Project RetroTech

Home Weatherization Instructor's Guide

MASTER

July 1979

U.S. Department of Energy
Assistant Secretary for Conservation
and Solar Applications
Office of Weatherization Assistance
Washington, D.C. 20585

Contract No. AC01-77CS20458

Conservation Paper
Number 28A

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

MASTER

Available from:

National Technical Information Service (NTIS)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

Price: Printed Copy: \$7.00
Microfiche: \$4.00

Project RetroTech

Home Weatherization Instructor's Guide

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Prepared by:
University of Maine
Orono, Maine 04473

Under Contract No. AC01-77CS20458

Prepared for:
U.S. Department of Energy
Assistant Secretary for Conservation
and Solar Applications
Office of Weatherization Assistance
Washington, D.C. 20545

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, mark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Home Weatherization Instructor's Guide

Contents

Preface	2
General Lesson Plan	3
A. Course Objectives	3
B. Instructional Objectives	3
C. Equipment Required	3
D. Student Materials	3
E. Lesson Topics	3
F. Format of Lesson Plans	4
Lesson Plans:	5
1. Overview of Course	5
2. Introduction to Heat Loss	6
3. Building Heat Loss by Conduction	14
4. Building Heat Loss by Infiltration	22
Home Weatherization in 4 Steps:	24
5A. Step 1: Inspection	24
5B. Step 2: Calculation	28
5C. Step 3: Evaluation	39
5D. Step 4: Installation	50

Preface

This booklet was prepared as a guide to instructors in developing lesson plans for a Home Weatherization Course that promotes the use of known **RETROfit TECHNOLOGY** to improve thermal characteristics and conserve energy in residential housing.

Although the suggested lesson plans contained in this booklet have been designed for a special course for personnel involved in the DOE Weatherization Assistance program at the State level, the concepts embodied in the individual lessons can also be incorporated into the curriculum of construction trades programs at vocational-technical schools at the secondary, post-secondary, or adult education levels.

This material was developed for the U.S. Department of Energy (DOE) by the following individuals at the University of Maine at Orono: **Richard C. Hill**, Professor, Mechanical Engineering; **Charles W. Kittridge**, Extension Agricultural Engineer; and **Norman Smith**, Professor, Agricultural Engineering

DOE welcomes your ideas and comments about the Home Weatherization Course. In addition, we would appreciate information from you regarding your use of the training materials, either for special groups or for vocational students pursuing a career in the construction trades. Your comments, along with any suggestions for improving the training materials should be mailed to:

**Director
Office of Weatherization Assistance
U.S. Department of Energy
Washington, DC 20545**

General Lesson Plan for Course on Home Weatherization

A. Course Objectives:

1. The DOE Weatherization Manual and Job Book are based on known technology for retrofitting residential housing. The principal objective of the course on Home Weatherization is to train personnel involved at the state and program level in the DOE Weatherization Assistance Program in the methods of assessing priorities for weatherization measures on existing residential housing. Retrofit measures can be an effective means for improving thermal characteristics of housing and reducing energy use.

B. Instructional Objectives

Given the physical dimensions and construction features of a detached residential structure a participant will prepare a written analysis of weatherization priorities (Job Book) containing the following:

- a. Identification of gross thermal deficiencies of the structure that result in heat losses by infiltration and conduction;
- b. Comparison of current heating requirements with the potential fuel and cost savings;
- c. Determination of cost effective measures in priority order;
- d. List of recommended weatherization measures.

C. Equipment Required

The following equipment is required for the classroom lectures and/or demonstrations:

- 1—Projection screen
- 1—Overhead projector
- 1—Set of transparencies (prepare from charts contained in supplement to this guide)

D. Student Materials

1. DOE Home Weatherization Manual
2. DOE Home Weatherization Job Book

E. **Lessons:** Lesson plans are included in this booklet on the following topics:

No. Topic	Suggested Class Time (hr:min)
1 Overview of Course	0:30
2 Introduction to Heat Loss	:30
3 Heat Loss By Conduction	1:00
4 Heat Loss By Infiltration	:30
Home Weatherization in Four Steps	
5A Step 1 — Inspection	:30
5B Step 2 — Calculation	:30
5C Step 3 — Evaluation	1:30
Job Book Example by Students	1:30
Total Suggested Class Time	6:30

F. Format of Lesson Plans

The lesson plans starting on the facing page contain "points of emphasis" to be covered by the instructor during the classroom lecture. Adjacent to each emphasis point is a page reference in the student's manual and the chart number of the visual aid to be used to reinforce the emphasis point.

The visual aids, transparencies for overhead projection, should be prepared locally from a set of 8" x 10½" charts contained in a separate package that accompanies this instructor's guide. Each chart is numbered to coincide with the appropriate point of emphasis.

For the convenience of the instructor when reviewing a lesson plan, each chart appears in miniature at the bottom of the appropriate page of the instructor's guide.

