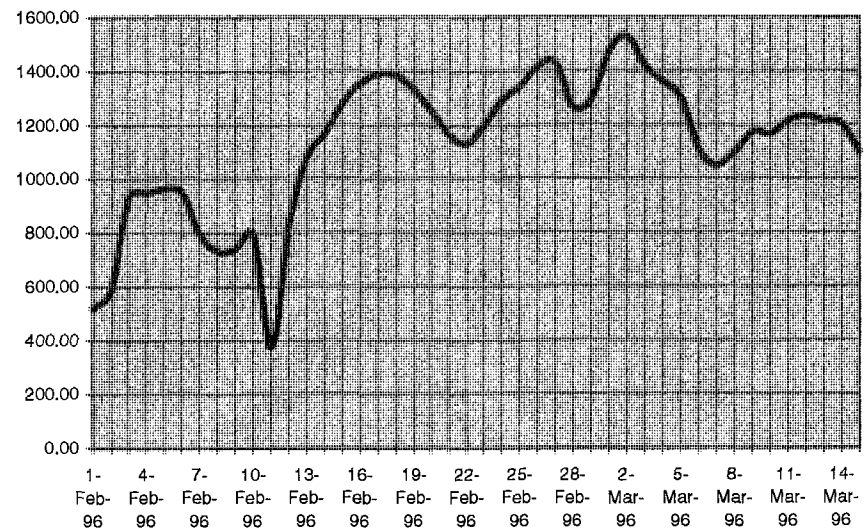
Air Infiltration Weatherized



Air Infiltration Weatherized

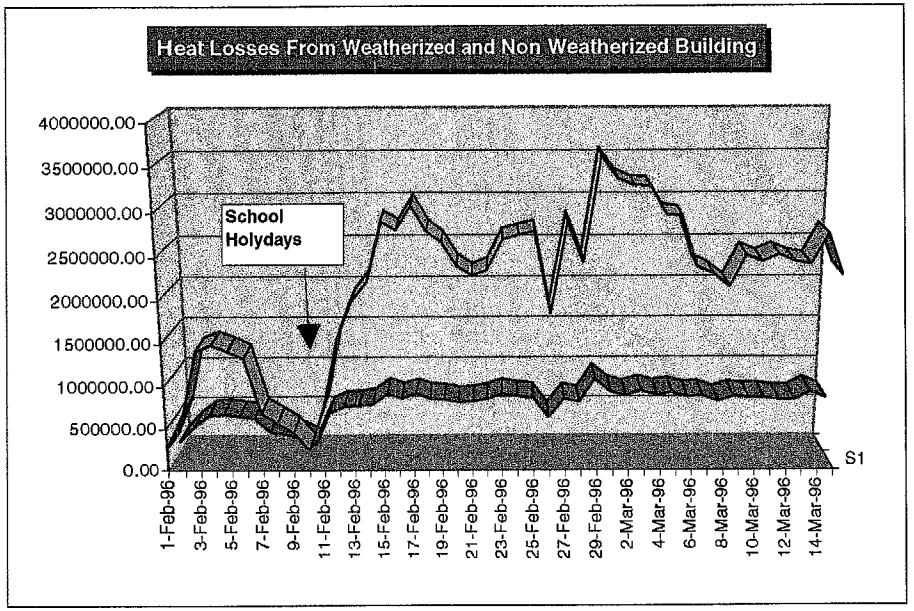


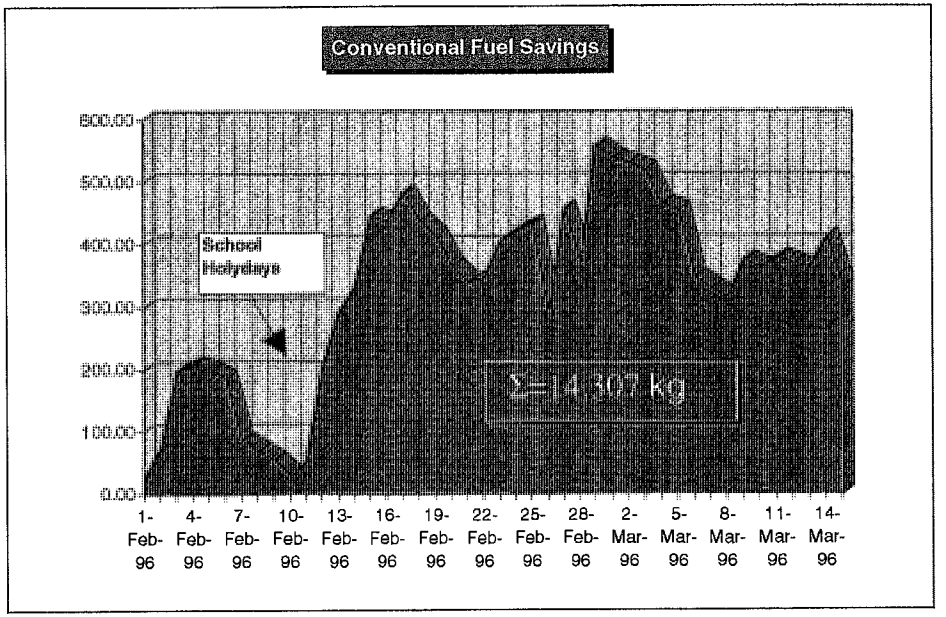
Inlet Air From Broken window

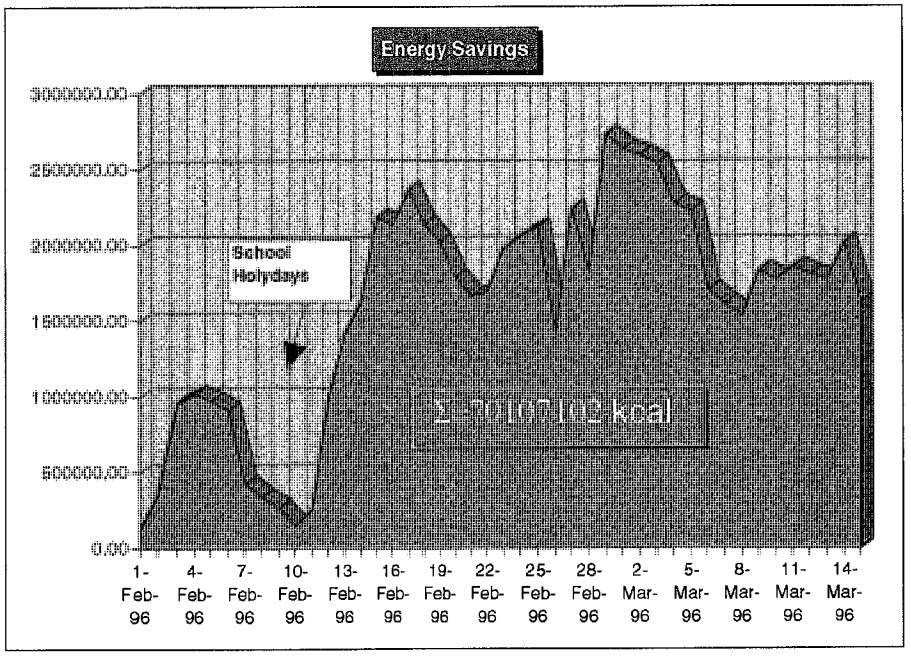


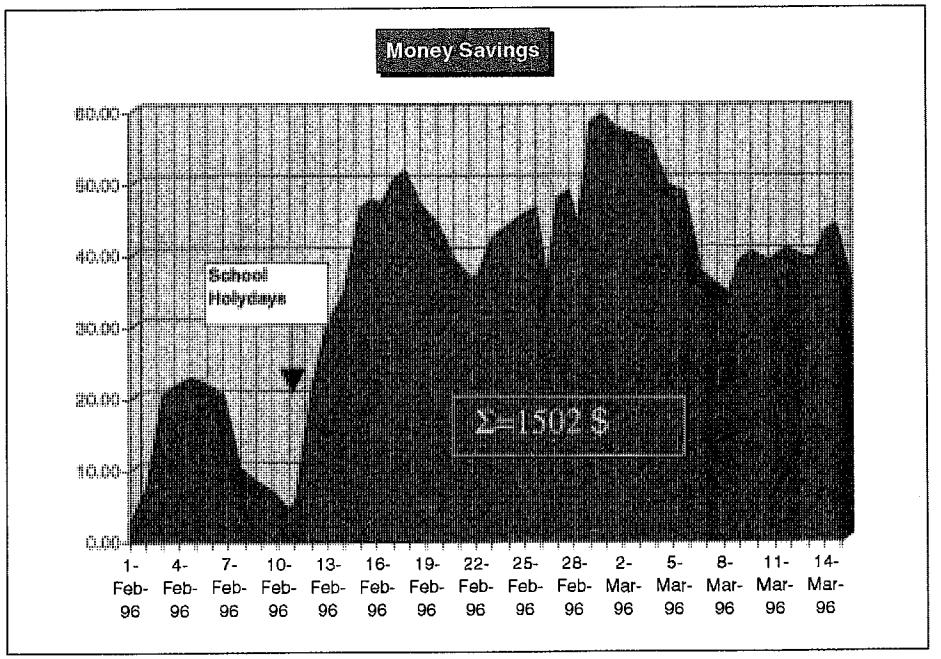
Secondary School # 20

Secondary School # 20









3.2 Qualitative Results

This section presents the results of the surveys from each of the survey groups:

- Participants
- Non-Participants
- Workers
- Persistence of Weatherization Measures

The surveys which were administered (in English and Russian) are contained in *Appendix B*.

3.2.1 Participant Surveys

The objective of surveying the participants was to determine their satisfaction with the weatherization work. Participants of the weatherization program are those people who work in or receive services from the buildings which were weatherized as part of the program. A total of 59 persons were interviewed for the participant survey, from nine sites which had been fully or partially weatherized. The survey sample is described more fully in *Section 4.2.1*. The survey questions generally fell into five different categories:

- Weatherization Impacts
- Quality of the Weatherization Work
- Perception of the Cost of the Work
- Achievable Energy Savings
- Comments

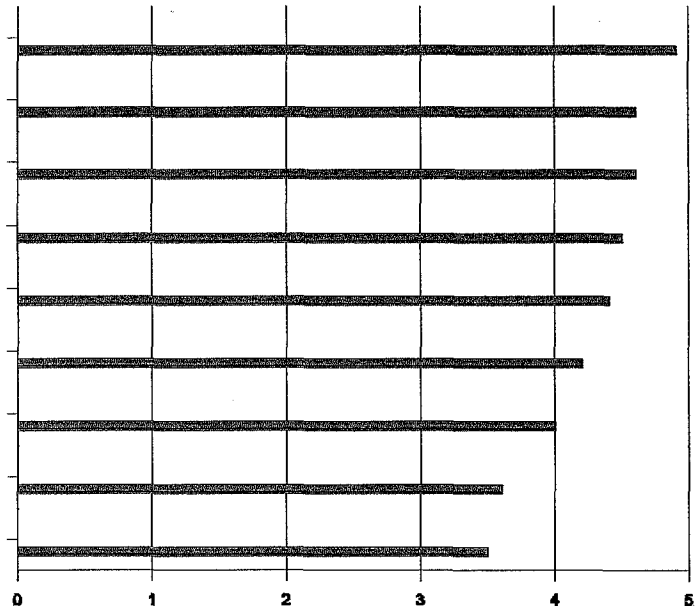
<u>Weatherization Impacts</u>

The impacts of the weatherization work could be both positive (e.g., higher level of comfort, better working environment) and negative (higher level of moisture). A series of questions were designed to measure the participant's perception of the impacts of the weatherization. Respondents were asked to rank their opinion of the possible impact, based on a scale of 1 to 5, with 1 being "strongly disagree" to 5 being "strongly agree". For each of the questions, the mean was calculated. The possible impacts which the respondents agreed to and their means are shown (from highest to lowest) on the following chart.

Weatherization Impacts Survey Results #1

Note: 1 = "strongly disagree"; 5 = "strongly agree"

1. Weatherization is important for keeping the building in good shape
2. More attractive building
3. Better working environment
4. Employees more productive
5. Reduction in the level of dust
6. More energy efficient
7. Weatherization saves energy
8. Reduced noise level
9. Reduced number of sick days



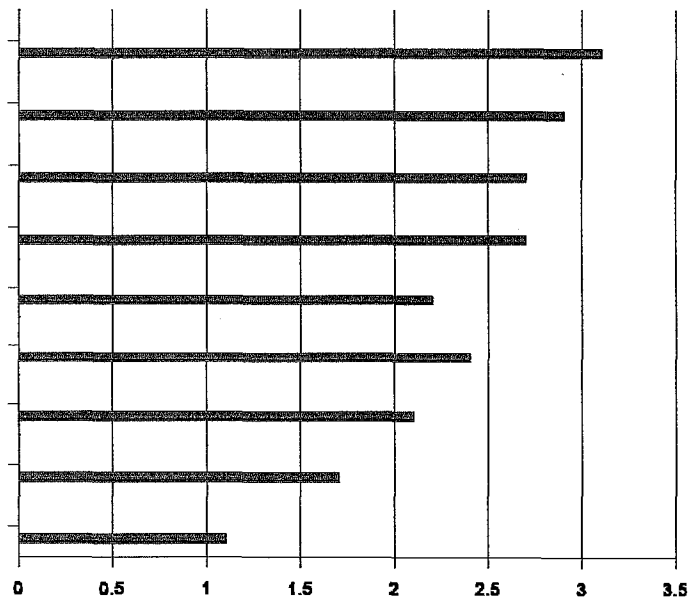
It is interesting that the impacts which the respondents agreed to be the strongest were the ones which were either visible or led to a greater physical comfort. That weatherization made the facility more energy efficient and that it saved money were not perceived to be among the strongest impacts. This could lead to the conclusion that in "selling" weatherization, the most important element is improved comfort.

The following chart displays the results of survey questions regarding impact statements with which the respondents either disagreed or were neutral.

Weatherization Impacts Survey Results #2

Note: 1 = "strongly disagree"; 5 = "strongly agree"

1. Increased security in the building
2. Energy efficiency could be improved with additional work
3. Reduction in the rate of complications due to cold - hospitals only
4. Number of patient days decreased
5. Fewer complaints of noise
6. Poorer indoor air quality
7. Greater problems with moisture
8. Significant disruption in the work during weatherization
9. The level of infection decreased - hospitals only

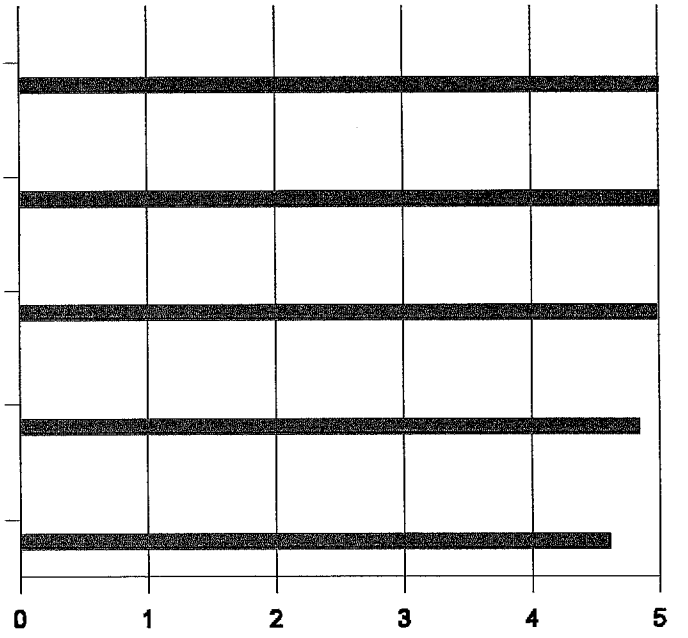


Quality of the Work

One of the emphases of the weatherization program was on the quality of the work, both through the use of quality materials and the intensive training of the workers. The reasons for this were to demonstrate the energy savings possible using low-technology materials and to raise the standard of workmanship which is expected. The survey contained five questions regarding the quality of the work and the materials. The respondents were asked to rank the statement on a scale of 1 to 5, with 1 being "strongly disagree," and 5 being "strongly agree." These statements and the means of the responses are displayed on the following chart.

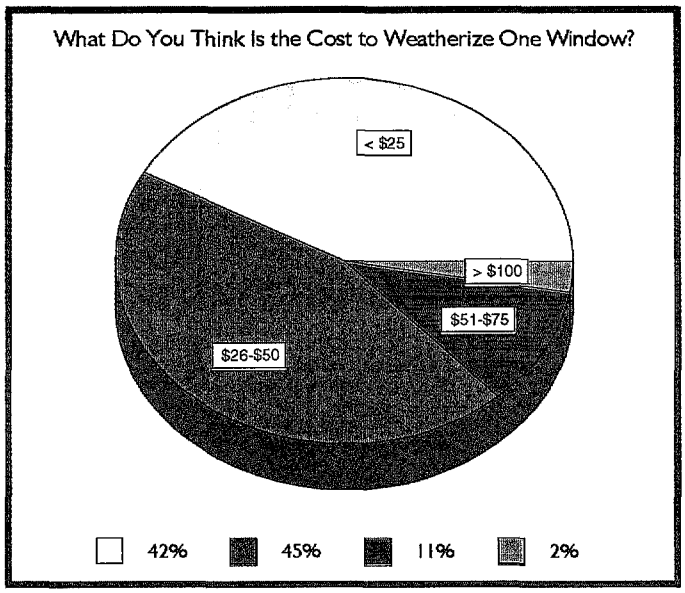
Responses Relating to Quality of Work

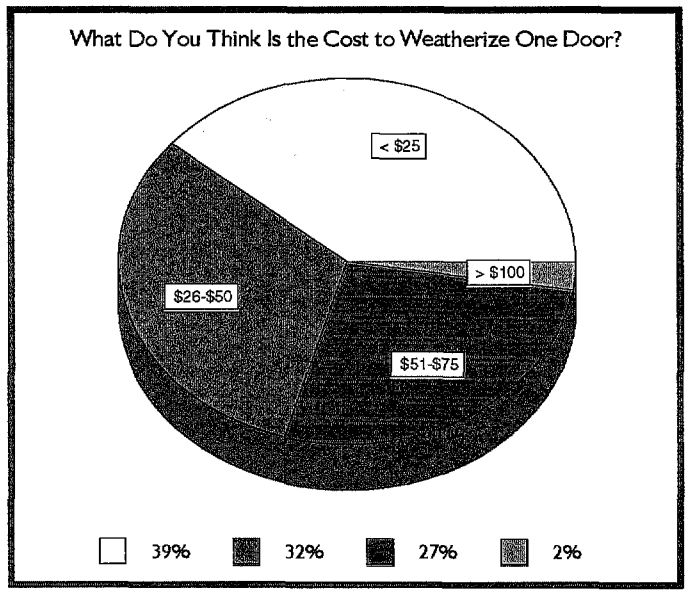
1. RMA was easy to work with
2. The workers were highly skilled
3. RMA was responsive to problems which came up in the work
4. RMA uses high-quality materials in the work
5. Overall rating of the quality of the work (5 is "excellent", 1 is "poor")



Cost of the Weatherization

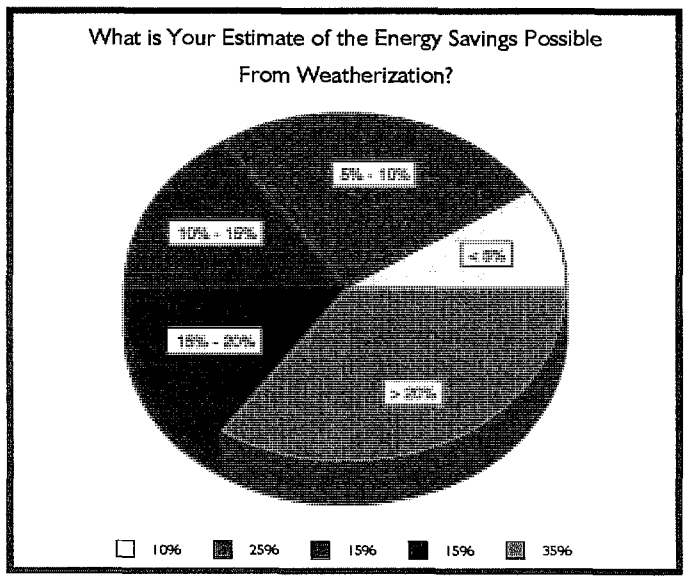
Respondents were asked their estimate of the cost to weatherize a single door and a window. The distribution of their responses is shown in next two figures. The actual cost for Maternity Hospital #4 (basic weatherization) is approximately $56 per window or door.





Possible Energy Savings

Respondents were also asked what their estimate of energy savings would be. The distribution of their responses is shown on the adjacent graph.



Respondents' Comments

Several comments have been selected to indicate important additional points from the survey activity.

- "The number of days which the school could remain open increased by 20."
- "All teachers detected a major increase (around 50%) in the attendance of students this year as compared to last year."
- "It is quite important and will be very informative to conduct next year the same survey at the same sites".
- (Hospital) "The number of patients increased not only because of the weatherization, but also because we started to feed patients... It was foreseen to consume 4,000 kWh per day, instead we consumed 1,300 kWh because of weatherization and our thriftiness. It is also expected to save another 300 kWh in the summer time."

Several sites requested additional weatherization work.

Notes from interviewer:

"All participants were pleasantly surprised with the weatherization materials, the tools; they never saw anything like that. But most of all, by the style, attitude towards work and people around showed by the workers. They never believed that our Armenian ex-Soviet people are able to maintain such a quality".

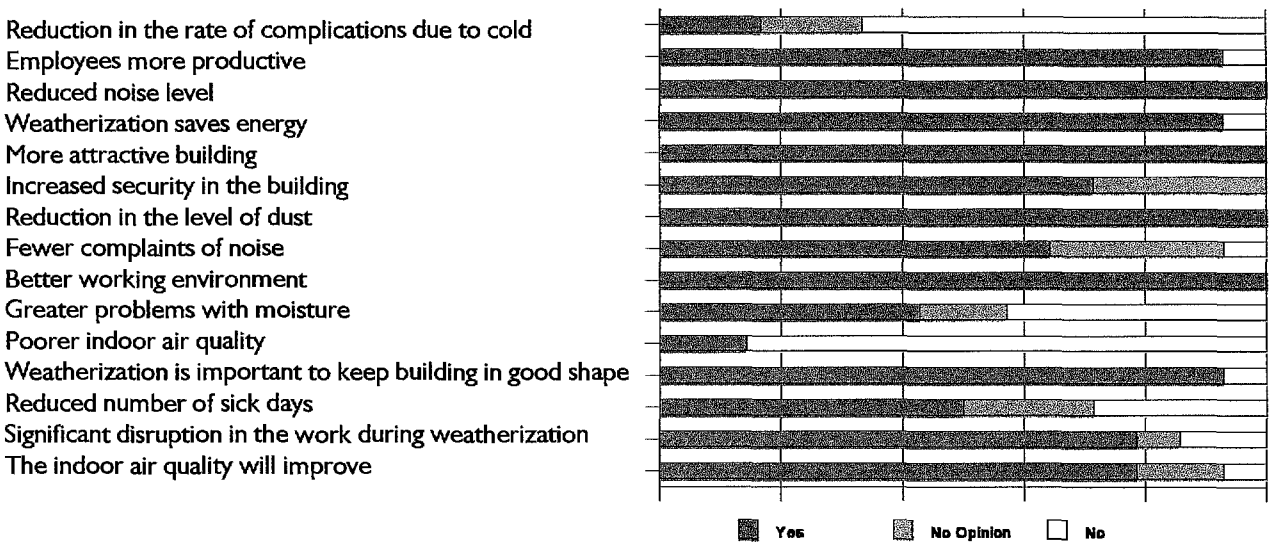
"It became difficult for participants to do a comprehensive estimation of the benefits and impacts of the weatherization because this winter was not as severe as the previous one. Also, this year, in some places the kerosene distribution was more plentiful."

3.2.2 Non-Participant Surveys

The primary purpose of conducting surveys of the non-participants was to determine if the demonstration aspects of the project increased awareness of weatherization impacts on the part of participants. They were asked questions similar to those posed to participants, and the results were compared. Two sites were selected for the non-participant surveys: School #8 (portions of which were not yet weatherized) and Erebouni Hospital, who had requested weatherization work. Personnel at both sites were obviously aware of the weatherization work, especially at School #8, where parts of the building had already been weatherized at the time of the surveys. The survey contained questions which addressed possible positive and negative aspects of weatherization as well as perceptions of weatherization costs.

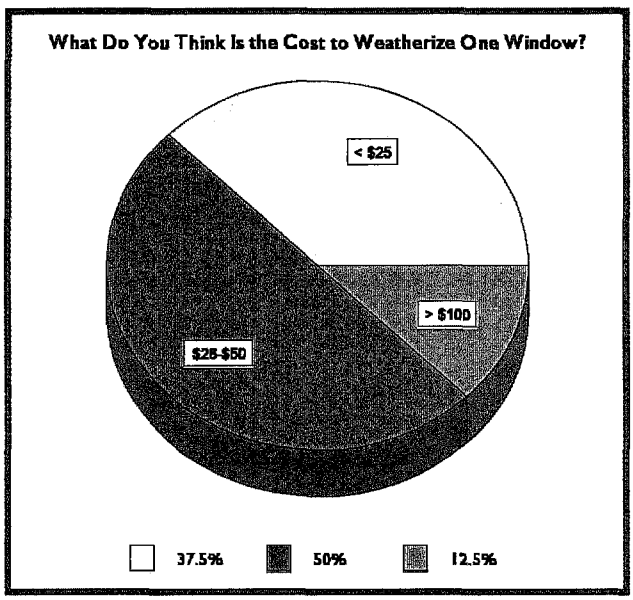
In field testing the surveys, we found that it was not possible for non-participants to respond to the impact statements with any differentiation in degree of agreement or disagreement with a particular statement. In other words, a non-participant could not select from a range of responses when presented with a statement such as "Weatherization will result in a better working environment." A non-participant could agree or disagree with the statement, or have no opinion. Thus, the survey was modified so that all questions on potential impacts of weatherization were answered "yes," "no," or "no opinion." This means that these responses cannot be directly compared to those of the participants, except in the area of expected cost of weatherization, where the questions were the same.

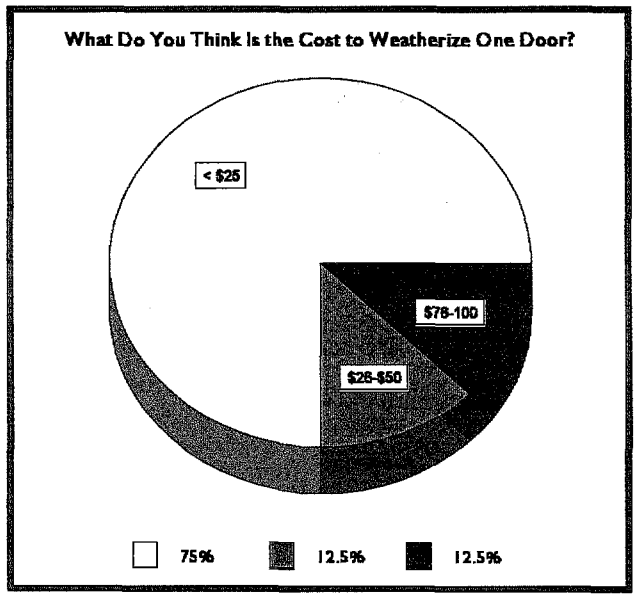
Impacts of Weatherization



Costs of Weatherization

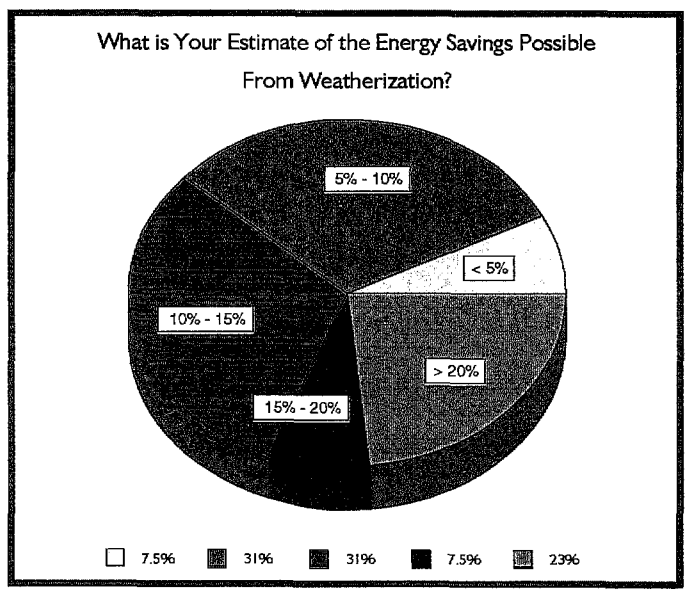
The next two figures give the breakdown of responses to the questions of expected cost of weatherizing one window and one door.





Potential for Energy Savings

The adjacent figure shows the distribution of estimated energy savings.



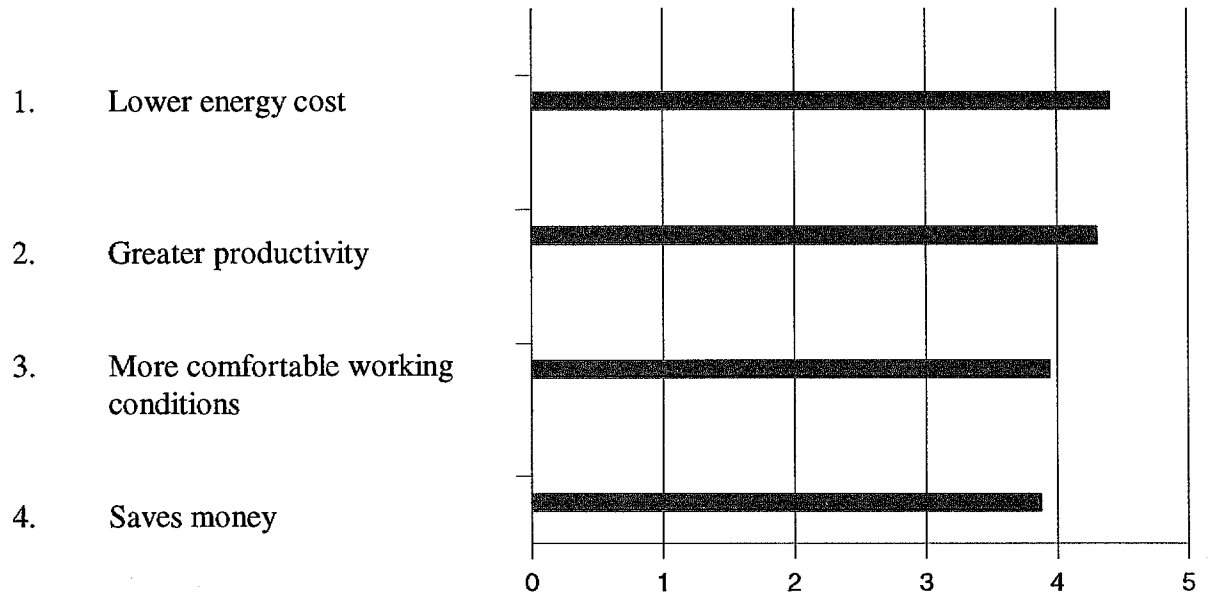
3.2.3 Workers Surveys

The objective of surveying the workers was to determine their perceptions of the customer's views on impacts of weatherization, the skills which the workers had learned in performing the weatherization work, and whether a market seemed to be developing in Armenia for weatherization services. Surveys were completed by sixteen of fifty workers, roughly one-third of the crew members. Efforts were made to survey all of the job categories, including crew leaders, workers, carpenters, and support personnel (warehouse, estimation). The sample which was surveyed is described in more detail in *Section 4.2.1.*

Impacts of Weatherization

Workers were asked to rate the importance of the following impacts of weatherization according to their importance to the customer (1 is not important, 5 is very important). They have been ranked according to the mean response, from highest to lowest.

Workers' Assessment of the Impacts of Weatherization



Possible negative impacts of the weatherization work, such as moisture or increased indoor air pollution, were judged not to be important factors.

Market for Weatherization Services

Workers were questioned about their perception of whether a market was developing, by asking about increased supply of materials in response to market demand, greater awareness of benefits of weatherization, and the usefulness of skills that had been taught. The answers to all of these questions tended to settle around a mean of 3 to 3.73. This indicates a fairly neutral response to whether there is a sustainable market. This is most likely due to the general economic situation in Armenia, rather than a reflection on sustainability of a market for weatherization services.

On the other hand, four of the sixteen workers who were surveyed strongly agreed that they would be interested in starting their own weatherization business when the project was completed. These are the persons who are being targeted for further training in estimating, preparing bids, and contracting construction-related work.

Quality of Work

All workers strongly agreed that RMA stressed high quality in the work which was done (mean of 5, which is the highest possible score).

The workers also judged that the administration of the buildings which were weatherized were very happy with the work which was done (mean: 4.9).

Comments

Comments of the workers are included in Appendix C. In general, when asked about the most important things learned from the work, workers cited the following:

- A greater awareness of the benefits of weatherization
- The importance of good management
- Familiarization with new materials and techniques
- A sense of satisfaction in achieving impressive results

3.2.4 Persistence of Weatherization Measures

The weatherization program has been fortunate to have had multiple years in which to improve and refine operations. While the emphasis and the funding level allocated has been quite different in each of the three years, the basic activity of weatherization has remained largely the same. The first year was a relatively small demonstration activity of the benefits of weatherization. The second year of funding focused more on critically needy populations, primarily a humanitarian effort, rather than on skills development or energy savings. In the third year, the main emphasis has been on making the services cost-effective and market-oriented. Because the program had multiple years, we felt it was appropriate in the impact assessment to revisit some of the sites which were weatherized in the first and second years to see whether the measures were still in place and to determine whether the recipients had experienced any problems or difficulties with the weatherization.

A reviewer was sent out to each of the sites to interview personnel and to assess the status of the weatherization measures through visual inspection. In all of the institutional sites visited, the condition of the weatherized windows and doors was visually inspected and was judged to be satisfactory.

The reviewer also visited two residential sites which had been weatherized, the Sayat Nova Apartment building and a refugee center. At Sayat Nova, problems with increased moisture were reported. There are several reasons for this. First, Sayat Nova was the first residential building

which was weatherized in this program. The crews were relatively inexperienced at that time, so they made the rooms too airtight in locations which had more moisture because of room usage (e.g., bathroom or kitchen). Second, residents did not follow recommendations on room usage, e.g. not to cook in living rooms. Third, the problem was compounded when another organization applied ouside-the-wall insulation without making adjustments in the indoor conditions. As a result, it was noted in the visit that residents had removed weatherstripping. Moisture problems were not reported by residents in the refugee hostel.

Selected comments from the persons interviewed in the persistence survey follow.

Comments

Director of Spitak School #4: "After the earthquake of 1988 we felt like we had been abandoned... Of course, some assistance was provided by different organizations, but we felt that this help was somewhat formal. RMA was the first organization whose management differed dramatically from any other I had ever seen. The final results of their job are exceptional; you can see with your own eyes the quality of work.. ...Last year we were forced to have only 15-minute classes (instead of the regular 45 minutes), and only in two or three classrooms. This number of classrooms was necessary to maintain warmth during the winter. After the weatherization performed by RMA, we now have 45-minute classes and all of our classrooms are operating. I noticed that inside the building, the drafts vanished. ...After the weatherization, the building aesthetically looks more attractive..."

The administration of Spitak School #6: "The winters here in Spitak are quite severe (lows of -25° C). Before the weatherization done by RMA, we used to burn the furnaces all day, with very little results. The children would sit in their coats, wearing gloves and hats. The classrooms at school were so chilly that we were even forced to stop our studies for a month. This year, we had all of our classes. The kids didn't even wear coats during their lessons."

The Director of School #67 in Yerevan: "I would like to stress the significant effect of the thermoinsulation, which I correspond with RMA's work. ...The amount of fuel used this year was the same as compared to the previous year, but the temperature inside the building was noticeably higher. My office used to be the coldest place in the building, and during winter, I was always cold and wore a coat. Now I feel comfortable in my office. Thank you."

Hospital - cardiology unit: "We've noticed a significant change in the inside temperature."

The maintenance man of the Aparan Refugee Center: "Before the weatherization, parents didn't allow their kids to attend kindergarten because of the cold. This is the first year the Kindergarten actually operated during the winter. We were even able to celebrate New Year's Eve here. Thank you all."

Chief of Depository of the National Art Gallery: "Our institution is one of honor for all Armenians, and therefore is considered a site of first priority. However, due to the energy crisis and poor insulation, all of the art pieces in the Depository were doomed to perish. Because of the cool inside temperature, the quality of the paintings was deteriorating. ...After weatherization, we were able to preserve our art in improved conditions. I felt the difference in temperature in my own office as well as the offices of other employees. ...We are very happy with this initiative."

4. IMPACT ASSESSMENT DESIGN AND METHODS

4.1 Quantitative Assessment

Four sites were monitored to determine temperature and air infiltration differences, utilizing a weatherized room and a non-weatherized room for comparison. The measurement period used for comparison is January through March 1996. Energy savings during the measurement period were calculated assuming a constant energy supply where the supply has been erratic. Four buildings were monitored: Maternity Hospital #4, School #8, School #20, and Traumatological Hospital #6.

Energy savings were calculated for the four buildings based on collected data. Formulas which were used in the calculations are shown in Appendix D.

Engineering calculations were done for all buildings weatherized to determine theoretical (expected) energy savings, taking into account data limitations. The expected energy savings were compared to measured savings, and energy savings payback periods calculated and compared.

4.2 Qualitative Assessment

4.2.1 Survey Design and Implementation

Participant Survey

Five different use types of buildings have been weatherized in the total weatherization program funded by USAID in FY '94, '95 and '96:

- Schools
- Hospitals
- Refugee Centers/Orphanage
- Housing (Apartments)
- Commercial (Office, Museum, Theater)

A survey was developed to determine program impacts, such as increased awareness of the benefits of weatherization, increased comfort, productivity improvements, ease of working with RMA, and overall customer satisfaction with the weatherization. Unintended consequences of the program are also addressed, such as moisture-related problems, increase in indoor air pollution, and inconvenience to the customer. The survey was administered to program participants at several levels:

- Schools: Administrators, Building Maintenance, Teachers, Parents
- Hospitals: Administration, Heads of Departments, Doctors/Nurses
- Refugee Centers: Regional Managers, Refugees, Building Maintenance

The survey also contained general questions which were used to profile the respondents. A draft survey was prepared prior to Ms. Mary Worzala's April visit to Yerevan, and the RMA/Yerevan office was consulted regarding the relevance and phrasing of all questions. Modifications were made to the survey based on these discussions, and a version was prepared in Russian for implementation.

The impact survey was field tested during the April visit of Ms. Worzala by conducting interviews with a small number of respondents in each group. School #8, Hospital #4, and the refugee hostel in Sevan were used for field testing. Modifications were made based on the respondents ability to understand the questions and the ranking scale used in the survey. The final version of the survey is included in Appendix B.

After field testing and adjustment, the survey was implemented by the RMA/Yerevan staff (Rita Haroutunyan). Surveys were administered to personnel at a total of nine sites (listed below) which were weatherized in the period September 1995 through April 1996. Unless otherwise indicated, the sites were all located in Yerevan.

- Maternity Hospital #4
- School #8
- School #20
- Maternity Hospital #2
- Traumatological Hospital #6
- Refugee Hostel (Aparan)
- Refugee Hostel (Sevan)
- School #8 (Spitak)
- St. Mary's Hospital

Non-Participant Survey

Several questions on the participant survey are oriented towards what the customer perceives are the benefits of weatherization. This section of the survey was administered to non-participants in the program (i.e., customer groups who would like to have weatherization done in their facilities or unweatherized areas of buildings where work was done). One school (School #8) and one hospital (Erebouni) were included in the non-participant group.

The non-participant survey was developed and field-tested during the April trip of Ms. Worzala. It was decided to change the ranking scale from a numerical one (1 to 5), to a "yes," "no," or "don't know" response. This was because, in the field test, it was determined that respondents could not judge over a spectrum of responses to questions such as "Weatherization will save energy". Either the respondent agreed with the statement or disagreed, but didn't have any basis for differentiating on a scale. The non-participant survey was finalized after the field test, and is included in Appendix B (both in English and in Russian).

Worker Survey

One of the benefits to the weatherization program should be the increased skill level of the workers who were responsible for installing weatherization. A survey was developed to determine the impact of the training and other benefits of the program, including income generation, increased awareness of weatherization, market development, other employment opportunities, and interest in forming a weatherization company. The survey was field tested with a group of five workers and revised, based on their comments. The survey was administered to approximately one-third of the 60 crew members working on the program. Workers were also asked their opinion of the positive and negative attributes of weatherization.

Persistence Survey

The primary methods of assessing persistence of the weatherization done in previous years was through visual inspection and interviews. A checklist was developed for the reviewer to visually inspect the weatherized areas. The general condition was rated "1" (poor), "2" (average), or "3" (excellent). The reviewer also solicited comments from beneficiaries of the weatherization. In all, eight sites were visited in the persistence survey (three schools, two hospitals, two residential buildings, and the art gallery).

4.2.2 Descriptive Summary of Sample

Participant Survey

Site	Job Title	Number Interviewed	Average Years at Site
School #8	Administrator	1	16
	Teacher/Administrator	1	2
	Teacher	5	9.4
	Parent	3	N/A
School #20	Administrator	1	44
	Teacher/Administrator	2	18.5
	Teacher	4	20.5
School #4	Administrator	1	3
	Teacher	2	3
	Maintenance	1	3
	U.N. Representative	1	N/A
School #6	Teacher/Administrator	1	2
	Teacher	1	2
Hospital #6	Administrator	3	13.7
	Chief Physician	1	6
	Physician	3	19.3
	Nurse	1	11
	Maintenance	1	9
Maternity Hospital #2	Administrator	1	10
	Physician/Administrator	2	18.5
	Physician	2	15.5
	Nurse	4	28.25
	Cleaner	1	14
Maternity Hospital #4	Administrator	2	2.5
	Physician Administrator	1	12
	Nurse	4	9.75
	Maintenance		3
Refugee Center/Aparan	Administrator	1	1
	Refugee	2	8
Refugee Center/Sevan	Administrator (UN Rep.)	1	2
	Refugee	4	4

Non-Participant Survey

Site	Job Title	Number Interviewed	Average Years at Site
School #8	Administrator	2	11.5
	Teacher	4	10.25
	Maintenance	2	12
Erebouni Hospital	Chief of Department	3	5
	Chief Nurse	1	6
	Nurse	1	5
	Maintenance	1	1

Workers Survey

Job Title	Number Interviewed	Average Years with RMA
Crew Leader	5	2.8
Carpenter	4	1.75
Worker	5	2.3
Other	2	1

Persistence Survey

The following shows the sites which were visited to determine persistence of weatherization measures, their location, year of weatherization, and number of persons interviewed at each site.

Site	Year of Weatherization	Persons Interviewed at Site
School #4, Spitak	1994	2: Director, Maintenance
School #6, Spitak	1995	3: Director, Deputy Director, Maintenance
School #67, Yerevan	1994	1: Director
Republican Maternity Hospital, Yerevan	1993	1: Administrator
Cardiology Hospital, Yerevan	1994	11: 9 Nurses, Chief of Laboratory, Deputy Chief
Sayat Nova Apartment Building, Yerevan	1993	Members of 3 Families
Refugee Center, Aparan	1995	2: Director of Kindergarten, Maintenance
National Art Gallery, Yerevan	1994	3: Chief of Depository, 2 Employees

5. OTHER PROGRAM IMPACTS AND LESSONS LEARNED

In addition to the impacts discussed in the previous sections, there have been several spillover effects of the project as well. These effects are very difficult to measure scientifically and may not be sustained in the long term. Nonetheless, they are worth mentioning and recognizing as directly related to the project activities.

1. Multiple economic benefits have accrued to the Armenian economy through wages paid and local procurement purchases. A standard economic multiplier effect in the U.S. might be 2 - 3. In the third phase of the project alone, approximately $300,000 was spent on local wages and local procurement. Many bilateral projects are criticized by the host governments because most of the funds stay in the country which is providing the assistance, i.e., providing work for consultants. This project can be used as an example of one which has successfully enhanced the livelihood of people in the country receiving the assistance.

2. Other donor organizations have recognized the benefits of this type of program, and have committed funds to similar programs in other parts of Armenia. While the programs may not contain the same elements, the weatherization project demonstrated that a large number of local personnel can be mobilized and trained to do high quality weatherization and construction-related work.

3. The demand for weatherization supplies has assisted in the development of two small local manufacturers.

4. The awareness of the benefits of building weatherization is increasing, contributing to the beginning of a market demand for such services. Several private companies will be starting up within the next few months, formed from the crews who were trained to do the weatherization work.

The Armenia Weatherization Project has been widely regarded throughout the country as a successful project. This is largely due to the grassroots nature of the project. It is highly visible and has an immediate effect on people's lives. Skills which are marketable and transferable to other types of work (e.g., general construction) were taught. One indication of the project's success is that two other donor agencies have designed and implemented similar projects, with a third considering this for next year.

Several factors contributed to the success of the project. Strong local leadership by the Armenian Project Manager was crucial. His ability to direct and manage the work, and to absorb and pass along Western business practices made the project possible without a resident expatriate. Scheduling the work, working with administrators at the sites, obtaining local materials, and relations with the work crews was delegated entirely to the local staff. Very high standards were set for the quality of the work, and the workers took pride in being able to meet those standards. The weatherization work which emphasized long-term solutions to infiltration problems, rather than stop-gap measures which will not be sustained. Job costing and tracking were given priority,

which has developed a strong foundation from which to form small businesses. The costs of weatherization were closely tracked through the project period in an effort to make the service more cost-effective, thus more affordable in a market-oriented economy. Continued support over a three-year period allowed the program to evolve.

The primary obstacles which needed to be overcome in implementing the project, and for the long-term sustainability of weatherization services, may not be unique to Armenia. First, the state of the Armenian economy is very poor, though improving. This means that only a select few can afford the services which are being offered, so there is unlikely to be much of a sustained market for weatherization. The second obstacle is the lack of quality materials which are available locally. Caulking and weatherstripping are rarely available on the local market, and when they are, the quality is generally very poor and the price very high.

A third obstacle which affects the demand for services is that the cost of energy is highly subsidized and supply is uncertain. This means that the payback period for weatherization is very long, making the service uneconomic. The slow pace of privatization has also contributed to a lack of incentives for weatherization.

Appendix A
Facility Descriptions and Data

Maternity Hospital # 4

Address:	Gurjyan Str. # 6, III Massiv
Phone:	63-25-10
Chief Administrator:	Armen Manukyan
Head of Maintenance:	Arthur Martirossyan
Building Operational Capacity:	140
Date of Construction:	1984
Significance:	The only Maternity Hospital for the Region with population 400,000 p.
Total Number of Rooms:	180

Current Staffing	
Doctors:	30
Nurses/Laborants/etc.:	70
Administrative:	20
Maintenance:	5

Description of Room Use	
Patient rooms:	48
Operating Rooms:	21
Laboratory Rooms:	6
Critical Care Room:	3
Laundry:	1
Kitchen:	5
Storage Rooms:	8
Offices:	36
Maintenance Rooms	5
Bathrooms	24
Different	28

Maternity Hospital # 4

Armenia Weatherization Project
Monitoring Data Collected

	Parameter	Nov	Dec	Jan	Feb	Mar
1	Temperature inside the building '93-'94	no data	no data	no data	no data	no data
2	Temperature inside the building '94-'95	no data	no data	no data	no data	no data
3	Temperature inside the building '95-'96	+22 C	+20 C	+19 C	+22 C	+21 C
4	Temperature outside the building '93-'94	+3C	-15 C	-15 C	-13 C	-4 C
5	Temperature outside the building '94-'95	+3 C	-10 C	-10 C	-8 C	+2 C
6	Temperature outside the building '95-'96	+ 6 C	+2 C	0 C	+3 C	+7 C
		actual		estimate		
7	Power consumption '93-'94	43973	66253	53620	52440	75480
	Power used for heating	no data	no data	no data	no data	no data
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	no data	no data	no data	no data	no data
		actual		estimate		
8	Power consumption '94-'95	72200	73760	93740	71780	69820
	Power used for heating	no data	no data	no data	no data	no data
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	1800 kw/h	1800 kw/h	1800 kw/h	1800 kw/h	1800 kw/h
		actual		estimate		
9	Power consumption '95-'96	27920	46520	42113	38073	48313
	Power used for heating	no data	no data	no data	no data	no data
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	1800 kw/h	1800 kw/h	1800 kw/h	1800 kw/h	1800 kw/h
		actual		estimate		
10	Fuel consumption '93-'94					
	gas	non	non	non	non	non
	wood	non	non	non	non	non
	kerosene	non	non	non	non	non
	mazut	non	non	non	non	non
		actual		estimate		
11	Fuel consumption '94-'95					
	gas	non	non	non	non	non
	wood	non	non	non	non	non
	kerosene	non	non	non	non	non
	mazut	non	non	non	non	non
		actual		estimate		
12	Fuel consumption '95-'96					
	gas	non	non	non	non	non
	wood	non	non	non	non	non
	kerosene	non	non	non	non	non
	mazut	non	non	non	non	non
13	Hours heat supplied per day '94-'95	24	24	24	24	24
14	Hours heat supplied per day '95-'96	24	24	24	24	24
15	Temperature of heat carrier (supply) '94-'95	50 C	45 C	45 C	45 C	45 C
16	Temperature of heat carrier (return) '94-'95	35 C	30 C	30 C	30 C	30 C
17	Temperature of heat carrier (supply) '95-'96	50 C	45 C	45 C	45 C	45 C
18	Temperature of heat carrier (return) '95-'96	45 C	40 C	40 C	40 C	40 C
19	Power consumption limit '94-'95	91500	91500	91500	91500	91500
20	Power consumption limit '95-'96	91500	91500	91500	91500	91500
21	Used power comparing to limit '94-'95	78.9%	80.6%	102.5%	78.5%	76.3%
22	Used power comparing to limit '95-'96	30.5%	50.8%	46.0%	41.6%	52.8%

Maternity Hospital # 4

Armenia Weatherization Project
Monitoring Data Collected

	Parameter	front view	rear view	left view	right view	roof
1	Thickness of outside walls	300 mm	300 mm	300 mm	300 mm	200 mm
2	Surface of glazing	339 sq.m	211 sq.m	327 sq.m	208 sq.m	non
3	Surface of building envelope	936	1092	977	977	986
4	Surface of windows covered w/ Astro-Foil	non	non	non	non	non
5	Surface of walls insulated	non	non	non	non	non
6	Thickness of insullation	non	non	non	non	non
7	Surface of glazing missing	90	90	55	55	
8	Orientation	N-E	S-W	S-E	N-W	
9	Number of windows	129	81	127	80	
10	Average size of windows	2.59	2.57	2.57	2.57	
11	Average perimeter of window	6.47	6.42	6.42	6.46	
12	Average size of gap between window sash and frame	7mm	7 mm	8 mm	7 mm	
13	Average size of gap between window frame and building	10 mm	5 mm	12 mm	7 mm	
14	Number of exterior doors	4	2	2	2	
15	Average size of doors	5.36 sq.m	4.28 sq.m	3.88 sq.m	3.46 sq.m	
16	Average perimeter of doors	11.5 m	8.5 m	8 m	7.6 m	
17	Average size of gap between door sash and frame	4 mm	8 mm	10 mm	7 mm	
18	Average size of gap between door frame and building	6 mm	8 mm	12 mm	7 mm	

19	Building material	Concrete w/tufa plates
20	Number of existing glass panes	2
21	Type of the roof	flat roof
22	Number of floors	7
23	Total volume of the building	20700 cub. m
24	Average size of the gaps around windows	7 mm
25	Heating system	Hot water w/electrick heaters
26	Type of heating units	Radiators & Heaters el.
27	Number of heating units	417
28	Efficiency of heating units	60%
29	R- Value of wall material	0.66
30	U- Value of wall material	1.5
31	R- Value of roof material	0.55
32	U- Value of roof material	1.8

33	Area of one floor	986
34	Total floor area	7888
35	Total surface of the building	4700 sq. m
36	Total surface area of exterior doors	44.7 sq.m
37	Total surface area of glass	1085x2=2170 sq. m

Data Collected by : Hovik Chibukhchyan, Gagik Karapetyan, Vahag Karapetyan
Data Provided by: Armen Manukyan - Chief Administrator,
Arthur Martirossyan - Head of Maintenance.
Date: Sept. 1995

Armenia Weatherization Project
Monitoring Data Collected

Building:_____

	Parameter	week 1	week 2	week 3	week 4
1	Temperature inside the building '95-'96				
2	Temperature outside the building '95-'96				
		actual		estimate	
3	Power consumption '95-'96				
	Power used for heating				
	Power used for ligting				
	Power used for kitchen and laundry				
	Power used for other purposes				
		actual		estimate	
4	Fuel consumption '95-'96				
	gas				
	wood				
	kerosene				
	mazut				
5	Hours heat supplied per day '95-'96				
6	Temperature of heat carrier (supply) '95-'96				
7	Temperature of heat carrier (return) '95-'96				
8	Power consumption limit '95-'96				
9	Used power comparing to limit '95-'96				

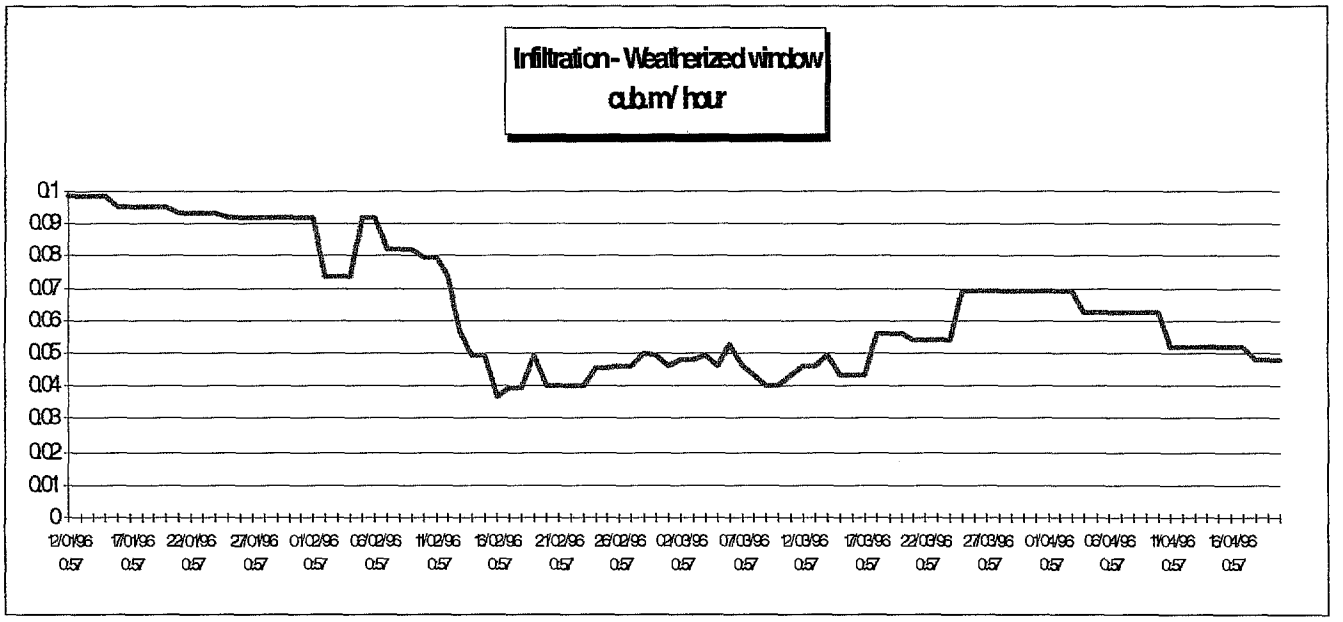
Data Collected by :
Data Provided by:
Date:

Maternity Hospital # 4
(Actual Data for Winter '96)

Date / Time	Temperature non weatherized	Temperature weatherized	Outside Temperature	Infiltration weatherized per window	Infiltration non weatherized per window	Air Density non weatherized	Air Density weatherized	Air Density Outside Air	Infiltration weatherized per window	Infiltration non weatherized per window	Temperature non weatherized absolute	Temperature weatherized absolute	Outside Temperature absolute	Inlet Air From One Broken Window Non weather	Inlet Air From One Broken Window Non weather
	t nw	t w	t o	L w	L nw	D nw	D w	D o	G w	G nw	T nw	T w	T o	V b	G b
	(C)	(C)	(C)	(cub.m/h)	(cub.m/h)	kg / cub.m	kg / cub.m	kg / cub.m	kg / hour	kg / hour	(T)	(T)	(T)	cub.m/hour	kg / hour
11/01/96 0:57	5.62	15.26	0.14	0.0987	12.587	1.2733	1.2275	1.2993	0.1282	16.3547	278.62	288.26	273.14	1615.3415	1982.8560
12/01/96 0:57	5.62	15.23	0.13	0.0987	16.477	1.2733	1.2277	1.2994	0.1282	20.1105	278.62	288.23	273.13	1614.3568	1981.8773
13/01/96 0:57	5.62	15.24	0.14	0.0987	13.254	1.2733	1.2276	1.2993	0.1282	17.2214	278.62	288.24	273.14	1614.3288	1981.7662
14/01/96 0:57	3.72	14.62	-1.64	0.0987	11.542	1.2823	1.2306	1.3078	0.1291	15.0945	276.72	287.62	271.36	1676.9935	2063.6328
15/01/96 0:57	2.55	13.72	-2.16	0.0987	12.744	1.2879	1.2348	1.3103	0.1293	16.6980	275.55	286.72	270.84	1659.8808	2049.6707
16/01/96 0:57	2.55	13.69	-2.07	0.0954	12.488	1.2879	1.2350	1.3098	0.1260	16.3572	275.55	286.69	270.93	1653.6839	2042.2541
17/01/96 0:57	1.76	13.18	-2.98	0.0954	16.872	1.2916	1.2374	1.3142	0.1254	22.1724	274.76	286.18	270.02	1676.0296	2073.9107
18/01/96 0:57	2.16	14.03	-1.78	0.0954	16.854	1.2897	1.2334	1.3085	0.1248	22.0527	275.16	287.03	271.22	1655.3238	2041.6060
19/01/96 0:57	2.94	14.11	-1.68	0.0954	14.257	1.2860	1.2330	1.3080	0.1248	18.6479	275.94	287.11	271.32	1654.0459	2039.4014
20/01/96 0:57	4.1	14.92	-0.34	0.0954	14.354	1.2805	1.2291	1.3016	0.1242	19.3342	277.1	287.92	272.66	1623.7606	1995.8129
21/01/96 0:57	3.54	14.47	-0.83	0.09354	15.268	1.2832	1.2313	1.3039	0.1220	19.9086	276.54	287.47	272.17	1627.1594	2003.4685
22/01/96 0:57	3.72	14.81	-1.67	0.09354	15.268	1.2823	1.2297	1.3079	0.1223	19.9695	276.72	287.81	271.33	1687.7430	2075.3374
23/01/96 0:57	4.86	15.27	-0.42	0.09354	16.428	1.2769	1.2275	1.3020	0.1218	21.3892	277.86	288.27	272.58	1645.4792	2019.7723
24/01/96 0:57	5.99	15.59	0.38	0.09354	16.428	1.2715	1.2259	1.2982	0.1214	21.3267	278.99	288.59	273.38	1619.2154	1985.0731
25/01/96 0:57	7.15	16.29	1.98	0.0924	12.546	1.2660	1.2226	1.2906	0.1193	16.1918	280.15	289.29	274.98	1568.6778	1917.9008
26/01/96 0:57	7.85	16.61	0.79	0.0924	13.3056	1.2627	1.2211	1.2962	0.1198	17.2474	280.85	289.61	273.79	1648.4551	2012.9326
27/01/96 0:57	8.58	17.87	1.59	0.0924	13.3056	1.2592	1.2151	1.2924	0.1194	17.1968	281.58	290.87	274.59	1668.6236	2027.5738
28/01/96 0:57	8.94	17.91	1.98	0.0924	13.3056	1.2575	1.2149	1.2906	0.1193	17.1721	281.94	290.91	274.98	1650.4760	2005.2087
29/01/96 0:57	8.94	18.56	1.98	0.0924	16.632	1.2575	1.2118	1.2906	0.1193	21.4652	281.94	291.56	274.98	1681.9340	2038.2349
30/01/96 0:57	9.31	18.19	1.98	0.0924	16.632	1.2558	1.2136	1.2906	0.1193	21.4652	282.31	291.19	274.98	1664.1173	2019.5686
31/01/96 0:57	8.94	18.91	1.19	0.0924	16.632	1.2575	1.2102	1.2943	0.1196	21.5276	281.94	291.91	274.19	1737.7529	2102.9895
01/02/96 0:57	10.03	20.76	3.16	0.0924	22.176	1.2524	1.2014	1.2850	0.1187	28.4959	283.03	293.76	276.16	1726.3970	2074.0760
02/02/96 0:57	7.74	18.16	-0.01	0.0739	16.632	1.2632	1.2137	1.3000	0.0961	21.6224	280.74	291.16	272.99	1761.9447	2138.5427
03/02/96 0:57	6.74	17.86	-4.71	0.0739	16.632	1.2680	1.2152	1.3224	0.0977	21.9937	279.74	290.86	268.29	1964.7371	2387.4797
04/02/96 0:57	5.99	17.78	-5.16	0.0739	22.176	1.2715	1.2155	1.3245	0.0979	29.3723	278.99	290.78	267.84	1981.0485	2408.0535
05/02/96 0:57	5.99	17.75	-4.71	0.0924	22.176	1.2715	1.2157	1.3224	0.1222	29.3249	278.99	290.75	268.29	1960.3141	2383.1294
06/02/96 0:57	4.86	17.58	-4.27	0.0924	22.176	1.2769	1.2165	1.3203	0.1220	29.2786	277.86	290.58	268.73	1934.0759	2352.7937
07/02/96 0:57	6.37	19.46	-0.83	0.0821	16.632	1.2697	1.2076	1.3039	0.1071	21.6872	279.37	292.46	272.17	1857.7550	2243.3599
08/02/96 0:57	8.58	20.81	0.38	0.0821	16.632	1.2592	1.2012	1.2982	0.1066	21.5916	281.58	293.81	273.38	1859.8656	2233.9822
09/02/96 0:57	10.03	21.11	3.16	0.0821	16.632	1.2524	1.1997	1.2850	0.1055	21.3720	283.03	294.11	276.16	1742.4406	2090.4539
10/02/96 0:57	11.47	21.75	5.84	0.0795	15.264	1.2455	1.1967	1.2723	0.1011	19.4198	284.47	294.75	278.84	1638.6600	1960.9639
11/02/96 0:57	12.18	22.51	4.7	0.0795	15.264	1.2421	1.1931	1.2777	0.1016	19.5024	285.18	295.51	277.7	1731.5161	2065.8329
12/02/96 0:57	11.82	22.15	3.93	0.0739	13.3056	1.2439	1.1948	1.2813	0.0947	17.0489	284.82	295.15	276.93	1752.4008	2093.7466

13/02/96 0:57	11.82	22.01	2.77	0.0559	13.3056	1.2439	1.1955	1.2868	0.0732	17.1222	284.82	295.01	275.77	1801.2120	2153.2633
14/02/96 0:57	11.47	22.18	4.32	0.0493	13.3056	1.2455	1.1946	1.2795	0.0631	17.0242	284.47	295.18	277.32	1734.9139	2072.6062
15/02/96 0:57	11.82	22.31	3.16	0.0493	16.632	1.2439	1.1940	1.2850	0.0633	21.3720	284.82	295.31	276.16	1796.0812	2144.5704
16/02/96 0:57	11.82	22.47	3.93	0.0370	13.3056	1.2439	1.1933	1.2813	0.0474	17.0489	284.82	295.47	276.93	1766.7652	2108.2234
17/02/96 0:57	11.47	22.21	4.7	0.0395	13.3056	1.2455	1.1945	1.2777	0.0509	17.0002	284.47	295.21	277.7	1717.7430	2051.8484
18/02/96 0:57	10.75	21.67	5.84	0.0395	13.3056	1.2489	1.1971	1.2723	0.0506	16.9282	283.75	294.67	278.84	1634.7568	1956.9142
19/02/96 0:57	10.75	21.45	5.08	0.0493	13.3056	1.2489	1.1981	1.2759	0.0629	16.9762	283.75	294.45	278.08	1663.0267	1992.4931
20/02/96 0:57	11.47	22.89	6.59	0.0400	13.3056	1.2455	1.1913	1.2687	0.0508	16.8808	284.47	295.89	279.59	1655.4243	1972.0614
21/02/96 0:57	12.53	23.03	5.84	0.0400	13.3056	1.2405	1.1906	1.2723	0.0509	16.9282	285.53	296.03	278.84	1699.6157	2023.5752
22/02/96 0:57	10.39	21.71	6.96	0.0400	16.632	1.2506	1.1969	1.2669	0.0507	21.0717	283.39	294.71	279.96	1577.8991	1888.5519
23/02/96 0:57	12.53	22.98	5.84	0.0400	16.632	1.2405	1.1908	1.2723	0.0509	21.1602	285.53	295.98	278.84	1697.2854	2021.2039
24/02/96 0:57	10.39	21.67	5.84	0.0457	16.847	1.2506	1.1971	1.2723	0.0581	21.4338	283.39	294.67	278.84	1634.7568	1956.9142
25/02/96 0:57	10.39	21.87	5.08	0.0457	16.847	1.2506	1.1961	1.2759	0.0583	21.4946	283.39	294.87	278.08	1683.0256	2013.0963
26/02/96 0:57	12.53	22.95	8.07	0.0462	16.632	1.2405	1.1910	1.2617	0.0583	20.9841	285.53	295.95	281.07	1581.5137	1883.5630
27/02/96 0:57	9.31	21.48	4.7	0.0462	13.3056	1.2558	1.1980	1.2777	0.0590	17.0002	282.31	294.48	277.7	1683.6381	2016.9479
28/02/96 0:57	8.22	21.27	5.46	0.0498	22.176	1.2610	1.1990	1.2741	0.0634	28.2537	281.22	294.27	278.46	1634.8338	1960.1125
29/02/96 0:57	5.62	20.34	2.38	0.0495	13.3056	1.2733	1.2034	1.2887	0.0638	17.1469	278.62	293.34	275.38	1745.2120	2100.1619
01/03/96 0:57	5.62	20.07	2.38	0.0462	11.088	1.2733	1.2047	1.2887	0.0595	14.2891	278.62	293.07	275.38	1732.8417	2087.4981
02/03/96 0:57	5.78	19.86	2.77	0.0478	11.088	1.2725	1.2057	1.2868	0.0615	14.2685	278.78	292.86	275.77	1703.8119	2054.2264
03/03/96 0:57	7.48	19.78	4.32	0.0478	11.088	1.2645	1.2060	1.2795	0.0612	14.1869	280.48	292.78	277.32	1620.7450	1954.6914
04/03/96 0:57	7.73	19.56	4.7	0.0493	11.088	1.2633	1.2071	1.2777	0.0630	14.1669	280.73	292.56	277.7	1589.5807	1918.7670
05/03/96 0:57	8.19	19.01	5.46	0.0462	11.088	1.2611	1.2097	1.2741	0.0589	14.1268	281.19	292.01	278.46	1519.3277	1837.9345
06/03/96 0:57	8.98	19.27	6.59	0.0524	11.088	1.2573	1.2085	1.2687	0.0664	14.0673	281.98	292.27	279.59	1469.0892	1775.3465
07/03/96 0:57	9.26	19.05	7.7	0.0462	9.504	1.2560	1.2095	1.2634	0.0584	12.0076	282.26	292.05	280.7	1390.4327	1681.7458
08/03/96 0:57	10.03	18.86	8.8	0.0435	9.504	1.2524	1.2104	1.2582	0.0547	11.9579	283.03	291.86	281.8	1309.4604	1584.9905
09/03/96 0:57	9.12	18.63	6.96	0.0400	9.678	1.2567	1.2115	1.2669	0.0507	12.2614	282.12	291.63	279.96	1410.9122	1709.3307
10/03/96 0:57	9.18	18.71	7.33	0.0400	9.678	1.2564	1.2111	1.2652	0.0506	12.2444	282.18	291.71	280.33	1393.0802	1687.1978
11/03/96 0:57	9.68	18.81	8.43	0.0433	9.504	1.2540	1.2107	1.2600	0.0546	11.9746	282.68	291.81	281.43	1330.2377	1610.4556
12/03/96 0:57	10.14	18.89	8.8	0.0462	9.504	1.2518	1.2103	1.2582	0.0581	11.9579	283.14	291.89	281.8	1311.3440	1587.0836
13/03/96 0:57	10.26	18.79	8.8	0.0462	11.088	1.2513	1.2107	1.2582	0.0581	13.9509	283.26	291.79	281.8	1305.0531	1580.0898
14/03/96 0:57	10.3	18.81	8.8	0.0491	11.088	1.2511	1.2107	1.2582	0.0618	13.9509	283.3	291.81	281.8	1306.3141	1581.4924
15/03/96 0:57	12.17	19.36	10.24	0.0433	12.654	1.2422	1.2080	1.2514	0.0542	15.8347	285.17	292.36	283.24	1245.7162	1504.8750
16/03/96 0:57	10.01	18.75	8.43	0.0433	12.654	1.2525	1.2109	1.2600	0.0546	15.9435	283.01	291.75	281.43	1326.5239	1606.3375
17/03/96 0:57	8.67	17.38	5.84	0.0433	13.542	1.2588	1.2174	1.2723	0.0551	17.2289	281.67	290.38	278.84	1406.0482	1711.7864
18/03/96 0:57	8.41	17.26	5.46	0.0557	13.542	1.2601	1.2180	1.2741	0.0710	17.2534	281.41	290.26	278.46	1422.0932	1732.1309
19/03/96 0:57	6.11	14.67	0.38	0.0557	13.542	1.2710	1.2303	1.2982	0.0723	17.5802	279.11	287.67	273.38	1571.9889	1934.0455
20/03/96 0:57	6.89	14.79	3.16	0.0557	14.327	1.2673	1.2297	1.2850	0.0716	18.4101	279.89	287.79	276.16	1417.8578	1743.6070
21/03/96 0:57	7.43	14.65	3.54	0.0541	14.327	1.2647	1.2304	1.2832	0.0694	18.3842	280.43	287.65	276.54	1386.1349	1705.5177
22/03/96 0:57	7.76	14.79	4.7	0.0541	14.327	1.2631	1.2297	1.2777	0.0691	18.3052	280.76	287.79	277.7	1320.6520	1624.0685
23/03/96 0:57	8.65	15.50	6.59	0.0541	14.327	1.2589	1.2264	1.2687	0.0686	18.1766	281.65	288.50	279.59	1239.5002	1520.0921
24/03/96 0:57	8.79	15.62	6.96	0.0541	14.327	1.2582	1.2258	1.2669	0.0685	18.1514	281.79	288.62	279.96	1221.7332	1497.6067
25/03/96 0:57	10.62	15.26	9.16	0.0691	15.268	1.2496	1.2275	1.2565	0.0868	19.1841	283.62	288.26	282.16	1026.0142	1259.4479
26/03/96 0:57	8.59	15.01	5.84	0.0691	15.268	1.2592	1.2287	1.2723	0.0879	19.4249	281.59	288.01	278.84	1258.5241	1546.3517
27/03/96 0:57	8.95	15.62	6.59	0.0691	15.268	1.2575	1.2258	1.2687	0.0877	19.3705	281.95	288.62	279.59	1247.5597	1529.2649

28/03/96 0:57	9.87	15.39	6.96	0.0691	15.268	1.2531	1.2269	1.2669	0.0875	19.3436	282.87	288.39	279.96	1205.8807	1479.4920
29/03/96 0:57	11.85	15.21	9.52	0.0691	15.268	1.2437	1.2278	1.2548	0.0867	19.1580	284.85	288.21	282.52	991.0197	1216.7269
30/03/96 0:57	12.64	14.18	10.61	0.0691	15.6984	1.2400	1.2326	1.2496	0.0863	19.6168	285.64	287.18	283.61	786.3894	969.3390
31/03/96 0:57	12.6	14.20	10.61	0.0691	15.6964	1.2402	1.2326	1.2496	0.0863	19.6168	285.6	287.20	283.61	788.5617	971.9417
01/04/96 0:57	12.46	14.14	10.24	0.0691	15.6984	1.2408	1.2328	1.2514	0.0865	19.6443	285.46	287.14	283.24	821.9892	1013.3771
02/04/96 0:57	12.07	14.30	9.74	0.0691	15.6984	1.2427	1.2321	1.2537	0.0866	19.6816	285.07	287.30	282.74	888.5774	1094.7940
03/04/96 0:57	11.97	14.11	9.03	0.0691	15.6984	1.2431	1.2330	1.2571	0.0869	19.7346	284.97	287.11	282.03	938.1847	1156.7606
04/04/96 0:57	11.43	13.89	8.8	0.0624	14.234	1.2457	1.2340	1.2582	0.0785	17.9092	284.43	286.89	281.8	939.4677	1159.3243
05/04/96 0:57	11.39	14.01	8.43	0.0624	14.234	1.2459	1.2335	1.2600	0.0786	17.9342	284.39	287.01	281.43	983.4431	1213.0304
06/04/96 0:57	11.35	14.01	8.43	0.0624	14.234	1.2461	1.2335	1.2600	0.0786	17.9342	284.35	287.01	281.43	983.4431	1213.0304
07/04/96 0:57	11.33	14.12	8.24	0.0624	14.234	1.2462	1.2329	1.2609	0.0787	17.9471	284.33	287.12	281.24	1009.3403	1244.4459
08/04/96 0:57	11.64	14.14	8.81	0.0624	13.952	1.2447	1.2328	1.2582	0.0785	17.5537	284.64	287.14	281.81	960.9425	1184.6836
09/04/96 0:57	12.34	14.26	9.16	0.0624	13.952	1.2414	1.2323	1.2565	0.0784	17.5305	285.34	287.26	282.16	939.7843	1158.0633
10/04/96 0:57	12.34	14.36	8.68	0.0624	13.952	1.2414	1.2318	1.2588	0.0785	17.5624	285.34	287.36	281.68	991.6118	1221.4574
11/04/96 0:57	12.03	14.39	9.88	0.0623	13.952	1.2429	1.2316	1.2531	0.0655	17.4828	285.03	287.39	282.88	883.5540	1088.2271
12/04/96 0:57	12.11	14.46	9.88	0.0623	13.952	1.2426	1.2313	1.2531	0.0655	17.4828	285.11	287.46	282.88	890.2760	1096.2102
13/04/96 0:57	12.14	15.10	10.96	0.0623	12.423	1.2423	1.2283	1.2479	0.0653	15.5032	285.14	288.10	283.96	845.4914	1038.4960
14/04/96 0:57	12.79	14.71	9.52	0.0623	12.423	1.2392	1.2301	1.2548	0.0656	15.5881	285.79	287.71	282.52	947.2985	1165.2980
15/04/96 0:57	12.38	15.80	10.43	0.0623	12.423	1.2412	1.2250	1.2505	0.0654	15.5344	285.38	288.80	283.43	961.7655	1178.1147
16/04/96 0:57	12.76	15.20	10.96	0.0623	12.423	1.2394	1.2278	1.2479	0.0653	15.5032	285.76	288.20	283.96	855.4933	1050.3746
17/04/96 0:57	13.96	15.61	13.09	0.0623	11.564	1.2337	1.2259	1.2378	0.0647	14.3142	286.96	288.61	286.09	659.0604	807.9109
18/04/96 0:57	15.53	15.86	13.45	0.0483	11.564	1.2262	1.2247	1.2361	0.0597	14.2944	288.53	288.86	286.45	644.2367	788.9742
19/04/96 0:57	15.47	16.23	14.16	0.0483	11.564	1.2265	1.2229	1.2327	0.0595	14.2554	288.47	289.23	287.16	596.6837	729.6889
20/04/96 0:57	16.24	16.47	14.87	0.0483	12.562	1.2229	1.2218	1.2294	0.0594	15.4433	289.24	289.47	287.87	524.3712	640.6597


Infiltration - Weatherized window
cub.m/ hour
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
12/01/96 0:57
17/01/96 0:57
22/01/96 0:57
27/01/96 0:57
01/02/96 0:57
06/02/96 0:57
11/02/96 0:57
16/02/96 0:57
21/02/96 0:57
26/02/96 0:57
02/03/96 0:57
07/03/96 0:57
12/03/96 0:57
17/03/96 0:57
22/03/96 0:57
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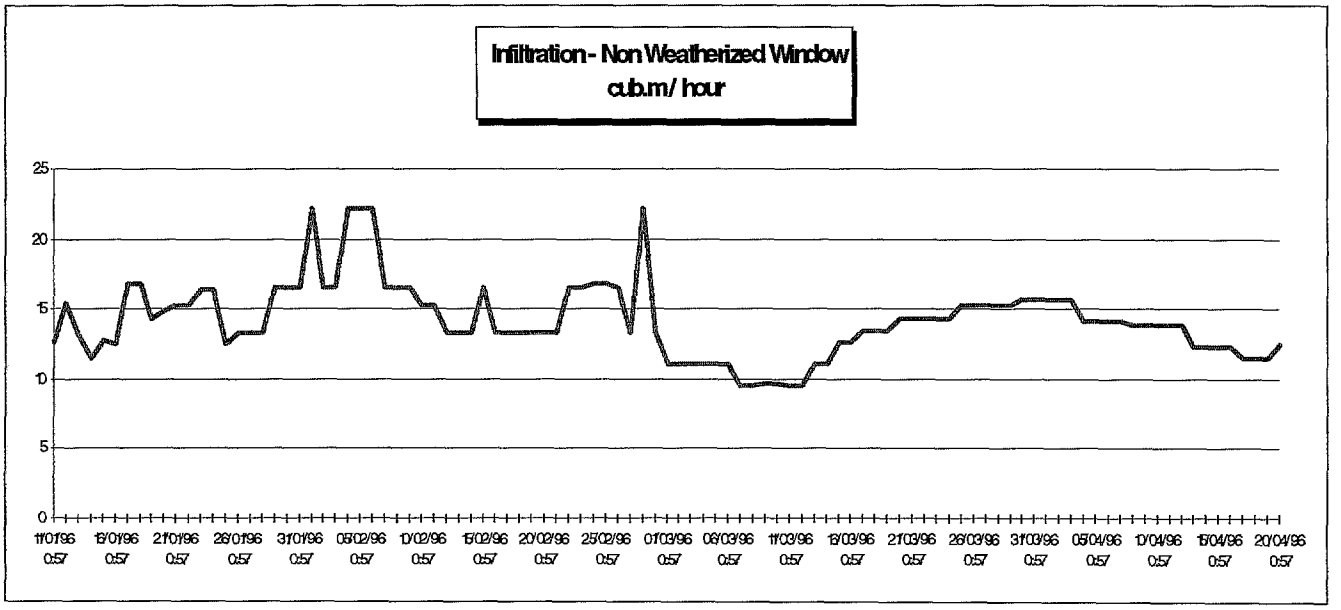
06/04/96 0:57
11/04/96 0:57
16/04/96 0:57


Infiltration - Non Weatherized Window
cub.m/ hour
25
20
15
10
5
0
11/01/96 0:57
16/01/96 0:57
21/01/96 0:57
26/01/96 0:57
31/01/96 0:57
05/02/96 0:57
10/02/96 0:57
15/02/96 0:57
20/02/96 0:57
25/02/96 0:57
01/03/96 0:57
06/03/96 0:57
11/03/96 0:57
16/03/96 0:57
21/03/96 0:57
26/03/96 0:57
31/03/96 0:57
05/04/96 0:57
10/04/96 0:57
15/04/96 0:57
20/04/96 0:57

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Maternity Hospital # 4

Calculations Based on Actual Data - Winter '96

Date / Time	Heat losses from one non weatherized window by infiltration	Heat losses from one non weatherized window single pane window by transfere	Heat losses from one non weatherized window double pane window by transfere	Heat losses from one broken window by inlet air	Heat losses from 85 non weatherized single pane windows	Heat losses from 320 non weatherized double pane windows	Heat losses from 22 broken windows	Total heat losses from non weatherized building	Heat losses from one weatherized window by infiltration	Heat losses from one weatherized window double pane window by transfere	Total heat losses from weatherized building	Energy savings in the period of monitoring	Conventional fuel saved in the perion of monitoring	Money savings in the period of monitoring
	per day	per day	per day	per day	per day	per day	per day	per day	per day	per day	per day	per day	per day	per day
	Q inf. nw	Q tr. nw1	Q tr. nw2	Q b. nw	Q nw 1	Q nw 2	Q b	Q nw	Q inf. w	Q tr. w2	Q nw	delta Q	B	E
	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kg/day	$ / day
11/01/96 0:57	1424.36	4164.05	2313.36	172689.31	475014.09	1196068.17	3799164.73	5470236.69	11.17	1850.69	775012.92	4675234.07	954.13	$100.18
12/01/96 0:57	1749.13	4158.54	2310.30	172375.76	502152.34	1299019.07	3792266.70	5593436.11	11.15	1848.24	793961.49	4799476.62	979.49	$102.85
13/01/96 0:57	1497.85	4158.54	2310.30	172366.10	480792.92	1218607.13	3792054.19	5491454.24	11.15	1848.24	793961.52	4697492.92	958.67	$100.66
14/01/96 0:57	1413.72	4478.00	2487.78	193274.89	500796.18	1248478.65	4252047.64	6001323.47	12.09	1990.22	854987.24	5146334.73	1050.27	$110.28
15/01/96 0:57	1527.34	4373.35	2429.64	187480.92	501558.97	1266234.16	4124580.14	5892273.28	11.83	1943.71	835014.00	5057357.27	1032.11	$108.37
16/01/96 0:57	1484.87	4340.30	2411.28	185390.93	495139.47	1246766.81	4078600.38	5820506.63	11.34	1929.02	828556.85	4991969.80	1018.77	$106.97
17/01/96 0:57	2063.84	4450.46	2472.48	193042.93	553716.23	1451623.88	4246944.38	6252294.49	11.67	1977.98	849592.12	5402702.37	1102.59	$115.77
18/01/96 0:57	2008.24	4354.07	2418.93	185920.07	540796.89	1416695.17	4090241.59	6042733.86	11.37	1935.14	831160.37	5216573.28	1064.61	$111.78
19/01/96 0:57	1696.03	4348.57	2415.87	185484.37	513790.77	1315808.42	4080656.22	6910286.41	11.35	1932.70	830107.18	5080148.23	1036.76	$108.86
20/01/96 0:57	1699.43	4202.60	2334.78	175427.16	501672.79	1290946.83	3859397.61	5652017.23	10.91	1867.82	802221.58	4849795.84	989.75	$103.92
21/01/96 0:57	1754.50	4213.62	2340.90	176561.67	507290.59	1310529.47	3884356.83	5702176.89	10.75	1872.72	804341.78	4897935.61	999.58	$104.96
22/01/96 0:57	1895.60	4538.59	2521.44	197000.99	546906.50	1413453.46	4334021.78	6294381.74	11.61	2017.15	866282.86	5428098.88	1107.78	$116.32
23/01/96 0:57	1933.03	4321.03	2400.57	182535.71	531595.08	1386753.20	4015785.57	5934133.55	11.01	1920.46	824734.62	5109399.33	1042.73	$109.49
24/01/96 0:57	1868.43	4188.83	2327.13	173911.46	514867.25	1342578.50	3826052.07	5685497.82	10.64	1861.70	799490.34	4884007.48	996.74	$104.66
25/01/96 0:57	1334.62	3940.97	2189.43	158084.13	448425.42	1127695.75	3477850.79	5053521.97	9.83	1751.54	752106.81	4301865.55	877.93	$92.18
26/01/96 0:57	1571.63	4356.83	2420.46	183424.86	503919.25	1277470.01	4035346.98	5816736.26	10.91	1936.37	831489.47	4985246.78	1017.40	$106.83
27/01/96 0:57	1612.59	4483.51	2490.84	190131.27	518168.76	1313097.95	4182887.96	6014184.66	11.20	1992.67	856652.72	5158501.95	1052.76	$110.54
28/01/96 0:57	1575.66	4387.12	2437.29	183991.53	506836.53	1284144.22	4047813.76	5838794.51	10.94	1949.83	837250.54	5001543.97	1020.72	$107.18
29/01/96 0:57	2049.94	4566.13	2536.74	194653.06	562366.25	1467738.07	4282367.39	6312471.71	11.39	2029.39	871413.30	5441058.41	1110.42	$116.59
30/01/96 0:57	2004.19	4464.23	2480.13	188566.31	549816.46	1434983.97	4148458.87	6133259.29	11.13	1984.10	851964.89	5281292.49	1077.81	$113.17
31/01/96 0:57	2197.26	4880.09	2711.16	214646.25	601574.63	1570694.59	4722217.49	6934486.71	12.21	2168.93	931344.65	5963142.06	1216.97	$127.78
01/02/96 0:57	2888.80	4847.04	2692.80	210261.53	657546.76	1786113.36	4625753.71	7066413.53	12.04	2154.24	925000.14	6144413.68	1253.96	$131.67
02/02/96 0:57	2262.98	5004.02	2780.01	223818.17	617695.00	1613757.45	4923999.75	7158492.38	10.06	2224.01	954946.05	6201506.15	1265.61	$132.89
03/02/96 0:57	2859.25	6215.78	3453.21	310380.00	771377.49	2019987.62	6828360.04	9619128.16	12.71	2762.57	1185042.76	8434682.39	1721.36	$180.74
04/02/96 0:57	3881.10	6317.68	3509.82	318186.71	866895.59	2365093.02	7000107.62	10232056.24	12.94	2807.86	1204478.60	9027617.63	1842.37	$193.45
05/02/96 0:57	3793.75	6185.48	3436.38	308304.50	848235.30	2313643.13	6782698.91	9944517.34	15.81	2749.10	1180617.13	8763960.21	1788.56	$187.80
06/02/96 0:57	3684.89	6017.49	3343.05	296113.20	824701.92	2248939.38	6514490.45	9588131.78	15.35	2674.44	1148541.91	8439589.85	1722.37	$180.85
07/02/96 0:57	2534.59	5587.87	3104.37	262182.37	690408.63	1804466.70	5768012.21	8262887.63	12.52	2483.50	1065797.33	7197090.20	1468.79	$154.22
08/02/96 0:57	2540.83	5626.42	3125.79	262887.87	694216.25	1813317.74	5783533.22	8291067.21	12.55	2500.63	1073127.66	7217939.65	1473.05	$154.67
09/02/96 0:57	2209.69	4943.43	2746.35	216136.21	608015.12	1585932.49	4754996.69	6948944.98	10.91	2197.08	942812.60	6006131.70	1225.74	$128.70
10/02/96 0:57	1779.66	4381.61	2434.23	179705.87	523708.24	1348444.61	3953529.09	5828681.94	9.27	1947.38	835490.86	4990191.08	1018.41	$106.93