Lesson Plan 1. Overview of Course

Points of Emphasis		Manual Page	Chart No.
1.	Objective(s) of Course: <ol style="list-style-type: none"> Learn to use the Retro-Tech method for <ul style="list-style-type: none"> —identifying weatherization deficiencies —determining a priority listing of cost effective measures Learn the use of the Building Check and Job Order Sheet for applying the appropriate weatherization measures to individual buildings. <p>(Lesson continued on next page)</p>		C-1

Chart C-1

HOME WEATHERIZATION COURSE

Chart C-2

Home Weatherization
Charts
RetroTech

INSTRUCTIONAL OBJECTIVES

ESTIMATION

Student will prepare written
analysis containing:

- (1) Identification of deficiencies
- (2) Comparison of requirements/savings
- (3) Priority Ranking of Measures
- (4) Building Check and Job Order Sheet

Lesson Plan 1.
Overview
of Course

Points of Emphasis		Manual Page	Chart No.
	(Continued from previous page)		
2.	Instructional Objectives Given the physical dimensions and construction features of a detached residential structure a participant will prepare a written analysis of weatherization priorities (Job Book) containing the following: (a) Identification of gross thermal deficiencies of the structure that result in heat losses by infiltration and conduction; (b) Comparison of current heating requirements with the potential fuel and cost savings; (c) Determination of cost effective measures in priority order; (d) List of recommended weatherization measures.		C-2
	(Lesson continued on next page)		

Lesson Plan 1.
Overview
of Course

Points of Emphasis		Manual Page	Chart No.
3.	(Continued from previous page)		
	Course Content: (a) Introduction to Heat Loss (b) Building Heat Loss by Conduction (c) Building Heat Loss by Infiltration (d) Four Steps to Home Weatherization Optional: (e) Laboratory Exercises _____ (f) Field Exercises _____ End of lesson no. 1		C-3

Chart C-3

LESSONS

- A. INTRODUCTION TO
HEAT LOSS**
- B. BUILDING HEAT LOSS
BY CONDUCTION**
- C. BUILDING HEAT LOSS
BY INFILTRATION**
- D. 4 STEPS TO HOME
WEATHERIZATION**

Lesson Plan 2.
Introduction
to Heat Loss

Points of Emphasis		Manual Page	Chart No.
1.	Most homes can use much less fuel without sacrificing comfort. Fuel can be saved by improving building.		C-4
2.	Heat always tends to flow from a high-temperature area to a low-temperature area.		
(Lesson continued on next page)			

Chart C-4

<p>MOST HOMES CAN USE MUCH LESS FUEL WITHOUT SACRIFICING COMFORT</p>	
---	--

Lesson Plan 2. Introduction to Heat Loss

Points of Emphasis	Manual Page	Chart No.
<p>(Continued from previous page)</p> <p>3. Heat that escapes must be replaced.</p> <p>4. When less heat escapes, less fuel is required.</p> <p>(Lesson continued on next page)</p>		<p>C-5</p> <p>C-6</p>

Chart C-5

Chart C-6

Points of Emphasis		Manual Page	Chart No.
5.	(Continued from previous page)		C-7
	"Btu" as a unit of measure is very small.		
	Heating unit concept will simplify calculations.		
6.	1 heating unit represents about 100,000 Btu.		C-8
(Lesson continued on next page)			

Lesson Plan 2.

Introduction to Heat Loss

Chart C-7

1 British Thermal Unit (Btu)
is
THE HEAT NEEDED TO RAISE 1 POUND OF WATER 1 DEGREE FAHRENHEIT WHICH IS APPROXIMATELY THE HEAT GIVEN OFF BY BURNING ONE KITCHEN MATCH

Chart C-8

Lesson Plan 2.
Introduction
to Heat Loss

Points of Emphasis	Manual Page	Chart No.
<p>(Continued from previous page)</p> <p>7. Heating requirements are calculated on seasonal basis to determine total fuel use.</p> <p>8. District heating factor concept allows for climatic differences between areas.</p> <p>(Lesson continued on next page)</p>	<p>3</p> <p>3</p>	<p>C-9 C-10</p>

Chart C-9

Chart C-10

Lesson Plan 2.
Introduction
to Heat Loss

Points of Emphasis		Manual Page	Chart No.
	(Continued from previous page)		
9.	Home Weatherization is a Four-Step Process:		C-11
	(a) Step 1: Inspection of the building Inspect the building to determine its construction characteristics.		C-12
	(b) Step 2: Calculation of heat losses Calculate the heat losses from the house.		C-12
	(Lesson continued on next page)		

Chart C-11

**HOME
WEATHERIZATION
IS
A
FOUR-
STEP
PROCESS**

Lesson Plan 2. Introduction to Heat Loss

Points of Emphasis		Manual Page	Chart No.
10.	(Continued from previous page)		
	(c) Step 3: Evaluation of the data Evaluate the building characteristics and heat losses to determine what measures should be taken.		C-12
	(d) Step 4: Installation of materials Install the weatherizing materials.		C-12
	The Job Book has been designed for recording information needed on each individual building or sample building for the Inspection, Calculation and Evaluation steps.		C-13
End of Lesson No. 2			

Chart C-12

FOUR - STEP PROCESS

1. INSPECTION OF
THE BUILDING
2. CALCULATION OF
HEAT LOSSES
3. EVALUATION OF
THE DATA
4. INSTALLATION OF
THE MATERIALS

Chart C-13

Home Weatherization
Charts
Chart 13

Revised
July 1976
U.S. Department of Energy
Assistant Secretary for Conservation
and Solar Applications
Office of Weatherization Assistance
Washington, D.C. 20585
REFERENCE NO.