11/02/96 0:57	2000.67	4904.87	2724.93	211924.70	586971.12	1512191.55	4662343.48	6731506.16	10.42	2179.94	936286.49	5826220.66	1189.02	$124.85
12/02/96 0:57	1789.23	5017.79	2787.66	219732.84	578596.88	1464606.10	4834122.56	6817325.54	9.94	2230.13	956509.12	5920816.42	1208.33	$126.87
13/02/96 0:57	1897.52	5298.70	2943.72	238629.81	611678.75	1549198.27	5249855.85	7410732.56	8.11	2354.98	1009037.53	6401695.54	1306.47	$137.18
14/02/96 0:57	1751.35	4918.64	2732.58	213216.46	566949.13	1434856.25	4690762.11	6592567.50	6.49	2186.06	936819.05	5756348.45	1174.76	$123.35
15/02/96 0:57	2357.41	5273.91	2929.95	236554.69	648662.37	1691955.83	5204203.15	7544821.39	6.98	2343.96	1009563.48	6540967.87	1334.89	$140.16
16/02/96 0:57	1820.66	5105.92	2836.62	225138.02	588758.84	1490329.15	4953036.54	7082124.54	5.06	2269.30	971148.90	6060975.64	1236.93	$129.88
17/02/96 0:57	1714.60	4822.25	2679.03	206944.50	555632.82	1405962.45	4552779.02	6514824.28	5.13	2143.22	917546.63	5597027.65	1142.25	$119.94
18/02/96 0:57	1543.53	4359.58	2421.99	178433.01	501764.12	1268964.88	3925526.13	5696256.12	4.62	1937.59	829523.28	4866931.86	993.25	$104.29
19/02/96 0:57	1600.71	4508.30	2504.61	187874.56	519265.49	1313701.69	4133240.35	5946207.52	5.93	2003.69	856104.27	5108101.26	1042.47	$109.46
20/02/96 0:57	1584.90	4489.02	2493.90	185152.90	516283.44	1305216.90	4073363.81	5894864.16	4.77	1995.12	853953.77	5040911.38	1028.76	$108.02
21/02/96 0:57	1676.13	4734.13	2630.07	200363.08	544872.09	1377985.23	4407987.84	6330845.18	5.04	2104.06	900585.67	5430259.49	1108.22	$116.36
22/02/96 0:57	1790.26	4062.15	2256.75	160451.37	497454.47	1295041.78	3529930.20	5329426.49	4.31	1805.40	772744.12	4549680.33	928.51	$97.49
23/02/96 0:57	2089.07	4720.36	2622.42	199546.18	578801.48	1507677.81	4390015.99	6476495.28	5.03	2097.94	897566.16	5578529.12	1138.48	$119.54
24/02/96 0:57	1954.35	4359.58	2421.99	178433.01	536684.03	1400428.09	3925526.13	5862538.24	5.30	1937.59	829615.61	5033022.74	1027.15	$107.85
25/02/96 0:57	2078.75	4623.97	2568.87	194687.35	569730.83	1487238.28	4283121.71	6340090.81	5.64	2055.10	879933.81	5460167.00	1114.32	$117.00
26/02/96 0:57	1798.52	4097.95	2276.64	161437.93	501199.96	1304050.58	3551634.36	5356884.90	5.00	1821.31	779833.87	4577061.44	934.09	$98.08
27/02/96 0:57	1643.12	4621.21	2567.34	194943.66	532468.23	1347347.22	4288760.52	6168576.97	5.71	2053.87	879439.90	5289136.47	1079.42	$113.34
28/02/96 0:57	2572.94	4354.07	2418.93	178498.83	588795.93	1597397.44	3926974.15	6113167.52	5.77	1935.14	828771.39	5284396.13	1078.45	$113.24
29/02/96 0:57	1773.84	4946.18	2747.88	217260.91	571201.69	1446949.06	4779739.96	6797890.71	6.60	2198.30	941494.62	5856397.09	1195.18	$125.49
01/03/96 0:57	1455.97	4871.83	2706.57	212704.36	537863.02	1332014.14	4679496.02	6549373.18	6.07	2165.26	927164.73	5622218.45	1147.39	$120.48
02/03/96 0:57	1404.57	4706.59	2614.77	202214.76	519448.20	1286188.56	4448724.79	6264361.59	6.06	2091.82	895794.94	5358570.61	1093.69	$114.83
03/03/96 0:57	1263.34	4257.68	2365.38	174064.49	469286.66	1161188.95	3829418.80	5496894.41	5.45	1892.30	810339.43	4649555.07	948.89	$99.63
04/03/96 0:57	1212.59	4092.44	2273.58	164234.17	450928.11	1115575.23	3613151.85	5179655.16	5.39	1818.86	778956.16	4400699.03	898.10	$94.30
05/03/96 0:57	1102.57	3731.67	2073.15	143447.11	410910.49	1016230.73	3155836.39	4542977.51	4.59	1658.52	710149.70	3872827.92	790.37	$82.99
06/03/96 0:57	1027.43	3492.07	1940.04	129665.63	384157.83	949591.00	2852643.87	4186992.70	4.85	1552.03	664789.37	3521603.34	718.69	$75.46
07/03/96 0:57	785.01	3125.79	1736.55	109945.81	332417.85	806898.65	2418807.85	3558124.36	3.82	1389.24	594854.92	2963289.44	604.75	$63.50
08/03/96 0:57	692.91	2770.52	1539.18	91843.22	294391.86	714268.67	2020550.92	3029211.49	3.17	1231.34	527137.85	2502073.90	510.63	$53.62
09/03/96 0:57	824.20	3213.92	1785.51	114899.84	343240.42	835108.65	2527796.53	3706145.69	3.41	1428.41	611384.79	3094760.81	631.58	$66.32
10/03/96 0:57	802.61	3134.05	1741.14	110593.79	334616.11	813999.39	2433063.37	3561875.88	3.32	1392.91	596169.89	2985488.99	609.28	$63.97
11/03/96 0:57	715.95	2858.65	1588.14	96287.21	303841.10	737308.52	2118318.55	3159465.17	3.26	1270.51	543901.85	2615566.33	533.79	$56.05
12/03/96 0:57	694.98	2778.79	1543.77	92238.76	295269.76	716398.69	2029252.68	3040921.14	3.38	1235.02	528394.39	2512126.75	512.68	$53.83
13/03/96 0:57	802.77	2751.25	1528.47	90922.16	302091.32	745996.64	2000287.55	3048375.92	3.34	1222.78	523051.91	2524821.90	515.27	$54.10
14/03/96 0:57	804.38	2756.75	1531.53	91185.06	302696.11	747490.13	2006071.26	3056287.49	3.56	1225.22	524161.21	2531566.28	516.65	$54.25
15/03/96 0:57	831.82	2511.65	1395.36	79052.89	284194.46	712696.41	1739163.52	2755064.40	2.85	1116.29	477570.12	2258183.68	460.85	$48.39
16/03/96 0:57	947.73	2842.13	1578.96	95485.84	322138.17	808541.69	2100688.53	3231369.39	3.24	1263.17	540757.89	2690610.49	549.10	$57.66
17/03/96 0:57	1145.21	3178.12	1765.62	113783.12	367483.12	931467.16	2503228.73	3802175.01	3.66	1412.50	604699.82	3197479.19	652.55	$68.52
18/03/96 0:57	1172.68	3249.72	1805.40	117729.47	375903.85	952985.05	2590048.36	3918937.27	4.82	1444.32	618764.22	3300163.05	673.50	$70.72
19/03/96 0:57	1447.03	3935.47	2186.37	159192.06	457512.14	1162687.91	3502225.29	5122425.34	5.95	1749.10	749405.42	4373019.92	892.45	$93.71
20/03/96 0:57	1233.27	3202.90	1779.39	116802.14	377074.39	964050.33	2569647.15	3910771.86	4.79	1423.51	609846.94	3300884.92	673.65	$70.73
21/03/96 0:57	1176.47	3059.69	1699.83	109142.22	360073.99	920416.19	2401128.79	3681616.97	4.44	1359.86	582558.96	3099060.12	632.46	$66.41
22/03/96 0:57	1063.87	2778.79	1543.77	94388.26	326625.92	834445.38	2076541.76	3237613.06	4.02	1235.02	529037.21	2708545.85	552.76	$58.04
23/03/96 0:57	932.85	2453.81	1363.23	78013.56	287866.75	734746.78	1716298.24	2734911.77	3.52	1090.58	467184.49	2271728.28	463.62	$48.68
24/03/96 0:57	905.42	2384.96	1324.98	74703.02	279682.92	713729.07	1643466.43	2633079.42	3.42	1059.98	454074.06	2182805.36	445.47	$46.77
25/03/96 0:57	674.05	1679.94	933.30	44251.96	200089.33	514352.69	973543.12	1667985.14	3.05	746.64	320117.90	1367867.24	279.16	$29.31
26/03/96 0:57	1026.01	2525.42	1403.01	81677.06	301871.03	777285.08	1796895.34	2879051.48	4.64	1122.41	481269.99	2394800.46	488.73	$51.32

FILE4.

27/03/96 0:57	1007.51	2486.86	1381.59	79541.35	297021.84	764512.82	1749909.64	2811444.30	4.56	1105.27	473898.18	2337546.12	477.05	$50.09
28/03/96 0:57	939.27	2321.62	1289.79	71839.40	277175.42	713297.68	1580466.76	2570519.84	4.25	1031.83	442807.41	2128532.45	434.39	$45.61
29/03/96 0:57	627.89	1567.03	870.57	39877.49	186567.97	479507.63	877304.84	1543180.44	2.84	696.46	298500.12	1244780.32	254.04	$26.67
30/03/96 0:57	403.38	983.18	546.21	19932.71	117857.72	303869.87	438519.66	860247.25	1.78	436.97	161343.61	672903.74	137.33	$14.42
31/03/96 0:57	405.64	988.69	549.27	20098.20	118517.98	305572.23	442160.38	864250.99	1.79	439.42	158375.05	677857.53	138.34	$14.53
01/04/96 0:57	441.29	1074.06	596.70	22764.50	128804.81	332157.02	500819.05	961180.67	1.94	477.36	204662.14	757118.73	154.51	$16.22
02/04/96 0:57	516.95	1255.82	697.68	28755.42	150685.78	388681.57	632619.27	1171986.65	2.28	558.14	239279.11	932687.51	190.34	$19.99
03/04/96 0:57	577.45	1399.03	777.24	33847.74	168000.93	433500.64	744650.32	1346191.89	2.54	621.79	266590.92	1079561.37	220.32	$23.13
04/04/96 0:57	525.07	1401.79	778.77	33989.53	163782.73	417228.68	747769.71	1328751.12	2.30	623.02	267010.72	1061770.41	216.69	$22.75
05/04/96 0:57	576.42	1536.73	853.74	38987.77	179617.98	457651.41	857730.86	1495000.25	2.53	682.99	292715.59	1202283.65	245.36	$25.76
06/04/96 0:57	576.42	1536.73	853.74	38987.77	179617.98	457651.41	857730.86	1495000.25	2.53	682.99	292715.59	1202283.65	245.36	$25.76
07/04/96 0:57	607.85	1619.35	899.64	42147.89	189311.84	482395.55	927253.56	1599969.95	2.66	719.71	308454.64	1290506.09	263.37	$27.65
08/04/96 0:57	538.91	1467.88	815.49	36370.73	170577.66	433409.27	800156.14	1404143.07	2.41	652.39	277300.67	1124542.50	229.50	$24.10
09/04/96 0:57	514.98	1404.54	780.30	34019.27	163158.98	414488.77	748423.85	1321071.40	2.30	624.24	267533.76	1058537.64	216.03	$22.68
10/04/96 0:57	574.58	1564.27	869.04	39962.18	181802.78	461959.74	879167.94	1522930.85	2.57	695.23	297941.37	1224969.08	249.99	$26.25
11/04/96 0:57	454.16	1242.05	690.03	28269.53	144178.36	366141.45	621929.62	1132249.45	1.70	552.02	236421.30	895808.23	182.82	$19.20
12/04/96 0:57	461.21	1261.33	700.74	28918.90	146416.16	371824.36	636215.87	1154456.39	1.73	560.59	240111.52	914345.37	186.60	$19.59
13/04/96 0:57	369.69	1140.16	633.42	24764.39	128337.29	320996.65	544816.58	994150.52	1.56	506.74	211040.86	777109.67	158.59	$16.65
14/04/96 0:57	466.00	1429.33	794.07	34835.88	161102.53	403221.71	766389.43	1330713.67	1.96	635.26	272792.01	1058621.66	216.05	$22.68
15/04/96 0:57	480.50	1478.90	821.61	36440.50	166548.72	416674.77	801691.02	1384914.61	2.02	657.29	281925.74	1103388.77	225.18	$23.64
16/04/96 0:57	378.62	1167.70	648.72	25652.67	131437.23	328750.19	564358.73	1024644.15	1.59	518.98	222383.35	802262.76	163.73	$17.19
17/04/96 0:57	207.77	694.01	385.56	11726.99	76651.40	189866.62	257993.74	524611.75	0.94	308.45	132108.54	392403.21	80.08	$8.41
18/04/96 0:57	198.43	663.71	368.73	10952.22	73282.17	181490.95	240948.92	495122.04	0.83	294.98	126312.06	369409.98	75.39	$7.92
19/04/96 0:57	169.97	570.08	316.71	8700.23	62904.08	155737.62	191405.00	410046.70	0.71	253.37	108491.27	301555.43	61.54	$6.46
20/04/96 0:57	142.33	440.64	244.80	5904.32	49552.07	123880.19	129895.04	302927.31	0.55	195.84	83857.36	219469.96	44.79	$4.70
								45578809.81			6661519.86	390101490	79,612.55	$8,359.32

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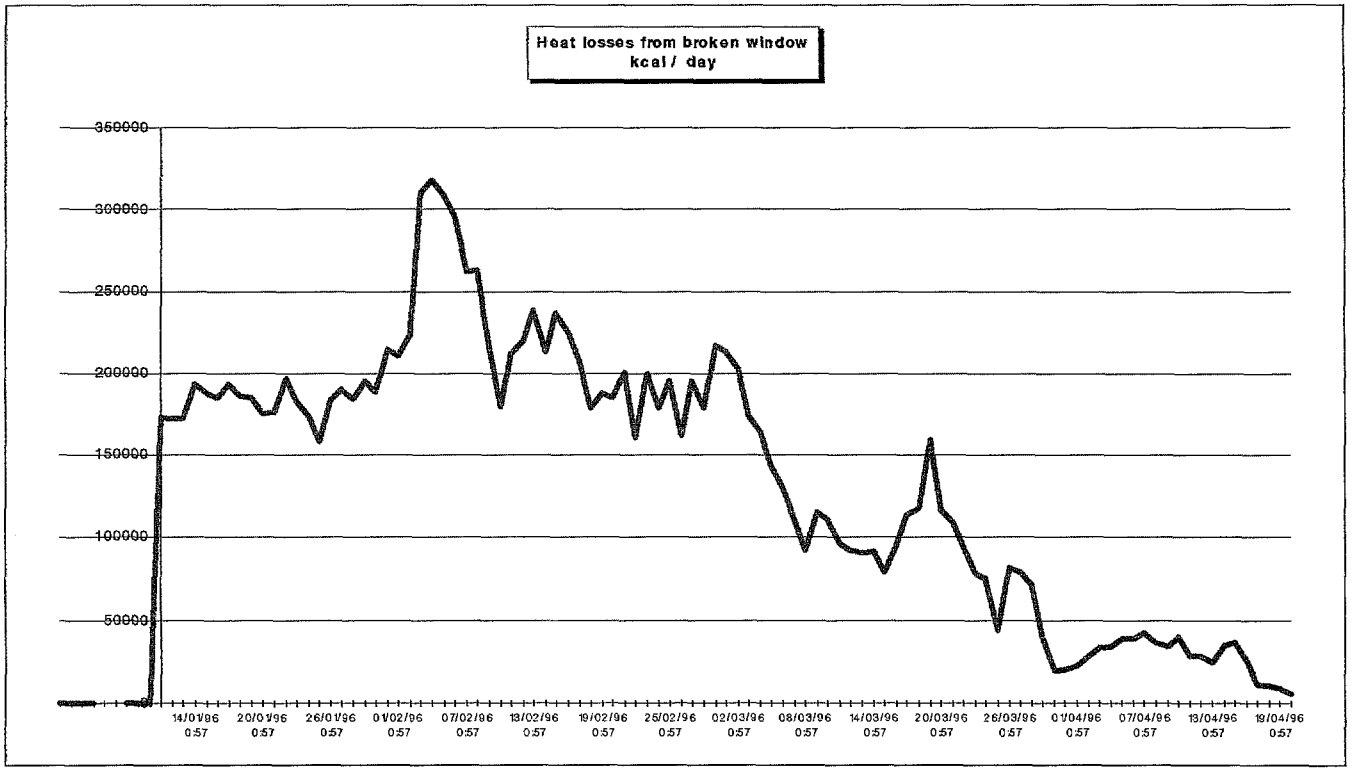
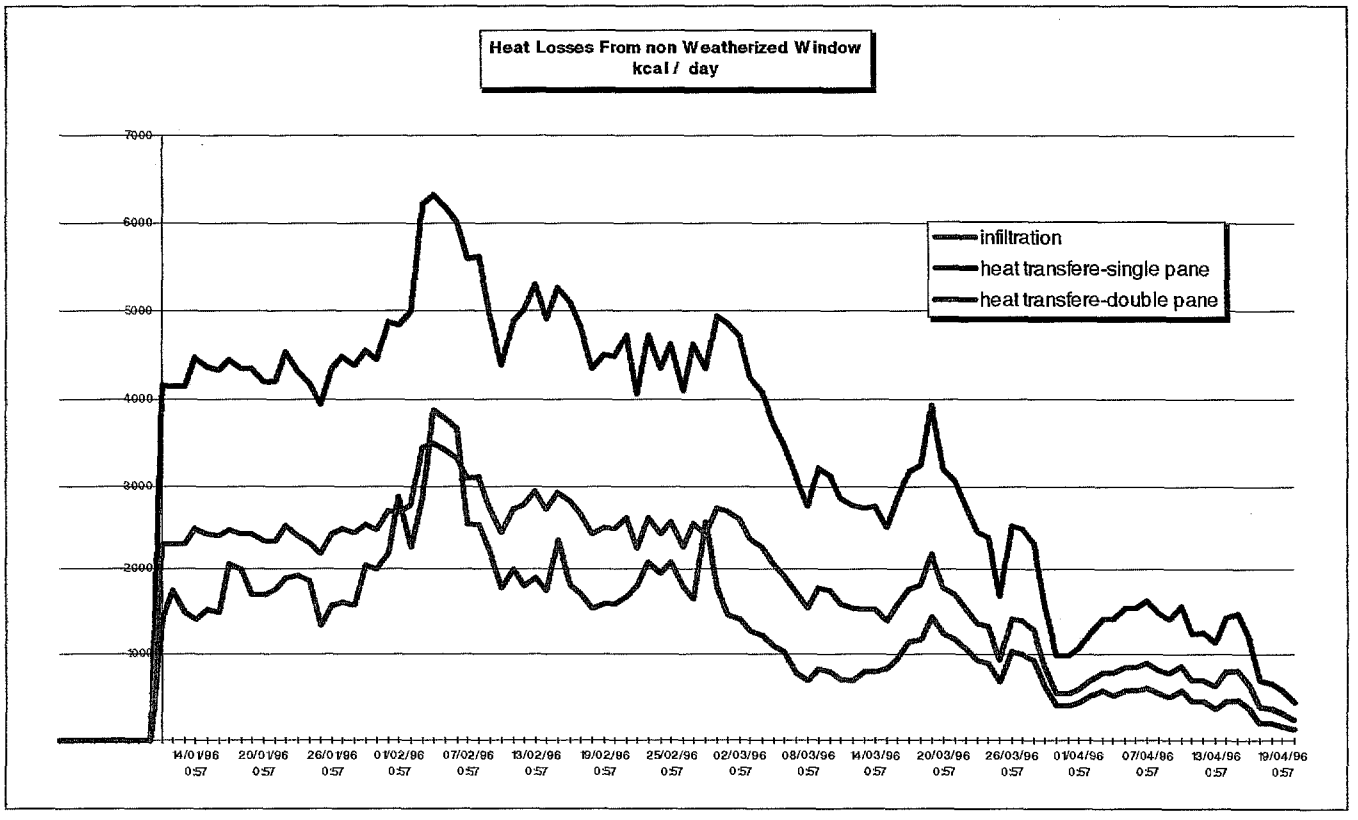

Heat losses from broken window
kcal / day
350000
300000
250000
200000
150000
100000
50000
14/01/96 0:57
20/01/96 0:57
26/01/96 0:57
01/02/96 0:57
07/02/96 0:57
13/02/96 0:57
19/02/96 0:57
25/02/96 0:57
02/03/96 0:57
08/03/96 0:57
14/03/96 0:57
20/03/96 0:57
26/03/96 0:57
01/04/96 0:57
07/04/96 0:57
13/04/96 0:57
19/04/96 0:57


Heat Losses From non Weatherized Window
kcal / day
7000
6000
5000
4000
3000
2000
1000
infiltration
heat transfere-single pane
heat transfere-double pane
14/01/96 0:57
20/01/96 0:57
26/01/96 0:57
01/02/96 0:57
07/02/96 0:57
13/02/96 0:57
19/02/96 0:57
25/02/96 0:57
02/03/96 0:57
08/03/96 0:57
14/03/96 0:57
20/03/96 0:57
26/03/96 0:57
01/04/96 0:57
07/04/96 0:57
13/04/96 0:57
19/04/96 0:57

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Energy Saved for the period of monitoring:

Delta Q=390101489.96 kcal / season

Conventional Fuel Saved for the period of monitoring:

B=79612.55 kg / season

Money Savings: E=8359 $/ season

Payback Period: Z=2,894 seasons

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Maternity Hospital # 4
(Typical Winter Data)

Date / Time	Temperature non weatherized	Temperature weatherized	Outside Temperature	Infiltration weatherized per window	Infiltration non weatherized per window	Air Density non weatherized	Air Density weatherized	Air Density Outside Air	Infiltration weatherized per window	Infiltration non weatherized per window	Temperature non weatherized absolute	Temperature weatherized absolute	Outside Temperature absolute	Inlet Air From One Broken Window Non weather	Inlet Air From One Broken Window Non weather
	t nw	t w	t o	L w	L nw	D nw	D w	D o	G w	G nw	T nw	T w	T o	V b	G b
	(C)	(C)	(C)	(cub.m/h)	(cub.m/h)	kg / cub.m	kg / cub.m	kg / cub.m	kg / hour	kg / hour	(T)	(T)	(T)	cub.m/hour	kg / hour
11/01/96 0:57	22.00	22.00	-10.86	0.0987	12.547	1.1955	1.1955	1.3516	0.1334	17.0124	295	295.00	262.14	2353.9836	2814.1874
12/01/96 0:57	22.00	22.00	-10.87	0.0987	15.477	1.1955	1.1955	1.3516	0.1334	20.9192	295	295.00	262.13	2354.3417	2814.6155
13/01/96 0:57	22.00	22.00	-10.86	0.0987	13.254	1.1955	1.1955	1.3516	0.1334	17.9139	295	295.00	262.14	2353.9836	2814.1874
14/01/96 0:57	22.00	22.00	-12.64	0.0987	11.642	1.1955	1.1955	1.3600	0.1342	15.6976	295	295.00	260.36	2416.8995	2889.4033
15/01/96 0:57	22.00	22.00	-13.16	0.0987	12.744	1.1955	1.1955	1.3625	0.1345	17.3638	295	295.00	259.84	2434.9726	2911.0098
16/01/96 0:57	22.00	22.00	-13.07	0.0954	12.488	1.1955	1.1955	1.3621	0.1299	17.0097	295	295.00	259.93	2431.8542	2907.2817
17/01/96 0:57	22.00	22.00	-13.98	0.0954	16.972	1.1955	1.1955	1.3664	0.1304	23.0540	295	295.00	259.02	2463.2031	2944.7593
18/01/96 0:57	22.00	22.00	-12.78	0.0954	16.864	1.1955	1.1955	1.3607	0.1298	22.9333	295	295.00	260.22	2421.7786	2895.2363
19/01/96 0:57	22.00	22.00	-12.68	0.0954	14.257	1.1955	1.1955	1.3602	0.1298	19.3928	295	295.00	260.32	2418.2945	2891.0711
20/01/96 0:57	22.00	22.00	-11.34	0.0954	14.854	1.1955	1.1955	1.3539	0.1292	20.1103	295	295.00	261.66	2371.1141	2834.6669
21/01/96 0:57	22.00	22.00	-11.83	0.09364	15.246	1.1955	1.1955	1.3562	0.1269	20.7063	295	295.00	261.17	2388.4747	2855.4215
22/01/96 0:57	22.00	22.00	-12.67	0.09364	15.246	1.1955	1.1955	1.3602	0.1272	20.7673	295	295.00	260.33	2417.9458	2890.6543
23/01/96 0:57	22.00	22.00	-11.42	0.09364	16.428	1.1955	1.1955	1.3542	0.1267	22.2475	295	295.00	261.58	2373.9571	2838.0657
24/01/96 0:57	22.00	22.00	-10.62	0.09364	16.428	1.1955	1.1955	1.3504	0.1263	22.1851	295	295.00	262.38	2345.3714	2803.8915
25/01/96 0:57	22.00	22.00	-9.02	0.0924	12.546	1.1955	1.1955	1.3428	0.1241	16.8473	295	295.00	263.98	2287.1284	2734.2620
26/01/96 0:57	22.00	22.00	-10.21	0.0924	13.3066	1.1955	1.1955	1.3485	0.1246	17.9426	295	295.00	262.79	2330.5853	2786.2148
27/01/96 0:57	22.00	22.00	-9.41	0.0924	13.3066	1.1955	1.1955	1.3447	0.1243	17.8920	295	295.00	263.59	2301.4610	2751.3966
28/01/96 0:57	22.00	22.00	-9.02	0.0924	13.3066	1.1955	1.1955	1.3428	0.1241	17.8674	295	295.00	263.98	2287.1284	2734.2620
29/01/96 0:57	22.00	22.00	-9.02	0.0924	16.632	1.1955	1.1955	1.3428	0.1241	22.3342	295	295.00	263.98	2287.1284	2734.2620
30/01/96 0:57	22.00	22.00	-9.02	0.0924	16.632	1.1955	1.1955	1.3428	0.1241	22.3342	295	295.00	263.98	2287.1284	2734.2620
31/01/96 0:57	22.00	22.00	-9.81	0.0924	16.632	1.1955	1.1955	1.3466	0.1244	22.3966	295	295.00	263.19	2316.0689	2768.8604
01/02/96 0:57	22.00	22.00	-7.84	0.0924	22.176	1.1955	1.1955	1.3372	0.1236	29.6546	295	295.00	265.16	2243.2055	2681.7522
02/02/96 0:57	22.00	22.00	-11.01	0.0739	16.632	1.1955	1.1955	1.3523	0.1000	22.4914	295	295.00	261.99	2359.3502	2820.6032
03/02/96 0:57	22.00	22.00	-15.71	0.0739	16.632	1.1955	1.1955	1.3746	0.1016	22.8627	295	295.00	257.29	2521.7261	3014.7236
04/02/96 0:57	22.00	22.00	-16.16	0.0739	22.176	1.1955	1.1955	1.3768	0.1018	30.5310	295	295.00	256.84	2536.7276	3032.6578
05/02/96 0:57	22.00	22.00	-15.71	0.0924	22.176	1.1955	1.1955	1.3746	0.1270	30.4836	295	295.00	257.29	2521.7261	3014.7236
06/02/96 0:57	22.00	22.00	-15.27	0.0924	22.176	1.1955	1.1955	1.3725	0.1268	30.4373	295	295.00	257.73	2506.9712	2997.0841
07/02/96 0:57	22.00	22.00	-11.83	0.0821	16.632	1.1955	1.1955	1.3562	0.1114	22.5562	295	295.00	261.17	2388.4747	2855.4215
08/02/96 0:57	22.00	22.00	-10.62	0.0821	16.632	1.1955	1.1955	1.3504	0.1109	22.4606	295	295.00	262.38	2345.3714	2803.8915
09/02/96 0:57	22.00	22.00	-7.84	0.0821	16.632	1.1955	1.1955	1.3372	0.1098	22.2410	295	295.00	265.16	2243.2055	2681.7522
10/02/96 0:57	22.00	22.00	-5.16	0.0755	15.264	1.1955	1.1955	1.3245	0.1053	20.2173	295	295.00	267.84	2140.1023	2558.4923
11/02/96 0:57	22.00	22.00	-6.3	0.0755	15.264	1.1955	1.1955	1.3299	0.1057	20.3000	295	295.00	266.7	2184.5544	2611.6348
12/02/96 0:57	22.00	22.00	-7.07	0.0739	13.3066	1.1955	1.1955	1.3336	0.0986	17.7441	295	295.00	265.93	2214.0742	2646.9257
13/02/96 0:57	22.00	22.00	-8.23	0.0739	13.3066	1.1955	1.1955	1.3391	0.0761	17.8174	295	295.00	264.77	2257.8169	2699.2201

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14/02/96 0:57	22.00	22.00	-6.68	0.0493	13.3056	1.1955	1.1955	1.3317	0.0656	17.7195	295	295.00	266.32	2199.1721	2629.1103
15/02/96 0:57	22.00	22.00	-7.84	0.0439	16.532	1.1955	1.1955	1.3372	0.0659	22.2410	295	295.00	265.16	2243.2055	2681.7522
16/02/96 0:57	22.00	22.00	-7.07	0.0370	13.3056	1.1955	1.1955	1.3336	0.0493	17.7441	295	295.00	265.93	2214.0742	2646.9257
17/02/96 0:57	22.00	22.00	-6.3	0.0398	13.3056	1.1955	1.1955	1.3299	0.0529	17.6955	295	295.00	266.7	2184.5544	2611.6348
18/02/96 0:57	22.00	22.00	-5.16	0.0398	13.3056	1.1955	1.1955	1.3245	0.0527	17.6234	295	295.00	267.84	2140.1023	2558.4923
19/02/96 0:57	22.00	22.00	-5.92	0.0464	13.3056	1.1955	1.1955	1.3281	0.0654	17.6714	295	295.00	267.08	2169.8382	2594.0416
20/02/96 0:57	22.00	22.00	-4.41	0.0400	13.3056	1.1955	1.1955	1.3209	0.0529	17.5760	295	295.00	268.59	2110.3469	2522.9197
21/02/96 0:57	22.00	22.00	-5.16	0.0400	13.3056	1.1955	1.1955	1.3245	0.0530	17.6234	295	295.00	267.84	2140.1023	2558.4923
22/02/96 0:57	22.00	22.00	-4.04	0.0400	16.532	1.1955	1.1955	1.3192	0.0628	21.9408	295	295.00	268.96	2095.5119	2505.1845
23/02/96 0:57	22.00	22.00	-5.16	0.0400	16.532	1.1955	1.1955	1.3245	0.0530	22.0293	295	295.00	267.84	2140.1023	2558.4923
24/02/96 0:57	22.00	22.00	-5.16	0.0437	16.841	1.1955	1.1955	1.3245	0.0605	22.3140	295	295.00	267.84	2140.1023	2558.4923
25/02/96 0:57	22.00	22.00	-5.92	0.0437	16.841	1.1955	1.1955	1.3281	0.0607	22.3748	295	295.00	267.08	2169.8382	2594.0416
26/02/96 0:57	22.00	22.00	-2.93	0.0462	16.852	1.1955	1.1955	1.3139	0.0607	21.8531	295	295.00	270.07	2050.3632	2451.2091
27/02/96 0:57	22.00	22.00	-0.83	0.0462	13.3056	1.1955	1.1955	1.3039	0.0602	17.3497	295	295.00	272.17	1962.1066	2345.6985
28/02/96 0:57	22.00	22.00	0.38	0.0498	22.176	1.1955	1.1955	1.2982	0.0646	28.7888	295	295.00	273.38	1909.4025	2282.6907
29/02/96 0:57	22.00	22.00	3.16	0.0495	13.3056	1.1955	1.1955	1.2850	0.0636	17.0976	295	295.00	276.16	1782.4202	2130.8834
01/03/96 0:57	22.00	22.00	5.84	0.0462	11.088	1.1955	1.1955	1.2723	0.0588	14.1068	295	295.00	278.84	1650.7843	1973.5126
02/03/96 0:57	22.00	22.00	4.7	0.0478	11.088	1.1955	1.1955	1.2777	0.0611	14.1669	295	295.00	277.7	1708.0190	2041.9367
03/03/96 0:57	22.00	22.00	3.93	0.0478	11.088	1.1955	1.1955	1.2813	0.0612	14.2074	295	295.00	276.93	1745.6160	2086.8840
04/03/96 0:57	22.00	22.00	2.77	0.0495	11.088	1.1955	1.1955	1.2868	0.0634	14.2685	295	295.00	275.77	1800.7743	2152.8257
05/03/96 0:57	22.00	22.00	4.32	0.0462	11.088	1.1955	1.1955	1.2795	0.0591	14.1869	295	295.00	277.32	1726.6757	2064.2408
06/03/96 0:57	22.00	22.00	3.16	0.0524	11.088	1.1955	1.1955	1.2850	0.0673	14.2480	295	295.00	276.16	1782.4202	2130.8834
07/03/96 0:57	22.00	22.00	3.93	0.0462	9.504	1.1955	1.1955	1.2813	0.0592	12.1778	295	295.00	276.93	1745.6160	2086.8840
08/03/96 0:57	22.00	22.00	4.7	0.0455	9.504	1.1955	1.1955	1.2777	0.0556	12.1430	295	295.00	277.7	1708.0190	2041.9367
09/03/96 0:57	22.00	22.00	5.84	0.0400	9.676	1.1955	1.1955	1.2723	0.0509	12.3129	295	295.00	278.84	1650.7843	1973.5126
10/03/96 0:57	22.00	22.00	7.33	0.0400	9.676	1.1955	1.1955	1.2652	0.0506	12.2444	295	295.00	280.33	1572.8406	1880.3309
11/03/96 0:57	22.00	22.00	8.43	0.0439	9.504	1.1955	1.1955	1.2600	0.0546	11.9746	295	295.00	281.43	1512.7236	1808.4610
12/03/96 0:57	22.00	22.00	8.8	0.0462	9.504	1.1955	1.1955	1.2582	0.0581	11.9579	295	295.00	281.8	1491.9581	1783.6359
13/03/96 0:57	22.00	22.00	8.8	0.0462	11.088	1.1955	1.1955	1.2582	0.0581	13.9509	295	295.00	281.8	1491.9581	1783.6359
14/03/96 0:57	22.00	22.00	8.8	0.0491	11.088	1.1955	1.1955	1.2582	0.0618	13.9509	295	295.00	281.8	1491.9581	1783.6359
15/03/96 0:57	22.00	22.00	10.24	0.0454	12.654	1.1955	1.1955	1.2514	0.0542	15.8347	295	295.00	283.24	1408.2291	1683.5379
16/03/96 0:57	22.00	22.00	8.43	0.0455	12.654	1.1955	1.1955	1.2600	0.0546	15.9435	295	295.00	281.43	1512.7236	1808.4610
17/03/96 0:57	22.00	22.00	5.84	0.0455	13.542	1.1955	1.1955	1.2723	0.0551	17.2289	295	295.00	278.84	1650.7843	1973.5126
18/03/96 0:57	22.00	22.00	5.46	0.0557	13.542	1.1955	1.1955	1.2741	0.0710	17.2534	295	295.00	278.46	1670.0805	1996.5812
19/03/96 0:57	22.00	22.00	0.38	0.0547	13.542	1.1955	1.1955	1.2982	0.0723	17.5802	295	295.00	273.38	1909.4025	2282.6907
20/03/96 0:57	22.00	22.00	3.16	0.0547	14.327	1.1955	1.1955	1.2850	0.0716	18.4101	295	295.00	276.16	1782.4202	2130.8834
21/03/96 0:57	22.00	22.00	3.54	0.0541	14.327	1.1955	1.1955	1.2832	0.0694	18.3842	295	295.00	276.54	1764.3531	2109.2841
22/03/96 0:57	22.00	22.00	4.7	0.0541	14.327	1.1955	1.1955	1.2777	0.0691	18.3052	295	295.00	277.7	1708.0190	2041.9367
23/03/96 0:57	22.00	22.00	6.59	0.0541	14.327	1.1955	1.1955	1.2687	0.0686	18.1766	295	295.00	279.59	1612.0220	1927.1723
24/03/96 0:57	22.00	22.00	6.96	0.0541	14.327	1.1955	1.1955	1.2669	0.0685	18.1514	295	295.00	279.96	1592.5518	1903.8957
25/03/96 0:57	22.00	22.00	9.16	0.0691	15.268	1.1955	1.1955	1.2565	0.0868	19.1841	295	295.00	282.16	1471.4725	1759.1454
26/03/96 0:57	22.00	22.00	5.84	0.0691	15.268	1.1955	1.1955	1.2723	0.0879	19.4249	295	295.00	278.84	1650.7843	1973.5126
27/03/96 0:57	22.00	22.00	6.59	0.0691	15.268	1.1955	1.1955	1.2687	0.0877	19.3705	295	295.00	279.59	1612.0220	1927.1723
28/03/96 0:57	22.00	22.00	6.96	0.0691	15.268	1.1955	1.1955	1.2669	0.0876	19.3436	295	295.00	279.96	1592.5518	1903.8957
29/03/96 0:57	22.00	22.00	9.52	0.0691	15.268	1.1955	1.1955	1.2548	0.0867	19.1580	295	295.00	282.52	1450.6978	1734.3092

30/03/96 0:57	22.00	22.00	10.61	0.0691	15.6984	1.1955	1.1955	1.2496	0.0863	19.6168	295	295.00	283.61	1385.8988	1656.8420
31/03/96 0:57	22.00	22.00	10.61	0.0691	15.6984	1.1955	1.1955	1.2496	0.0863	19.6168	295	295.00	283.61	1385.8988	1656.8420
01/04/96 0:57	22.00	22.00	10.24	0.0691	15.6984	1.1955	1.1955	1.2514	0.0865	19.6443	295	295.00	283.24	1408.2291	1683.5379
02/04/96 0:57	22.00	22.00	9.74	0.0691	15.6984	1.1955	1.1955	1.2537	0.0866	19.6816	295	295.00	282.74	1437.8543	1718.9548
03/04/96 0:57	22.00	22.00	9.03	0.0691	15.6984	1.1955	1.1955	1.2571	0.0869	19.7346	295	295.00	282.03	1478.9028	1768.0283
04/04/96 0:57	22.00	22.00	8.8	0.0624	14.234	1.1955	1.1955	1.2582	0.0785	17.9092	295	295.00	281.8	1491.9581	1783.6359
05/04/96 0:57	22.00	22.00	8.43	0.0624	14.234	1.1955	1.1955	1.2600	0.0786	17.9342	295	295.00	281.43	1512.7236	1808.4610
06/04/96 0:57	22.00	22.00	8.43	0.0624	14.234	1.1955	1.1955	1.2600	0.0786	17.9342	295	295.00	281.43	1512.7236	1808.4610
07/04/96 0:57	22.00	22.00	8.24	0.0624	14.234	1.1955	1.1955	1.2609	0.0787	17.9471	295	295.00	281.24	1523.2769	1821.0776
08/04/96 0:57	22.00	22.00	8.81	0.0624	13.952	1.1955	1.1955	1.2582	0.0786	17.5637	295	295.00	281.81	1491.3928	1782.9601
09/04/96 0:57	22.00	22.00	9.16	0.0624	13.952	1.1955	1.1955	1.2565	0.0784	17.5305	295	295.00	282.16	1471.4725	1759.1454
10/04/96 0:57	22.00	22.00	8.68	0.0624	13.952	1.1955	1.1955	1.2588	0.0785	17.5624	295	295.00	281.68	1498.7243	1791.7250
11/04/96 0:57	22.00	22.00	9.88	0.0623	13.952	1.1955	1.1955	1.2531	0.0655	17.4828	295	295.00	282.88	1429.6211	1709.1121
12/04/96 0:57	22.00	22.00	9.88	0.0623	13.952	1.1955	1.1955	1.2531	0.0655	17.4828	295	295.00	282.88	1429.6211	1709.1121
13/04/96 0:57	22.00	22.00	10.96	0.0523	12.423	1.1955	1.1955	1.2479	0.0653	15.5032	295	295.00	283.96	1364.4392	1631.1871
14/04/96 0:57	22.00	22.00	9.52	0.0523	12.423	1.1955	1.1955	1.2548	0.0656	15.5881	295	295.00	282.52	1450.6978	1734.3092
15/04/96 0:57	22.00	22.00	10.43	0.0523	12.423	1.1955	1.1955	1.2505	0.0654	15.5344	295	295.00	283.43	1396.8068	1669.8825
16/04/96 0:57	22.00	22.00	10.96	0.0523	12.423	1.1955	1.1955	1.2479	0.0653	15.5032	295	295.00	283.96	1364.4392	1631.1871
17/04/96 0:57	22.00	22.00	13.09	0.0523	11.964	1.1955	1.1955	1.2378	0.0647	14.3142	295	295.00	286.09	1225.7686	1465.4064
18/04/96 0:57	22.00	22.00	13.45	0.0483	11.964	1.1955	1.1955	1.2361	0.0597	14.2944	295	295.00	286.45	1200.7503	1435.4970
19/04/96 0:57	22.00	22.00	14.16	0.0483	11.964	1.1955	1.1955	1.2327	0.0595	14.2554	295	295.00	287.16	1149.8142	1374.6029
20/04/96 0:57	22.00	22.00	14.87	0.0483	11.964	1.1955	1.1955	1.2294	0.0594	14.4433	295	295.00	287.87	1096.5146	1310.8832

Maternity Hospital # 4
(Theoretical Calculations for Typical Winter)

Date / Time	Heat losses from one non weathe-rized window by infiltration per day Q inf. nw kcal day	Heat losses from one non weatherized single pane window by transfere per day Q tr. nw1 kcal day	Heat losses from one non weatherized double pane window by transfere per day Q tr. nw2 kcal day	Heat losses from one broken window by inlet air per day Q b. nw kcal day	Heat losses from 85 non weatherized single pane windows per day Q nw 1 kcal day	Heat losses from 320 non weatherized double pane windows per day Q nw 2 kcal day	Heat losses from 22 broken windows per day Q b kcal day	Total heat losses from non weatherized weatherized building per day Q nw kcal day	Heat losses from one weatherized window by infiltration per day Q inf. w kcal day	Heat losses from one weatherized double pane window by transfere per day Q tr. w2 kcal day	Total heat losses from weatherized building per day Q nw kcal day	Energy savings in the period of monitoring per day delta Q kcal day	Conventional fuel saved in the perion of monitoring per day B kg/day	Money savings in the period of monitoring per day E $ / day
11/01/96 0:57	3220.00	9049.64	5027.58	532651.37	1042919.59	2639225.05	11718330.23	15400474.87	25.25	4022.06	1728202.81	13672272.06	2790.26	$292.98
12/01/96 0:57	3960.66	9052.40	5029.11	532894.54	1106109.96	2876726.50	11723679.84	15706516.30	25.26	4023.29	1728729.12	13977787.18	2852.61	$299.52
13/01/96 0:57	3390.63	9049.64	5027.58	532651.37	1057423.27	2693827.13	11718330.23	15469580.63	25.25	4022.06	1728202.81	13741377.82	2804.36	$294.46
14/01/96 0:57	3132.08	9539.86	5299.92	576512.25	1077114.73	2698240.63	12683269.45	16458624.80	26.78	4239.94	1821889.28	14636735.53	2987.09	$313.64
15/01/96 0:57	3516.55	9683.06	5379.48	589542.36	1121967.20	2846729.64	12969931.83	16938628.67	27.24	4303.58	1849259.73	15089368.93	3079.46	$323.34
16/01/96 0:57	3436.01	9658.28	5365.71	587280.20	1113014.57	2816550.74	12920164.49	16849729.79	26.25	4292.57	1844134.79	15005595.00	3062.37	$321.55
17/01/96 0:57	4777.82	9908.89	5504.94	610286.06	1248370.40	3290482.73	13426293.37	17965146.50	27.02	4403.95	1892023.08	16073123.42	3280.23	$344.42
18/01/96 0:57	4594.30	9578.41	5321.34	580010.80	1204680.23	3173003.72	12760237.58	17137921.53	26.01	4257.07	1828874.07	15309047.46	3124.30	$328.05
19/01/96 0:57	3873.84	9550.87	5306.04	577511.11	1141100.82	2937562.72	12705244.50	16783908.04	25.92	4244.83	1823611.80	14960296.24	3053.12	$320.58
20/01/96 0:57	3861.95	9181.84	5101.02	544364.89	1108721.97	2868151.01	11976027.57	15952900.55	24.80	4080.82	1753099.50	14199801.05	2897.92	$304.28
21/01/96 0:57	4034.86	9316.78	5175.99	556409.72	1134889.18	2947470.51	12241013.88	16323373.57	24.72	4140.79	1778673.50	14544700.06	2968.31	$311.67
22/01/96 0:57	4147.21	9548.12	5304.51	577261.34	1164102.58	3024549.28	12699749.55	16888401.41	25.41	4243.61	1822869.84	15065531.56	3074.60	$322.83
23/01/96 0:57	4282.63	9203.87	5113.26	546325.39	1146352.59	3006685.78	12019158.49	16172196.86	24.39	4090.61	1757102.03	14415094.83	2941.86	$308.89
24/01/96 0:57	4168.39	8983.55	4990.86	526826.54	1117914.48	2930959.05	11590183.95	15639057.48	23.73	3992.69	1715012.42	13924045.06	2841.64	$298.37
25/01/96 0:57	3010.20	8542.91	4746.06	488544.81	982014.24	2482003.41	10747985.80	14212003.45	22.17	3796.85	1630720.61	12581282.84	2567.61	$269.60
26/01/96 0:57	3328.88	8870.63	4928.13	516925.31	1036958.48	2642242.41	11372356.91	15051557.80	23.12	3942.50	1693320.25	13358237.54	2726.17	$286.25
27/01/96 0:57	3237.05	8650.31	4805.73	497787.08	1010425.99	2573689.77	10951315.69	14535431.45	22.48	3844.58	1651236.12	12884195.33	2629.43	$276.09
28/01/96 0:57	3192.45	8542.91	4746.06	488544.81	997505.76	2540324.43	10747985.80	14285815.99	22.17	3796.85	1630720.61	12655095.38	2582.67	$271.18
29/01/96 0:57	3990.57	8542.91	4746.06	488544.81	1065345.40	2795720.74	10747985.80	14609051.94	22.17	3796.85	1630720.61	12978331.33	2648.64	$278.11
30/01/96 0:57	3990.57	8542.91	4746.06	488544.81	1065345.40	2795720.74	10747985.80	14609051.94	22.17	3796.85	1630720.61	12978331.33	2648.64	$278.11
31/01/96 0:57	4103.63	8760.47	4866.93	507326.11	1093449.03	2870579.92	11161174.48	15125203.43	22.80	3893.54	1672278.02	13452925.41	2745.49	$288.28
01/02/96 0:57	5096.99	8217.94	4565.52	460935.27	1131768.80	3092003.55	10140575.95	14364348.30	21.24	3652.42	1568650.03	12795698.27	2611.37	$274.19
02/02/96 0:57	4276.46	9090.95	5050.53	536302.72	1136230.45	2984637.79	11798659.84	15919528.08	19.01	4040.42	1733376.82	14186151.26	2895.13	$303.99
03/02/96 0:57	4966.00	10385.33	5769.63	654826.90	1304863.61	3435402.42	14406191.80	19146457.83	22.07	4615.70	1980329.98	17166127.85	3503.29	$367.85
04/02/96 0:57	6710.77	10509.26	5838.48	666583.04	1463702.82	4015759.74	14664826.96	20144289.52	22.37	4670.78	2003976.43	18140313.10	3702.10	$388.72
05/02/96 0:57	6621.34	10385.33	5769.63	654826.90	1445567.02	3965109.37	14406191.80	19816868.18	27.59	4615.70	1982686.07	17834182.11	3639.63	$382.16
06/02/96 0:57	6534.13	10264.16	5702.31	643399.62	1427854.42	3915660.58	14154791.71	19498306.72	27.23	4561.85	1959534.40	17538772.31	3579.34	$375.83
07/02/96 0:57	4395.32	9316.78	5175.99	556409.72	1165528.50	3062818.54	12241013.88	16469360.92	21.71	4140.79	1777386.34	14691974.58	2998.36	$314.83
08/02/96 0:57	4220.15	8983.55	4990.86	526826.54	1122314.27	2947522.98	11590183.95	15660021.21	20.84	3992.69	1713776.56	13946244.65	2846.17	$298.85
09/02/96 0:57	3822.74	8217.94	4565.52	460935.27	1023457.74	2684244.26	10140575.95	13848277.95	18.88	3652.42	1567642.43	12280635.52	2506.25	$263.16
10/02/96 0:57	3162.83	7479.86	4155.48	400254.63	904628.99	2341859.20	8805601.80	12052089.99	16.47	3324.38	1426545.97	10625544.02	2168.48	$227.69

56

11/02/96 0:57	3309.06	7793.82	4329.90	425717.37	943744.66	2444466.67	9365782.05	12753993.38	17.23	3463.92	1486453.05	11267540.34	2299.50	$241.45
12/02/96 0:57	2971.13	8005.88	4447.71	443209.70	933045.80	2374029.26	9750613.49	13057688.56	16.51	3558.17	1526385.92	11531302.64	2353.33	$247.10
13/02/96 0:57	3102.46	8325.34	4625.19	470001.16	971362.85	2472846.81	10340025.61	13784235.28	13.26	3700.15	1585626.22	12198609.06	2489.51	$261.40
14/02/96 0:57	2927.20	7898.47	4388.04	434320.60	920182.05	2340876.54	9555053.31	12816111.90	10.84	3510.43	1503583.78	11312528.13	2308.68	$242.41
15/02/96 0:57	3822.74	8217.94	4565.52	460935.27	1023457.74	2684244.26	10140575.95	13848277.95	11.33	3652.42	1564418.11	12283859.84	2506.91	$263.23
16/02/96 0:57	2971.13	8005.88	4447.71	443209.70	933045.80	2374029.26	9750613.49	13057688.56	8.25	3558.17	1522861.83	11534826.73	2354.05	$247.17
17/02/96 0:57	2884.50	7793.82	4329.90	425717.37	907657.19	2308607.98	9365782.05	12582047.22	8.63	3463.92	1482778.07	11099269.15	2265.16	$237.84
18/02/96 0:57	2757.03	7479.86	4155.48	400254.63	870136.24	2212004.14	8805601.80	11887742.18	8.25	3324.38	1423033.39	10464708.79	2135.65	$224.24
19/02/96 0:57	2841.91	7689.17	4271.76	417171.69	895141.27	2276373.05	9177777.29	12349291.62	10.53	3417.41	1463727.64	10885563.98	2221.54	$233.26
20/02/96 0:57	2673.69	7273.31	4040.73	383790.58	845495.26	2148614.11	8443392.84	11437502.21	8.05	3232.58	1383748.93	10053753.28	2051.79	$215.44
21/02/96 0:57	2757.03	7479.86	4155.48	400254.63	870136.24	2212004.14	8805601.80	11887742.18	8.30	3324.38	1423054.63	10464687.55	2135.65	$224.24
22/02/96 0:57	3290.90	7171.42	3984.12	375753.63	889297.25	2328007.87	8266579.82	11483884.94	7.92	3187.30	1364358.32	10119526.62	2065.21	$216.85
23/02/96 0:57	3446.29	7479.86	4155.48	400254.63	928723.19	2432566.77	8805601.80	12166891.76	8.30	3324.38	1423054.63	10743837.14	2192.62	$230.23
24/02/96 0:57	3490.84	7479.86	4155.48	400254.63	932509.92	2446822.72	8805601.80	12184934.44	9.47	3324.38	1423555.41	10761379.03	2196.20	$230.60
25/02/96 0:57	3598.30	7689.17	4271.76	417171.69	959435.08	2518420.32	9177777.29	12655632.68	9.76	3417.41	1463401.14	11192231.55	2284.13	$239.83
26/02/96 0:57	3138.03	6865.72	3814.29	351985.79	850319.07	2224742.96	7743687.38	10818749.41	8.72	3051.43	1306683.52	9512065.89	1941.24	$203.83
27/02/96 0:57	2281.50	6287.38	3492.99	308461.23	728355.34	1847838.19	6786146.97	9362340.50	7.92	2794.39	1196588.03	8165752.47	1666.48	$174.98
28/02/96 0:57	3585.10	5954.15	3307.86	284266.22	810836.11	2205747.32	6253856.74	9270440.16	8.04	2646.29	1133399.55	8137040.62	1660.62	$174.37
29/02/96 0:57	1855.40	5188.54	2882.52	231240.05	598734.57	1516134.46	5087281.17	7202150.20	6.90	2306.02	987616.21	6214533.99	1268.27	$133.17
01/03/96 0:57	1313.09	4450.46	2472.48	183697.71	489901.69	1211380.89	4041349.67	5742632.24	5.47	1977.98	846935.37	4895696.88	999.12	$104.91
02/03/96 0:57	1411.70	4764.42	2646.90	203474.91	524970.14	1298751.78	4476448.05	6300169.97	6.09	2117.52	906779.67	5393390.29	1100.69	$115.57
03/03/96 0:57	1478.75	4976.48	2764.71	217209.56	548694.65	1357908.22	4778610.39	6685213.26	6.37	2211.77	947147.00	5738066.26	1171.03	$122.96
04/03/96 0:57	1580.45	5295.94	2942.19	238457.31	584493.20	1447244.36	5246060.81	7277798.37	7.02	2353.75	1008051.44	6269746.92	1279.54	$134.35
05/03/96 0:57	1444.75	4869.07	2705.04	210215.68	536674.52	1327931.48	4624744.93	6489350.93	6.02	2164.03	926612.11	5562738.82	1135.25	$119.20
06/03/96 0:57	1546.17	5188.54	2882.52	231240.05	572449.74	1417179.78	5087281.17	7076910.69	7.30	2306.02	987786.51	6089124.18	1242.68	$130.48
07/03/96 0:57	1267.50	4976.48	2764.71	217209.56	530738.36	1290308.08	4778610.39	6599656.82	6.16	2211.77	947055.88	5652600.94	1153.59	$121.13
08/03/96 0:57	1210.03	4764.42	2646.90	203474.91	507828.08	1234216.95	4476448.05	6218493.08	5.54	2117.52	906544.94	5311948.13	1084.07	$113.83
09/03/96 0:57	1146.11	4450.46	2472.48	183697.71	475708.57	1157947.98	4041349.67	5675006.22	4.74	1977.98	846621.85	4828384.37	985.38	$103.47
10/03/96 0:57	1034.65	4040.12	2244.51	158886.46	431354.86	1049329.62	3495502.08	4976186.56	4.28	1795.61	768550.59	4207635.97	858.70	$90.16
11/03/96 0:57	935.98	3737.18	2076.21	141355.10	397218.08	963899.48	3109812.22	4470929.78	4.27	1660.97	711054.71	3759875.07	767.32	$80.57
12/03/96 0:57	909.19	3635.28	2019.60	135613.40	386279.57	937211.37	2983494.84	4306985.78	4.42	1615.68	691782.55	3615203.23	737.80	$77.47
13/03/96 0:57	1060.72	3635.28	2019.60	135613.40	399159.70	985701.27	2983494.84	4368355.81	4.42	1615.68	691782.55	3676573.26	750.32	$78.78
14/03/96 0:57	1060.72	3635.28	2019.60	135613.40	399159.70	985701.27	2983494.84	4368355.81	4.70	1615.68	691900.50	3676455.31	750.30	$78.78
15/03/96 0:57	1072.61	3238.70	1799.28	114038.81	366461.28	919003.27	2508853.93	3794318.48	3.67	1439.42	616201.71	3178116.77	648.60	$68.10
16/03/96 0:57	1246.20	3737.18	2076.21	141355.10	423586.72	1063169.65	3109812.22	4596568.58	4.27	1660.97	711054.71	3885513.87	792.96	$83.26
17/03/96 0:57	1603.70	4450.46	2472.48	183697.71	514603.75	1304376.88	4041349.67	5860330.30	5.13	1977.98	846789.35	5013540.95	1023.17	$107.43
18/03/96 0:57	1643.74	4555.12	2530.62	190215.09	526902.52	1335794.30	4184732.02	6047428.84	6.76	2024.50	867346.70	5180082.14	1057.16	$111.00
19/03/96 0:57	2189.28	5954.15	3307.86	284266.22	692191.21	1759084.16	6253856.74	8705132.11	9.00	2646.29	1133810.02	7571322.09	1545.17	$162.24
20/03/96 0:57	1997.83	5188.54	2882.52	231240.05	610841.06	1561711.79	5087281.17	7259834.02	7.77	2306.02	987985.38	6271848.64	1279.97	$134.40
21/03/96 0:57	1954.78	5083.88	2824.38	224279.33	598286.76	1529332.39	4934145.35	7061764.50	7.38	2259.50	967960.08	6093804.42	1243.63	$130.58
22/03/96 0:57	1824.08	4764.42	2646.90	203474.91	560022.63	1430714.09	4476448.05	6467184.76	6.89	2117.52	907122.17	5560062.60	1134.71	$119.14
23/03/96 0:57	1613.39	4243.91	2357.73	171058.90	497870.56	1270757.34	3763295.77	5531923.66	6.09	1886.18	808001.98	4723921.69	964.07	$101.23
24/03/96 0:57	1572.47	4142.02	2301.12	164935.24	485731.08	1239547.94	3628575.37	5353854.39	5.94	1840.90	788598.02	4565256.37	931.68	$97.83
25/03/96 0:57	1418.82	3536.14	1964.52	130103.58	421171.65	1082670.26	2862278.77	4366120.67	6.42	1571.62	673821.94	3692298.74	753.53	$79.12
26/03/96 0:57	1808.10	4450.46	2472.48	183697.71	531977.73	1369784.82	4041349.67	5943112.23	8.18	1977.98	848093.35	5095018.88	1039.80	$109.18

FILE6.

27/03/96 0:57	1719.35	4243.91	2357.73	171058.90	506877.80	1304666.95	3763295.77	5574840.51	7.78	1886.18	808723.25	4766117.26	972.68	$102.13
28/03/96 0:57	1676.75	4142.02	2301.12	164935.24	494509.88	1272597.52	3628575.37	5395682.77	7.58	1840.90	789301.01	4606381.77	940.08	$98.71
29/03/96 0:57	1377.17	3436.99	1909.44	124670.47	409203.57	1051714.44	2742750.30	4203668.32	6.23	1527.55	654926.11	3548742.21	724.23	$76.04
30/03/96 0:57	1286.98	3136.81	1742.67	108699.44	376022.23	969489.60	2391387.64	3736899.47	5.66	1394.14	597715.01	3139184.47	640.65	$67.27
31/03/96 0:57	1286.98	3136.81	1742.67	108699.44	376022.23	969489.60	2391387.64	3736899.47	5.66	1394.14	597715.01	3139184.47	640.65	$67.27
01/04/96 0:57	1330.66	3238.70	1799.28	114038.81	388396.03	1001581.16	2508853.93	3898831.12	5.86	1439.42	617135.07	3281696.05	669.73	$70.32
02/04/96 0:57	1389.87	3376.40	1875.78	121388.46	405133.27	1045007.91	2670546.22	4120687.40	6.12	1500.62	643378.76	3477308.64	709.65	$74.51
03/04/96 0:57	1474.31	3571.94	1984.41	132084.45	428931.50	1106791.98	2905857.80	4441581.28	6.49	1587.53	680645.48	3760935.80	767.54	$80.59
04/04/96 0:57	1361.67	3635.28	2019.60	135613.40	424741.07	1082007.59	2983494.84	4490243.50	5.97	1615.68	692444.29	3797799.20	775.06	$81.38
05/04/96 0:57	1401.80	3737.18	2076.21	141355.10	436812.89	1112962.30	3109812.22	4659587.41	6.15	1660.97	711857.38	3947730.04	805.66	$84.59
06/04/96 0:57	1401.80	3737.18	2076.21	141355.10	436812.89	1112962.30	3109812.22	4659587.41	6.15	1660.97	711857.38	3947730.04	805.66	$84.59
07/04/96 0:57	1422.44	3789.50	2105.28	144334.24	443015.46	1128871.23	3175353.24	4747239.92	6.24	1684.22	721826.34	4025413.59	821.51	$86.26
08/04/96 0:57	1333.64	3632.53	2018.07	135459.32	422123.70	1072545.65	2980105.14	4474774.49	5.96	1614.46	691919.62	3782854.87	772.01	$81.06
09/04/96 0:57	1296.53	3536.14	1964.52	130103.58	410776.72	1043536.42	2862278.77	4316591.91	5.80	1571.62	673556.08	3643035.83	743.48	$78.07
10/04/96 0:57	1347.44	3668.33	2037.96	137466.87	426340.31	1083328.12	3024271.18	4533939.62	6.03	1630.37	698740.41	3835199.21	782.69	$82.18
11/04/96 0:57	1220.50	3337.85	1854.36	119315.16	387459.37	983954.41	2624933.61	3996347.39	4.58	1483.49	635402.95	3360944.44	685.91	$72.02
12/04/96 0:57	1220.50	3337.85	1854.36	119315.16	387459.37	983954.41	2624933.61	3996347.39	4.58	1483.49	635402.95	3360944.44	685.91	$72.02
13/04/96 0:57	985.85	3040.42	1689.12	103727.84	342232.78	855991.06	2282012.42	3480236.26	4.15	1351.30	578775.60	2901460.66	592.13	$62.17
14/04/96 0:57	1120.55	3436.99	1909.44	124670.47	387391.05	969596.72	2742750.30	4099738.07	4.72	1527.55	654279.05	3445459.02	703.15	$73.83
15/04/96 0:57	1035.26	3186.38	1770.21	111286.31	358839.60	897751.80	2448298.87	3704890.27	4.36	1416.17	606564.77	3098325.50	632.31	$66.39
16/04/96 0:57	985.85	3040.42	1689.12	103727.84	342232.78	855991.06	2282012.42	3480236.26	4.15	1351.30	578775.60	2901460.66	592.13	$62.17
17/04/96 0:57	734.63	2453.81	1363.23	75207.00	271017.45	671314.11	1654554.02	2596885.57	3.32	1090.58	467098.06	2129787.51	434.65	$45.64
18/04/96 0:57	703.97	2354.67	1308.15	70695.36	259984.47	643878.67	1555297.83	2459160.98	2.94	1046.52	448119.55	2011041.42	410.42	$43.09
19/04/96 0:57	643.75	2159.14	1199.52	62074.87	238245.42	589846.82	1365647.10	2193739.34	2.69	959.62	410904.15	1782835.19	363.84	$38.20
20/04/96 0:57	634.24	1963.60	1090.89	53836.40	220816.43	552041.09	1184400.79	1967258.31	2.44	872.71	373689.31	1583569.00	323.18	$33.93
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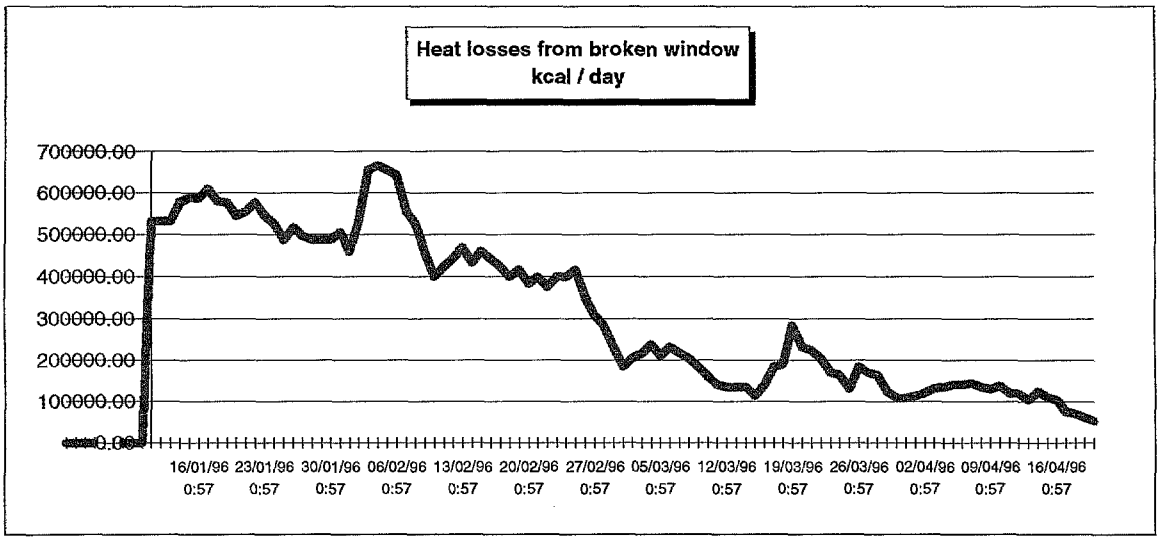
Heat losses from broken window
kcal / day
700000.00
600000.00
500000.00
400000.00
300000.00
200000.00
100000.00
0.00
16/01/96 0:57
23/01/96 0:57
30/01/96 0:57
06/02/96 0:57
13/02/96 0:57
20/02/96 0:57
27/02/96 0:57
05/03/96 0:57
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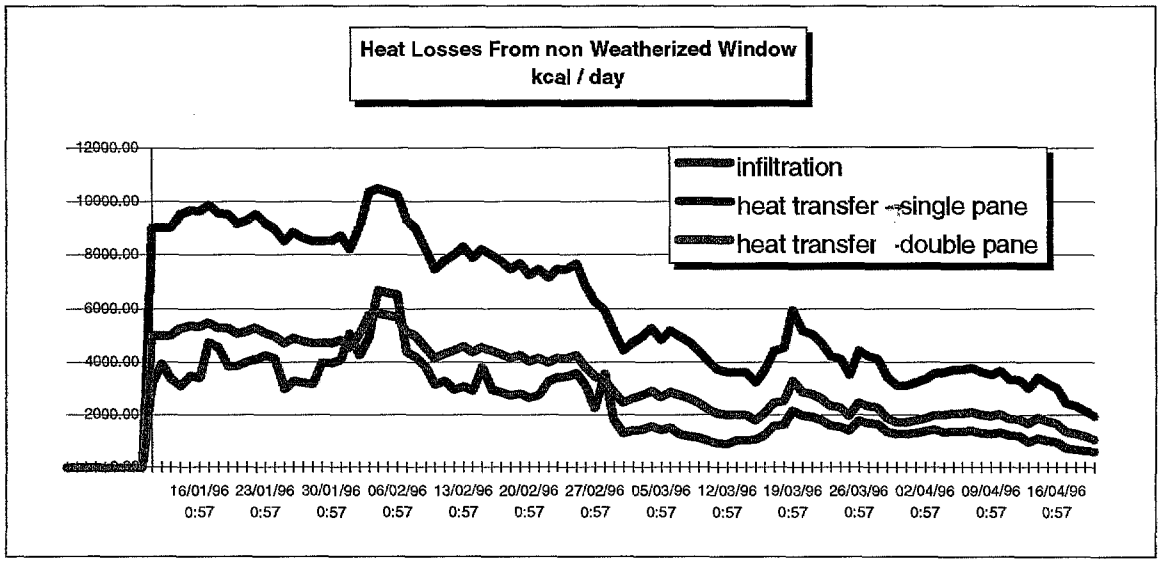
09/04/96 0:57
16/04/96 0:57


Heat Losses From non Weatherized Window
kcal / day
12000.00
10000.00
8000.00
6000.00
4000.00
2000.00
0.00
infiltration
heat transfer -single pane
heat transfer -double pane
16/01/96 0:57
23/01/96 0:57
30/01/96 0:57
06/02/96 0:57
13/02/96 0:57
20/02/96 0:57
27/02/96 0:57
05/03/96 0:57
12/03/96 0:57
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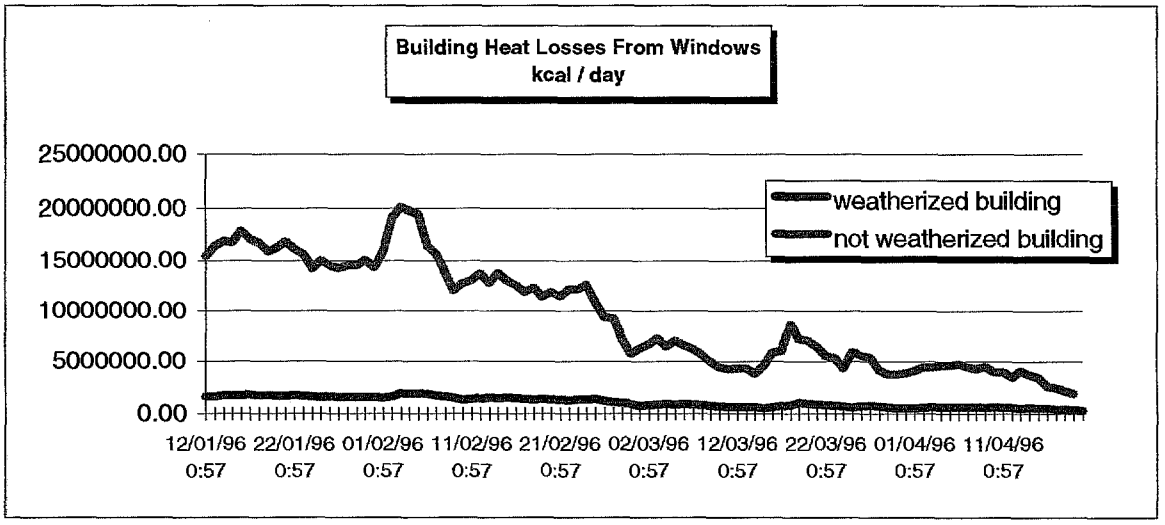
09/04/96 0:57
16/04/96 0:57


Building Heat Losses From Windows
kcal / day
25000000.00
20000000.00
15000000.00
10000000.00
5000000.00
0.00
weatherized building
not weatherized building
12/01/96 0:57
22/01/96 0:57
01/02/96 0:57
11/02/96 0:57
21/02/96 0:57
02/03/96 0:57
12/03/96 0:57
22/03/96 0:57
01/04/96 0:57
11/04/96 0:57

59

Energy Saved for the period of monitoring:

Delta Q=855435203.87 kcal / season

Conventional Fuel Saved for the period of monitoring:

B=174578.61 kg / season

Money Savings: E=18330.75 $/ season

Payback Period: Z=1.38 seasons

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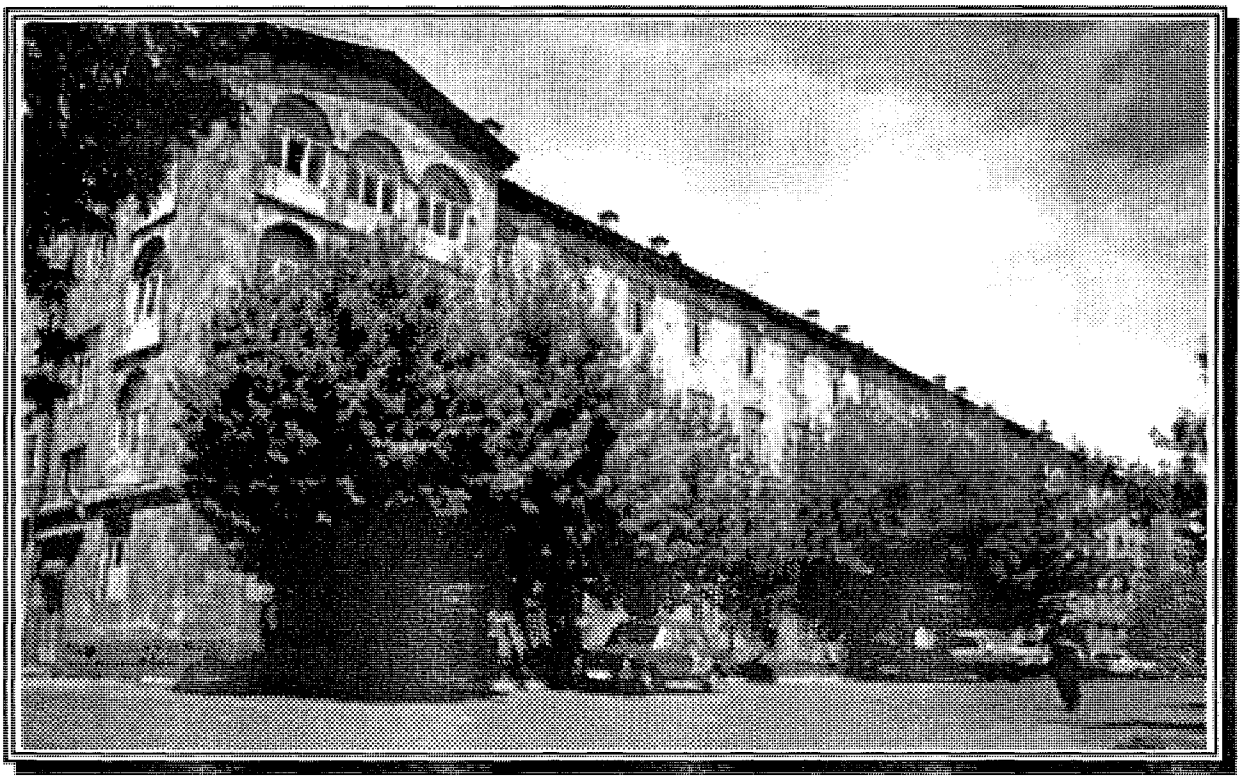
Traumatological Hospital # 6



Address:	Tamantsineri Str. # 1
Phone:	42-11-83
Chief Administrator:	Ruben Khachatryan
Deputy Chief Administrator	Ekaterina Alaverdyan
Head of Maintenance:	Armen Akopyan
Building Operational Capacity:	350
Date of Construction:	1963
Total Number of Rooms:	190

Current Staffing	
Doctors:	60
Nurses/Laborants/etc.:	390
Administrative:	30
Maintenance:	120

Description of Room Use	
Patient rooms:	93
Operating Rooms:	11
Laboratory Rooms:	4
Critical Care Room:	6
Laundry:	1
Kitchen:	1
Storage Rooms:	4
Offices:	36
Different:	34

Traumatological Hospital # 6

Armenia Weatherization Project

Monitoring Data Collected

	Parameter	Nov	Dec	Jan	Feb	Mar
1	Temperature inside the building '93-'94	+12 C	+11 C	+11 C	+10 C	+11 C
2	Temperature inside the building '94-'95	+12 C	+12 C	+12 C	+12 C	+13 C
3	Temperature inside the building '95-'96	+12 C	+12 C	+12 C	+19 C	+22 C
4	Temperature outside the building '93-'94	+3C	-15 C	-15 C	-13 C	-4 C
5	Temperature outside the building '94-'95	+3 C	-10 C	-10 C	-8 C	+2 C
6	Temperature outside the building '95-'96	+ 6 C	+ 2 C	0 C	+3 C	+7 C
		actual		estimate		
7	Power consumption '93-'94	28580 kw/h	38800 kw/h	56340 kw/h	39780 kw/h	31620 kw/h
	Power used for heating	no data	no data	no data	no data	no data
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	no data	no data	no data	no data	no data
		actual		estimate		
8	Power consumption '94-'95	26880 kw/h	61300 kw/h	61320 kw/h	71460 kw/h	64440 kw/h
	Power used for heating	no data	no data	no data	no data	no data
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	no data	no data	no data	no data	no data
		actual		estimate		
9	Power consumption '95-'96	25200 kw/h	54100 kw/h	55720 kw/h	61240 kw/h	57100 kw/h
	Power used for heating	no data	no data	no data	no data	no data
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	no data	no data	no data	no data	no data
		actual		estimate		
10	Fuel consumption '93-'94					
	gas	none	none	none	none	none
	wood	none	4 cub.m	4 cub.m	5 cub.m	none
	kerosene	none	none	none	none	none
	mazut	none	none	none	none	none
		actual		estimate		
11	Fuel consumption '94-'95					
	gas	none	none	none	none	none
	wood	none	5 cub.m	5 cub.m	7 cub.m	none
	kerosene	none	none	none	none	none
	mazut	none	none	none	none	none
		actual		estimate		
12	Fuel consumption '95-'96					
	gas	none	none	none	none	none
	wood	none	none	none	none	none
	kerosene	none	none	none	none	none
	mazut	none	none	none	none	none
13	Hours heat supplied per day '94-'95	none	none	none	none	none
14	Hours heat supplied per day '95-'96	no data	no data	no data	no data	no data
15	Temperature of heat carrier (supply) '94-'95	none	none	none	none	none
16	Temperature of heat carrier (return) '94-'95	none	none	none	none	none
17	Temperature of heat carrier (supply) '95-'96	50 C	50 C	50 C	50 C	50 C
18	Temperature of heat carrier (return) '95-'96	45 C	45 C	45 C	45 C	45 C
19	Power consumption limit '94-'95	70000 kw/h	70000 kw/h	70000 kw/h	70000 kw/h	70000 kw/h
20	Power consumption limit '95-'96	70000 kw/h	70000 kw/h	70000 kw/h	70000 kw/h	70000 kw/h
21	Used power comparing to limit '94-'95	38.4%	87.6%	87.6%	102.1%	92.1%
22	Used power comparing to limit '95-'96	36.0%	77.3%	79.6%	87.5%	81.6%

Traumatological Hospital # 6

Armenia Weatherization Project
Monitoring Data Collected

	Parameter	front view	rear view	left view	right view	roof
1	Thickness of outside walls	600 mm	600 mm	600 mm	600 mm	300 mm
2	Surface of glazing	374 sq.m	360 sq.m	85 sq.m	85 sq. m	none
3	Surface of building envelope	1470 sq.m	1470 sq.m	390 sq.m	390 sq.m	1690 sq.m
4	Surface of windows covered w/ Astro-Foil	none	none	none	none	none
5	Surface of walls insulated	none	none	none	none	none
6	Thickness of insullation	none	none	none	none	none
7	Surface of glazing missing	50 sq.m	50 sq.m	20 sq.m	20 sq.m	none
8	Orientation	N-E	S-W	S-E	N-W	
9	Number of windows	108	121	32	32	
10	Average size of windows	3.46 sq.m	2.96 sq.m	2.66 sq.m	2.66 sq.m	
11	Average perimeter of window	7.5 m	7 m	6.7 m	6.7 m	
12	Average size of gap between window sash and frame	5 mm	5 mm	5 mm	5 mm	
13	Average size of gap between window frame and building	4 mm	4 mm	4 mm	4 mm	
14	Number of exterior doors	2	5		2	
15	Average size of doors	1.8 sq.m	1.8 sq.m		1.8 sq.m	
16	Average perimeter of doors	6.2 m	6.2 m		6.2 m	
17	Average size of gap between door sash and frame	4 mm	4 mm		4 mm	
18	Average size of gap between door frame and building	4 mm	5 mm		3 mm	

19	Building material	toufa
20	Number of existing glass panes	2
21	Type of the roof	metal w/attic
22	Number of floors	4
23	Total volume of the building	25,350 cub.m
24	Average size of the gaps around windows	4
25	Heating system	District Heating
26	Type of heating units	Radiators (Wood Stoves)
27	Number of heating units	293 (20)
28	Efficiency of heating units	60% (20%)
29	R- Value of wall material	0.9
30	U- Value of wall material	1.1
31	R- Value of roof material	0.66
32	U- Value of roof material	1.5

33	Area of one floor	1690 sq.m
34	Total floor area	6760 sq.m
35	Total surface of the building	5410 sq.m
36	Total surface area of exterior doors	14.4 sq.m
37	Total surface area of glass	904 x2=1808 sq.m

Data Collected by : H. Chibukhchyan, G. Karapetyan, E. Zorikyan, V. Karapetyan
Data Provided by: Ekaterina Alaverdyan - Deputy Chief Administrator,
Armen Akopyan - Head of Maintenance
Date: Nov 1995 - Apr 1996

Traumatology Hospital # 6

(Typical Winter Data)