HOME WEATHERIZATION JOB BOOK FOR PRIORITY SETTING

Insert Address for Building Type if for sample evaluation

Leave for Name if for sample evaluation

This revised Job Book replaces the original Research Job Book and is used in much the same way. Additional information is developed which allows priority of various weatherization measures for a building to be determined as required by the National Energy Conservation Policy Act.

The booklet is also intended to be used for determining costs of weatherization measures and consequent fuel savings for sample buildings of frequently occurring types in an area, e.g. "leaky houses, colonial, row houses, etc. to establish a priority listing which will hold for all similarly constructed buildings in the area. This procedure eliminates the necessity for using a Job Book for every building where many buildings of a particular type are of similar construction.

Name Evaluation

Inspection by _____ Date _____

Calculation and Priority

_____ Date _____

_____ Date _____

Lesson Plan 3. Building Heat Loss by Conduction

Points of Emphasis		Manual Page	Chart No.
1.	Heat loss by conduction means heat removed by flow through the exterior materials.		C-14
2.	Rate of heat loss depends on: <ul style="list-style-type: none"> - Area of surface - Length of time - Type of material - Temperature difference across the surface. 		C-15
3.	Materials that have low rate of heat flow are thermal insulators.		C-15
(Lesson continued on next page)			

Chart C-14

Chart C-15

Lesson Plan 3.
Building
Heat Loss by
Conduction

Points of Emphasis	Manual Page	Chart No.
<p>(Continued from previous page)</p> <p>4. Types of insulation material commonly used in building construction are:</p> <p>(a) Loose fill</p> <ul style="list-style-type: none"> - Glass or rockwool, wood fiber, plastics - Low cost - Use on horizontal surfaces - Will settle <p>(b) Blanket or batt</p> <ul style="list-style-type: none"> - Glass or rockwool, wood fiber - Low cost - Most common - Common thickness 3-1/2" to 6" - Common widths 16" & 24" - Blankets comes in rolls - Batts come in shorter lengths - Both come with, or without, vapor barrier. <p>(c) Rigid Insulation</p> <ul style="list-style-type: none"> - Fiber boards, foamed plasters - Higher cost - Generally not used for home weatherization. <p>5. Insulating value of material is measured by its Resistance, or R value.</p> <p style="padding-left: 40px;">The higher the R value, the better the insulation.</p> <p>(Lesson continued on next page)</p>		<p>(Show sample of each)</p> <p>(Show sample of each)</p> <p>(Show sample of each)</p>

Lesson Plan 3.

Building Heat Loss by Conduction

Points of Emphasis		Manual Page	Chart No.
(Continued from previous page)			
6.	From the table of R Values in the manual, compare the values of some common materials found in house construction:		C-16
	(a) Air film and spaces		C-17
	(b) Masonry		C-17
(Lesson continued on next page)			

Chart C-16

Table 1:
Insulation Value of Common Materials

MATERIAL	THICKNESS (Inches)	R VALUE
Air Film and Spaces:		
Air space, bounded by ordinary materials	1/4 or more	.91
Air space, bounded by aluminum foil	1/4 or more	2.17
Exterior surface resistance	—	.17
Interior surface resistance	—	.68
Masonry:		
Sand and gravel concrete block	8	1.11
Lightweight concrete block	12	1.28
Face brick	4	2.13
Concrete cast in place	8	.64
Building Materials - General:		
Wood sheathing or surface	3/4	1.00
Fiber board sheathing (sheathing)	3/4	2.10
Plywood	3/4	.63
Shear-resistant siding	1/2	.43
Vertical tongue and groove board	1 1/2 x 8	.81
Drop siding	3/4 x 10	.57
Horizontal tongue and groove board	3/4	1.00
Drop siding	3/4	.64
Asbestos board	1 1/4	1.3
2" x 8" extruded foam 1/4" spacer	3/4	.63
Ceramic board (shear resistant)	3/8	.32
Interior protected panel	1 1/4	.31
Building Paper:		
Water-resistant	—	.05
Flashed	—	.03
Asphalt shingles	—	.44
Limestone	—	.06
Carpet with foam pad	—	2.08
Hardwood floor	—	.71
Insulation Materials (cellulose wool, glass wool, wool wool):		
Blanket or batts	1	3.70
	3 1/2	17.00
Loose fill	1	19.00
Rigid mineral wool board (sheathing)	3/4	2.10
Windows and Doors:		
Single window	—	approx. 1.00
Double window	—	approx. 2.00
Exterior door	—	approx. 2.00

Source: ASHRAE Guide and Data Book

Chart C-17

R VALUES OF SOME COMMON MATERIALS

AIR FILM AND SPACES

MATERIAL	THICKNESS (Inches)	R VALUE
Air space, bounded by ordinary materials	3/4 or more	0.91
Air space, bounded by aluminum foil	3/4 or more	2.17
Exterior surface resistance	—	.17
Interior surface resistance	—	.68

MASONRY

MATERIAL	THICKNESS (Inches)	R VALUE
Sand and gravel concrete block	8	1.11
Lightweight concrete block	12	1.28
Face brick	4	2.13
Concrete cast in place	8	.64