Date / Time	Temperature non weatherized room	Temperature weatherized room	Outside Temperature	Infiltration per weatherized window	Infiltration per non weatherized window	Air Density non weatherized room	Air Density weatherized room	Air Density Outside Air	Infiltration per weatherized window	Infiltration per non weatherized window	Temperature non weatherized absolute	Temperature weatherized absolute	Outside Temperature absolute	Inlet Air From One Broken Window Non weather	Inlet Air From One Broken Window Non weather
	t nw	t w	t o	L w	L nw	D nw	D w	D o	G w	G nw	T nw	T w	T o	V b	G b
	(C)	(C)	(C)	(cub.m/h)	(cub.m/h)	kg / cub.m	kg / cub.m	kg / cub.m	kg / hour	kg / hour	(T)	(T)	(T)	cub.m/hour	kg / hour
07/Feb/96 00:57	22.00	22.00	-11.83	0.0050	0.2016	1.1955	1.1955	1.3561925	0.01	0.27340841	295	295	261.17	2388.474715	2855.42152
08/Feb/96 00:57	22.00	22.00	-10.62	0.0050	0.2016	1.1955	1.1955	1.350445	0.01	0.27224971	295	295	262.38	2345.371414	2803.89153
09/Feb/96 00:57	22.00	22.00	-7.84	0.0050	0.2016	1.1955	1.1955	1.33724	0.01	0.26958758	295	295	265.16	2243.205487	2681.75216
10/Feb/96 00:57	22.00	22.00	-5.16	0.0046	0.1916	1.1955	1.1955	1.32451	0.01	0.25377612	295	295	267.84	2140.102291	2558.49229
11/Feb/96 00:57	22.00	22.00	-6.3	0.0046	0.1926	1.1955	1.1955	1.329925	0.01	0.25614356	295	295	266.7	2184.554414	2611.6348
12/Feb/96 00:57	22.00	22.00	-7.07	0.0046	0.1148	1.1955	1.1955	1.3335825	0.01	0.15309527	295	295	265.93	2214.074168	2646.92567
13/Feb/96 00:57	22.00	22.00	-8.23	0.0040	0.1440	1.1955	1.1955	1.3390925	0.01	0.19282932	295	295	264.77	2257.816917	2699.22012
14/Feb/96 00:57	22.00	22.00	-6.68	0.0040	0.1440	1.1955	1.1955	1.33173	0.01	0.19176912	295	295	266.32	2199.172128	2629.11028
15/Feb/96 00:57	22.00	22.00	-7.84	0.0040	0.2440	1.1955	1.1955	1.33724	0.01	0.32628656	295	295	265.16	2243.205487	2681.75216
16/Feb/96 00:57	22.00	22.00	-7.07	0.0038	0.1440	1.1955	1.1955	1.3335825	0.01	0.19203588	295	295	265.93	2214.074168	2646.92567
17/Feb/96 00:57	22.00	22.00	-6.3	0.0038	0.1440	1.1955	1.1955	1.329925	0.01	0.1915092	295	295	266.7	2184.554414	2611.6348
18/Feb/96 00:57	22.00	22.00	-5.16	0.0038	0.1440	1.1955	1.1955	1.32451	0.00	0.19072944	295	295	267.84	2140.102291	2558.49229
19/Feb/96 00:57	22.00	22.00	-5.92	0.0041	0.1440	1.1955	1.1955	1.32812	0.01	0.19124928	295	295	267.08	2169.838227	2594.0416
20/Feb/96 00:57	22.00	22.00	-4.41	0.0040	0.1440	1.1955	1.1955	1.3209475	0.01	0.19021644	295	295	268.59	2110.346895	2522.91971
21/Feb/96 00:57	22.00	22.00	-5.16	0.0040	0.1440	1.1955	1.1955	1.32451	0.01	0.19072944	295	295	267.84	2140.102291	2558.49229
22/Feb/96 00:57	22.00	22.00	-4.04	0.0040	0.3280	1.1955	1.1955	1.31919	0.01	0.43269432	295	295	268.96	2095.511937	2505.18452
23/Feb/96 00:57	22.00	22.00	-5.16	0.0040	0.3280	1.1955	1.1955	1.32451	0.01	0.43443928	295	295	267.84	2140.102291	2558.49229
24/Feb/96 00:57	22.00	22.00	-5.16	0.0041	0.3280	1.1955	1.1955	1.32451	0.01	0.43443928	295	295	267.84	2140.102291	2558.49229
25/Feb/96 00:57	22.00	22.00	-5.92	0.0041	0.3280	1.1955	1.1955	1.32812	0.01	0.43562336	295	295	267.08	2169.838227	2594.0416
26/Feb/96 00:57	22.00	22.00	-2.93	0.0041	0.3280	1.1955	1.1955	1.3139175	0.01	0.43096494	295	295	270.07	2050.363152	2451.20915
27/Feb/96 00:57	22.00	22.00	-0.83	0.0041	0.1926	1.1955	1.1955	1.3039425	0.01	0.25113933	295	295	272.17	1962.106628	2345.69847
28/Feb/96 00:57	22.00	22.00	0.38	0.0042	0.4040	1.1955	1.1955	1.298195	0.01	0.52447078	295	295	273.38	1909.402531	2282.69073
29/Feb/96 00:57	22.00	22.00	3.16	0.0042	0.1926	1.1955	1.1955	1.28499	0.01	0.24748907	295	295	276.16	1782.420212	2130.88336
01/Mar/96 00:57	22.00	22.00	5.84	0.0041	0.1012	1.1955	1.1955	1.27226	0.01	0.12875271	295	295	278.84	1650.784291	1973.51262
02/Mar/96 00:57	22.00	22.00	4.7	0.0041	0.1012	1.1955	1.1955	1.277675	0.01	0.12930071	295	295	277.7	1708.019013	2041.93673
03/Mar/96 00:57	22.00	22.00	3.93	0.0041	0.1012	1.1955	1.1955	1.2813325	0.01	0.12967085	295	295	276.93	1745.616046	2086.88398
04/Mar/96 00:57	22.00	22.00	2.77	0.0041	0.1012	1.1955	1.1955	1.2868425	0.01	0.13022846	295	295	275.77	1800.77433	2152.82571
05/Mar/96 00:57	22.00	22.00	4.32	0.0041	0.1012	1.1955	1.1955	1.27948	0.01	0.12948338	295	295	277.32	1726.675709	2064.24081
06/Mar/96 00:57	22.00	22.00	3.16	0.0050	0.1012	1.1955	1.1955	1.28499	0.01	0.13004099	295	295	276.16	1782.420212	2130.88336
07/Mar/96 00:57	22.00	22.00	3.93	0.0041	0.0828	1.1955	1.1955	1.2813325	0.01	0.10609433	295	295	276.93	1745.616046	2086.88398
08/Mar/96 00:57	22.00	22.00	4.7	0.0050	0.0828	1.1955	1.1955	1.277675	0.01	0.10579149	295	295	277.7	1708.019013	2041.93673
09/Mar/96 00:57	22.00	22.00	5.84	0.0051	0.0828	1.1955	1.1955	1.27226	0.01	0.10534313	295	295	278.84	1650.784291	1973.51262
10/Mar/96 00:57	22.00	22.00	7.33	0.0054	0.0828	1.1955	1.1955	1.2651825	0.01	0.10475711	295	295	280.33	1572.840582	1880.33092
11/Mar/96 00:57	22.00	22.00	8.43	0.0056	0.0828	1.1955	1.1955	1.2599575	0.01	0.10432448	295	295	281.43	1512.723567	1808.46102
12/Mar/96 00:57	22.00	22.00	8.8	0.0053	0.0828	1.1955	1.1955	1.2582	0.01	0.10417896	295	295	281.8	1491.958059	1783.63586
13/Mar/96 00:57	22.00	22.00	8.8	0.0051	0.1056	1.1955	1.1955	1.2582	0.01	0.13286592	295	295	281.8	1491.958059	1783.63586
14/Mar/96 00:57	22.00	22.00	8.8	0.0052	0.1056	1.1955	1.1955	1.2582	0.01	0.13286592	295	295	281.8	1491.958059	1783.63586
15/Mar/96 00:57	22.00	22.00	10.24	0.0051	0.1086	1.1955	1.1955	1.25136	0.01	0.1358977	295	295	283.24	1408.229086	1683.53787

Traumatology Hospital # 6

(Calculations Based On Typical Winter Data)

Date / Time	Heat losses from one non weatherized window by infiltration per day Q inf. nw kcal day	Heat losses from one non weatherized single pane window by transfere per day Q tr. nw1 kcal day	Heat losses from one non weatherized double pane window by transfere per day Q tr. nw2 kcal day	Heat losses from one broken window by inlet air per day Q b. nw kcal day	Heat losses from 278 non weatherize single pane windows per day Q nw 1 kcal day	Heat losses from 0 non weatherize double pane windows per day Q nw 2 kcal day	Heat losses from 15 broken windows per day Q b kcal day	Total heat losses from non weatherized building per day Q nw kcal day	Heat losses from one weatherized window by infiltration per day Q inf. w kcal day	Heat losses from one weatherized single pane window by transfere per day Q tr. w2 kcal day	Total heat losses from weatherized building per day Q nw kcal day	Energy savings in the period of monitoring per day delta Q kcal day	Conventional fuel saved in the perion of monitoring per day B kg/day	Money savings in the period of monitoring per day E $ / day
7-Feb-96	53.28	12130.08	0.00	556409.72	3386974.46	0.00	8346145.83	11733120.29	1.33	12130.08	5180114.94	6553005.36	1337.35	140.42
8-Feb-96	51.15	11696.23	0.00	526826.54	3265771.79	0.00	7902398.15	11168169.94	1.27	11696.23	4994830.74	6173339.19	1259.87	132.29
9-Feb-96	46.34	10699.43	0.00	460935.27	2987323.14	0.00	6914029.06	9901352.19	1.15	10699.43	4569147.49	5332204.70	1088.21	114.26
10-Feb-96	39.70	9738.49	0.00	400254.63	2718337.03	0.00	6003819.41	8722156.44	0.95	9738.49	4158742.06	4563414.38	931.31	97.79
11-Feb-96	41.75	10147.25	0.00	425717.37	2832542.40	0.00	6385760.49	9218302.89	1.00	10147.25	4333300.71	4885002.18	996.94	104.68
12-Feb-96	25.63	10423.34	0.00	443209.70	2904814.76	0.00	6648145.56	9552960.32	1.03	10423.34	4451204.44	5101755.88	1041.17	109.32
13-Feb-96	33.58	10839.27	0.00	470001.16	3022650.96	0.00	7050017.46	10072668.42	0.94	10839.27	4628770.01	5443898.41	1111.00	116.65
14-Feb-96	31.68	10283.50	0.00	434320.60	2867620.16	0.00	6514809.07	9382429.24	0.89	10283.50	4391434.35	4990994.88	1018.57	106.95
15-Feb-96	56.08	10699.43	0.00	460935.27	2990032.34	0.00	6914029.06	9904061.39	0.93	10699.43	4569053.28	5335008.12	1088.78	114.32
16-Feb-96	32.16	10423.34	0.00	443209.70	2906627.42	0.00	6648145.56	9554772.98	0.84	10423.34	4451124.35	5103648.63	1041.56	109.36
17-Feb-96	31.22	10147.25	0.00	425717.37	2829613.42	0.00	6385760.49	9215373.91	0.82	10147.25	4333222.95	4882150.95	996.36	104.62
18-Feb-96	29.84	9738.49	0.00	400254.63	2715595.08	0.00	6003819.41	8719414.49	0.78	9738.49	4158667.74	4560746.75	930.76	97.73
19-Feb-96	30.76	10011.00	0.00	417171.69	2791606.99	0.00	6257575.42	9049182.41	0.87	10011.00	4275065.23	4774117.18	974.31	102.30
20-Feb-96	28.94	9469.57	0.00	383790.58	2640584.56	0.00	5756858.75	8397443.32	0.81	9469.57	4043852.86	4353590.45	888.49	93.29
21-Feb-96	29.84	9738.49	0.00	400254.63	2715595.08	0.00	6003819.41	8719414.49	0.84	9738.49	4158692.51	4560721.98	930.76	97.73
22-Feb-96	64.90	9336.90	0.00	375753.63	2613701.07	0.00	5636304.42	8250005.49	0.80	9336.90	3987196.66	4262806.83	869.96	91.35
23-Feb-96	67.96	9738.49	0.00	400254.63	2726194.21	0.00	6003819.41	8730013.61	0.84	9738.49	4158692.51	4571321.10	932.92	97.96
24-Feb-96	67.96	9738.49	0.00	400254.63	2726194.21	0.00	6003819.41	8730013.61	0.84	9738.49	4158694.28	4571319.33	932.92	97.96
25-Feb-96	70.06	10011.00	0.00	417171.69	2802532.40	0.00	6257575.42	9060107.83	0.87	10011.00	4275065.23	4785042.60	976.54	102.54
26-Feb-96	61.89	8938.90	0.00	351985.79	2502218.50	0.00	5279786.85	7782005.35	0.77	8938.90	3817239.34	3964766.01	809.14	84.96
27-Feb-96	33.03	8185.92	0.00	308461.23	2284868.05	0.00	4626918.39	6911786.44	0.70	8185.92	3495688.62	3416097.82	697.16	73.20
28-Feb-96	65.31	7752.07	0.00	284266.22	2173231.69	0.00	4263993.23	6437224.92	0.68	7752.07	3310421.25	3126803.67	638.12	67.00
29-Feb-96	26.86	6755.27	0.00	231240.05	1885431.45	0.00	3468600.80	5354032.25	0.58	6755.27	2884749.35	2469282.90	503.94	52.91
1-Mar-96	11.98	5794.33	0.00	183697.71	1614155.32	0.00	2755465.68	4369621.01	0.48	5794.33	2474384.04	1895236.96	386.78	40.61
2-Mar-96	12.88	6203.09	0.00	203474.91	1728040.37	0.00	3052123.67	4780164.04	0.52	6203.09	2648940.38	2131223.66	434.94	45.67
3-Mar-96	13.50	6479.18	0.00	217209.56	1804963.86	0.00	3258143.45	5063107.31	0.54	6479.18	2766841.86	2296265.44	468.63	49.21
4-Mar-96	14.42	6895.11	0.00	238457.31	1920850.32	0.00	3576859.64	5497709.96	0.58	6895.11	2944459.78	2553250.18	521.07	54.71
5-Mar-96	13.19	6339.34	0.00	210215.68	1766002.50	0.00	3153235.18	4919237.68	0.53	6339.34	2707124.41	2212113.27	451.45	47.40
6-Mar-96	14.11	6755.27	0.00	231240.05	1881888.26	0.00	3468600.80	5350489.06	0.69	6755.27	2884795.79	2465693.27	503.20	52.84
7-Mar-96	11.04	6479.18	0.00	217209.56	1804281.67	0.00	3258143.45	5062425.12	0.54	6479.18	2766840.72	2295584.39	468.49	49.19
8-Mar-96	10.54	6203.09	0.00	203474.91	1727389.12	0.00	3052123.67	4779512.78	0.64	6203.09	2648992.57	2130520.21	434.80	45.65
9-Mar-96	9.81	5794.33	0.00	183697.71	1613549.56	0.00	2755465.68	4369015.24	0.61	5794.33	2474438.65	1894576.59	386.65	40.60
10-Mar-96	8.85	5260.08	0.00	158886.46	1464761.73	0.00	2383296.87	3848058.60	0.58	5260.08	2246297.70	1601760.90	326.89	34.32
11-Mar-96	8.15	4865.66	0.00	141355.10	1354920.16	0.00	2120326.51	3475246.67	0.55	4865.66	2077872.81	1397373.86	285.18	29.94
12-Mar-96	7.92	4732.99	0.00	135613.40	1317973.80	0.00	2034201.03	3352174.82	0.51	4732.99	2021203.26	1330971.56	271.63	28.52
13-Mar-96	10.10	4732.99	0.00	135613.40	1318580.15	0.00	2034201.03	3352781.17	0.48	4732.99	2021194.28	1331586.90	271.75	28.53
14-Mar-96	10.10	4732.99	0.00	135613.40	1318580.15	0.00	2034201.03	3352781.17	0.49	4732.99	2021198.36	1331582.81	271.75	28.53
15-Mar-96	9.21	4216.67	0.00	114038.81	1174792.13	0.00	1710582.22	2885374.36	0.43	4216.67	1800700.08	1084674.28	221.36	23.24
								269023711			133290258	136733453	27760.70	2908.57

Energy Saved for the period of monitoring:

Delta Q=135733454 kcal / 38 days

Conventional Fuel Saved for the period of monitoring:

B=27700.70 kg / 38 days

Money Savings:

E=2908.57 $/ 38 days

Payback Period:

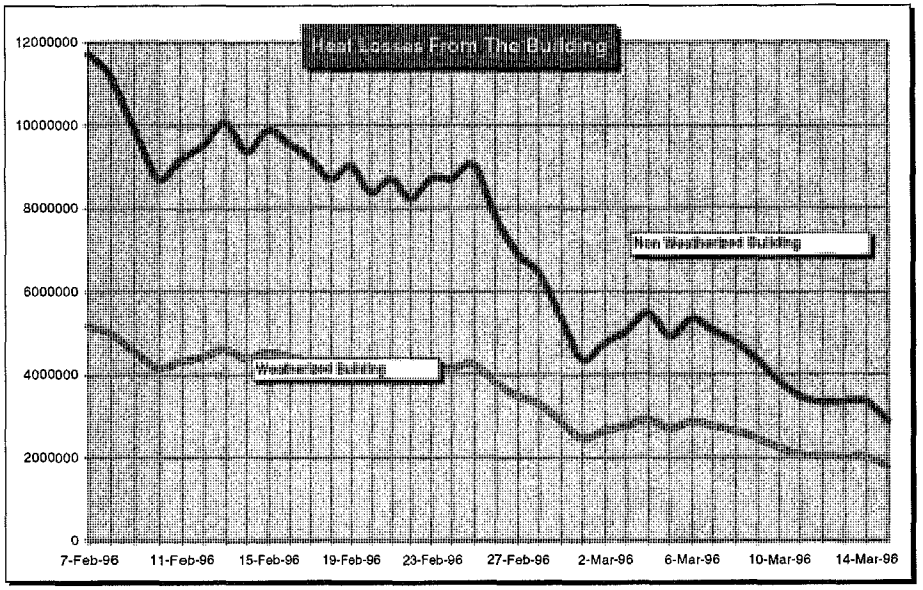
Z=4.36 x 38 days = 165.7 days

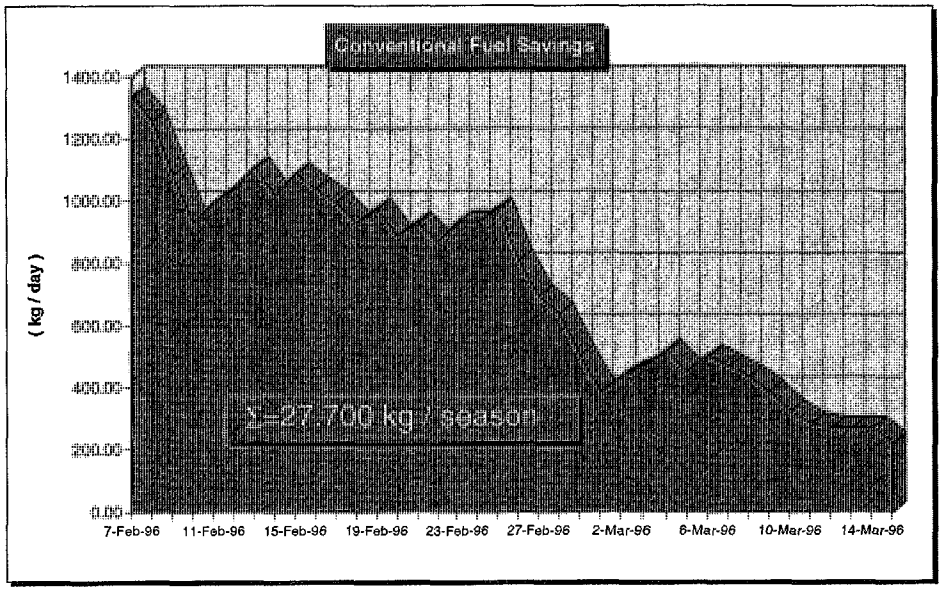
Energy, Fuel, Money Savings Percent:

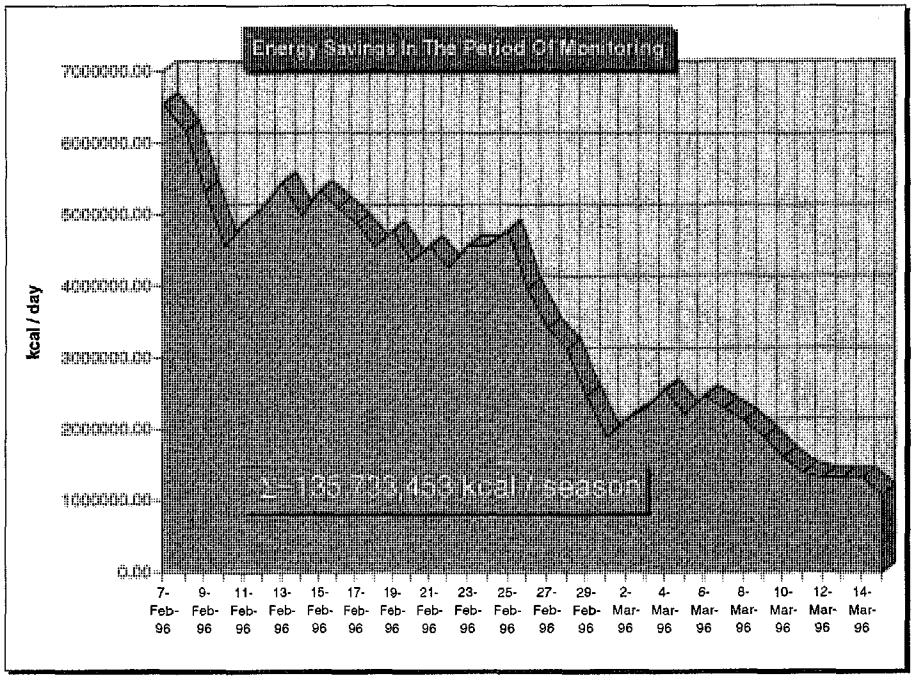
Ratio = 50.45%

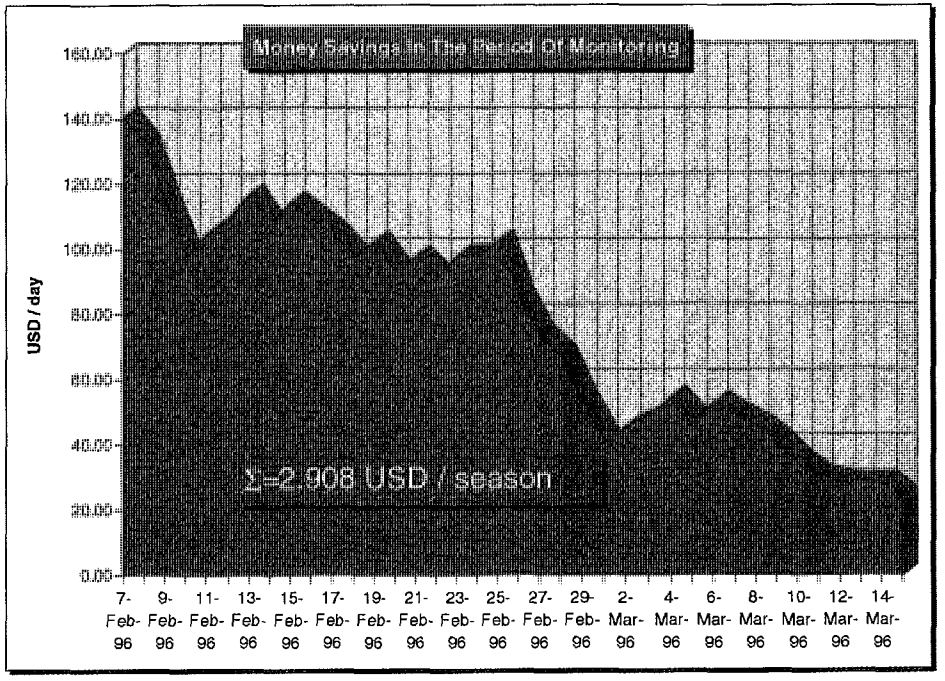
Traumatology Hospital # 6 Yerevan

Traumatology Hospital # 6 Yerevan





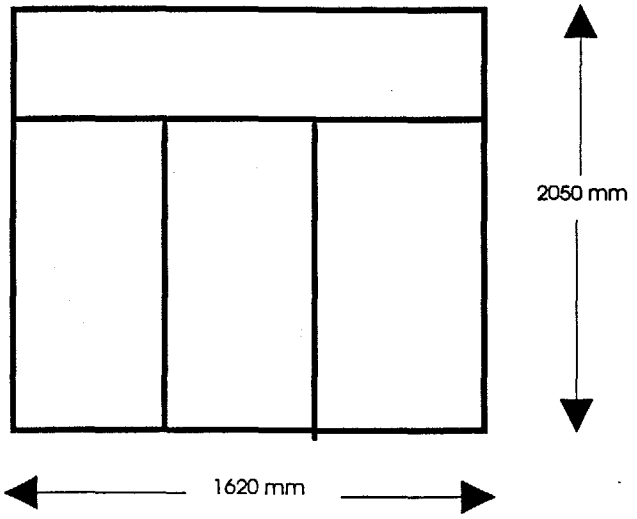




Traumatology Hospital # 6

(Actual Data for Winter '96)

Date / Time	Temperature non weatherized room	Temperature weatherized room	Outside Temperature	Infiltration per weatherized window	Infiltration per non weatherized window	Air Density non weatherized room	Air Density weatherized room	Air Density Outside Air	Infiltration per weatherized window	Infiltration per non weatherized window	Temperature non weatherized absolute	Temperature weatherized absolute	Outside Temperature absolute	Inlet Air From One Broken Window Non weather	Inlet Air From One Broken Window Non weather
	t nw	t w	t o	L w	L nw	D nw	D w	D o	G w	G nw	T nw	T w	T o	V b	G b
	(C)	(C)	(C)	(cub.m/h)	(cub.m/h)	kg / cub.m	kg / cub.m	kg / cub.m	kg / hour	kg / hour	(T)	(T)	(T)	cub.m/hour	kg / hour
07/Feb/96 00:57	10.30	14.50	-0.83	0.0050	0.2016	1.25	1.23	1.30	0.01	0.26	283.30	287.50	272.17	1628.67	2005.10
08/Feb/96 00:57	12.00	15.30	0.38	0.0050	0.2016	1.24	1.23	1.30	0.01	0.26	285.00	288.30	273.38	1604.51	1969.26
09/Feb/96 00:57	12.80	17.30	3.16	0.0050	0.2016	1.24	1.22	1.28	0.01	0.26	285.80	290.30	276.16	1556.62	1895.69
10/Feb/96 00:57	13.40	17.80	5.84	0.0046	0.1916	1.24	1.22	1.27	0.01	0.24	286.40	290.80	278.84	1430.37	1738.55
11/Feb/96 00:57	13.10	17.10	4.70	0.0046	0.1926	1.24	1.22	1.28	0.01	0.25	286.10	290.10	277.70	1458.20	1777.22
12/Feb/96 00:57	13.10	17.60	3.93	0.0046	0.1148	1.24	1.22	1.28	0.01	0.15	286.10	290.60	276.93	1529.74	1860.77
13/Feb/96 00:57	12.00	17.80	2.77	0.0040	0.1440	1.24	1.22	1.29	0.01	0.19	285.00	290.80	275.77	1603.48	1948.95
14/Feb/96 00:57	12.10	19.10	4.32	0.0040	0.1440	1.24	1.21	1.28	0.01	0.18	285.10	292.10	277.32	1586.54	1918.57
15/Feb/96 00:57	12.60	18.60	3.16	0.0040	0.2440	1.24	1.21	1.28	0.01	0.31	285.60	291.60	276.16	1622.97	1966.47
16/Feb/96 00:57	12.10	18.60	3.93	0.0038	0.1440	1.24	1.21	1.28	0.00	0.18	285.10	291.60	276.93	1581.98	1916.81
17/Feb/96 00:57	12.20	17.40	4.70	0.0038	0.1440	1.24	1.22	1.28	0.00	0.18	285.20	290.40	277.70	1474.97	1795.56
18/Feb/96 00:57	12.00	17.80	5.84	0.0038	0.1440	1.24	1.22	1.27	0.00	0.18	285.00	290.80	278.84	1430.37	1738.55
19/Feb/96 00:57	12.00	18.10	5.08	0.0041	0.1440	1.24	1.21	1.28	0.01	0.18	285.00	291.10	278.08	1491.64	1810.89
20/Feb/96 00:57	11.90	20.70	6.59	0.0040	0.1440	1.24	1.20	1.27	0.01	0.18	284.90	293.70	279.59	1545.94	1857.72
21/Feb/96 00:57	12.90	19.50	5.84	0.0040	0.1440	1.24	1.21	1.27	0.01	0.18	285.90	292.50	278.84	1524.20	1840.29
22/Feb/96 00:57	12.60	20.80	6.96	0.0040	0.3280	1.24	1.20	1.27	0.01	0.42	285.60	293.80	279.96	1530.82	1838.82
23/Feb/96 00:57	12.80	21.20	5.84	0.0040	0.3280	1.24	1.20	1.27	0.01	0.42	285.80	294.20	278.84	1611.59	1932.78
24/Feb/96 00:57	13.50	22.10	5.84	0.0041	0.3280	1.24	1.20	1.27	0.01	0.42	286.50	295.10	278.84	1655.60	1978.49
25/Feb/96 00:57	13.80	21.50	5.08	0.0041	0.3280	1.23	1.20	1.28	0.01	0.42	286.80	294.50	278.08	1665.42	1994.97
26/Feb/96 00:57	13.20	21.50	8.07	0.0041	0.3280	1.24	1.20	1.26	0.01	0.41	286.20	294.50	281.07	1506.18	1804.21
27/Feb/96 00:57	10.40	20.60	4.70	0.0041	0.1926	1.25	1.20	1.28	0.01	0.25	283.40	293.60	277.70	1641.35	1973.15
28/Feb/96 00:57	10.60	21.40	5.46	0.0042	0.4040	1.25	1.20	1.27	0.01	0.51	283.60	294.40	278.46	1641.18	1966.71
29/Feb/96 00:57	9.20	22.50	2.38	0.0042	0.1926	1.26	1.19	1.29	0.01	0.25	282.20	295.50	275.38	1840.42	2195.85
01/Mar/96 00:57	9.10	22.70	2.38	0.0041	0.1012	1.26	1.19	1.29	0.01	0.13	282.10	295.70	275.38	1848.91	2204.23
02/Mar/96 00:57	9.60	22.10	2.77	0.0041	0.1012	1.25	1.20	1.29	0.01	0.13	282.60	295.10	275.77	1805.14	2157.19
03/Mar/96 00:57	10.50	21.60	4.32	0.0041	0.1012	1.25	1.20	1.28	0.01	0.13	283.50	294.60	277.32	1708.19	2045.39
04/Mar/96 00:57	10.80	21.00	4.70	0.0041	0.1012	1.25	1.20	1.28	0.01	0.13	283.80	294.00	277.70	1660.74	1993.30
05/Mar/96 00:57	12.00	22.00	5.46	0.0041	0.1012	1.24	1.20	1.27	0.01	0.13	285.00	295.00	278.46	1670.08	1996.58
06/Mar/96 00:57	14.60	24.00	6.59	0.0050	0.1012	1.23	1.19	1.27	0.01	0.13	287.60	297.00	279.59	1707.66	2025.29
07/Mar/96 00:57	9.26	23.05	7.70	0.0041	0.0828	1.26	1.19	1.26	0.01	0.10	282.26	296.05	280.70	1606.03	1911.99
08/Mar/96 00:57	10.03	22.86	8.80	0.0050	0.0828	1.25	1.19	1.26	0.01	0.10	283.03	295.86	281.80	1537.55	1831.86
09/Mar/96 00:57	9.12	22.63	6.96	0.0051	0.0828	1.26	1.19	1.27	0.01	0.10	282.12	295.63	279.96	1623.83	1936.43
10/Mar/96 00:57	9.18	22.71	7.33	0.0054	0.0828	1.26	1.19	1.27	0.01	0.10	282.18	295.71	280.33	1608.52	1917.56
11/Mar/96 00:57	9.68	22.81	8.43	0.0056	0.0828	1.25	1.19	1.26	0.01	0.10	282.68	295.81	281.43	1555.08	1853.12
12/Mar/96 00:57	10.14	22.89	8.80	0.0053	0.0828	1.25	1.19	1.26	0.01	0.10	283.14	295.89	281.80	1539.11	1833.51
13/Mar/96 00:57	10.26	22.79	8.80	0.0051	0.1056	1.25	1.19	1.26	0.01	0.13	283.26	295.79	281.80	1533.90	1828.02
14/Mar/96 00:57	10.30	22.81	8.80	0.0052	0.1056	1.25	1.19	1.26	0.01	0.13	283.30	295.81	281.80	1534.95	1829.12
15/Mar/96 00:57	12.17	23.36	10.24	0.0051	0.1086	1.24	1.19	1.25	0.01	0.14	285.17	296.36	283.24	1484.01	1764.55



Two windows of the size drawn to the left (weatherized and non weatherized) were tested for infiltration at the Maternity Hospital # 4. The windows are located in the same size (3.00m x 4.00m)rooms on East side of the building.
There are 293 windows of this size and shape at the hospital.
There was 278 single glass pane windows, and 15 broken windows.
All the missing glass panes were replaced. Windows were caulked and weather-stripped.
For temperature measurements HOBO-XT automatic temperature loggers were used for the period of 7 February 1996 through 15 March 1996.
For the infiltrating air volume measurements special installation was used for the period of 7 Februaryary 1996 through 15 March 1996.
The principe of that installation is to measure the time during which a very tight sealed to window bag with known volume is filled by infiltrating air.
Both rooms and the entire building were district heated

Traumatology Hospital # 6

Calculations Based on Actual Data - Winter '96

Date / Time	Heat losses per none weatherized window by infiltration	Heat losses per none weatherized single pane window by transfere	Heat losses per none weatherized double pane window by transfere	Heat losses per broken window by inlet air	Heat losses from 278 non weatherized single pane windows	Heat losses from 0 non weatherized double pane windows	Heat losses from 15 broken windows	Total heat losses from non weatherized building	Heat losses per weatherized window by infiltration	Heat losses per weatherized single pane window by transfere	Total heat losses from weatherized building	Energy savings in the period of monitoring	Conventional fuel saved in the perion of monitoring	Money savings in the period of monitoring
	per day	per day	per day	per day	per day	per day	per day	per day	per day	per day	per day	per day	per day	per day
	Q inf. nw	Q tr. nw1	Q tr. nw2	Q b. nw	Q nw 1	Q nw 2	Q b	Q nw	Q inf. w	Q tr. w2	Q nw	delta Q	B	E
	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kcal day	kg/day	$ / day
07/Feb/96 00:57	23.21	5496.72	0.00	177051.50	1534542.45	0.00	2655772.43	4390314.87	0.58	5496.72	2347349.28	1842965.60	376.12	39.49
08/Feb/96 00:57	22.49	5349.72	0.00	169236.34	1493473.51	0.00	2538545.16	4202016.37	0.56	5349.72	2284596.58	1747452.09	356.62	37.45
09/Feb/96 00:57	21.10	5070.04	0.00	154396.92	1415336.20	0.00	2315953.74	3731289.95	0.52	5070.04	2165127.84	1566160.10	319.62	33.56
10/Feb/96 00:57	16.79	4288.38	0.00	119767.73	1196837.39	0.00	1796515.90	2992350.27	0.40	4288.38	1813309.39	1162043.91	237.15	24.90
11/Feb/96 00:57	17.58	4446.14	0.00	126936.16	1240914.17	0.00	1904042.33	3144956.50	0.42	4446.14	1898682.73	1246273.77	254.34	26.71
12/Feb/96 00:57	11.58	4901.52	0.00	146515.82	1365841.10	0.00	2197737.29	3563678.40	0.46	4901.52	2093145.16	1470433.24	300.09	31.51
13/Feb/96 00:57	16.04	5389.16	0.00	168725.80	1502645.38	0.00	2530887.07	4203532.45	0.45	5389.16	2301562.14	1732170.31	353.50	37.12
14/Feb/96 00:57	15.69	5299.52	0.00	163333.06	1477626.18	0.00	2449995.84	3927622.00	0.44	5299.52	2263081.56	1664540.44	339.70	35.67
15/Feb/96 00:57	27.88	5536.17	0.00	174886.99	1546806.09	0.00	2623304.90	4170110.97	0.46	5536.17	2364140.19	1805970.79	368.57	38.70
16/Feb/96 00:57	15.59	5260.08	0.00	161968.94	1466635.23	0.00	2429534.09	3896169.32	0.41	5260.08	2246226.94	1649943.38	336.72	35.36
17/Feb/96 00:57	13.46	4553.71	0.00	131348.73	1269673.51	0.00	1970230.94	3323904.45	0.35	4553.71	1944985.08	1295319.36	264.35	27.76
18/Feb/96 00:57	12.62	4288.38	0.00	119767.73	1195677.60	0.00	1796515.90	3092195.50	0.33	4288.38	1831277.95	1160915.55	236.92	24.88
19/Feb/96 00:57	13.78	4668.45	0.00	135808.25	1301659.86	0.00	2037123.71	3538793.57	0.39	4668.45	1992564.54	1345189.03	274.53	28.83
20/Feb/96 00:57	14.85	5059.28	0.00	150983.23	1410608.05	0.00	2264748.46	3676355.61	0.42	5059.28	2160491.12	1514865.39	309.16	32.46
21/Feb/96 00:57	14.41	4897.93	0.00	144796.62	1365631.77	0.00	2171949.35	3537581.12	0.40	4897.93	2091588.43	1445992.49	295.10	30.99
22/Feb/96 00:57	33.13	4962.47	0.00	146587.42	1388776.21	0.00	2198811.31	3587587.52	0.41	4962.47	2119142.06	1468438.43	299.68	31.47
23/Feb/96 00:57	36.92	5507.48	0.00	171000.14	1541343.69	0.00	2565002.09	4106345.77	0.45	5507.48	2351588.52	1754456.95	358.05	37.60
24/Feb/96 00:57	39.08	5830.19	0.00	185300.39	1631656.79	0.00	2779505.88	4411162.58	0.48	5830.19	2489696.82	1921466.85	392.14	41.17
25/Feb/96 00:57	39.58	5887.56	0.00	188682.54	1647743.59	0.00	2830238.15	4477981.74	0.49	5887.56	2514195.27	1963786.47	400.77	42.08
26/Feb/96 00:57	32.01	4815.46	0.00	139568.05	1347597.53	0.00	2093520.75	3441118.26	0.40	4815.46	2056371.19	1384746.49	282.60	29.67
27/Feb/96 00:57	22.54	5701.10	0.00	180708.87	1591172.20	0.00	2710633.00	4301806.20	0.48	5701.10	2434576.47	1867229.93	381.07	40.01
28/Feb/96 00:57	47.26	5715.45	0.00	180571.99	1602032.08	0.00	2708579.91	4310011.99	0.49	5715.45	2440704.40	1869907.58	381.61	40.07
29/Feb/96 00:57	28.76	7214.23	0.00	254479.21	2013551.69	0.00	3817188.15	5830739.88	0.62	7214.23	3081741.58	2749998.27	561.22	58.93
01/Mar/96 00:57	15.26	7285.94	0.00	257990.10	2029734.57	0.00	3869851.53	5899865.10	0.61	7285.94	3111953.55	2788228.58	569.03	59.75
02/Mar/96 00:57	14.50	6930.96	0.00	240183.58	1930839.14	0.00	3602753.65	5533721.79	0.58	6930.96	2959771.66	2573821.21	525.27	55.15
03/Mar/96 00:57	12.89	6195.92	0.00	203583.06	1726047.69	0.00	3053745.85	4779734.54	0.52	6195.92	2645878.34	2133915.20	435.49	45.73
04/Mar/96 00:57	12.14	5844.53	0.00	187146.88	1628153.64	0.00	2807203.23	4438356.88	0.49	5844.53	2479622.44	1939534.44	395.82	41.56
05/Mar/96 00:57	12.28	5930.58	0.00	190215.09	1652116.78	0.00	2853226.37	4506343.16	0.49	5930.58	2532594.11	1972774.04	402.61	42.27
06/Mar/96 00:57	12.88	6242.53	0.00	203098.99	1739002.58	0.00	3046484.84	4785487.42	0.63	6242.53	2666829.60	2119657.82	432.58	45.42
07/Mar/96 00:57	9.25	5503.90	0.00	169050.76	1532654.40	0.00	2535761.46	4038415.84	0.45	5503.90	2253367.35	1718058.61	350.62	36.82
08/Mar/96 00:57	8.44	5041.35	0.00	148354.61	1403841.79	0.00	2225319.21	3629561.00	0.51	5041.35	2152877.28	1476283.72	301.28	31.63
09/Mar/96 00:57	9.47	5618.64	0.00	174780.71	1564612.81	0.00	2621710.67	4186323.45	0.59	5618.64	2399406.21	1786915.27	364.68	38.29
10/Mar/96 00:57	9.28	5514.65	0.00	169874.17	1535653.40	0.00	2548112.53	4084765.93	0.60	5514.65	2285014.23	1728751.71	352.81	37.04
11/Mar/96 00:57	8.64	5156.09	0.00	153491.62	1435796.02	0.00	2302374.31	3726870.33	0.59	5156.09	2201902.06	1536268.27	313.52	32.92
12/Mar/96 00:57	8.45	5052.11	0.00	148604.34	1406837.18	0.00	2232065.12	3638902.81	0.54	5052.11	2157481.16	1481420.94	302.33	31.74
13/Mar/96 00:57	10.71	5016.25	0.00	147306.60	1397495.17	0.00	2209599.06	3607094.94	0.51	5016.25	2142159.69	1464934.55	298.97	31.39
14/Mar/96 00:57	10.72	5023.43	0.00	147605.84	1399493.02	0.00	2214087.63	3611580.65	0.52	5023.43	2146222.44	1468354.21	299.66	31.46
15/Mar/96 00:57	10.27	4704.31	0.00	133349.25	1310652.45	0.00	2000238.69	3310671.14	0.48	4704.31	2008944.30	1301946.84	265.70	27.90
								152749583.46			87628451.63	53121132	10850.04	1138.35

Energy Saved for the period of monitoring:

Delta Q=65121132 kcal / 38 days

Conventional Fuel Saved for the period of monitoring:

B=13290.03 kg / 38 days

Money Savings:

E=1395 $/ 38 days

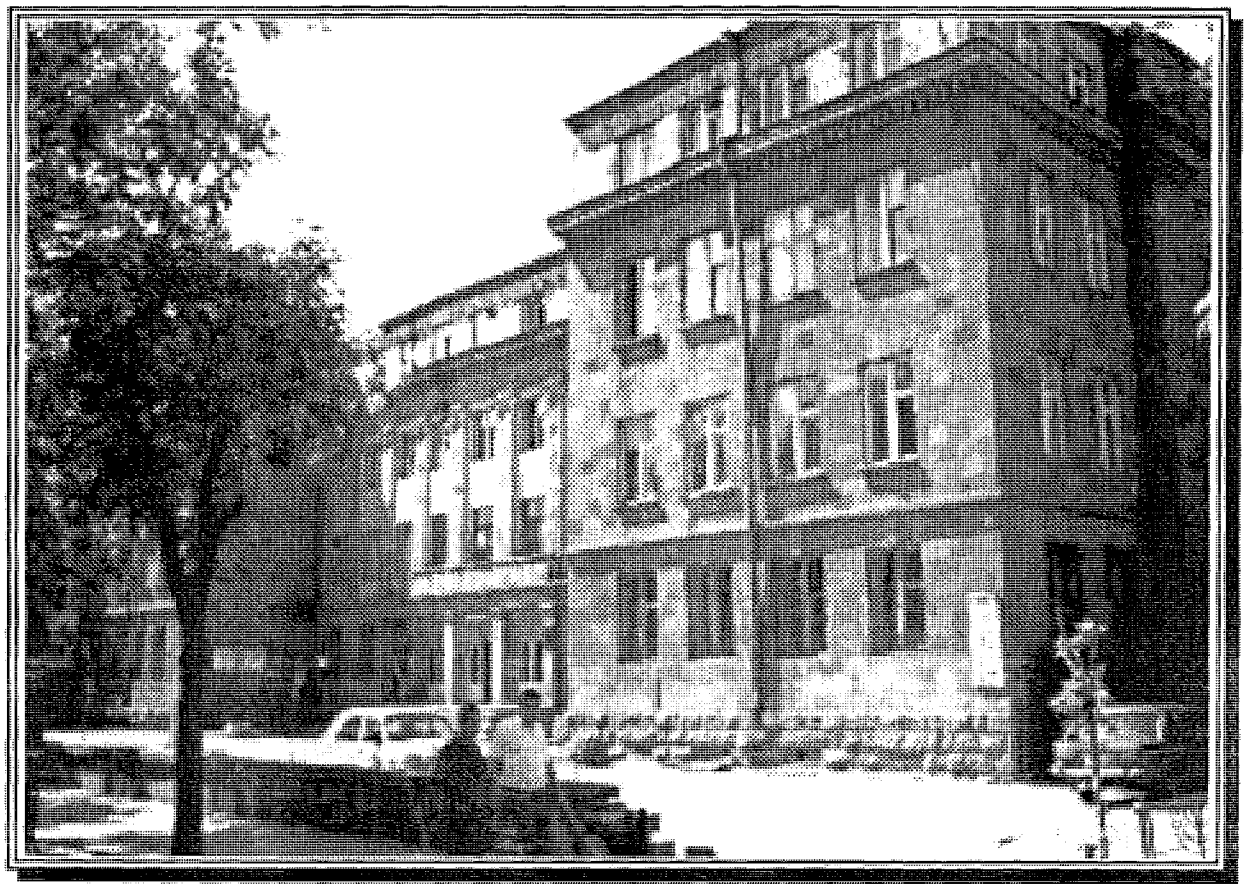
Payback Period:

Z=9.09 x 38 days = 345.5 days

Energy, Fuel, Money Savings Percent:

Ratio = 42.63%

School # 8 (Yerevan)



Address:	Moskovyan Str. # 17
Phone:	58-08-01
Chief Administrator:	Marietta Matghashyan
Deputy Chief Administrator:	Eleonora Tumanyan
Head of Maintenance:	Mikael Hovhannessyan
Building Operational Capacity:	1124
Date of Construction:	1923
Significance:	One of the oldest and largest schools in Yerevan, one of the few wich provides profound Russian language teaching
Total Number of Rooms:	82

Current Staffing	
Teachers:	120
Administrative:	3
Maintenance:	1

Description of Room Use	
Class rooms:	46
Laboratory Rooms:	10
Critical Care Room:	1
Kitchen:	2
Storage Rooms:	6
Offices:	10
Maintenance Rooms	1
Bathrooms	6

School # 8 (Yerevan)

Armenia Weatherization Project
Monitoring Data Collected

	Parameter	Nov	Dec	Jan	Feb	Mar
1	Temperature inside the building '93-'94 (with heaters)	+10C	+4C	+4C	+4C	+4C
2	Temperature inside the building '94-'95 (with heaters)	+10	+4C	+4C	+4C	+4C
3	Temperature inside the building '95-'96	+20 C	+16 C	+9 C	+12 C	+21 C
4	Temperature outside the building '93-'94	+3C	-15 C	-15 C	-13 C	-4 C
5	Temperature outside the building '94-'95	+3 C	-10 C	-10 C	-8 C	+2 C
6	Temperature outside the building '95-'96	+ 6 C	+2 C	0 C	+3 C	+7 C
		actual	+	estimate		
7	Power consumption '93-'94, kWh	1,200 kw/h	1,400 kw/h	1,250 kw/h	1,200 kw/h	1,200 kw/h
	Power used for heating	none	none	none	none	none
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	no data	no data	no data	no data	no data
		actual	+	estimate		
8	Power consumption '94-'95, kWh	1,200 kw/h	1,100 kw/h	1,280 kw/h	1,320 kw/h	1,300 kw/h
	Power used for heating	none	none	none	none	none
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	no data	no data	no data	no data	no data
		actual		estimate		
9	Power consumption '95-'96	1320 kw/h	1760 kw/h	1760 kw/h	760 kw/h	800 kw/h
	Power used for heating	none	none	none	none	none
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	no data	no data	no data	no data	no data
		actual		estimate		
10	Fuel consumption '93-'94					
	gas	none	none	none	none	none
	wood	none	none	none	none	none
	12 kerosene heaters with the total kerosene consumption for the whole winter=1,540	290	320	260	330	340
	mazut	none	none	none	none	none
		actual		estimate		
11	Fuel consumption '94-'95					
	gas	none	none	none	none	none
	wood	none	none	none	none	none
	25 kerosene heaters with the total kerosene comsumption for the whole winter =					
	mazut	none	none	none	none	none
		actual		estimate		
12	Fuel consumption '95-'96					
	gas	none	none	none	none	none
	wood	none	none	none	none	none
	kerosene					
	mazut	none	none	none	none	none
13	Hours heat supplied per day , average 6 hours '94-'95	none	none	none	none	none
14	Hours heat supplied per day , average 6 hours '95-'96	none	none	none	none	none
15	Temperature of heat carrier (supply) '94-'95	none	none	none	none	none
16	Temperature of heat carrier (return) '94-'95	none	none	none	none	none
17	Temperature of heat carrier (supply) '95-'96	none	none	none	none	none
18	Temperature of heat carrier (return) '95-'96	none	none	none	none	none
19	Power consumption limit '94-'95	2400 kw/h	2400 kw/h	2400 kw/h	2400 kw/h	2400 kw/h
20	Power consumption limit '95-'96	2400 kw/h	2400 kw/h	2400 kw/h	2400 kw/h	2400 kw/h
21	Used power comparing to limit '94-'95	50%	45.8%	53.3%	55%	54.2%
22	Used power comparing to limit '95-'96	55%	73.3%	73.3%	31.7%	33.3%

School # 8 (Yerevan)

Armenia Weatherization Project
Monitoring Data Collected

	Parameter	front view	rear view	left view	right view	roof
1	Thickness of outside walls	700 mm	420 mm	400 mm	400 mm	300 mm
2	Surface of glazing	188.5 sq.m	145.9 sq.m	276.1sq.m	337.3sq.m	none
3	Surface of building envelope	1198sq.m	1151sq.m	1707sq.m	1707 sq.m	1756sq.m
4	Surface of windows covered w/ Astro-Foil	none	none	none	none	none
5	Surface of walls insulated	none	none	none	none	none
6	Thickness of insullation	none	none	none	none	none
7	Surface of glazing missing	42 sq.m	37 sq.m	99 sq.m	71 sq.m	
8	Orientation	N-E	S-W	S-E	N-W	
9	Number of windows	62	51	78	77	
10	Average size of windows	3.04 sq.m	2.86 sq.m	3.54 sq.m	4.38 sq.m	
11	Average perimeter of window	7.17 m	6.89 m	7.40 m	8.43 m	
12	Average size of gap between window sash and frame	4 mm	4 mm	4 mm	4 mm	
13	Average size of gap between window frame and building	5 mm	5mm	5 mm	5 mm	
14	Number of exterior doors	6	1	2	3	
15	Average size of doors	3.75 sq.m	2.6 sq.m	3.3 sq.m	3.1 sq.m	
16	Average perimeter of doors	8.0 m	7.2 m	7.7 m	7.6 m	
17	Average size of gap between door sash and frame	4 mm	4 mm	4 mm	4 mm	
18	Average size of gap between door frame and building	5 mm	5 mm	5 mm	5 mm	

19	Building material	tufa, concrete blocks w/tufa, glass blocks
20	Number of existing glass panes	2; 6 big aluminum windows - of 1 leyer)
21	Type of the roof	two slope
22	Number of floors	4
23	Total volume of the building	33,640 cub.m
24	Average size of the gaps around windows	5 mm
25	Heating system	District heating (not operating) (back up: kerosene stoves)
26	Type of heating units	Radiators (kerosene stoves)
27	Number of heating units	268 (25 in the year of 1994-95)
28	Efficiency of heating units	60% (20%)
29	R- Value of wall material	0.78
30	U- Value of wall material	1.3
31	R- Value of roof material	0.60
32	U- Value of roof material	1.65

33	Area of one floor	1,756 sq.m
34	Total floor area	6,648 sq.m
35	Total surface of the building	7,520 sq.m
36	Total surface area of exterior doors	41 sq.m
37	Total surface area of glass	948x2=1896 sq.m

Data Collected by : Rita, Hovik, Edward, Vahag
Data Provided by: Maintenanceman, assistant, Mr. Arshakyan
Date: October 16-29, 1995,

Secondary School # 8

Typical Winter Data

Date / Time	Temperature non weatherized not in use t nw (C)	Temperature weatherized t w (C)	Outside Temperature t o (C)	Temperature non weatherized in use t o (C)	Infiltration per weatherized window L w (cub.m/h)	Infiltration per non weatherized window L nw (cub.m/h)	Air Density non weatherized room D nw kg / cub.m	Air Density weatherized room D w kg / cub.m	Air Density Outside Air D o kg / cub.m	Infiltration per weatherized window G w kg / hour	Infiltration per non weatherized per window G nw kg / hour	Temperature non weatherized absolute T nw (T)	Temperature weatherized absolute T w (T)	Outside Temperature absolute T o (T)	Inlet Air From One Broken Window Non weather V b cub.m/hour	Inlet Air Per Broken Window Non weather G b kg / hour
1-Feb-96	5.00	5.00	3.11	5.00	0.09	22.18	1.28	1.28	1.29	0.12	28.50	278.00	278.00	276.11	581.55	742.21
2-Feb-96	5.00	5.00	-0.01	5.00	0.07	16.63	1.28	1.28	1.30	0.10	21.62	278.00	278.00	272.99	946.84	1208.41
3-Feb-96	5.00	5.00	-4.71	5.00	0.07	16.63	1.28	1.28	1.32	0.10	21.99	278.00	278.00	268.29	1318.16	1682.30
5-Feb-96	5.00	5.00	-5.16	5.00	0.07	22.18	1.28	1.28	1.32	0.10	29.37	278.00	278.00	267.84	1348.36	1720.84
6-Feb-96	5.00	5.00	-4.71	5.00	0.09	22.18	1.28	1.28	1.32	0.12	29.32	278.00	278.00	268.29	1318.16	1682.30
7-Feb-96	5.00	5.00	-11.83	5.00	0.07	22.18	1.28	1.28	1.36	0.13	30.07	278.00	278.00	261.17	1735.40	2214.81
8-Feb-96	18.00	18.00	-10.62	18.00	0.08	16.63	1.21	1.21	1.35	0.11	22.46	291.00	291.00	262.38	2211.92	2686.37
9-Feb-96	18.00	18.00	-7.84	18.00	0.08	16.63	1.21	1.21	1.34	0.11	22.24	291.00	291.00	265.16	2101.75	2552.57
12-Feb-96	18.00	18.00	-5.16	18.00	0.08	16.63	1.21	1.21	1.32	0.11	22.03	291.00	291.00	267.84	1989.77	2416.58
13-Feb-96	18.00	18.00	-6.3	18.00	0.08	15.26	1.21	1.21	1.33	0.11	20.30	291.00	291.00	266.70	2038.16	2475.34
14-Feb-96	18.00	18.00	-7.07	18.00	0.08	15.26	1.21	1.21	1.33	0.11	20.36	291.00	291.00	265.93	2070.20	2514.25
15-Feb-96	18.00	18.00	-8.23	18.00	0.07	13.31	1.21	1.21	1.34	0.10	17.82	291.00	291.00	264.77	2117.55	2571.76
16-Feb-96	18.00	18.00	-6.68	18.00	0.06	13.31	1.21	1.21	1.33	0.08	17.72	291.00	291.00	266.32	2054.03	2494.62
19-Feb-96	18.00	18.00	-7.84	18.00	0.05	13.31	1.21	1.21	1.34	0.07	17.79	291.00	291.00	265.16	2101.75	2552.57
20-Feb-96	18.00	18.00	-7.07	18.00	0.05	16.63	1.21	1.21	1.33	0.07	22.18	291.00	291.00	265.93	2070.20	2514.25
21-Feb-96	18.00	18.00	-6.3	18.00	0.04	13.31	1.21	1.21	1.33	0.05	17.70	291.00	291.00	266.70	2038.16	2475.34
22-Feb-96	18.00	18.00	-5.16	18.00	0.04	13.31	1.21	1.21	1.32	0.05	17.62	291.00	291.00	267.84	1989.77	2416.58
23-Feb-96	18.00	18.00	-5.92	18.00	0.04	13.31	1.21	1.21	1.33	0.05	17.67	291.00	291.00	267.08	2022.16	2455.91
26-Feb-96	18.00	18.00	-4.41	18.00	0.06	13.31	1.21	1.21	1.32	0.07	17.58	291.00	291.00	268.59	1967.29	2377.13
27-Feb-96	18.00	18.00	-5.16	18.00	0.04	13.31	1.21	1.21	1.32	0.05	17.62	291.00	291.00	267.84	1989.77	2416.58
28-Feb-96	18.00	18.00	-4.04	18.00	0.04	13.31	1.21	1.21	1.32	0.05	17.55	291.00	291.00	268.96	1941.06	2357.42
29-Feb-96	18.00	18.00	-5.16	18.00	0.04	16.63	1.21	1.21	1.32	0.05	22.03	291.00	291.00	267.84	1989.77	2416.58
1-Mar-96	18.00	18.00	-5.16	18.00	0.04	16.63	1.21	1.21	1.32	0.05	22.03	291.00	291.00	267.84	1989.77	2416.58
4-Mar-96	18.00	18.00	-5.92	18.00	0.05	16.63	1.21	1.21	1.33	0.06	22.37	291.00	291.00	267.08	2022.16	2455.91
5-Mar-96	18.00	18.00	-2.93	18.00	0.05	16.63	1.21	1.21	1.31	0.06	22.14	291.00	291.00	270.07	1891.55	2297.29
6-Mar-96	18.00	18.00	-0.83	18.00	0.05	16.63	1.21	1.21	1.30	0.06	21.69	291.00	291.00	272.17	1794.15	2179.00
7-Mar-96	18.00	18.00	0.38	18.00	0.05	13.31	1.21	1.21	1.30	0.06	17.27	291.00	291.00	273.38	1735.55	2107.83
8-Mar-96	18.00	18.00	3.16	18.00	0.05	22.18	1.21	1.21	1.28	0.06	28.50	291.00	291.00	276.16	1592.76	1934.41
11-Mar-96	18.00	18.00	5.84	18.00	0.05	13.31	1.21	1.21	1.27	0.06	16.93	291.00	291.00	278.84	1441.79	1751.05
12-Mar-96	18.00	18.00	4.7	18.00	0.05	11.09	1.21	1.21	1.28	0.06	14.17	291.00	291.00	277.70	1507.86	1831.29

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13-Mar-96	18.00	18.00	3.93	18.00	0.05	11.09	1.21	1.21	1.28	0.06	14.21	291.00	291.00	276.93	1550.89	1883.56
14-Mar-96	18.00	18.00	2.77	18.00	0.05	11.09	1.21	1.21	1.29	0.06	14.27	291.00	291.00	275.77	1613.56	1959.66
15-Mar-96	18.00	18.00	4.32	18.00	0.05	11.09	1.21	1.21	1.28	0.06	14.19	291.00	291.00	277.32	1529.25	1857.27
18-Mar-96	18.00	18.00	3.16	18.00	0.05	11.09	1.21	1.21	1.28	0.06	14.25	291.00	291.00	276.16	1592.76	1934.41
19-Mar-96	18.00	18.00	3.93	18.00	0.05	11.09	1.21	1.21	1.28	0.07	14.21	291.00	291.00	276.93	1550.89	1883.56
20-Mar-96	18.00	18.00	4.7	18.00	0.05	9.50	1.21	1.21	1.28	0.06	12.14	291.00	291.00	277.70	1507.86	1831.29
21-Mar-96	18.00	18.00	5.84	18.00	0.04	9.50	1.21	1.21	1.27	0.06	12.09	291.00	291.00	278.84	1441.79	1751.05
22-Mar-96	18.00	18.00	7.33	18.00	0.04	9.68	1.21	1.21	1.27	0.05	12.24	291.00	291.00	280.33	1350.57	1640.26
25-Mar-96	18.00	18.00	8.43	18.00	0.04	9.68	1.21	1.21	1.26	0.05	12.19	291.00	291.00	281.43	1279.06	1553.42
26-Mar-96	18.00	18.00	8.8	18.00	0.04	9.50	1.21	1.21	1.26	0.05	11.96	291.00	291.00	281.80	1254.09	1523.09
27-Mar-96	18.00	18.00	8.8	18.00	0.05	9.50	1.21	1.21	1.26	0.06	11.96	291.00	291.00	281.80	1254.09	1523.09
28-Mar-96	18.00	18.00	8.8	18.00	0.05	11.09	1.21	1.21	1.26	0.06	13.95	291.00	291.00	281.80	1254.09	1523.09
29-Mar-96	18.00	18.00	10.24	18.00	0.05	11.09	1.21	1.21	1.25	0.06	13.88	291.00	291.00	283.24	1151.77	1398.82

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Secondary School # 8

Calculations Based on Typical Winter Data

Date / Time	Heat losses per none weatherized window by infiltration per day Q inf. nw kcal day	Heat losses per none weatherized single pane window by transfere per day Q tr. nw1 kcal day	Heat losses per none weatherized double pane window by transfere per day Q tr. nw2 kcal day	Heat losses per broken window by inlet air per day Q b. nw kcal day	Heat losses from 73 non weatherized single pane windows per day Q nw 1 kcal day	Heat losses from 160 non weatherized double pane windows per day Q nw 2 kcal day	Heat losses from 35 broken windows per day Q b kcal day	Total heat losses from non weatherized building per day Q nw kcal day	Heat losses per weatherized window by infiltration per day Q inf. w kcal day	Heat losses per weatherized single pane window by transfere per day Q tr. w2 kcal day	Total heat losses from weatherized building per day Q nw kcal day	Energy savings in the period of monitoring per day delta Q kcal day	Conventional fuel saved in the perion of monitoring per day B kg/day	Money savings in the period of monitoring per day E $ / day
1-Feb-96	310.28	828.73	460.40	8080	83147	123309	282799	489255	1.29	828.73	354419	134836	27.52	2.89
2-Feb-96	623.97	2196.78	1220.44	34872	205915	295105	1220509	1721530	2.77	2196.78	939211	782318	159.66	16.76
3-Feb-96	1230.10	4257.64	2365.36	94090	400605	575273	3293164	4269042	5.47	4257.64	1820347	2448695	499.73	52.47
5-Feb-96	1718.92	4454.96	2474.98	100706	450693	671023	3524724	4646439	5.73	4454.96	1904713	2741726	559.54	58.75
6-Feb-96	1640.13	4257.64	2365.36	94090	430537	640878	3293164	4364580	6.83	4257.64	1820931	2543649	519.11	54.51
7-Feb-96	2915.49	7379.62	4099.79	214705	751543	1122444	7514684	9388671	12.15	7379.62	3156284	6232386	1271.92	133.55
8-Feb-96	3702.66	12549.30	6971.83	442852	1186393	1707918	15499820	18394131	18.28	12549.30	5366358	13027773	2658.73	279.17
9-Feb-96	3310.31	11330.32	6294.62	379921	1068766	1536790	13297224	15902780	16.35	11330.32	4845028	11057751	2256.68	236.95
12-Feb-96	2938.74	10155.20	5641.78	322375	955857	1372882	11283142	13611881	14.51	10155.20	4342466	9269415	1891.72	198.63
13-Feb-96	2841.35	10655.06	5919.48	346468	985238	1401732	12126392	14513363	14.80	10655.06	4556031	9957331	2032.11	213.37
14-Feb-96	2939.44	10992.69	6107.05	363066	1017046	1447439	12707313	15171798	15.31	10992.69	4700417	10471380	2137.02	224.39
15-Feb-96	2691.94	11501.33	6389.63	388554	1036109	1453051	13599397	16088557	14.96	11501.33	4917454	11171103	2279.82	239.38
16-Feb-96	2518.94	10821.69	6012.05	354627	973866	1364959	12411948	14750772	10.76	10821.69	4625457	10125316	2066.39	216.97
19-Feb-96	2648.25	11330.32	6294.62	379921	1020436	1430860	13297224	15748519	9.81	11330.32	4842236	10906283	2225.77	233.71
20-Feb-96	3202.88	10992.69	6107.05	363066	1036277	1489590	12707313	15233179	9.49	10992.69	4697932	10535247	2150.05	225.76
21-Feb-96	2476.80	10655.06	5919.48	346468	958626	1343404	12126392	14428423	6.88	10655.06	4552650	9875772	2015.46	211.62
22-Feb-96	2350.99	10155.20	5641.78	322375	912952	1278843	11283142	13474936	7.03	10155.20	4339272	9135664	1864.42	195.76
23-Feb-96	2434.76	10488.44	5826.91	338373	943393	1321867	11843061	14108321	7.28	10488.44	4481674	9626647	1964.62	206.29
26-Feb-96	2268.74	9826.34	5459.08	306844	882940	1236450	10739523	12858914	8.40	9826.34	4199434	8659480	1767.24	185.56
27-Feb-96	2350.99	10155.20	5641.78	322375	912952	1278843	11283142	13474936	7.07	10155.20	4339290	9135646	1864.42	195.76
28-Feb-96	2228.31	9664.10	5368.94	299276	868146	1215561	10474652	12558359	6.71	9664.10	4129434	8428925	1720.19	180.62
29-Feb-96	2938.74	10155.20	5641.78	322375	955857	1372882	11283142	13611881	7.07	10155.20	4339290	9272591	1892.37	198.70
1-Mar-96	2938.74	10155.20	5641.78	322375	955857	1372882	11283142	13611881	7.07	10155.20	4339290	9272591	1892.37	198.70
4-Mar-96	3082.79	10488.44	5826.91	338373	990700	1425552	11843061	14259313	8.36	10488.44	4482135	9777177	1995.34	209.51
5-Mar-96	2668.59	9177.39	5098.55	276954	864757	1242743	9693398	11800897	7.24	9177.39	3921835	7879062	1607.97	168.84
6-Mar-96	2352.21	8256.58	4586.99	236336	774441	1110271	8271756	10156468	6.53	8256.58	3528349	6628119	1352.68	142.03
7-Mar-96	1753.08	7726.02	4292.23	213926	691974	967251	7487401	9146626	6.09	7726.02	3301609	5845017	1192.86	125.25
8-Mar-96	2435.79	6507.04	3615.02	165350	652827	968130	5787261	7408217	5.46	6507.04	2780841	4627376	944.36	99.16
11-Mar-96	1185.68	5331.92	2962.18	122646	475784	663656	4292621	5432062	4.41	5331.92	2278612	3153450	643.56	67.57
12-Mar-96	1085.29	5831.78	3239.88	140292	504947	692028	4910206	6107180	4.52	5831.78	2492103	3615078	737.77	77.47
13-Mar-96	1151.41	6169.41	3427.45	152649	534420	732619	5342732	6609771	4.96	6169.41	2636459	3973312	810.88	85.14
14-Mar-96	1251.70	6678.05	3710.03	171911	578872	793877	6016890	7389639	5.40	6678.05	2853832	4535807	925.67	97.20
15-Mar-96	1117.88	5998.41	3332.45	146347	519489	712053	5122139	6353680	4.97	5998.41	2563441	3790239	773.52	81.22
18-Mar-96	1217.89	6507.04	3615.02	165350	563920	773267	5787261	7124448	5.07	6507.04	2780674	4343774	886.48	93.08
19-Mar-96	1151.41	6169.41	3427.45	152649	534420	732619	5342732	6609771	5.44	6169.41	2636661	3973109	810.84	85.14
20-Mar-96	930.25	5831.78	3239.88	140292	493629	667221	4910206	6071055	4.52	5831.78	2492103	3578953	730.40	76.69

21-Mar-96	846.91	5331.92	2962.18	122646	451055	609454	4292621	5353130	3.87	5331.92	2278383	3074747	627.50	65.89
22-Mar-96	752.53	4678.58	2599.21	100809	396471	536279	3528327	4461078	3.11	4678.58	1999082	2461995	502.45	52.76
25-Mar-96	672.17	4196.25	2331.25	85629	355395	480547	2997023	3832965	2.78	4196.25	1792987	2039978	416.32	43.71
26-Mar-96	633.67	4034.02	2241.12	80712	340741	459967	2824906	3625614	2.89	4034.02	1723758	1901856	388.13	40.75
27-Mar-96	633.67	4034.02	2241.12	80712	340741	459967	2824906	3625614	3.08	4034.02	1723840	1901774	388.12	40.75
28-Mar-96	739.29	4034.02	2241.12	80712	348451	476865	2824906	3650222	3.08	4034.02	1723840	1926382	393.14	41.28
29-Mar-96	620.18	3402.60	1890.34	62524	293663	401683	2188340	2883686	2.75	3402.60	1454085	1429602	291.76	30.63
								404323582			139054247	265269336	54137	5684

Energy Saved for the period of monitoring:

Delta Q=265269336 kcal / 58 da

Conventional Fuel Saved for the period of monitoring:

B=54136.99 kg / 58 days

Money Savings:

E=5,684 $/ 58 days

Payback Period:

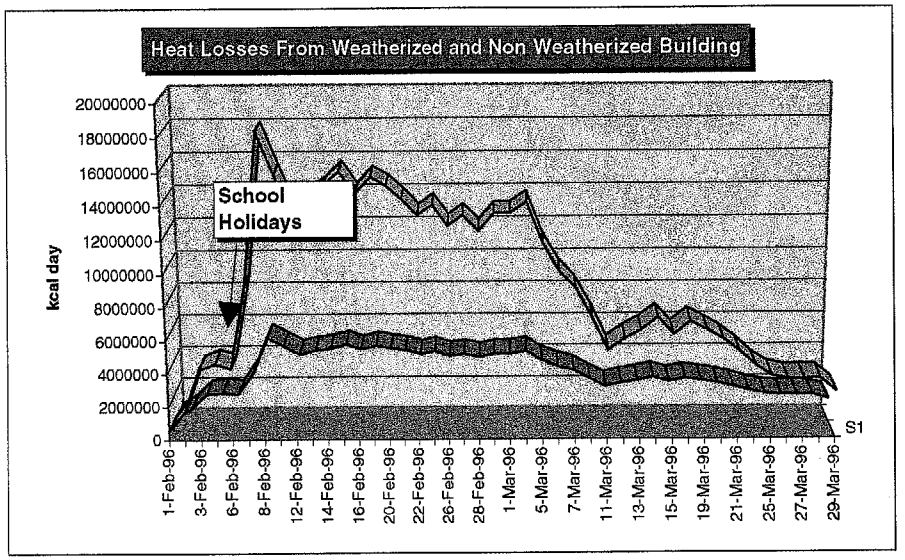
Z=7.49 x 58 days = 434.4 days

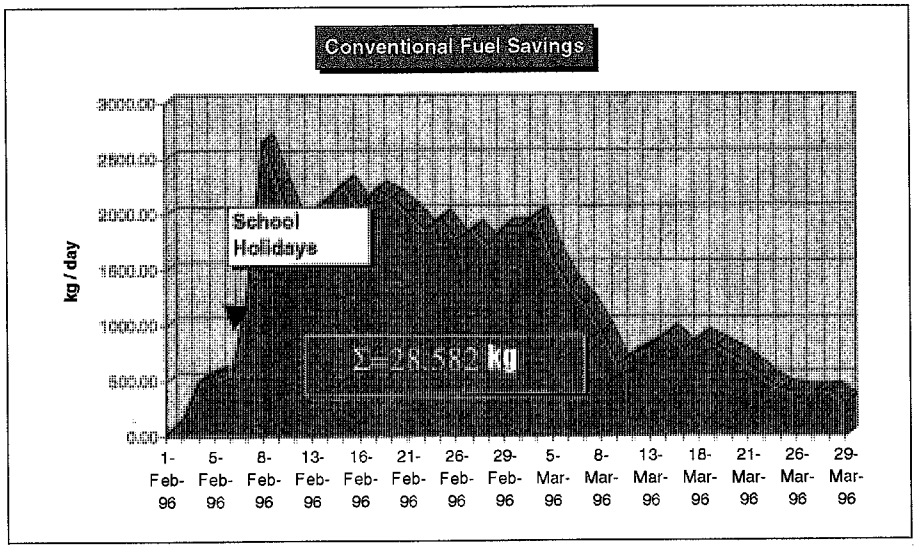
Energy, Fuel, Money Savings Percent:

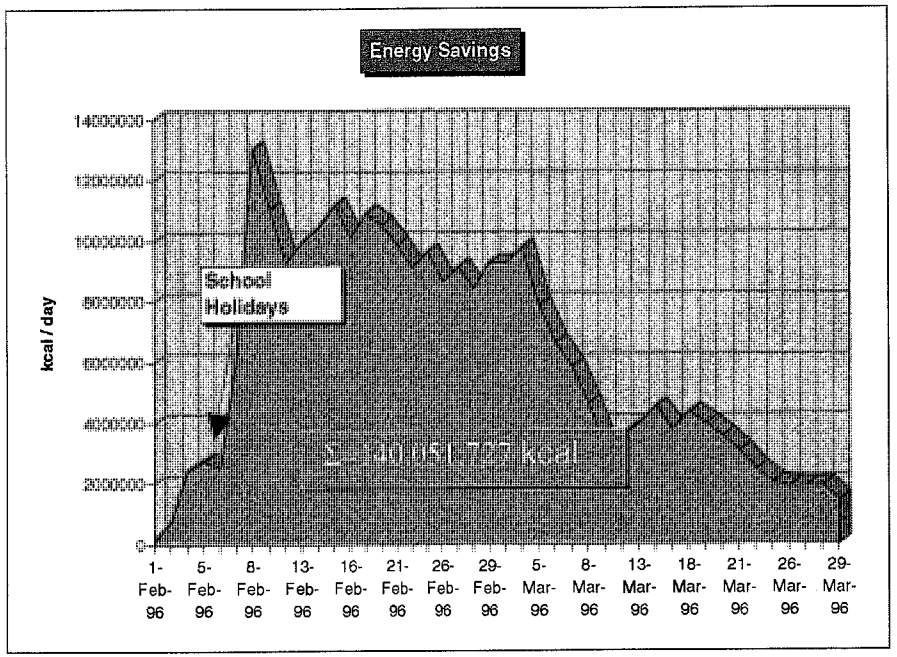
Ratio = 65.6%

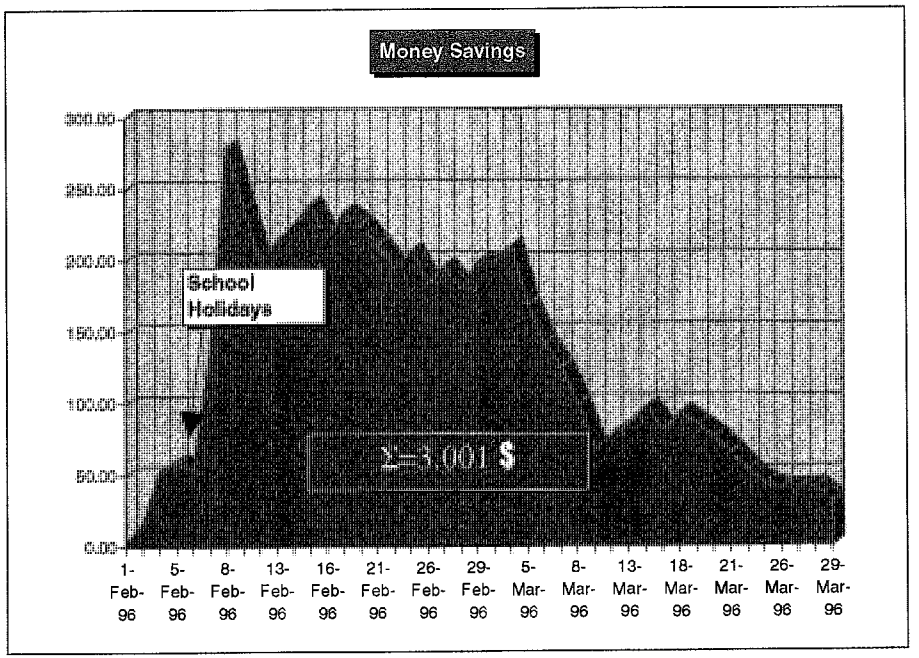
Secondary School # 8

Secondary School # 8









Secondary School # 8

Actual Data for Winter '96

Date / Time	Temperature non weatherized not in use t nw (C)	Temperature weatherized t w (C)	Outside Temperature t o (C)	Temperature non weatherized in use t o (C)	Infiltration per weatherized window I w (cub.m/h)	Infiltration per non weatherized window I nw (cub.m/h)	Air Density non weatherized room D nw kg / cub.m	Air Density weatherized room D w kg / cub.m	Air Density Outside Air D o kg / cub.m	Infiltration per weatherized window G w kg / hour	Infiltration per non weatherized per window G nw kg / hour	Temperature non weatherized absolute T nw (T)	Temperature weatherized absolute T w (T)	Outside Temperature absolute T o (T)	Inlet Air From One Broken Window Non weather V b cub.m/hour	Inlet Air Per Broken Window Non weather G b kg / hour
1-Feb-96	3.16	5.02	3.11	3.50	0.09	22.18	1.28	1.28	1.29	0.12	28.50	276.16	278.02	276.11	94.90	121.95
2-Feb-96	2.25	4.25	-0.01	2.50	0.07	16.63	1.29	1.28	1.30	0.10	21.62	275.25	277.25	272.99	639.10	824.00
3-Feb-96	0.26	4.12	-4.71	0.00	0.07	16.63	1.30	1.28	1.32	0.10	21.99	273.26	277.12	268.29	951.20	1235.38
5-Feb-96	-1.05	3.05	-5.16	-0.48	0.07	22.18	1.30	1.29	1.32	0.10	29.37	271.95	276.05	267.84	867.08	1131.52
6-Feb-96	-1.16	3.78	-4.71	-0.50	0.09	22.18	1.31	1.28	1.32	0.12	29.32	271.84	276.78	268.29	806.01	1052.25
7-Feb-96	-1.00	4.65	-4.27	-0.46	0.09	22.18	1.30	1.28	1.32	0.12	29.28	272.00	277.65	268.73	773.34	1009.01
8-Feb-96	1.38	5.16	-0.83	2.23	0.08	16.63	1.29	1.28	1.30	0.11	21.69	274.38	278.16	272.17	633.00	818.74
9-Feb-96	1.86	7.26	0.38	3.49	0.08	16.63	1.29	1.27	1.30	0.11	21.59	274.86	280.26	273.38	517.55	668.25
12-Feb-96	3.81	7.64	3.16	5.50	0.08	16.63	1.28	1.26	1.28	0.11	21.37	276.81	280.64	276.16	341.78	438.13
13-Feb-96	5.84	7.79	5.72	6.65	0.08	15.26	1.27	1.26	1.27	0.10	19.43	278.84	280.79	278.72	146.32	186.15
14-Feb-96	6.26	10.34	4.70	7.26	0.08	15.26	1.27	1.25	1.28	0.10	19.50	279.26	283.34	277.70	527.16	669.63
15-Feb-96	4.39	13.56	3.93	7.39	0.07	13.31	1.28	1.24	1.28	0.09	17.05	277.39	286.56	276.93	287.22	367.40
16-Feb-96	4.12	13.25	2.77	7.35	0.06	13.31	1.28	1.24	1.29	0.07	17.12	277.12	286.25	275.77	492.28	630.33
19-Feb-96	5.46	14.05	4.32	8.94	0.05	13.31	1.27	1.23	1.28	0.06	17.02	278.46	287.05	277.32	451.29	574.97
20-Feb-96	4.65	17.65	3.16	8.28	0.05	16.63	1.28	1.22	1.28	0.06	21.37	277.65	290.65	276.16	516.68	660.28
21-Feb-96	5.24	19.68	3.93	8.86	0.04	13.31	1.28	1.21	1.28	0.05	17.05	278.24	292.68	276.93	483.96	617.10
22-Feb-96	6.38	22.79	4.70	9.24	0.04	13.31	1.27	1.19	1.28	0.05	17.00	279.38	295.79	277.70	546.94	694.44
23-Feb-96	8.25	22.85	5.84	10.34	0.04	13.31	1.26	1.19	1.27	0.05	16.93	281.25	295.85	278.84	652.89	823.18
26-Feb-96	6.35	21.66	5.08	10.12	0.05	13.31	1.27	1.20	1.28	0.06	16.98	279.35	294.66	278.08	475.56	603.89
27-Feb-96	7.16	21.73	6.59	11.76	0.04	13.31	1.27	1.20	1.27	0.05	16.88	280.16	294.73	279.59	318.14	402.76
28-Feb-96	7.05	20.35	5.84	11.53	0.04	13.31	1.27	1.20	1.27	0.05	16.93	280.05	293.35	278.84	463.61	587.17
29-Feb-96	8.61	19.64	6.96	12.36	0.04	16.63	1.26	1.21	1.27	0.05	21.07	281.61	292.64	279.96	539.88	679.77
1-Mar-96	7.36	19.38	5.84	11.20	0.04	16.63	1.27	1.21	1.27	0.05	21.16	280.36	292.38	278.84	519.33	656.97
4-Mar-96	7.35	18.64	5.84	11.15	0.05	16.63	1.27	1.21	1.27	0.06	21.43	280.35	291.64	278.84	517.63	654.85
5-Mar-96	7.36	19.20	5.08	11.19	0.06	16.63	1.27	1.21	1.28	0.06	21.49	280.36	292.20	278.08	636.05	804.63
6-Mar-96	9.61	20.46	8.07	11.68	0.05	16.63	1.25	1.20	1.26	0.06	20.98	282.61	293.46	281.07	520.65	653.08
7-Mar-96	6.35	18.69	4.70	9.84	0.05	13.31	1.27	1.21	1.28	0.06	17.00	279.35	291.69	277.70	542.06	688.33
8-Mar-96	7.52	19.35	5.46	11.34	0.05	22.18	1.26	1.21	1.27	0.06	28.25	280.52	292.35	278.46	604.41	764.14
11-Mar-96	4.21	17.69	2.38	10.46	0.05	13.31	1.28	1.22	1.29	0.06	17.15	277.21	290.69	275.38	573.06	733.52
12-Mar-96	4.61	18.73	2.38	10.84	0.05	11.09	1.28	1.21	1.29	0.06	14.29	277.61	291.73	275.38	632.14	807.94
13-Mar-96	5.24	21.64	2.77	10.89	0.05	11.09	1.28	1.20	1.29	0.06	14.27	278.24	294.64	275.77	664.54	847.36
14-Mar-96	6.02	22.71	4.32	10.98	0.05	11.09	1.27	1.19	1.28	0.06	14.19	279.02	295.71	277.32	550.54	699.96
15-Mar-96	6.00	22.84	4.70	10.96	0.05	11.09	1.27	1.19	1.28	0.06	14.17	279.00	295.84	277.70	481.45	612.16

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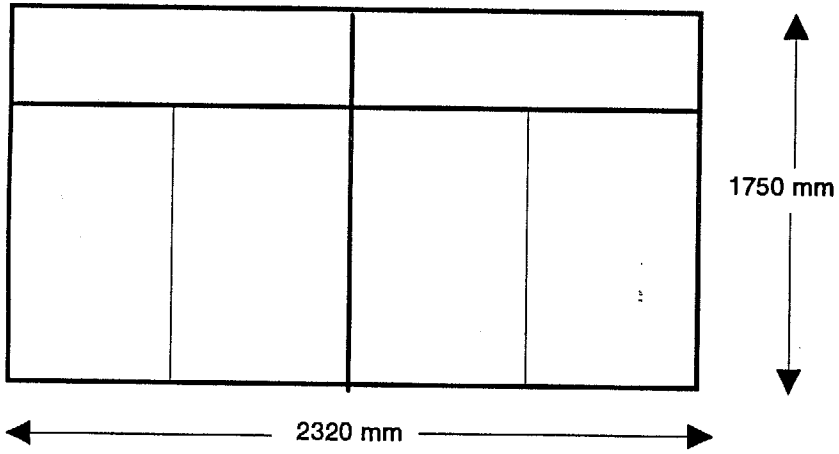
18-Mar-96	6.92	19.67	5.46	11.32	0.05	11.09	1.27	1.21	1.27	0.06	14.13	279.92	292.67	278.46	509.38	645.45
19-Mar-96	8.64	19.82	6.59	11.50	0.05	11.09	1.26	1.21	1.27	0.07	14.07	281.64	292.82	279.59	601.74	757.57
20-Mar-96	8.85	19.86	7.70	11.53	0.05	9.50	1.26	1.21	1.26	0.06	12.01	281.85	292.86	280.70	450.53	566.75
21-Mar-96	10.29	20.53	8.80	12.50	0.04	9.50	1.25	1.20	1.26	0.05	11.96	283.29	293.53	281.80	511.51	639.97
22-Mar-96	8.64	18.32	6.96	12.46	0.04	9.66	1.26	1.21	1.27	0.05	12.26	281.64	291.32	279.96	544.74	685.80
25-Mar-96	8.64	18.95	7.33	12.56	0.04	9.66	1.26	1.21	1.27	0.05	12.24	281.64	291.95	280.33	481.03	605.59
26-Mar-96	9.26	21.38	8.43	13.28	0.04	9.50	1.26	1.20	1.26	0.05	11.97	282.26	294.38	281.43	382.47	480.39
27-Mar-96	10.31	21.43	8.80	14.02	0.05	9.50	1.25	1.20	1.26	0.06	11.96	283.31	294.43	281.80	514.92	644.18
28-Mar-96	10.29	21.46	8.80	14.05	0.05	11.09	1.25	1.20	1.26	0.06	13.95	283.29	294.46	281.80	511.51	639.97
29-Mar-96	10.35	21.43	8.80	14.08	0.05	11.09	1.25	1.20	1.26	0.06	13.95	283.35	294.43	281.80	521.66	652.51



Two windows of the size drawn to the left (weatherized and non weatherized) were tested for infiltration at the Secondary School # 8. The windows are located in the same size (3.00m x 4.00m)rooms on North side of the building.
There are 268 windows of this size and shape at the hospital.
There was 73 single glass pane windows, and 35 broken windows.
All the missing glass panes were replaced. Windows were caulked and weather-stripped.
For temperature measurements HOBO-XT automatic temperature loggers were used for the period of 1 February 1996 through 29 March 1996.
For the infiltrating air volume measurements special installation was used for the period of 1 February 1996 through 29 March 1996.
The principe of that installation is to measure the time during which a very tight sealed to window bag with known volume is filled by infiltrating air.
Both rooms and the entire building were heated with kerosene stoves