Lesson Plan 3.
Building
Heat Loss by
Conduction

Points of Emphasis	Manual Page	Chart No.
(Continued from previous page)		
(c) Building materials — general		C-18
(d) Insulation materials		C-19
(e) Windows and doors		C-19
(Lesson continued on next page)		

Chart C-18

R VALUES OF SOME COMMON MATERIALS		
BUILDING MATERIALS		
MATERIAL	THICKNESS (inches)	R VALUE
Wood sheathing or subfloor	3/4	1.00
Fiberboard insulating sheathing	3/4	2.10
Plywood	5/8	.79
	1/2	.63
	3/8	.47
Bevel-lapped siding	1/2 x 8	.61
	3/4 x 10	1.05
Vertical tongue and groove	3/4	1.00
Drop siding	3/4	.94
Asbestos board	1/3	.13
3/8" gypsum lath and 3/8" plaster	3/4	.42
Gypsum board	3/8	.32
Interior plywood paneling	1/4	.31
Building paper	—	.08
Vapor barrier	—	.02
Wood shingles	—	.87
Asphalt shingles	—	.44
Linoleum	—	.08
Carpet with fiber pad	—	2.08
Hardwood floor	—	.71

Chart C-19

R VALUES OF SOME COMMON MATERIALS		
INSULATION MATERIALS		
MATERIAL	THICKNESS (inches)	R VALUE
Blanket or batts	1	3.70
	3-1/2	11.00
	6	19.0
Loose fill	1	3.35
Rigid insulation board (sheathing)	3/4	2.10
WINDOWS AND DOORS		
TO SIMPLIFY CALCULATIONS, USE THE FOLLOWING APPROXIMATE R VALUES.		
MATERIALS	R VALUE	
Single window	1.00	
Double window	2.00	
Exterior door	2.00	

Lesson Plan 3. Building Heat Loss by Conduction

Points of Emphasis	Manual Page	Chart No.
<p>(Continued from previous page)</p> <p>7. R value of materials can be added together to obtain an overall resistance, or R value of a building section.</p> <p>(a) Typical overall R for wall section.</p> <p>(b) Typical overall R for ceiling.</p> <p>(Lesson continued on next page)</p>		<p>C-20</p> <p>C-21</p>

Chart C-20

Chart C-21

Lesson Plan 3. Building Heat Loss by Conduction

Points of Emphasis	Manual Page	Chart No.
(Continued from previous page)		
(c) Typical overall R for roof.		C-22
(d) Typical overall R for floor.		C-23
8. Vapor barrier: Moisture in air exerts pressure. Moisture flows from high pressure side to low pressure side.		C-24
As moisture flows from inside to outside, the temperature drops. When the dew point is reached, the moisture condenses and causes wetting of insulation and structural materials.		
(Lesson continued on next page)		

Chart C-22

Chart C-23

Lesson Plan 3. Building Heat Loss by Conduction

Points of Emphasis	Manual Page	Chart No.
<p>(Continued from previous page)</p> <p>Since a vapor barrier will reduce the flow of moisture before it reaches the insulation, place the vapor barrier on the inside (warm side).</p> <p>(a) Polyethylene film and aluminum foil are excellent; kraft paper is average.</p> <p>(b) Seal with pressure joint. Remove moisture that escapes through vapor barrier by venting to the outside.</p> <p>End of lesson no. 3</p> <p>(Lesson no. 4 starts on next page)</p>		

Chart C-24

Chart C-25

**INFILTRATION
IS
HEAT LOST BY
COLD AIR
COMING IN
AND
WARM AIR
GOING OUT**

Lesson Plan 3:
Building
Heat Loss by
Conduction

Points of Emphasis	Manual Page	Chart No.
<p>1. Heat is lost by cold air coming in and warm air going out. This leakage or infiltration is caused by two factors:</p> <p>(a) Infiltration by wind occurs when wind flows in on one side and warm air flows out on the leeward side.</p> <p>(b) Infiltration by "Chimney Effect" occurs when inside air is warmer than outside air. The building acts like a chimney: heated air, which tends to rise, leaks out of cracks and is replaced by cold air, which is sucked in at lower levels.</p> <p>(Lesson continued on next page)</p>		<p>C-25</p> <p>C-26</p> <p>C-27</p>

Chart C-26

Chart C-27

Lesson Plan 4. Building Heat Loss by Infiltration

Points of Emphasis	Manual Page	Chart No.
<p>(Continued from previous page)</p> <p>2. Each cubic foot of air that must be heated requires 0.02 Btu for every 1°F increase.</p> <p>3. Reducing excess infiltration is always cost effective and is carried out as a standard measure in every case.</p> <p>End of lesson no. 4</p> <p>(Lesson no. 5A starts on next page)</p>		C-28

Chart C-28

Home Weatherization
Charts
Project RetroTech

PRECISE
DETERMINATION OF
INFILTRATION LOSS
IS DIFFICULT

BUT

REDUCING EXCESS INFILTRATION
IS ALWAYS COST EFFECTIVE AND
IS PRIORITY NO. 1

Lesson Plan 5a.
Home
Weatherization
in Four Steps
Step 1:
Inspection

Points of Emphasis		Manual Page	Chart No.
1.	<p>(Refresher from Introduction Section) Home Weatherization is a Four-Step Process:</p> <p>(a) Step 1 — Inspect the building to determine its construction characteristics.</p> <p>(b) Step 2 — Calculate the heat losses from the building.</p> <p>(c) Step 3 — Evaluate the building characteristics and heat losses to determine what measures should be taken.</p> <p>(d) Step 4 — Install the weatherizing materials.</p>		
2.	<p>The Job Book is designed to allow implementation of the Inspection, Calculation and Evaluation steps of the process.</p> <p>It can be used in two ways:</p> <p>(a) to evaluate sample buildings to allow pre-ranking of weatherization priorities</p> <p>(b) to evaluate individual buildings, usually those of non-standard construction or type.</p> <p>Steps in using the Job Book are the same in both cases.</p> <p>Perhaps, the best way to become familiar with the job book is to simulate the process by working out an example of a building to be weatherized.</p> <p>The charts that you will see have been marked up to show the information that an estimator will obtain when he inspects the building to determine the construction characteristics.</p> <p>(Lesson continued on next page)</p>		

Lesson Plan 5a. Home Weatherization in Four Steps Step 1: Inspection

Points of Emphasis		Manual Page	Chart No.
3.	(Continued from previous page)		
	<p>Step 1 — Inspect the building to determine the construction characteristics.</p> <p>(a) <i>Visual inspection</i> of building should consist of the 10 steps listed on chart.</p>		<p>C-29</p> <p>C-30</p>
(Lesson continued on next page)			

Chart C-29

FOUR - STEP PROCESS

1. INSPECTION OF THE BUILDING

Chart C-30

10 STEPS IN BUILDING INSPECTION

1. Talk to the occupant
2. Take overall building dimensions (length, width, sidewall height)
3. Measure windows (height, width)
4. Measure doors (height, width)
5. Check condition of exterior (look for cracks, lack of paint, caulking)
6. Check wall construction
7. Check ceiling, roof
8. Check floor construction
9. Inspect foundation for cracks
10. Check for infiltration, feel for drafts, open outside door quickly (resistance means a tight fit)

Lesson Plan 5a.
Home
Weatherization
in Four Steps
Step 1:
Inspection

Points of Emphasis	Manual Page	Chart No.
<p>(Continued from previous page)</p> <p>(b) Fill In the Job Book: During the inspection, fill in the sections of the Job Book marked "Fill In At The Site."</p> <p>(NOTE: The student will be able to follow the instructions by referring to the example which follows page 12 of the Home Weatherization Manual).</p> <p>(1) Page 1: Address/Building Type and Town/Area</p> <p>(2) Page 2: Sketches of Building</p> <p>(3) Page 3: Sketches and Dwelling Information</p> <p>(4) Page 4: Ceiling Construction Details</p> <p>(5) Page 6: Floor Exposure Factor</p> <p>(6) Page 7: Wall Construction Details</p> <p>End of lesson 5A</p>		<p>C-31</p> <p>C-32</p> <p>C-33</p> <p>C-34</p> <p>C-35</p> <p>C-36</p>

Chart C-31

Project RetroTech

Revised July 1979
U.S. Department of Energy
Residential Energy Conservation
and Solar Incentives
Office of Weatherization Assistance
Washington, D.C. 20501
SPW2023 10

HOME WEATHERIZATION JOB BOOK FOR PRIORITY SETTING

SAMPLE RANCH HOUSE
Street address for Building Type II (see sample worksheet)

EAST MASS. AREA
Name for use if the sample worksheet

This revised Job Book replaces the original Bureau Job Book and is used to make the same very additional information is developed which shows priority of various weatherization measures for a building to be determined as required by the National Energy Conservation Policy Act.

The booklet is also intended to be used for determining costs of weatherization measures and consequent fuel savings for sample buildings of frequently occurring types in an area, e.g., ranch houses, individual, row houses, etc., as available in priority listing which will be held for all similarly constructed buildings in the area. This procedure eliminates the necessity for using a Job Book for every building where every building of a particular type are of similar construction.

Home Evaluation
Inspector by JB Date 10/27/79
Calculator and Priority setting by ALC Date 10/28/79

Chart C-32

Project RetroTech Home Weatherization Job Book

Description of Building

Set all dimensions and part dimensions on each drawing, for example, length of walls, etc. and length of windows, etc. Label all the glass surfaces and double doors and windows. Complete all items in the Job Book about "R-10 in air Job Book."

Front View

Left Side View

Plan View

A grid is provided on pages for these drawings and can be used to scale.

Lesson Plan 5a. Home Weatherization in Four Steps Step 1: Inspection

Chart C-33

Project RetroTech Home Weatherization Job Book

Right Side View

Front View

Calculation of Floor Area

If the building is not rectangular or square add the areas of the surface parts together to find the floor area.