Secondary School # 8 — Yerevan

Calculations Based on Actual Data - Winter '96

Date / Time	Heat losses per none weatherized window by infiltration per day Q inf. nw kcal day	Heat losses per none weatherized single pane window by transfere per day Q tr. nw1 kcal day	Heat losses per none weatherized double pane window by transfere per day Q tr. nw2 kcal day	Heat losses per broken window by inlet air per day Q b. nw kcal day	Heat losses from 73 non weatherized single pane windows per day Q nw 1 kcal day	Heat losses from 160 non weatherized double pane windows per day Q nw 2 kcal day	Heat losses from 35 broken windows per day Q b kcal day	Total heat losses from non weatherized building per day Q nw kcal day	Heat losses per weatherized window by Infiltration per day Q inf. w kcal day	Heat losses per weatherized single pane window by transfere per day Q tr. w2 kcal day	Total heat losses from weatherized building per day Q nw kcal day	Energy savings in the period of monitoring per day delta Q kcal day	Conventional fuel saved in the period of monitoring per day B kg/day	Money savings in the period of monitoring per day E $ / day
1-Feb-96	305.29	815.57	453.10	7887	81823	121342	276062	479227	1.27	815.57	348793	130435	26.62	2.80
2-Feb-96	530.56	1867.92	1037.74	27455	175090	250928	960940	1388957	2.36	1867.92	798611	588346	120.07	12.61
3-Feb-96	1118.62	3871.78	2150.99	81991	384299	523137	2869684	3757120	4.97	3871.78	1655372	2101748	428.93	45.04
5-Feb-96	1389.01	3599.92	1999.96	73944	364192	542234	2588024	3494450	4.63	3599.92	1539143	1955307	399.04	41.90
6-Feb-96	1434.96	3722.70	2068.16	77446	378443	560356	2710620	3647419	5.96	3722.70	1592142	2055277	419.44	44.04
7-Feb-96	1504.31	3911.24	2172.91	80005	395035	588356	2905165	3888855	6.27	3911.24	1672777	2216079	452.26	47.49
8-Feb-96	748.26	2626.50	1459.16	45548	246357	353188	1594194	2193739	3.70	2626.50	1123091	1070647	218.50	22.94
9-Feb-96	855.65	3016.74	1675.97	55421	282685	405059	1939727	2627470	4.23	3016.74	1289953	1337517	272.96	28.66
12-Feb-96	551.50	1964.39	1091.33	29080	183680	262852	1017093	1463606	2.72	1964.39	839958	623648	127.28	13.36
13-Feb-96	218.12	855.04	475.02	8338	78341	110903	291833	481077	1.14	855.04	365585	115491	23.57	2.47
14-Feb-96	633.56	2473.03	1373.90	40438	226781	321195	1415316	1963292	3.30	2473.03	1057392	905900	184.88	19.41
15-Feb-96	945.68	4222.56	2345.87	88615	377262	526648	3101539	4005469	5.25	4222.56	1805278	2200191	449.02	47.15
18-Feb-96	1033.58	4595.27	2552.93	100778	410906	573841	3527216	4511963	4.42	4595.27	1964067	2547896	519.98	54.60
19-Feb-96	954.12	4266.41	2370.23	89753	381099	531896	3141356	4054351	3.53	4266.41	1823266	2231085	455.32	47.81
20-Feb-96	1783.75	6353.58	3529.76	159850	594025	850163	5594744	7038932	5.29	6353.58	2715233	4323698	882.39	92.65
21-Feb-96	1546.68	6906.06	3836.70	179086	617050	861340	6268015	7746405	4.30	6906.06	2950722	4795683	978.71	102.76
22-Feb-96	1771.40	7932.10	4406.72	216598	706056	988499	7580913	9277768	5.30	7932.10	3389271	5888496	1201.73	126.18
23-Feb-96	1858.58	7458.54	4143.64	197426	665550	928355	6909908	8503813	4.96	7458.54	3186917	5316896	1085.08	113.93
26-Feb-96	1621.24	7270.00	4038.89	191274	649061	905621	6694579	8249260	6.00	7270.00	3106853	5142407	1049.47	110.19
27-Feb-96	1472.11	6638.59	3688.10	166838	592061	825635	5839330	7257046	4.43	6638.59	2836568	4420478	902.14	94.72
28-Feb-96	1414.82	6362.34	3534.64	157761	567733	791912	5521622	6881268	4.26	6362.34	2718539	4162729	849.54	89.20
29-Feb-96	1539.01	5559.93	3088.85	129995	518223	740458	4528831	5787512	3.71	5559.93	2375671	3411841	696.29	73.11
1-Mar-96	1650.29	5937.02	3298.34	142990	553874	791782	5004636	6350292	3.97	5937.02	2536804	3813489	778.26	81.72
4-Mar-96	1580.27	5612.54	3118.08	131979	525075	751736	4619252	5896063	4.29	5612.54	2398387	3497677	713.81	74.95
5-Mar-96	1748.18	6191.34	3439.63	152430	579585	830050	5335039	6744673	4.74	6191.34	2645726	4098947	836.52	87.83
6-Mar-96	1497.56	5432.77	3018.20	124404	505914	722522	4354141	5582577	4.16	5432.77	2321568	3261009	665.51	69.88
7-Mar-96	1369.92	6134.34	3407.96	150782	547811	764461	5276682	6588954	4.76	6134.34	2621392	3967562	809.71	85.02
8-Mar-96	2260.47	6090.49	3383.60	148595	609820	903052	5200815	6713488	5.07	6090.49	2602804	4110684	838.92	88.09
11-Mar-96	1512.11	6713.13	3729.52	173570	600442	838660	6074950	7514051	5.63	6713.13	2868908	4645143	947.99	99.54
12-Mar-96	1345.69	7169.15	3982.86	190434	621583	852567	6665198	8139348	5.61	7169.15	3063620	5075728	1035.86	108.77
13-Mar-96	1550.86	8274.12	4596.73	232266	717223	983615	8129307	9630145	6.69	8274.12	3535903	6294242	1284.54	134.88
14-Mar-96	1502.76	8063.65	4479.80	222109	698348	957211	7773802	9429361	6.48	8063.65	3445944	5983417	1221.11	128.22
15-Mar-96	1480.24	7954.03	4418.90	217434	688702	943864	7610205	9242770	6.58	7954.03	3399179	5843592	1192.57	125.22
18-Mar-96	1156.28	6230.80	3461.56	153482	539257	738853	5371862	6649971	4.82	6230.80	2662609	3987362	813.75	85.44
19-Mar-96	1072.00	5801.09	3222.83	137765	501735	687172	4821761	6010668	5.06	5801.09	2479227	3531441	720.70	75.67
20-Mar-96	841.03	5331.92	2962.18	121387	450825	608513	4247840	5306978	4.09	5331.92	2278474	3028504	618.06	64.90
21-Mar-96	807.94	5143.37	2857.43	114552	434445	586458	4009320	5030223	3.70	5143.37	2197798	2832426	578.05	60.69
22-Mar-96	802.31	4981.13	2767.30	110545	422191	571137	3869075	4862404	3.32	4981.13	2128360	2734044	557.97	58.59
25-Mar-96	819.53	5095.14	2830.63	113956	431771	584027	3988476	5004274	3.39	5095.14	2177070	2827204	576.98	60.58
26-Mar-96	893.21	5678.32	3154.62	132243	479722	647653	4628495	5755870	4.07	5678.32	2426379	3329491	679.49	71.35
27-Mar-96	869.93	5538.00	3076.67	127335	467779	631455	4456739	5555973	4.23	5538.00	2366533	3189440	650.91	68.35
28-Mar-96	1017.32	5551.16	3083.98	127768	479499	656208	4471868	5607575	4.24	5551.16	2372154	3235421	660.29	69.33
29-Mar-96	1014.91	5538.00	3076.67	127335	478363	654653	4456739	5589755	4.49	5538.00	2366646	3223109	657.78	69.07
								236102412			96050685	140051727	28582	3001

Energy Saved for the period of monitoring:

Delta Q=140051727 kcal / 58 days

Conventional Fuel Saved for the period of monitoring:

B=28581.99 kg / 58 days

Money Savings:

E=3,001 $/ 58 days

Payback Period:

Z=14.19 x 58 days = 823 days

Energy, Fuel, Money Savings Percent:

Ratio = 59.31%

School # 20 (Yerevan)

Address:	Aigestan Str. 29, # 4
Phone:	55-28-81
Chief Administrator:	Marine Hovhannessyan
Deputy Chief Administrator	Jemma Jalalyan Marietta Bagramyan
Head of Maintenance:	Nvard Petrossyan
Building Operational Capacity:	780
Date of Construction:	1961
Date of the Last Repair	1985
Significance:	One of the biggest schools in Yerevan
Total Number of Rooms:	76

Current Staffing	
Teachers:	90
Administrative:	6
Maintenance:	38

Description of Room Use	
Class rooms:	50
Laboratory Rooms:	10
Medical Room:	1
Kitchen:	1
Storage Rooms:	8
Offices:	5
Maintenance Rooms	1
Bathrooms & Lavatory	

School # 20 (Yerevan)

Armenia Weatherization Project
Monitoring Data Collected

	Parameter	Nov.	Dec.	Jan.	Feb.	Mar.
1	Temperature inside the building '93-'94	+ 5 C	+3 C	+3 C	+3 C	+4 C
2	Temperature inside the building '94-'95	+5 C	+3 C	+3 C	+3 C	+ 6 C
3	Temperature inside the building '95-'96	+5 C	+11 C	+15 C	+18 C	+22 C
4	Temperature outside the building '93-'94	+3C	-15 C	-15 C	-13 C	-4 C
5	Temperature outside the building '94-'95	+3 C	-10 C	-10 C	-8 C	+2 C
6	Temperature outside the building '95-'96	+ 6 C	+2 C	0 C	+3 C	+7 C
		actual		estimate		
7	Power consumption '93-'94	1710 kw/h	1590 kw/h	no data	no data	3210 kw/h
	Power used for heating	no data	no data	no data	no data	no data
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	no data	no data	no data	no data	no data
		actual		estimate		
8	Power consumption '94-'95	no data	300 kw/h	no data	600 kw/h	140 kw/h
	Power used for heating	no data	no data	no data	no data	no data
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	no data	no data	no data	no data	no data
		actual		estimate		
9	Power consumption '95-'96	2700 kw/h	1300 kw/h	no data	1200 kw/h	1200 kw/h
	Power used for heating	no data	no data	no data	no data	no data
	Power used for ligting	no data	no data	no data	no data	no data
	Power used for kitchen and laundry	no data	no data	no data	no data	no data
	Power used for other purposes	no data	no data	no data	no data	no data
		actual		estimate		
10	Fuel consumption '93-'94					
	gas	none	none	none	none	none
	wood	none	none	none	none	none
	kerosene	no data	no data	no data	no data	no data
	mazut	none	none	none	none	none
		actual		estimate		
11	Fuel consumption '94-'95					
	gas	none	none	none	none	none
	wood	none	none	none	none	none
	disel fuel	150	150	140	150	150
	mazut	none	none	none	none	none
		actual		estimate		
12	Fuel consumption '95-'96					
	gas	none	none	none	none	none
	wood	none	none	none	none	none
	disel fuel	600	700	400	600	400
	mazut	none	none	none	none	none
13	Hours heat supplied per day '94-'95	3	3	3	3	3
14	Hours heat supplied per day '95-'96	none	none	none	none	none
15	Temperature of heat carrier (supply) '94-'95	no data	no data	no data	no data	no data
16	Temperature of heat carrier (return) '94-'95	no data	no data	no data	no data	no data
17	Temperature of heat carrier (supply) '95-'96	none	none	none	none	none
18	Temperature of heat carrier (return) '95-'96	none	none	none	none	none
19	Power consumption limit '94-'95	2000 kw/h	2000 kw/h	2000 kw/h	2000 kw/h	2000 kw/h
20	Power consumption limit '95-'96	2000 kw/h	2000 kw/h	2000 kw/h	2000 kw/h	2000 kw/h
21	Used power comparing to limit '94-'95	no data	15%	no data	30%	7%
22	Used power comparing to limit '95-'96	135%	65%	no data	60%	60%

School # 20 (Yerevan)

Armenia Weatherization Project
Monitoring Data Collected

	Parameter	front view	rear view	left view	right view	roof
1	Thickness of outside walls	900 mm	500 mm	500 mm	500 mm	300
2	Surface of glazing	237 sq.m	301 sq.m	147 sq.m	174 sq.m	none
3	Surface of building envelope	1455 sq.m	1339 sq.m	772 sq.m	772 sq.m	2465
4	Surface of windows covered w/ Astro-Foil	none	none	none	none	none
5	Surface of walls insulated	none	none	none	none	none
6	Thickness of insullation	none	none	none	none	none
7	Surface of glazing missing	80 sq.m	90 sq.m	40 sq.m	50 sq.m	
8	Orientation	W	E	N	S	
9	Number of windows	108	153	55	63	
10	Average size of windows	2.02 sq.m	1.92 sq.m	2.54 sq.m	2.63 sq.m	
11	Average perimeter of window	6.00 m	5.82 m	6.32 m	6.45 m	
12	Average size of gap between window sash and frame	5 mm	5 mm	5 mm	5 mm	
13	Average size of gap between window frame and building	6 mm	7 mm	5 mm	6 mm	
14	Number of exterior doors	3	5	4	4	
15	Average size of doors	6.28 sq.m	2.65 sq.m	4.2 sq.m	4.2 sq.m	
16	Average perimeter of doors	10.6 m	6.86 m	8.8 m	8.8 m	
17	Average size of gap between door sash and frame	8 mm	7 mm	7 mm	7 mm	
18	Average size of gap between door frame and building	8 mm	8 mm	8 mm	8 mm	

19	Building material	Tufa, concrete w/tufa plates
20	Number of existing glass panes	2
21	Type of the roof	hip-roof w/attic, flat roof
22	Number of floors	4
23	Total volume of the building	30,115 cub. m
24	Average size of the gaps around windows	6 mm
25	Heating system	district heating (back up: kerosene stoves)
26	Type of heating units	radiators (kerosene stoves)
27	Number of heating units	380 (12 in the year of 1993-94, and 24 in the year of 1994-95)
28	Efficiency of heating units	60% (20%)
29	R- Value of wall material	0.78
30	U- Value of wall material	1.3
31	R- Value of roof material	0.55
32	U- Value of roof material	1.8

33	Area of one floor	2,465 sq.m
34	Total floor area	12,325 sq. m
35	Total surface of the building	6,804 sq. m
36	Total surface area of exterior doors	67 sq.m
37	Total surface area of glass	859x2=1718 sq.m

Data Collected by: Hovik Chibukhchyan, Gagik Karapetyan
Data Provided by:
Date: Sept. 1995

Secondary School # 20

Typical Winter Data

Date / Time	Temperature non weatherized not in use t nw (C)	Temperature weatherized t w (C)	Temperature non weatherized in use t o (C)	Outside Temperature t o (C)	Infiltration per weatherized window L w (cub.m/h)	Infiltration per non weatherized window L nw (cub.m/h)	Air Density non weatherized room D nw kg / cub.m	Air Density weatherized room D w kg / cub.m	Air Density Outside Air D o kg / cub.m	Infiltration per weatherized window G w kg / hour	Infiltration per non weatherized per window G nw kg / hour	Temperature non weatherized absolute T nw (T)	Temperature weatherized absolute T w (T)	Outside Temperature absolute T o (T)	Inlet Air From One Broken Window Non weather V b cub.m/hour	Inlet Air Per Broken Window Non weather G b kg / hour
2/1/96 0:57	5	5	5	3.16	0.06	0.34	1.28	1.28	1.28	0.08	0.43	278	278	276.16	573.81	732.32
2/2/96 0:57	5	5	5	-0.01	0.04	0.34	1.28	1.28	1.30	0.06	0.44	278	278	272.99	946.84	1208.41
2/3/96 0:57	5	5	5	-4.71	0.04	0.25	1.28	1.28	1.32	0.06	0.33	278	278	268.29	1318.16	1682.30
2/4/96 0:57	5	5	5	-5.16	0.04	0.34	1.28	1.28	1.32	0.06	0.45	278	278	267.84	1348.36	1720.84
2/5/96 0:57	5	5	5	-4.71	0.06	0.34	1.28	1.28	1.32	0.08	0.44	278	278	268.29	1318.16	1682.30
2/6/96 0:57	5	5	5	-4.27	0.06	0.34	1.28	1.28	1.32	0.08	0.44	278	278	268.73	1287.95	1643.74
2/7/96 0:57	5	5	5	-0.83	0.05	0.34	1.28	1.28	1.30	0.07	0.44	278	278	272.17	1021.39	1303.55
2/8/96 0:57	18	18	18	0.38	0.05	0.34	1.21	1.21	1.30	0.07	0.44	291	291	273.38	1735.55	2107.83
2/9/96 0:57	18	18	18	3.16	0.05	0.25	1.21	1.21	1.28	0.07	0.32	291	291	276.16	1592.76	1934.41
2/10/96 0:57	18	18	18	5.84	0.04	0.25	1.21	1.21	1.27	0.06	0.32	291	291	278.84	1441.79	1751.05
2/11/96 0:57	18	18	18	4.7	0.03	0.20	1.21	1.21	1.28	0.04	0.26	291	291	277.7	1507.86	1831.29
2/12/96 0:57	18	18	18	3.93	0.03	0.20	1.21	1.21	1.28	0.04	0.26	291	291	276.93	1550.89	1883.56
2/13/96 0:57	18	18	18	2.77	0.02	0.25	1.21	1.21	1.29	0.03	0.32	291	291	275.77	1613.56	1959.66
2/14/96 0:57	18	18	18	4.32	0.02	0.25	1.21	1.21	1.28	0.03	0.32	291	291	277.32	1529.25	1857.27
2/15/96 0:57	18	18	18	3.16	0.01	0.08	1.21	1.21	1.28	0.02	0.10	291	291	276.16	1592.76	1934.41
2/16/96 0:57	18	18	18	3.93	0.04	0.08	1.21	1.21	1.28	0.05	0.10	291	291	276.93	1550.89	1883.56
2/17/96 0:57	18	18	18	4.7	0.02	0.06	1.21	1.21	1.28	0.02	0.07	291	291	277.7	1507.86	1831.29
2/18/96 0:57	18	18	18	5.84	0.02	0.06	1.21	1.21	1.27	0.02	0.07	291	291	278.84	1441.79	1751.05
2/19/96 0:57	18	18	18	5.08	0.02	0.14	1.21	1.21	1.28	0.02	0.18	291	291	278.08	1486.16	1804.94
2/20/96 0:57	18	18	18	6.59	0.02	0.17	1.21	1.21	1.27	0.02	0.21	291	291	279.59	1396.62	1696.19
2/21/96 0:57	18	18	18	5.84	0.03	0.20	1.21	1.21	1.27	0.03	0.26	291	291	278.84	1441.79	1751.05
2/22/96 0:57	18	18	18	6.96	0.03	0.17	1.21	1.21	1.27	0.03	0.21	291	291	279.96	1373.78	1668.46
2/23/96 0:57	18	18	18	5.84	0.02	0.14	1.21	1.21	1.27	0.02	0.18	291	291	278.84	1441.79	1751.05
2/24/96 0:57	18	18	18	5.84	0.03	0.14	1.21	1.21	1.27	0.03	0.18	291	291	278.84	1441.79	1751.05
2/25/96 0:57	18	18	18	5.08	0.03	0.13	1.21	1.21	1.28	0.04	0.17	291	291	278.08	1486.16	1804.94
2/26/96 0:57	18	18	18	8.07	0.03	0.14	1.21	1.21	1.26	0.04	0.18	291	291	281.07	1302.89	1582.36
2/27/96 0:57	18	18	18	4.7	0.03	0.13	1.21	1.21	1.28	0.04	0.16	291	291	277.7	1507.86	1831.29
2/28/96 0:57	18	18	18	5.46	0.03	0.11	1.21	1.21	1.27	0.03	0.14	291	291	278.46	1464.14	1778.20

2/29/96 0:57	18	18	18	2.38	0.03	0.11	1.21	1.21	1.29	0.03	0.15	291	291	275.38	1634.09	1984.60
3/1/96 0:57	18	18	18	2.38	0.02	0.10	1.21	1.21	1.29	0.03	0.13	291	291	275.38	1634.09	1984.60
3/2/96 0:57	18	18	18	2.77	0.02	0.10	1.21	1.21	1.29	0.03	0.13	291	291	275.77	1613.56	1959.66
3/3/96 0:57	18	18	18	4.32	0.03	0.10	1.21	1.21	1.28	0.03	0.13	291	291	277.32	1529.25	1857.27
3/4/96 0:57	18	18	18	4.7	0.02	0.09	1.21	1.21	1.28	0.03	0.12	291	291	277.7	1507.86	1831.29
3/5/96 0:57	18	18	18	5.46	0.03	0.13	1.21	1.21	1.27	0.04	0.16	291	291	278.46	1464.14	1778.20
3/6/96 0:57	18	18	18	6.59	0.03	0.13	1.21	1.21	1.27	0.04	0.16	291	291	279.59	1396.62	1696.19
3/7/96 0:57	18	18	18	7.7	0.03	0.13	1.21	1.21	1.26	0.04	0.16	291	291	280.7	1326.94	1611.57
3/8/96 0:57	18	18	18	8.8	0.03	0.13	1.21	1.21	1.26	0.03	0.16	291	291	281.8	1254.09	1523.09
3/9/96 0:57	18	18	18	6.96	0.03	0.09	1.21	1.21	1.27	0.03	0.11	291	291	279.96	1373.78	1668.46
3/10/96 0:57	18	18	18	7.33	0.03	0.09	1.21	1.21	1.27	0.04	0.11	291	291	280.33	1350.57	1640.26
3/11/96 0:57	18	18	18	8.43	0.03	0.09	1.21	1.21	1.26	0.03	0.11	291	291	281.43	1279.06	1553.42
3/12/96 0:57	18	18	18	8.8	0.03	0.11	1.21	1.21	1.26	0.03	0.14	291	291	281.8	1254.09	1523.09
3/13/96 0:57	18	18	18	8.8	0.03	0.09	1.21	1.21	1.26	0.03	0.11	291	291	281.8	1254.09	1523.09
3/14/96 0:57	18	18	18	8.8	0.03	0.09	1.21	1.21	1.26	0.03	0.11	291	291	281.8	1254.09	1523.09
3/15/96 0:57	18	18	18	10.24	0.02	0.10	1.21	1.21	1.25	0.02	0.12	291	291	283.24	1151.77	1398.82

Secondary School # 20

Calculations Based on Typical Winter Data

Date / Time	Heat losses per none weatherized window by infiltration per day Q inf. nw kcal day	Heat losses per none weatherized single pane window by transfere per day Q tr. nw1 kcal day	Heat losses per none weatherized double pane window by transfere per day Q tr. nw2 kcal day	Heat losses per broken window by inlet air per day Q b. nw kcal day	Heat losses from 66 non weatherized single pane windows per day Q nw 1 kcal day	Heat losses from 271 non weatherized double pane windows per day Q nw 2 kcal day	Heat losses from 42 broken windows per day Q b kcal day	Total heat losses from non weatherized building per day Q nw kcal day	Heat losses per weatherized window by infiltration per day Q inf. w kcal day	Heat losses per weatherized single pane window by transfere per day Q tr. w2 kcal day	Total heat losses from weatherized building per day Q nw kcal day	Energy savings in the period of monitoring per day delta Q kcal day	Conventional fuel saved in the perion of monitoring per day B kg/day	Money savings in the period of monitoring per day E $ / day
1-Feb-96	4.58	488.85	271.58	7761.46	32566.19	74839.34	325981.18	433386.71	0.82	488.85	209090.70	224296.00	45.77	4.81
2-Feb-96	12.61	1331.06	739.48	34871.70	88681.71	203814.08	1464611.29	1757107.07	1.64	1331.06	569060.98	1188046.09	242.46	25.46
3-Feb-96	18.64	2579.75	1433.20	94090.41	171493.78	393446.98	3951797.05	4516737.81	3.23	2579.75	1102933.90	3413803.92	696.69	73.15
4-Feb-96	26.04	2699.31	1499.62	100706.40	179873.30	413453.91	4229668.69	4822995.89	3.39	2699.31	1154050.57	3668945.32	748.76	78.62
5-Feb-96	24.85	2579.75	1433.20	94090.41	171903.82	395130.60	3951797.05	4518831.47	4.75	2579.75	1103581.93	3415249.53	696.99	73.18
6-Feb-96	23.69	2462.85	1368.25	87767.98	164111.67	377215.44	3686255.12	4227582.24	4.53	2462.85	1053571.04	3174011.20	647.76	68.01
7-Feb-96	14.71	1548.91	860.51	43774.31	103199.38	237184.78	1838521.11	2178905.26	2.39	1548.91	662408.07	1516497.20	309.49	32.50
8-Feb-96	44.27	4681.28	2600.71	213925.73	311886.39	716790.07	8984880.63	10013557.09	7.20	4681.28	2001981.26	8011575.83	1635.02	171.68
9-Feb-96	27.68	3942.69	2190.38	165350.31	262044.46	601095.18	6944713.07	7807852.71	6.00	3942.69	1686091.82	6121760.89	1249.34	131.18
10-Feb-96	22.46	3230.67	1794.82	122646.32	214706.24	492480.71	5151145.51	5858332.46	3.89	3230.67	1381157.62	4477174.84	913.71	95.94
11-Feb-96	19.73	3533.54	1963.08	140291.59	234516.26	537342.22	5892246.64	6664105.12	3.21	3533.54	1510192.49	5153912.63	1051.82	110.44
12-Feb-96	20.93	3738.12	2076.73	152649.47	248097.46	568467.70	6411277.90	7227843.06	3.40	3738.12	1597628.83	5630214.23	1149.02	120.65
13-Feb-96	28.45	4046.31	2247.95	171911.14	268933.78	616903.26	7220267.88	8106104.91	2.57	4046.31	1728869.94	6377234.97	1301.48	136.66
14-Feb-96	25.41	3634.50	2019.17	146346.83	241553.98	554079.65	6146566.74	6942200.37	2.29	3634.50	1552912.34	5389288.04	1099.85	115.48
15-Feb-96	8.86	3942.69	2190.38	165350.31	260802.21	595994.42	6944713.07	7801509.70	1.61	3942.69	1684216.37	6117293.33	1248.43	131.08
16-Feb-96	8.37	3738.12	2076.73	152649.47	247268.44	565063.71	6411277.90	7223610.04	4.28	3738.12	1598004.68	5625605.36	1148.08	120.55
17-Feb-96	5.64	3533.54	1963.08	140291.59	233586.01	533522.55	5892246.64	6659355.19	1.59	3533.54	1509504.04	5149851.15	1050.99	110.35
18-Feb-96	5.13	3230.67	1794.82	122646.32	213562.91	487786.13	5151145.51	5852494.54	1.63	3230.67	1380190.53	4472304.01	912.72	95.84
19-Feb-96	13.67	3432.59	1906.99	134322.24	227453.05	520500.13	5641534.21	6389487.39	1.74	3432.59	1466457.10	4923030.29	1004.70	105.49
20-Feb-96	14.01	3031.41	1684.12	111476.32	200997.51	460191.60	4682005.53	5343194.63	1.60	3031.41	1295095.15	4048099.49	826.14	86.74
21-Feb-96	17.96	3230.67	1794.82	122646.32	214409.82	491263.60	5151145.51	5856818.93	2.25	3230.67	1380454.45	4476364.48	913.54	95.92
22-Feb-96	13.53	2933.11	1629.50	106098.14	194478.38	445263.56	4456121.93	5095863.87	2.03	2933.11	1253303.69	3842560.18	784.20	82.34
23-Feb-96	12.83	3230.67	1794.82	122646.32	214071.05	489872.61	5151145.51	5855089.17	1.39	3230.67	1380089.16	4475000.01	913.27	95.89
24-Feb-96	12.83	3230.67	1794.82	122646.32	214071.05	489872.61	5151145.51	5855089.17	2.45	3230.67	1380541.62	4474547.55	913.17	95.88
25-Feb-96	12.31	3432.59	1906.99	134322.24	227362.81	520129.60	5641534.21	6389026.62	2.83	3432.59	1466921.50	4922105.11	1004.51	105.47
26-Feb-96	10.39	2638.20	1465.67	90506.14	174807.20	400012.13	3801257.84	4376077.16	2.15	2638.20	1127430.11	3248647.05	662.99	69.61
27-Feb-96	12.33	3533.54	1963.08	140291.59	234027.88	535336.89	5892246.64	6661611.40	2.69	3533.54	1509972.27	5151639.14	1051.35	110.39
28-Feb-96	10.44	3331.63	1850.90	128440.05	220576.16	504423.08	5394482.15	6119481.38	2.42	3331.63	1423638.11	4695843.28	958.34	100.63
29-Feb-96	13.15	4149.92	2305.51	178556.52	274762.61	628356.92	7499373.78	8402493.30	2.92	4149.92	1773264.14	6629229.16	1352.90	142.05
1-Mar-96	11.69	4149.92	2305.51	178556.52	274666.19	627961.01	7499373.78	8402000.98	2.79	4149.92	1773209.90	6628791.08	1352.81	142.05
2-Mar-96	11.38	4046.31	2247.95	171911.14	267807.24	612277.65	7220267.88	8100352.77	2.61	4046.31	1728886.33	6371466.44	1300.30	136.53
3-Mar-96	10.16	3634.50	2019.17	146346.83	240547.89	549948.58	6146566.74	6937063.21	2.65	3634.50	1553064.54	5383998.66	1098.78	115.37
4-Mar-96	8.88	3533.54	1963.08	140291.59	233799.96	534401.07	5892246.64	6660447.67	2.06	3533.54	1509700.98	5150746.69	1051.17	110.37
5-Mar-96	11.60	3331.63	1850.90	128440.05	220652.69	504737.31	5394482.15	6119872.15	3.01	3331.63	1423892.13	4695980.02	958.36	100.63
6-Mar-96	10.51	3031.41	1684.12	111476.32	200766.38	459242.56	4682005.53	5342014.46	2.73	3031.41	1295577.93	4046436.53	825.80	86.71
7-Mar-96	9.44	2736.50	1520.28	95611.47	181232.60	414555.34	4015681.80	4611469.75	2.46	2736.50	1169535.74	3441934.01	702.44	73.76
8-Mar-96	8.40	2444.26	1357.92	80711.59	161875.36	370272.99	3389886.81	3922035.16	1.83	2444.26	1044479.98	2877555.18	587.26	61.66
9-Mar-96	7.31	2933.11	1629.50	106098.14	194067.46	443576.29	4456121.93	5093765.68	2.12	2933.11	1253341.38	3840424.30	783.76	82.29

10-Mar-96	7.05	2834.81	1574.89	100809.35	187562.74	428707.40	4233992.50	4850262.65	2.32	2834.81	1211450.82	3638811.83	742.61	77.97
11-Mar-96	5.95	2542.56	1412.53	85629.24	168201.55	384408.82	3596427.93	4149038.30	1.91	2542.56	1086487.38	3062550.93	625.01	65.63
12-Mar-96	7.56	2444.26	1357.92	80711.59	161819.91	370045.32	3389886.81	3921752.04	1.68	2444.26	1044414.76	2877337.29	587.21	61.66
13-Mar-96	5.71	2444.26	1357.92	80711.59	161697.93	369544.45	3389886.81	3921129.19	1.75	2444.26	1044445.95	2876683.24	587.08	61.64
14-Mar-96	5.71	2444.26	1357.92	80711.59	161697.93	369544.45	3389886.81	3921129.19	1.68	2444.26	1044414.76	2876714.44	587.08	61.64
15-Mar-96	5.45	2061.68	1145.38	62524.00	136430.23	311873.26	2626007.96	3074311.45	1.09	2061.68	880799.33	2193512.12	447.66	47.00
								247983389.33	115.58	135730.60	58006316.30	189977073.03	38770.83	4070.94

Energy Saved for the period of monitoring:

Delta Q=189977073 kcal / 44 days

189977073

Conventional Fuel Saved for the period of monitoring:

B=38770.8 kg / 44 days

38770.83

Money Savings:

E=4,071 $/ 44 days

$4,071

Payback Period:

Z=3.56 x 44 days = 156.6 days

3.5638427

Energy, Fuel, Money Savings Percent:

Ratio = 76.6%

76.6088

Secondary School # 20

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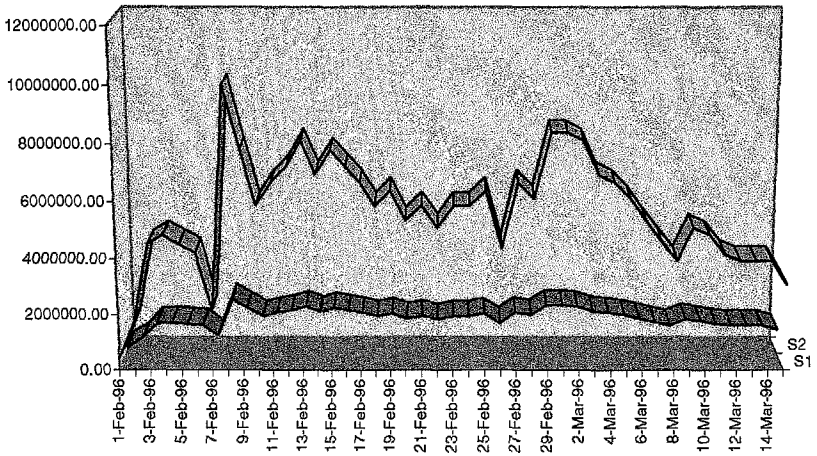
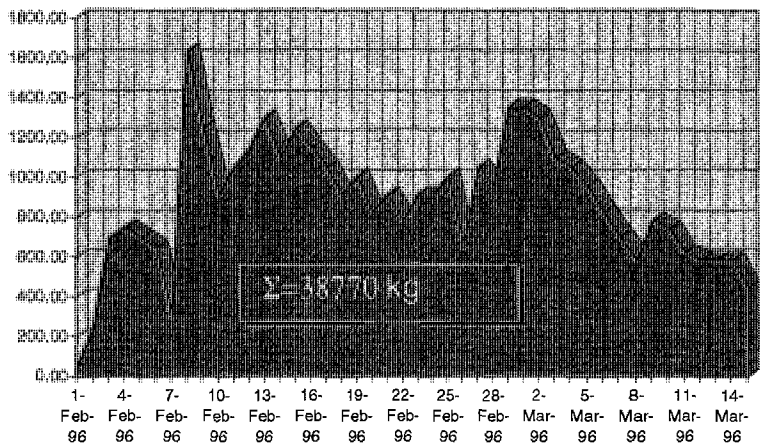
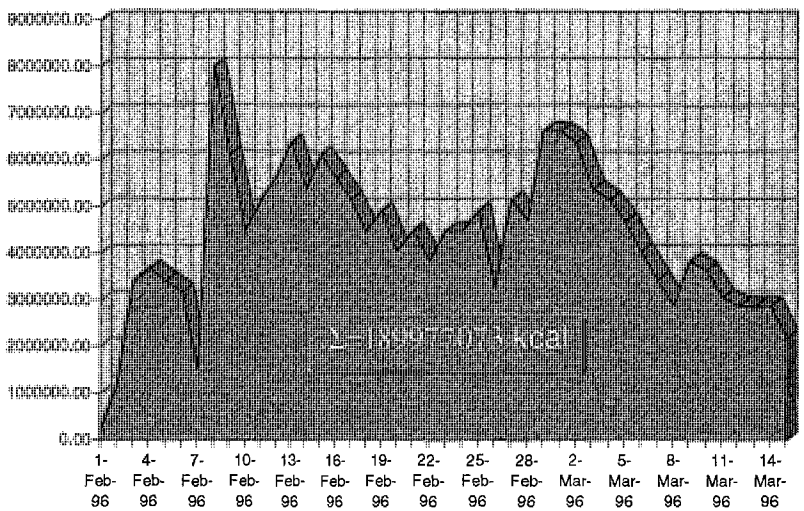
Heat Losses From the Weatherized and Non Weatherized Building



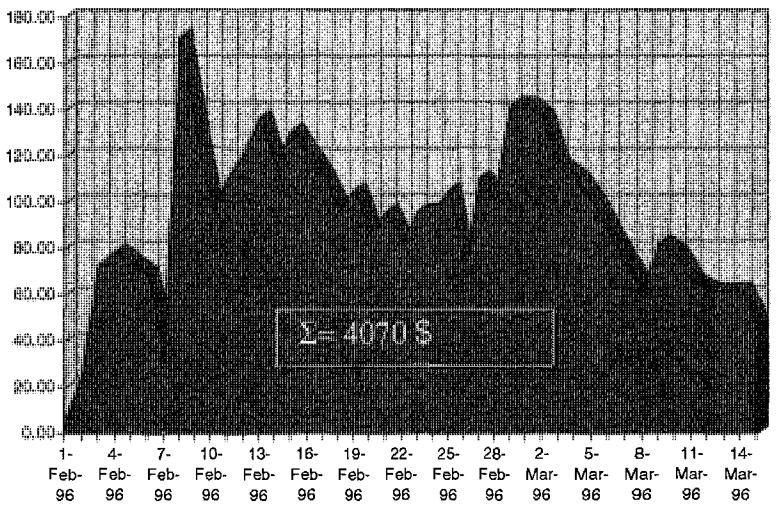
Conventional Fuel Savings



Energy Savings



Money Saving



Secondary School # 20

Actual Data for Winter '96

Date / Time	Temperature non weatherized not in use t nw (C)	Temperature weatherized t w (C)	Temperature non weatherized in use t o (C)	Outside Temperature t o (C)	Infiltration per weatherized window L w (cub.m/h)	Infiltration per non weatherized window L nw (cub.m/h)	Air Density non weatherized room D nw kg / cub.m	Air Density weatherized room D w kg / cub.m	Air Density Outside Air D o kg / cub.m	Infiltration per weatherized window G w kg / hour	Infiltration per non weatherized per window G nw kg / hour	Temperature non weatherized absolute T nw (T)	Temperature weatherized absolute T w (T)	Outside Temperature absolute T o (T)	Inlet Air From One Broken Window Non weather V b cub.m/hour	Inlet Air Per Broken Window Non weather G b kg / hour
2/1/96 0:57	3.86	5.89	4.39	3.16	0.0604	0.336	1.28	1.27	1.28	0.08	0.43	277.39	278.89	277.39	517.26	662.96
2/2/96 0:57	2.13	4.76	2.85	-0.01	0.04368	0.336	1.29	1.28	1.30	0.06	0.44	275.85	277.76	275.85	584.87	754.42
2/3/96 0:57	-1.23	4.19	-0.68	-4.71	0.04368	0.252	1.31	1.28	1.32	0.06	0.33	272.32	277.19	272.32	934.88	1220.81
2/4/96 0:57	-1.38	4.01	-0.98	-5.16	0.04368	0.336	1.31	1.28	1.32	0.06	0.45	272.02	277.01	272.02	946.64	1236.83
2/5/96 0:57	-1.21	4.38	-0.78	-4.71	0.0642	0.336	1.31	1.28	1.32	0.08	0.44	272.22	277.38	272.22	961.98	1256.11
2/6/96 0:57	-1.02	4.49	-0.53	-4.27	0.0642	0.336	1.30	1.28	1.32	0.08	0.44	272.47	277.49	272.47	948.66	1237.85
2/7/96 0:57	0.79	4.92	1.38	-0.83	0.05464	0.336	1.30	1.28	1.30	0.07	0.44	274.38	277.92	274.38	796.02	1031.84
2/8/96 0:57	1.81	5.34	2.35	0.38	0.05464	0.336	1.29	1.27	1.30	0.07	0.44	275.35	278.34	275.35	731.02	944.04
2/9/96 0:57	4.35	7.83	4.73	3.16	0.05464	0.252	1.28	1.26	1.28	0.07	0.32	277.73	280.83	277.73	741.04	948.04
2/10/96 0:57	6.46	10.24	6.64	5.84	0.04368	0.252	1.27	1.25	1.27	0.06	0.32	279.64	283.24	279.64	795.16	1009.31
2/11/96 0:57	5.32	9.84	9.04	4.7	0.03276	0.2016	1.27	1.25	1.28	0.04	0.26	282.04	282.84	282.04	375.11	478.16
2/12/96 0:57	5.21	12.89	8.92	3.93	0.03276	0.2016	1.28	1.24	1.28	0.04	0.26	281.92	285.89	281.92	831.14	1059.92
2/13/96 0:57	3.82	14.61	7.87	2.77	0.02276	0.252	1.28	1.23	1.29	0.03	0.32	280.87	287.61	280.87	1079.71	1384.04
2/14/96 0:57	4.69	17.59	9.64	4.32	0.02276	0.252	1.28	1.22	1.28	0.03	0.32	282.64	290.59	282.64	1166.61	1490.60
2/15/96 0:57	4.86	19.21	9.58	3.16	0.01465264	0.08064	1.28	1.21	1.28	0.02	0.10	282.58	292.21	282.58	1280.40	1634.96
2/16/96 0:57	5.67	20.68	9.86	3.93	0.041236364	0.08064	1.27	1.20	1.28	0.05	0.10	282.86	293.68	282.86	1353.81	1723.49
2/17/96 0:57	6.59	22.57	11.08	4.7	0.016288	0.0576	1.27	1.19	1.28	0.02	0.07	284.08	295.57	284.08	1390.63	1764.28
2/18/96 0:57	7.73	23.08	11.67	5.84	0.018264	0.0576	1.26	1.19	1.27	0.02	0.07	284.67	296.08	284.67	1384.58	1749.12
2/19/96 0:57	7.26	21.31	10.84	5.08	0.018327273	0.144	1.27	1.20	1.28	0.02	0.18	283.84	294.31	283.84	1330.31	1683.52
2/20/96 0:57	8.08	21.35	12.06	6.59	0.0192	0.168	1.26	1.20	1.27	0.02	0.21	285.06	294.35	285.06	1253.02	1580.83
2/21/96 0:57	7.38	19.34	11.38	5.84	0.0252	0.2016	1.26	1.21	1.27	0.03	0.26	284.38	292.34	284.38	1163.84	1472.19
2/22/96 0:57	8.64	20.36	12.83	6.96	0.0252	0.168	1.26	1.20	1.27	0.03	0.21	285.83	293.36	285.83	1130.00	1422.62
2/23/96 0:57	8.35	20.73	12.23	5.84	0.0156	0.144	1.26	1.20	1.27	0.02	0.18	285.23	293.73	285.23	1199.82	1512.18
2/24/96 0:57	8.4	21.82	11.94	5.84	0.027490909	0.144	1.26	1.20	1.27	0.03	0.18	284.94	294.82	284.94	1291.16	1626.99
2/25/96 0:57	6.31	21.74	11.02	5.08	0.029781818	0.1296	1.27	1.20	1.28	0.04	0.17	284.02	294.74	284.02	1345.11	1708.33
2/26/96 0:57	8.73	23.81	11.86	8.07	0.029781818	0.144	1.26	1.19	1.26	0.04	0.18	284.86	296.81	284.86	1415.22	1781.11
2/27/96 0:57	7.05	22.79	10.53	4.7	0.027490909	0.126	1.27	1.19	1.28	0.04	0.16	283.53	295.79	283.53	1435.93	1818.63
2/28/96 0:57	7.39	20.46	10.94	5.46	0.026295652	0.1134	1.26	1.20	1.27	0.03	0.14	283.94	293.46	283.94	1270.35	1606.87
2/29/96 0:57	4.92	20.16	10.35	2.38	0.0252	0.1134	1.28	1.20	1.29	0.03	0.15	283.35	293.16	283.35	1290.22	1647.13
3/1/96 0:57	4.98	21.82	9.00	2.38	0.024104348	0.1008	1.28	1.20	1.29	0.03	0.13	282	294.82	282	1470.77	1877.22
3/2/96 0:57	5.11	22.97	9.00	2.77	0.0231	0.1008	1.28	1.19	1.29	0.03	0.13	282	295.97	282	1532.34	1954.85
3/3/96 0:57	6.59	23.03	11.00	4.32	0.026295652	0.1008	1.27	1.19	1.28	0.03	0.13	284	296.03	284	1421.82	1803.86
3/4/96 0:57	7.05	21.97	11.00	4.7	0.021	0.09072	1.27	1.20	1.28	0.03	0.12	284	294.97	284	1360.18	1722.68
3/5/96 0:57	7.94	22.05	11.96	5.46	0.03276	0.126	1.26	1.20	1.27	0.04	0.16	284.96	295.05	284.96	1304.30	1646.40