Building Length ft.	33	Building Width ft.	28	Floor Area sq. ft.	924
Building Length ft.		Building Width ft.		Floor Area sq. ft.	924

Double Heating System: 1-5-1

Heat Losses by Conduction Through Ceilings

Area of Ceiling (ft. x ft.) = 40 x 40 = 1600

Heat Losses by Conduction Through Ceilings

Material: CYPRESS BOARD R-value: 3.5 Heat Losses by Conduction Through Ceilings: 33

Material: ATTIC FLOOR R-value: 9.1 Heat Losses by Conduction Through Ceilings: 91

Material: PLYWOOD R-value: 5.0 Heat Losses by Conduction Through Ceilings: 10

Material: ASPHALT/FLUTIC R-value: 1.0 Heat Losses by Conduction Through Ceilings: 160

Double Ceiling: 0.17 Heat Losses by Conduction Through Ceilings: 2.72

Total Heat Losses by Conduction Through Ceilings: 334

Chart C-34

Project RetroTech Home Weatherization Job Book

Area of Ceiling

Area of Ceiling (ft. x ft.) = 40 x 40 = 1600

Heat Losses by Conduction Through Ceilings

Material: CYPRESS BOARD R-value: 3.5 Heat Losses by Conduction Through Ceilings: 33

Material: ATTIC FLOOR R-value: 9.1 Heat Losses by Conduction Through Ceilings: 91

Material: PLYWOOD R-value: 5.0 Heat Losses by Conduction Through Ceilings: 10

Material: ASPHALT/FLUTIC R-value: 1.0 Heat Losses by Conduction Through Ceilings: 160

Double Ceiling: 0.17 Heat Losses by Conduction Through Ceilings: 2.72

Total Heat Losses by Conduction Through Ceilings: 334

Heat Losses through uninsulated ceilings

Area of Ceiling (ft. x ft.) = 40 x 40 = 1600

Heat Losses through uninsulated ceilings: 334

Heat Losses through partially insulated ceilings

Area of Ceiling (ft. x ft.) = 40 x 40 = 1600

Heat Losses through partially insulated ceilings: 334

Heat Losses through walls

Area of Wall (ft. x ft.) = 40 x 40 = 1600

Heat Losses through walls: 334

Heat Losses through doors and windows

Area of Door (ft. x ft.) = 40 x 40 = 1600

Heat Losses through doors and windows: 334

Heat Losses through floors

Area of Floor (ft. x ft.) = 40 x 40 = 1600

Heat Losses through floors: 334

Heat Losses through roofs

Area of Roof (ft. x ft.) = 40 x 40 = 1600

Heat Losses through roofs: 334

Heat Losses through foundations

Area of Foundation (ft. x ft.) = 40 x 40 = 1600

Heat Losses through foundations: 334

Heat Losses through other surfaces

Area of Other Surfaces (ft. x ft.) = 40 x 40 = 1600

Heat Losses through other surfaces: 334

Heat Losses through air infiltration

Area of Air Infiltration (ft. x ft.) = 40 x 40 = 1600

Heat Losses through air infiltration: 334

Heat Losses through ventilation

Area of Ventilation (ft. x ft.) = 40 x 40 = 1600

Heat Losses through ventilation: 334

Heat Losses through other losses

Area of Other Losses (ft. x ft.) = 40 x 40 = 1600

Heat Losses through other losses: 334

Heat Losses through other losses

Area of Other Losses (ft. x ft.) = 40 x 40 = 1600

Heat Losses through other losses: 334

Heat Losses through other losses

Area of Other Losses (ft. x ft.) = 40 x 40 = 1600

Heat Losses through other losses: 334

Points of Emphasis	Manual Page	Chart No.
<p>1. Step 2 — Calculate the heat losses expected during a complete heating season (these simple calculations do not have to be done at the job site).</p> <p>(NOTE: The Job Book pages shown on charts C-38 thru C-41 are to be completed during class time by the instructor and students. Copies of the completed charts are included in this guide and in the manual.)</p> <p>(Lesson continued on next page)</p>		C-37

Lesson Plan 5b. Home Weatherization in Four Steps Step 2: Calculation

Chart C-39

FOUR-STEP PROCESS

1. INSPECTION OF
THE BUILDING
2. CALCULATION OF
HEAT LOSSES

Lesson Plan 5b.
Home
Weatherization
in Four Steps
Step 2:
Calculation

Points of Emphasis	Manual Page	Chart No.
<p>(Continued from page 28)</p> <p>(c) Job Book page 4 Heat Losses by Conduction Through Uninsulated Ceilings</p> <ol style="list-style-type: none"> (1) Insert ceiling area (normally same as floor area on page 3). (2) From Table 1 on page 9 of Job Book, obtain R value for each material in the ceiling (or roof, where appropriate). Add these R values to obtain composite R value for ceiling (or roof). Round off value to nearest tenth of unit. (3) Enter district heating factor from page 3. (4) Use these factors to determine the required heating units and enter on bottom line. (5) In a similar manner, determine potential heating units based on an R value appropriate to the area, 30 in this example. (6) Subtract to determine potential heating savings, and enter on bottom line. <p>Job Book page 4: Heat Losses through Partially Insulated Ceilings</p> <ol style="list-style-type: none"> (1) Determine the heating units required if this ceiling were partially insulated (to R = 10 for a sample house or actual R value when calculation is for an individual house) (2) In a similar manner determine potential heating units based on an R value appropriate to the area, 30 in this example. (3) Subtract to determine potential heating savings, and enter on bottom line. <p>(Lesson continued on page 33)</p>		C-38

Lesson Plan 5b.