3/6/96 0:57	8.82	19.86	12.67	6.59	0.03276	0.126	1.26	1.21	1.27	0.04	0.16	285.67	292.86	285.67	1105.13	1390.38
3/7/96 0:57	9.67	20.34	13.84	7.7	0.03276	0.126	1.25	1.20	1.26	0.04	0.16	286.84	293.34	286.84	1049.91	1316.66
3/8/96 0:57	10.72	21.54	14.35	8.8	0.027490909	0.126	1.25	1.20	1.26	0.03	0.16	287.35	294.54	287.35	1101.98	1376.46
3/9/96 0:57	9.61	21.25	13.05	6.96	0.026295652	0.09072	1.25	1.20	1.27	0.03	0.11	286.05	294.25	286.05	1177.41	1476.89
3/10/96 0:57	9.81	21.35	13.28	7.33	0.029781818	0.09072	1.25	1.20	1.27	0.04	0.11	286.28	294.35	286.28	1167.85	1463.78
3/11/96 0:57	10.23	23.2	14.36	8.43	0.027490909	0.08568	1.26	1.19	1.26	0.03	0.11	287.36	296.2	287.36	1218.47	1524.80
3/12/96 0:57	10.28	23.56	14.49	8.8	0.0252	0.1134	1.25	1.19	1.26	0.03	0.14	287.49	296.56	287.49	1233.47	1543.28
3/13/96 0:57	10.21	23.31	14.48	8.8	0.026295652	0.08568	1.25	1.19	1.26	0.03	0.11	287.48	296.31	287.48	1217.55	1523.77
3/14/96 0:57	11.49	24.06	15.35	8.8	0.0252	0.08568	1.25	1.19	1.26	0.03	0.11	288.35	297.06	288.35	1207.72	1504.13
3/15/96 0:57	12.17	23.36	16.17	10.24	0.0194	0.0974	1.24	1.19	1.25	0.02	0.12	289.17	296.36	289.17	1098.59	1364.66

Secondary School # 20

Calculations Based on Actual Data - Winter '96

Date / Time	Heat losses per none weatherized window by infiltration per day Q inf. nw kcal day	Heat losses per none weatherized single pane window by transfere per day Q tr. nw1 kcal day	Heat losses per none weatherized double pane window by transfere per day Q tr. nw2 kcal day	Heat losses per broken window by inlet air per day Q b. nw kcal day	Heat losses from 73 non weatherized single pane windows per day Q nw 1 kcal day	Heat losses from 160 non weatherized double pane windows per day Q nw 2 kcal day	Heat losses from 36 broken windows per day Q b kcal day	Total heat losses from non weatherized building per day Q nw kcal day	Heat losses per weatherized window by infiltration per day Q inf. w kcal day	Heat losses per weatherized single pane window by transfere per day Q tr. w2 kcal day	Total heat losses from weatherized building per day Q tw kcal day	Energy savings in the period of monitoring per day delta Q kcal day	Conventional fuel saved in the perion of monitoring per day B kg/day	Money savings in the period of monitoring per day E $ / day
1-Feb-96	3.06	326.79	181.55	4696.91	21769.79	50028.47	197270.08	269068.35	0.55	326.79	139772.59	129295.76	26.39	2.77
2-Feb-96	7.20	759.84	422.14	12428.00	50624.69	116348.95	521975.89	688949.54	0.94	759.84	324853.18	364096.36	74.31	7.80
3-Feb-96	7.74	1070.69	594.83	28338.36	71176.10	163294.68	1190211.05	1424681.83	1.34	1070.69	457757.32	966924.51	197.33	20.72
4-Feb-96	10.72	1110.54	616.97	29778.97	74002.99	170102.10	1250716.73	1494821.82	1.39	1110.54	474796.40	1020025.42	208.17	21.86
5-Feb-96	10.06	1044.12	580.07	28434.28	69575.90	159924.12	1194239.59	1423739.61	1.92	1044.12	446660.87	977078.75	199.40	20.94
6-Feb-96	9.56	993.64	552.02	26666.24	66211.18	152188.32	1119982.27	1338381.78	1.83	993.64	425065.34	913316.44	186.39	19.57
7-Feb-96	5.58	587.15	326.20	13134.85	39120.18	89910.52	551663.65	680694.35	0.91	587.15	251101.51	429592.84	87.67	9.21
8-Feb-96	4.95	523.39	290.77	10712.20	34870.39	80140.55	449912.50	564923.44	0.80	523.39	223831.05	341092.39	69.61	7.31
9-Feb-96	2.93	417.12	231.73	8573.28	27723.03	63592.95	360077.77	451393.76	0.63	417.12	178380.33	273013.42	55.72	5.85
10-Feb-96	1.48	212.54	118.08	4650.89	14125.41	32400.05	195337.57	241863.03	0.26	212.54	90865.63	150997.40	30.82	3.24
11-Feb-96	6.44	1153.05	640.58	11953.24	76526.36	175343.25	502036.10	753905.71	1.05	1153.05	492799.65	261106.06	53.29	5.60
12-Feb-96	7.42	1325.74	736.52	30464.61	87989.08	201610.08	1279513.67	1569112.83	1.21	1325.74	566607.52	1002505.31	204.59	21.48
13-Feb-96	9.53	1354.97	752.76	40657.45	90056.62	206579.55	1707613.05	2004249.22	0.86	1354.97	578938.72	1425310.50	290.88	30.54
14-Feb-96	9.88	1413.42	785.23	45676.68	93937.66	215475.42	1918420.64	2227833.72	0.89	1413.42	603910.35	1623923.36	331.41	34.80
15-Feb-96	3.83	1705.67	947.59	60459.67	112826.83	257835.86	2539306.09	2909968.78	0.70	1705.67	728616.52	2181352.27	445.17	46.74
16-Feb-96	3.53	1575.48	875.27	58868.87	104214.77	238154.07	2472492.60	2814861.44	1.80	1575.48	673501.62	2141359.82	437.01	45.89
17-Feb-96	2.70	1695.04	941.69	64835.33	112051.03	255930.37	2723083.96	3091065.36	0.76	1695.04	724107.95	2366957.40	483.05	50.72
18-Feb-96	2.46	1548.91	860.51	58736.82	102390.77	233864.56	2466946.62	2803201.95	0.78	1548.91	661719.64	2141482.31	437.04	45.89
19-Feb-96	6.10	1530.32	850.18	55855.22	101403.22	232049.59	2345919.16	2679371.97	0.78	1530.32	653776.54	2025595.43	413.39	43.41
20-Feb-96	6.72	1453.27	807.37	49807.51	96359.02	220617.71	2091915.60	2408892.33	0.77	1453.27	620873.83	1788018.49	364.90	38.31
21-Feb-96	8.18	1471.87	817.70	46978.26	97683.42	223815.82	1973087.07	2294586.31	1.02	1471.87	628924.15	1665662.16	339.93	35.69
22-Feb-96	7.20	1559.54	866.41	48100.57	103404.72	236747.92	2020223.90	2360376.54	1.08	1559.54	666385.20	1693991.34	345.71	36.30
23-Feb-96	6.74	1697.70	943.16	55657.82	112492.93	257424.83	2337628.31	2707546.07	0.73	1697.70	725227.78	1982318.29	404.55	42.48
24-Feb-96	6.44	1620.65	900.36	57166.02	107387.62	245742.02	2400973.01	2754102.65	1.23	1620.65	692541.44	2061561.21	420.73	44.18
25-Feb-96	5.66	1578.14	876.74	58449.47	104530.58	239130.79	2454877.66	2798539.03	1.30	1578.14	674420.57	2124118.46	433.49	45.52
26-Feb-96	3.97	1006.93	559.40	38882.26	66718.96	152673.31	1633054.82	1852447.09	0.82	1006.93	430308.17	1422138.92	290.23	30.47
27-Feb-96	5.41	1548.91	860.51	61070.95	102585.15	234662.71	2564979.85	2902227.71	1.18	1548.91	661890.10	2240337.62	457.21	48.01
28-Feb-96	4.56	1455.93	808.85	50720.44	96392.13	220433.69	2130258.67	2447084.49	1.06	1455.93	622132.12	1824952.37	372.44	39.11
29-Feb-96	6.71	2117.47	1176.37	75615.12	140195.77	320614.89	3175835.11	3636645.77	1.49	2117.47	904796.11	2731849.67	557.52	58.54
1-Mar-96	4.95	1758.80	977.11	71580.50	116407.82	266139.69	3006381.18	3388928.68	1.18	1758.80	751514.05	2637414.63	538.25	56.52
2-Mar-96	4.65	1655.19	919.55	70149.32	109549.52	250458.95	2946271.41	3306279.87	1.07	1655.19	707220.08	2599059.79	530.42	55.69
3-Mar-96	4.96	1774.74	985.97	69406.90	117460.52	268542.14	2915089.74	3301092.40	1.29	1774.74	758367.77	2542724.62	518.92	54.49
4-Mar-96	4.21	1673.78	929.88	62512.60	110747.35	253137.35	2625529.19	2989413.89	0.97	1673.78	715121.52	2274292.37	464.14	48.73
5-Mar-96	6.01	1726.92	959.40	61641.29	114373.40	261626.20	2588934.02	2964933.62	1.56	1726.92	738062.11	2226871.51	454.46	47.72
6-Mar-96	5.60	1615.33	897.41	48692.05	106981.56	244714.70	2045065.94	2396762.19	1.46	1615.33	690369.31	1706392.88	348.24	36.57
7-Mar-96	5.63	1631.28	906.26	46565.41	108035.75	247123.28	1955747.35	2310906.37	1.46	1631.28	697179.56	1613726.82	329.33	34.58

10-Mar-96	3.93	1580.80	878.22	50166.69	104592.16	239063.64	2107000.80	2450656.60	1.29	1580.80	675551.30	1775105.30	362.27	38.04
11-Mar-96	3.69	1575.48	875.27	52082.30	104225.20	238196.90	2187456.79	2529878.89	1.18	1575.48	673236.17	1856642.72	378.91	39.79
12-Mar-96	4.68	1511.72	839.84	50580.03	100082.10	228864.99	2124361.28	2453308.37	1.04	1511.72	645947.82	1807360.54	368.85	38.73
13-Mar-96	3.53	1509.06	838.37	49852.90	99830.90	228153.53	2093821.65	2421806.08	1.08	1509.06	644831.85	1776974.23	362.65	38.08
14-Mar-96	4.07	1740.20	966.78	56747.68	115121.90	263099.58	2383402.70	2761624.19	1.20	1740.20	743577.90	2018046.29	411.85	43.24
15-Mar-96	4.16	1575.48	875.27	46612.39	104256.60	238325.83	1957720.46	2300302.89	0.83	1575.48	673085.05	1627217.84	332.09	34.87
								95867204.55	47.97	60280.14	25760101.84	70107102.71	14307.57	1502.30

Energy Saved for the period of monitoring:

Delta Q=1627218 kcal / 44 days

Conventional Fuel Saved for the period of monitoring:

B=14307.57 kg / 44 days

Money Savings:

E=1,502 $/ 44 days

Payback Period:

Z=9.65 x 44 days = 424.6 days

Energy, Fuel, Money Savings Percent:

Ratio = 73.13%

Appendix B
Survey Forms (English and Russian)

Armenia Weatherization Program
Customer Satisfaction Survey

We are conducting this survey to assist the funding agency in evaluating the results and impacts of the weatherization program. Your opinion will also be used to help improve the quality of the service which is provided. Your responses will be kept strictly confidential and only used in the evaluation. You will not be identified as a respondent at any time.

Date of conducting of the survey

1. Background Information

1.1. Indicate type of organization

_____ School _____ Hospital _____ Refugee Center

_____ Housing _____ Commercial

1.2. Indicate Months of Operation:

_____ All year _____ Part year (from _____ to _____)

1.3. Which of the following best describes your position:

_____ Administration
_____ Building Maintenance/ Manager
_____ Employee of Organization (Doctor, Nurse, Teacher)
_____ Client (Patient, Parent, Refugee)

1.4. How long have you been employed/resident at the hospital/school/refugee center?

_____ Years _____ Months

2. Impact of Weatherization

2.1. Has weatherization been conducted in your building?

_____ Yes _____ No _____ I do not know

2.2. If yes, which of the following was done at your building? (Check all that respondent mentions)

_____ Caulking windows _____ Weatherstripping
_____ Replacing doors _____ Rebuilding window frames
_____ Door thresholds _____ General maintenance
_____ Replacing windows _____ Painting
_____ Replacing glass _____ Other

2.3. If no, do you know what weatherization involves? (Check all that respondent mentions)

_____	Caulking Windows	_____	Weatherstripping
_____	Replacing doors	_____	Rebuilding window frames
_____	Door thresholds	_____	General maintenance
_____	Replacing windows	_____	Painting
_____	Replacing glass	_____	Other

3. Possible Impacts of Weatherization

Please, rate on a scale of 1 to 5 (1 strongly disagree, 3 - indifferent, 5 strongly agree) the following (* - hospitals only):

3.1. * The rate of complications caused by the cold (including those of the post operational period) has been reduced as a result of the weatherization.

1 2 3 4 5 _____ no opinion

3.2. Employees are more productive due to more comfortable working conditions.

1 2 3 4 5 _____ no opinion

3.3. The noise level in the building has been reduced.

1 2 3 4 5 _____ no opinion

3.4. Weatherization has saved energy.

1 2 3 4 5 _____ no opinion

3.5. The building is more attractive after weatherization.

1 2 3 4 5 _____ no opinion

3.6. Security in the building has increased due to the weatherization.

1 2 3 4 5 _____ no opinion

3.7. There has been a reduction in the level of dust due to weatherization.

1 2 3 4 5 _____ no opinion

If rating is 1 or 2, then
Do you have a solution to that problem

_____ Yes _____ No

3.8. Occupants of the building have complained less of noise since the weatherization.

1 2 3 4 5 _____ no opinion

3.9. Weatherization has resulted in a better working environment.

1 2 3 4 5 _____ no opinion

3.10. Weatherization has resulted in increased moisture problems.

1 2 3 4 5 _____ no opinion

If rating is 4 or 5, then

Do you have a solution to that problem

_____ Yes _____ No

3.11. Weatherization has made the indoor air quality poorer.

1 2 3 4 5 _____ no opinion

If rating is 4 or 5, then

Do you have a solution to that problem

_____ Yes _____ No

3.12. Weatherization is very important for keeping a building in a good shape.

1 2 3 4 5 _____ no opinion

3.13. Weatherization has reduced the number of sick days by employees.

1 2 3 4 5 _____ no opinion

3.14. The work of the hospital/school was significantly disrupted due to the weatherization work.

1 2 3 4 5 _____ no opinion

If rating is 4 or 5, then

Do you have a solution to that problem

_____Yes _____ No

3.15. The indoor air quality is better because of weatherization.

1 2 3 4 5 _____ no opinion

3.16. The building is more energy efficient after weatherization.

1 2 3 4 5 _____ no opinion

3.17. The building could be made more energy efficient with additional work.

1 2 3 4 5 _____ no opinion

3.18. * The number of patient days has decreased due to weatherization (estimate % decrease)

1 2 3 4 5 _____ no opinion

3.19. The number of days the school could remain open in the winter increased due to weatherization.(estimate the number of days)

1 2 3 4 5 _____ no opinion

3.20. * The level of infection has decreased.

1 2 3 4 5 _____ no opinion

4. Quality of the Weatherization Work

Please rate on a scale of 1 to 5 (1 strongly disagree to 5 strongly agree) the following:

4.1. RMA was very easy to work with.

4.2. The workers who performed the work were highly skilled.

4.3. RMA was responsive to problems which came up during the work.

4.4. RMA uses high quality materials in the weatherization work.

4.5. Overall rating of the quality of the work. (5 is excellent, 1 is poor).
If rating is 4 or 5 , then
I will expect higher quality work in the future because RMA' s work has shown it is possible.
____ Yes _____ No

5. Other Questions

5.1. What do you think the cost is per window to weatherize?
<$25 $26-50 $51-75 $76-100 >$100

5.2. Per door?
<$25 $26-50 $51-75 $76-100 >$100

5.3. How did you become aware of the weatherization work?
_____ Contacted by RMA
_____ Contacted by other school/hospital
_____ Saw the work being done
_____ Was told by someone in the building

5.4. Did you share the cost of weatherization?
_____Yes _____ No

5.5. What is your estimate of energy savings possible from weatherization?

_____ Less than 5% _____ 10-15% _____ More than 20%
_____ 5-10% _____ 15-20%

6. Comments of Respondents

Armenia Weatherization Program
Customer Satisfaction Survey
(For non-participants)

We are conducting this survey to assist the funding agency in evaluating the impacts of the weatherization program. This program has been implementing in Armenia since 1993 and we believe that the public awareness of weatherization is being spread out. In order to evaluate it we are conducting a survey among non-participants as well. Your responses will be kept strictly confidential and only used in the evaluation. You will not be identified as a respondent at any time.

Date of conducting of the survey

1. Background Information

1.1. Indicate type of organization

_____ School _____ Hospital _____ Refugee Center

_____ Housing _____ Commercial

1.2. Indicate Months of Operation:
_____ All year _____ Part year (from _____ to _____)

1.3. Which of the following best describes your position:

_____ Administration
_____ Building Maintenance/ Manager
_____ Employee of Organization (Doctor, Nurse, Teacher)
_____ Client (Patient, Parent, Refugee)

1.4. How long have you been employed/resident at the hospital/school/refugee center?

_____ Years _____ Months

2. Impact of Weatherization

2.1. Do you know what weatherization involves? (Check all that respondent mentions)

_____ Caulking Windows _____ Weatherstripping
_____ Replacing doors _____ Rebuilding window frames
_____ Door thresholds _____ General Maintenance
_____ Replacing windows _____ Painting
_____ Replacing Glass _____ Other

3. Possible Impacts of Weatherization

Do you think that (* - hospitals only):

3.1. * The rate of complications caused by the cold (including those of the post operational period) will be reduced as a result of the weatherization.
_____Yes _____ No _____ No opinion

3.2. Employees will be more productive due to more comfortable working conditions.
_____ Yes _____ No _____ No opinion

3.3. The noise level in the building will be reduced.
_____ Yes _____ No _____ No opinion

3.4. Weatherization will save energy.
_____ Yes _____ No _____ No opinion

3.5. The building will be more attractive after weatherization.
_____ Yes _____ No _____ No opinion

3.6. Security in the building will increase due to the weatherization.
_____ Yes _____ No _____ No opinion

3.7. There will be a reduction in the level of dust due to weatherization.
_____ Yes _____ No _____ No opinion
If "No", then
Do you have a solution to the problem
_____ Yes _____ No

3.8. Occupants of the building will complain less of noise since the weatherization.
_____ Yes _____ No _____ No opinion

3.9. Weatherization will result in a better working environment.
_____ Yes _____ No _____ No opinion

3.10. Weatherization will result in increased moisture problems.
_____ Yes _____ No _____ No opinion
If "Yes", then
Do you have a solution to the problem
_____ Yes _____ No

3.11. Weatherization will make the indoor air quality poorer.
_____ Yes _____ No _____ No opinion
If "Yes",

Do you have a solution to the problem
_____ Yes _____ No

3.12. Weatherization is very important for keeping a building in a good shape.
_____ Yes _____ No _____ No opinion

3.13. Weatherization will reduce the number of sick days by employees.
_____ Yes _____ No _____ No opinion

3.14. The work of the hospital/school will be significantly disrupted due to the weatherization work.
_____ Yes _____ No _____ No opinion
If "Yes", then
Do you have a solution to the problem
_____ Yes _____ No

3.15. The indoor air quality will be better because of weatherization.
_____ Yes _____ No _____ No opinion

4. Other Questions

4.1. Are you aware of the weatherization work?
_____ Yes _____ No

If Yes, then
4.1.1. How did you become aware of the weatherization work?
_____ Contacted by RMA
_____ Contacted by other school/hospital
_____ Saw the work being done
_____ Was told by someone in the building

4.2. What do you think the cost is per window to weatherize?
<$25 $26-50 $51-75 $76-100 >$100

4.3. " Per door?
<$25 $26-50 $51-75 $76-100 >$100

4.4. What is your estimate of energy savings possible from weatherization?

_____ Less than 5% _____ 10-15% _____ More than 20%
_____ 5-10% _____ 15-20%

ARMENIA WEATHERIZATION PROGRAM
Employee Survey

We are conducting this survey in order to use your opinion in improving the quality of the program. The survey is developed for internal use and will not affect any current or future work. Your responses will be kept strictly confidential and only be used in the evaluation. You will not be identified as a respondent at any time.

Date of conducting of the survey

1. Background Information

1.1. How long have you been working for RMA doing weatherization?

_____ Years _____ Months

1.2. Which of the following best describes your job:

____ Crew Leader
____ Lead Carpenter
____ Worker
____ Other (Warehouse, Driver, Supervisor)

2. Impacts of Weatherization

Please rate the following impacts of weatherization, on a scale from 1 to 5, according to their importance <u>to the customer</u> (1 is not important, 5 is very important).

2.1. Weatherization saves money.
1 2 3 4 5 _____ no opinion

2.2. Weatherization makes the building more comfortable to work in.
1 2 3 4 5 _____ no opinion

2.3. Weatherization has increased moisture problems in the buildings.
1 2 3 4 5 _____ no opinion

2.4. Weatherization lowers energy costs to the customer.
1 2 3 4 5 _____ no opinion

2.5. Weatherization leads to greater productivity due to more comfortable conditions.
1 2 3 4 5 _____ no opinion

2.6. Weatherization leads to greater indoor air pollution.
1 2 3 4 5 _____ no opinion

Rate the following statements on a scale from 1 to 5 according to your agreement with the statement (1 is strongly disagree, 5 is strongly agree).

2.7. There is an increased supply of weatherization materials due to the weatherization program.
1 2 3 4 5 _____ no opinion

2.8. People are more aware of the benefits of weatherization because of the program.
1 2 3 4 5 _____ no opinion

2.9. A market is starting to develop for weatherization services in Armenia.
1 2 3 4 5 _____ no opinion

2.10. The skills which I have developed will be very useful to me in finding other work in the future.
1 2 3 4 5 _____ no opinion

2.11. When the weatherization program ends, I would be interested in starting my own weatherzation business.
1 2 3 4 5 _____ no opinion

2.12. RMA stresses high quality in the work which we are doing.
1 2 3 4 5 _____ no opinion

2.13. The administration in the buildings that we have weatherized have been very happy with the work which we are doing.
1 2 3 4 5 _____ no opinion

2.14. Do you intend to look for another job with higher salary.
1 2 3 4 5 _____ no opinion

2.15. Is the living level of your family improved since working with RMA.
1 2 3 4 5 _____ no opinion

2.16. Do you manage to save money.
1 2 3 4 5 _____ no opinion

2.17. Is there any real job where you could apply, get accepted and make more money
1 2 3 4 5 _____ no opinion

3. Other Questions

3.1. How many members does your family consist of (including yourself). _____

3.2. What is your age? _____

3.3. I could find employment at an equal or greater wage if the weatherization work were not

available. _____ Yes _____ No

3.4. What is the most important thing you have learned from the work?

3.5. What has been the greatest benefit to you personally from working on the weatherization program?

3.6. What has been the biggest problem that you have experienced while working on the program?

Программа проведения утеплительных работ в Армении
Выявление степени удовлетворенности клиента выполненными работами

Целью данного опроса является оценка результатов выполненных утеплительных работ в Армении. Проведенный анализ предоставит финансирующим агентствам необходимую информацию о целесообразности и результатах работ. Мы гарантируем строгую конфиденциальность Ваших ответов, которые будут использованы только для оценки проведенных работ. Ваше имя никогда не будет упомянуто в качестве респондента.

Дата проведения опроса

1. Предварительная информация

1.1. Определите тип организации/объекта, которую Вы представляете

_____ Школа _____ Больница _____ Центр беженцев

_____ Жилой дом _____ Коммерческая

1.2. Определите цикл работы предприятия

_____ круглогодичный _____ сезонный (с_____ до_____)

1.3. Какая из нижеперечисленных должностей лучше всего описывает род вашей деятельности:

_____ Административная

_____ Хозяйственная

_____ Сотрудник (врач, медсестра, преподаватель)

_____ Клиент (пациент, родитель, беженец)

1.4. Как давно Вы работаете /в больнице/школе/центре беженцев

_____ лет _____ месяцев

2. Воздействия утепления

2.1. Было ли проведено утепление в Вашем здании

_____ да _____ нет

2.2. Если "да", какие из нижеперечисленных работ были выполнены в Вашем здании

_____ Замазка на окнах

_____ Установка теплоизолирующих материалов

_____ Восстановление дверей

_____ Ремонт дверных рам

_____ Установка дверных порогов

_____ Сопутствующие ремонтные работы

_____ Восстановление окон

_____ Покраска

_____ Выполнение остекления

_____ Другие работы

2.3. Если "нет", знаете ли Вы, что утепление включает в себя

_____ Замазку на окнах

_____ Установку теплоизолирующих материалов

_____ Восстановление дверей

_____ Ремонт дверных рам

_____ Установку дверных порогов

_____ Сопутствующие ремонтные работы

_____ Восстановление окон

_____ Покраску

_____ Выполнение остекления

_____ Другие работы

3. Возможные воздействия утепления

Пожайлуста, оцените вопросы по пятибальной шкале (где "1" будет означать резкое отрицание, "3" - равнодушие, "5" - полное согласие с приведенным утверждением) ("*" помечены вопросы, применимые для больниц)

3.1. * Количество осложнений у больных, вызванных простудой (включая послеоперационный период), уменьшилось вследствие выполненного утепления

1 2 3 4 5 _____ не знаю

3.2. Повысилась продуктивность работы вследствие возросшей комфортности

1 2 3 4 5 _____ не знаю

3.3. Уровень шума в здании при закрытых окнах/дверях понизился

1 2 3 4 5 _____ не знаю

3.4. Выполненное утепление позволило сберечь энергию

1 2 3 4 5 _____ не знаю

3.5. После проведенного утепления здание выглядит более привлекательным

1 2 3 4 5 _____ не знаю

3.6. Безопасность здания возросла вследствие проведенного утепления

1 2 3 4 5 _____ не знаю

3.7. Вследствие выполненного утепления уровень запыленности в помещениях снизился

1 2 3 4 5 _____ не знаю

Если выставлены ~1~ или ~2~, то
Имеется ли у Вас решение по этой проблеме
_____ да _____ нет

3.8. От находящихся в здании стало поступать меньше жалоб по поводу шума
1 2 3 4 5 _____ не знаю

3.9. В результате утепления условия работы улучшились
1 2 3 4 5 _____ не знаю

3.10. Вследствие проведенного утепления уровень влажности внутри помещений возрос
1 2 3 4 5 _____ не знаю
Если выставлены ~4~ или ~5~, то
Имеется ли у Вас решение по этой проблеме
_____ да _____ нет

3.11. Вследствие проведенного утепления качество воздуха внутри помещений ухудшилось
1 2 3 4 5 _____ не знаю
Если выставлены ~4~ или ~5~, то
Имеется ли у Вас решение по этой проблеме
_____ да _____ нет

3.12. Выполнение утепления является очень важным мероприятием в деле сохранности здания
1 2 3 4 5 _____ не знаю

3.13. Вследствие проведенного утепления количество пропусков по болезни уменьшилось
1 2 3 4 5 _____ не знаю

3.14. Рабочая обстановка в больнице/школе была сильно нарушена в ходе проводимых утеплительных работ
1 2 3 4 5 _____ не знаю
Если выставлены ~4~ или ~5~, то
Имеется ли у Вас решение по этой проблеме
_____ да _____ нет

3.15. Качество воздуха внутри помещений улучшилось вследствие проведенного утепления
1 2 3 4 5 _____ не знаю

3.16. Здание стало функционировать более энерго-эффективно в результате проведенного утепления
1 2 3 4 5 _____ не знаю

3.17. При осуществлении дополнительных работ здание могло бы стать более энерго-эффективным

1 2 3 4 5 _____ не знаю

3.18. * Количество койко-больных уменьшилось (на %) как результат выполненного утепления

1 2 3 4 5 _____ не знаю

3.19. Количество дней в году, когда школа могла бы быть открытой, увеличилось (на дней) вследствие проведенного утепления

1 2 3 4 5 _____ не знаю

3.20. * Уровень инфекционных болезней понизился вследствие проведенного утепления

1 2 3 4 5 _____ не знаю

4. Качество утеплительных работ

Пожалуйста, оцените вопросы по пятибальной шкале (где "1" будет означать резкое несогласие, "3" - равнодушие, "5" - полное согласие с приведенным утверждением)

4.1. Работать с РМА было легко

1 2 3 4 5 _____ не знаю

4.2. Рабочие, выполнявшие утеплительные работы, имели отличные навыки в работе

1 2 3 4 5 _____ не знаю

4.3. РМА реагировал на проблемы, возникающие в процессе работы

1 2 3 4 5 _____ не знаю

4.4. РМА использует в своей работе высококачественные материалы

1 2 3 4 5 _____ не знаю

4.5. Общая оценка качества работы ("5" - отлично, "1" - неудовлетворительно).

1 2 3 4 5 _____ не знаю

Если выставлена оценка "4" или "5", то

- в будущем я буду предъявлять более высокие требования к качеству подобных работ, потому что РМА показал, насколько высокий уровень работ может быть достигнут

_____ да _____нет

5. Другие вопросы

5.1. Каково Ваше мнение, какова стоимость утепления одного окна?

менее 25$ от 26 до 50$ от 51 до 75$ от 76 до 100$

свыше 100 $

5.2. Каково Ваше мнение, какова стоимость утепления одной двери?
менее 25$ от 26 до 50$ от 51 до 75$ от 76 до 100$
свыше 100 $

5.3. Каким образом Вы стали осведомлены об утеплительных работах
_____ РМА наладил со мной контакт
_____ получил информацию из других школ/больниц
_____ видел выполненную работу
_____ получил информацию от жильца здания

5.4. Участвовали ли Вы в оплате работ по утеплению
_____ да _____нет

5.5. Каково Ваше предположение: возможно ли благодаря утеплению сберечь энергию на

_____менее, чем 5% _____ от 10 до 15% _____ более 20%
_____ от 5 до 10% _____ от 15 до 20%

6. Комментарии респондентов

Программа проведения утеплительных работ в Армении
Выявление степени удовлетворенности клиента выполненными работами
(для лиц, не являвшихся клиентами)

Целью данного опроса является оценка результатов выполненных утеплительных работ в Армении. Данная программа начала внедряться с 1993 года и мы надеемся, что информированность населения о таком виде обслуживания все более расширяется. Для того, чтобы оценить качество выполнения программы и ее последствия мы проводим опрос также и среди тех, кто не являлся нашим клиентом. Мы гарантируем строгую конфиденциальность Ваших ответов, которые будут использованы только для оценки проведенных работ. Ваше имя никогда не будет упомянуто в качестве респондента.

Дата проведения опроса

1. Предварительная информация

1.1. Определите тип организации/объекта, которую Вы представляете

_____ Школа _____ Больница _____ Центр беженцев

_____ Жилой дом _____ Коммерческая

1.2. Определите цикл работы предприятия

_____ круглогодичный _____ сезонный (с_____ до _____)

1.3. Какая из нижеперечисленных должностей лучше всего описывает род вашей деятельности:

_____ Административная

_____ Хозяйственная

_____ Сотрудник (врач, медсестра, преподаватель)

_____ Клиент (пациент, родитель, беженец)

1.4. Как давно Вы работаете в данной /больнице/школе/центре беженцев

_____ лет _____ месяцев

2. Воздействия утепления

2.1. Знаете ли Вы, что включает в себя утепление?

_____ Замазка на окнах

_____ Восстановление дверей

_____ Установка дверных порогов

_____ Восстановление окон

_____ Выполнение остекления

_____ Установка теплоизолирующих материалов

_____ Ремонт дверных рам

_____ Общее обслуживание

_____ Покраска

_____ Другие работы

3. Возможные воздействия утепления

Думаете ли Вы, что ("*" помечены вопросы, применимые для больниц)

3.1. * Количество осложнений у больных, вызванных простудой (включая послеоперационный период), уменьшится вследствие проведения утепления

_____ да _____нет

3.2. Повысится продуктивность работы вследствие возросшей комфортности

_____ да _____ нет

3.3. Уровень шума в здании понизится

_____ да _____ нет

3.4. Проведение утепления позволит сберечь энергию

_____ да _____ нет

3.5. Здание будет выглядеть более привлекательным вследствие утепления

_____ да _____ нет

3.6. Возрастет безопасность здания вследствие проведения утепления

_____ да _____ нет

3.7. Уровень запыленности в помещениях снизится вследствие выполнения утепления

_____ да _____ нет

3.8. Станет поступать меньше жалоб по поводу шума от окружающих

_____ да _____ нет

3.9. Улучшатся условия работы вследствие проведения утепления

_____ да _____ нет

3.10. Возрастет уровень влажности внутри помещений вследствие проведения утепления

_____ да _____ нет

3.11. Ухудшится качество воздуха внутри помещений

_____ да _____ нет

3.12. Утепление окажется важным мероприятием в деле сохранности здания
_____ да _____ нет

3.13. Вследствие проведенного утепления количество пропусков по болезни уменьшится
_____ да _____ нет

3.14. Рабочая обстановка в больнице/школе будет сильно нарушена в ходе проводимых утеплительных работ
_____ да _____ нет

3.15. Качество воздуха внутри помещений улучшится вследствие проведения утепления
_____ да _____ нет

4. Другие вопросы

4.1. Осведомлены ли Вы об утеплительных работах
_____ да _____ нет

Если "да", то
4.1.1. Каким образом вы стали осведомлены об этом
_____ РМА наладил со мной контакт
_____ получил информацию из других школ/больниц
_____ видел выполненную работу
_____ получил информацию от жильца здания

4.2. Каково Ваше мнение, какова будет стоимость утепления одного окна?
менее 25$ от 26 до 50$ от 51 до 75$ от 76 до 100$
свыше 100 $

4.3. Каково Ваше мнение, какова будет стоимость утепления одной двери?
менее 25$ от 26 до 50$ от 51 до 75$ от 76 до 100$
свыше 100 $

4.4. Каково Ваше предположение: возможно ли благодаря утеплению сберечь энергию на

_____менее, чем 5% _____ от 10 до 15% _____ более 20%
_____ от 5 до 10% _____ от 15 до 20%

КОММЕНТАРИИ РЕСПОНДЕНТА

Программа выполнения утеплительных работ в Армении
Опрос среди работников

Цель данного опроса - учет Вашего мнения для дальнейшего совершенствования качества программы по утеплению. Данный опросник предусмотрен для внутреннего использования и ни в коем случае не повлияет на текущую или будущие работы по программе.
Мы гарантируем строгую конфиденциальность Ваших ответов, которые будут использованы только для оценки проведенных работ. Ваше имя никогда не будет упомянуто в качестве респондента.

Дата проведения опроса _____ 199 г.

1. Предварительная информация

1.1. Как давно Вы работаете в РМА и выполняете работы по утеплению.
_____ лет _____ месяцев

1.2. Какие из нижеследующих обязанностей Вы исполняете.
_____ бригадира
_____ ведущего плотника
_____ рабочего
_____ иную (складовщик, шофер, ответственный на объекте)

2. Воздействие утепления
Пожалуйста, оцените вопросы по пятибальной шкале с точки зрения клиента (где "1" - не важно, "5" - очень важно):

2.1. Утепление сберегает финансы
1 2 3 4 5 _____ не знаю

2.2. Утепление делает помещение более комфортабельным для работы
1 2 3 4 5 _____ не знаю

2.3. Утепление обострило проблемы, связанные с влажностью внутри помещений
1 2 3 4 5 _____ не знаю

2.4. Утепление уменьшает затраты клиента на энергию
1 2 3 4 5 _____ не знаю

2.5. Утепление ведет к большей продуктивности, благодаря возросшей комфортности
1 2 3 4 5 _____ не знаю

2.6. Утепление ведет к большему загрязнению воздуха внутри помещений
1 2 3 4 5 _____ не знаю

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Оцените степень согласия с вопросами по пятибальной шкале (где "1" означает резкое отрицание, "3" - равнодушие, "5" - полное согласие с приведенным утверждением)

2.7. Наблюдается возрастание поставки утеплительных материалов в торговле благодаря внедрению программы по утеплению

1 2 3 4 5 _____ не знаю

2.8. Благодаря программе по утеплению население стало информированным о выгодах утепления

1 2 3 4 5 _____ не знаю

2.9. В Армении начал складываться рынок услуг по выполнению утепления

1 2 3 4 5 _____ не знаю

2.10. Приобретенные мною навыки окажутся очень полезными при поисках другой работы в будущем

1 2 3 4 5 _____ не знаю

2.11. По завершении программы я мог бы проявить интерес к созданию своего собственного бизнеса по утеплению

1 2 3 4 5 _____ не знаю

2.12. РМА предьявляет высокие требования к качеству нашей работы

1 2 3 4 5 _____ не знаю

2.13. Администрация зданий, где мы выполняли утепление, очень довольна нашей работой

1 2 3 4 5 _____ не знаю

2.14. Намерены ли Вы искать другую работу с более высокой зарплатой

1 2 3 4 5 _____ не знаю

2.15. Поднялся ли жизненный уровень Вашей семьи за время работы с РМА

1 2 3 4 5 _____ не знаю

2.16. Удается ли Вам откладывать деньги

1 2 3 4 5 _____ не знаю

2.17. Имеется ли у Вас реальный вариант быть принятым на другую работу и зарабатывать больше денег

1 2 3 4 5 _____ не знаю

3. Другие вопросы

3.1. Из скольких человек состоит Ваша семья (включая Вас самих)

_____

3.2. Каков Ваш возраст? _____

3.3. Если работы по утеплению прекратятся я смогу найти работу с такой же или большей зарплатой

_____ да _____ нет

3.4. Какова самая главная вещь, о которой Вы узнали во время работы?

3.5. Что принесло лично Вам самую большую пользу при работе в программе по утеплению

3.6. С какой самой большой проблемой Вы столкнулись при участии в программе по утеплению?

Appendix C
Employees' Comments

Employees Comments

3.4 What is the most important thing you have learned from the work?
Answers:
- Now I am aware of weatherization
- How important are good management, sense of responsibility in achieving impressive results
- I got familiarized with new materials and instruments
- I got a new profession
- Humanity
- Friends, colleagues
- Got a handicraft

3.5 What has been the greatest benefit to you personally from working on the weatherization program?
- An understanding that in any difficult conditions there is a chance to get benefit
- Job, usefull occupation
- Gained experience
- Reliable source of income
- $$
- Familiarizing with a new technology
- Got a new specialty - gynecology
- Communication with colleagues
- Friendship

3.6 What has been the biggest problem that you have experienced while working on the program?
- Unceratinty about the future of the project
- Financial
- Lack of skills

Appendix D
Formulas

Formulas

Heat losses from non weatherized window by infiltration per day	**Q inf nw =C x G nw x (t nw - t o) x 24**
	Gnw=infiltrating air mass = L nw x D o (kg /hour)
	C =air heat capacity =0.24 (kcal x kg / C)
	L nw = volume of the outside air infiltrating through non weatherized window (experimental) (cub.m / hour)
	D o = Density of the outside a = (52-0.19 x t o) / 40 (kg/ cub.m)
	t o = temperature of the outside air
	t nw= temperature in non weatherized room
Heat losses from weatherized window per day by infiltration	**Q inf w =C x G w x (t w - t o) x 24**
	G w = L w x D o = outside air mass (kg /hour)
	D o = (52-0.19 x t o) / 40 (kg/ cub.m)
	C =air heat capacity =0.24 (kcal x kg / C)
	L w = volume of the outside air infiltrating through non weatherized window (experimental) (cub.m / hour)
	D o = Density of the outside air
	t o = temperature of the outside air
	t w= temperature in weatherized room
Heat losses from the broken window per day by inlet air	**Q b =G b x C (t nw - t o) x 24 (kcal day)**
	G b = inlet air mass from broken window
	G b = 3600 x M x Sx SQRT (2gh (1- To / Tnw)) x Dnw (kg / hour)
	S= surface of the broken window
	M= air flow coefficient = 0.75
	D nw = density of inside air
	g= 9.8 m/sq.seq
	h=height between the centers of air flow of the broken window
	To=absolute outside temperature
	Tnw=absolute air temperature in non weatherized room

Formulas

Heat losses from non weatherized window	**Qtr.nw1=k x F x (tnw - to) x 24**
with one glass pane by heat transfer per day	k=heat transfer coefficient (U-value) for one glass pane window = 4.5 kcal / sq.m x hour
	F= surface of the window
	tnw= temperature in non weatherized room
	to= temperature of outside air
Heat losses from non weatherized window	**Qtr.nw2=k x F x (tnw - to) x 24**
with two glass panes by heat transfer per day	k=heat transfer coefficient (U-value) for two glass pane window = 2.5 kcal / sq.m x hour
	F= surface of the window
	tnw= temperature in non weatherized room
	to= temperature of outside air
Heat losses from weatherized window	**Qtr.w=k x F x (tw - to) x 24**
double glass panes by heat transfer per day	k=heat transfer coefficient (U-value) for two glass pane window = 2.0 kcal / sq.m x hour
	F= surface of the window
	tnw= temperature in weatherized room
	to= temperature of outside air
Total heat losses from non weatherized	**Qnw1=Q inf nw + Q tr.nw1 (kcal/day)**
single glass pane window	
Total heat losses from non weatherized	**Qnw2=Q inf nw + Q tr.nw2 (kcal/day)**
with double glass pane window	
Total heat losses from weatherized	**Qw=(Q inf w + Q tr.w) N (kcal / day)**
with double glass panes windows building	N= number of weatherized windows= 427
Total heat losses from non weatherized building	**Q nw = Qnw1 x n1+Qnw2 x n2+Qb x n3**
	n1= number of single pane non weatherized windows = 85
	n2= number of double pane non weatherized windows = 320
	n3= number of broken non weatherized windows = 22

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Formulas

Energy savings	**SUM (delta Q) = SUM (Qnw-Qw)**
Conventional fuel savings	**B=SUM (deltaQ) / 7000 (kg / year)**
	7000 kcal / kg =heat content for conventional fuel
Money savings	**E= B x P ($ / year)**
	B= amount of conventional fuel saved (kg / year)
	P= fuel price = 0.105$ / kg
Payback period	**Z=1.05 x K / E (years)**
	E=money saving from saved fuel
	K=grand total cost of weatherization at Maternity # 4
	1.05=a coefficient accounting the costs for repair of damaged weatherization