Home Weatherization

in Four Steps

Step 2:

Calculation

C38

HOME WEATHERIZATION CHECKS

Check 28

Area of Ceiling
(Take area of room below ceiling in a rectangular house)

Ceiling area will naturally be the same as floor area. Draw building dimensions (feet)

Indicate the materials in the roof that address to the materials in the below listing. Most of the attic is insulated in the roof. Do not make same protection. Indicate the attic as an attic with a 0 - 91

RETROSEAL

Heat Losses by Conduction Through Ceilings

Material	Thickness (inches)	R Value	
Inside surface	--	0.01	
CYPSON BOARD	2 1/2"		
ATTIC SPACE			
PLYWOOD	5/8"		
ALUMINUM CLING			
Outside surface	-	0.17	
Total R value			

REB AT JOE WTS

If the Job Item is for a sample house complete both sections 1 and 2 below. For a specific house complete the section which describes the actual ceiling.

(1) Heat losses through uninsulated ceilings

If the Job Item is being completed for a sample house it is necessary to determine the potential heat savings for these examples without insulation. If the sample house has no insulation, subtract an R value from the total above and calculate the heating unit required using $1.75 \times (R-2) \times A$ in Btu/hr.

×

+

=

Ceiling area Outside Total Heating unit

in ft² heating factor R value in Btu/hr

(2) Heat losses through partially insulated ceilings

If ceilings are partially insulated, e.g., 1/2" or no more than 0.10, further savings can be made by adding insulation. However, the primary purpose here is to show how the comparison is made regarding the material used in a ceiling to affect the ceiling R value. The ceiling R value is determined by adding the R value for the existing building or actual R value for the insulation used in a basement attic ceiling should be assigned to the material.

×

+

=

Ceiling area Outside Total Heating unit

in ft² heating factor R value in Btu/hr

(Use 1-10 for sample house)

The appropriate amount of insulation for a ceiling depends on climate, fuel prices and insulation cost. Check the appropriate R recommendation on climate appropriate R values for your area. This indicates the maximum amount of insulation which will be an optimum for your climate. Any less amount of insulation than this will cause heat loss but will save some money during winter.

×

+

=

Ceiling area Outside Appropriate Potential

in ft² heating factor R value heating unit

Indicate the potential heating units from these now required for uninsulated or partially insulated ceilings and outer losses:

Potential savings

Insulation through ceiling

1. 2. 3.

Potential savings

Insulation through ceiling

1. 2. 3.

C39

[illegible]

C40

Charts

Chart #2

Project RetroTech

Heat Losses by Conduction Through Uninsulated Walls

Typically, insulated frame walls cannot normally be further (less) heated.)

2 Value of Outside Walls

Uninsulated frame walls usually have a total R value around 2.0 on exterior side or interior side or having insulation in between. If the wall is of different construction but still conforms to the wall in the table or walls, multiply these inside and outside air space values, the wall R-value R value for each component from Table 1.

Material	Thickness (Inches)	R Value
Interior surface	-	0.68
TYPESPAN GABLED	3/4	
AIR SPACE	3/4	
SHEDDING	3/4	
INSULATED SHEDDING	1/4	
Exterior surface	-	0.17
Outside surface	-	
Total R value		

R-11
 AT JOH 571

×

=

Total perimeter of outside wall ft.
 Total height of vertical wall ft.
 Gross wall area sq. ft.

-

=

Design wall area sq. ft.
 Total area of all walls and doors from elevation on pages 2 and 3

×

+

=

Area of roof area ft. x ft.
 Design height ft.
 Gross R value
 Heating value required

Potential Savings by Insulation

Fully insulated frame walls should have an R-value of 13. If less, use as far this building, the wall heat loss would be:

×

÷

=

Net wall area (from blue plans)
 Current heating factor
 R value
 Potential heating loss

Subtract the potential heating units from those now required and enter here _____

-

=

Types of Heat Loss
 Conduction Through Uninsulated Walls
 Potential remaining Savings

Lesson Plan 5b. Home Weatherization in Four Steps Step 2: Calculation

from Job Book,
page 4

Project RetroTech

Home Weatherization Job Book

Area of Ceiling
(Take area of upstairs
ceiling in a two-story
house)

Ceiling area will
normally be the same
as floor area (from
building description
sheet)

Always include the materials in the roof deck in
addition to the materials in the actual ceiling,
as even if the attic is ventilated the roof deck
adds some protection. Include the attic as an air
space with R = .91.

Material	Thickness (inches)	R Value
Inside surface	—	0.68
GYPSUM BOARD	3/8	.32
ATTIC SPACE	—	.91
PLYWOOD	5/8	.79
ASPHALT SHINGLES	—	.44
Outside Surface	—	0.17
Total R value		3.31

Heat Losses by Conduction Through Ceilings

FILL IN
AT JOB SITE

If the Job Book is for a sample house complete both sections 1 and 2 below. For a specific house complete the
section which describes the actual ceiling.

(1) Heat losses through uninsulated ceilings

If the Job Book is being completed for a sample house it is necessary to determine the potential heat savings for
those examples without insulation. If the sample house has some insulation, subtract its R value from the total
above and calculate the heating units required without insulation as below.

$$\boxed{924} \times \boxed{1.5} \div \boxed{3.3} = \boxed{420}$$

Ceiling area
sq. ft. District
heating factor Total
R value Heating units
required

(2) Heat losses through partially insulated ceilings

If ceilings are partially insulated, e.g. to no more than R-10, further savings can be made by adding
insulation. However, the primary savings have already been made and the investment in extra insulation may
not be as worthwhile as some other measures. Evaluate the savings by the calculations below, using R=10 for a
sample building or actual R value for an individual case to determine what priority should be assigned to this
measure.

$$\boxed{924} \times \boxed{1.5} \div \boxed{10} = \boxed{139}$$

Ceiling area
sq. ft. District
heating factor Total
R value Heating units
required

(Use R=10 for sample houses)

The appropriate amount of insulation for a ceiling depends on climate, fuel prices and insulation costs. Check
the current DOE recommendation on maximum appropriate R value for your area. This indicates the maximum
amount of insulation which will be cost effective for your climate. Any less amount of insulation than this will
save less total fuel but will save more per dollar spent.

$$\boxed{924} \times \boxed{1.5} \div \boxed{30} = \boxed{46}$$

Ceiling area
sq. ft. District
heating factor Appropriate
R value Potential
heating units

Subtract the potential heating units from those now required for uninsulated or partially uninsulated ceilings
and enter here:

Potential savings		Potential savings	
1. Conduction through Uninsulated ceilings	374	2. Conduction through Partially insulated ceilings	93

Chart C-38 (Form To Be Completed During Lesson)

Points of Emphasis	Manual Page	Chart No.
<p>(Continued from page 29)</p> <p>(b) Job Book page 5: Heat Losses by Conduction Through Floors</p> <ol style="list-style-type: none"> (1) Enter the floor area, appropriate exposure factor, District Heating Factor and R value and determine the heating units now required due to losses through the floor. (2) If the floor has an exposure factor over 0.5 check the potential heating units based on a floor exposure factor of 0.5. (3) If insulating the perimeter of the crawl space or basement is practical, determine the potential heating units if the floor exposure factor were reduced to 0.3 in this way. (4) If insulating the perimeter is not practical due to probable wetting of the insulation or the need for underfloor ventilation, insulating the whole floor may be the only possible treatment. Determine the potential heating units with a minimum R-15 for the floor. (5) Subtract the three separate potential heating unit figures from the heating units now required and enter the figures in the boxes at the bottom of the page. <p>(Lesson continued on page 35)</p>		C-39

Lesson Plan 5b. Home Weatherization in Four Steps Step 2: Calculation

Lesson Plan 5b. Home Weatherization in Four Steps Step 2: Calculation

from Job Book,
page 6

Home Weatherization Job Book

Project RetroTech

Heat Losses by Conduction Through Floors

Do not complete this page for
concrete slab floors. Heat loss
due to them is usually small but
cannot be evaluated by this
method.

Floor Exposure Factor

Select the appropriate factor from the descriptions
below:

Building on posts or pillars with no perimeter protection	1.0
Building on posts or rocks with some protection against wind blowing under building	.8
Tight skirt or foundation wall around perimeter	.5
Tight foundation wall with equivalent of R4 or better insulation on inside or outside of wall	.3

R value of floor

A typical uninsulated, uncarpeted wood floor will
have an R value of about 3. Carpet and pad will
increase the R value to 5.

R = 3

FILL IN
AT JOB SITE

Potential Savings on Heat Loss through Floors

1. Reducing below floor drafts

$$\boxed{924} \times \boxed{.5} \times \boxed{1.5} \div \boxed{3} = \boxed{231}$$

Floor area (from building description) sq. ft. Floor exposure factor District heating factor Floor R value from above Heating units Required

Unless vigorous underfloor ventilation is needed to remove moisture rising from the ground, a floor should be protected from drafts, so that it has a floor exposure factor of only 0.5. If the floor in this building has an exposure factor over 0.5, cutting out drafts below the floor could reduce the heat loss to:

$$\boxed{} \times \boxed{0.5} \times \boxed{} \div \boxed{} = \boxed{}$$

Floor area from above sq. ft. Floor exposure factor District heating factor Floor R value from above Potential heating units

DO NOT APPLY
ALREADY 0.5

2. Adding Insulation

EITHER (a) The perimeter wall of the crawl space or basement can be insulated (with R=4 or better) down to grade level or just below, to cut both drafts and conduction losses, reducing the floor exposure factor to 0.3. The heat loss with an insulated perimeter would be approximately:

$$\boxed{924} \times \boxed{0.3} \times \boxed{1.5} \div \boxed{3} = \boxed{139}$$

Floor area from above sq. ft. Floor exposure factor District heating factor Floor R value from above Potential heating units

OR

(b) Where perimeter walls cannot be insulated because the insulation would become wet (if water seeps through the basement walls or if water rises above the level of the insulation or if underfloor ventilation is needed) the whole floor may be insulated instead of the perimeter. This is usually more expensive than perimeter insulation but can give extra savings. Insulating this floor with a minimum of 3 1/2" fiberglass between the joists will increase the R value to 15. More insulation will increase the R value further still. The potential heating units will be:

$$\boxed{924} \times \boxed{0.5} \times \boxed{1.5} \div \boxed{15} = \boxed{46}$$

Floor area from above sq. ft. Floor exposure factor (Use 0.5 if drafts can be eliminated. 0.8 if underfloor ventilation is needed) District heating factor Floor R value (minimum of 15) Potential heating units with whole floor insulation

Subtract the potential heating units for any of the three possible floor treatments which are feasible from the heating units now required and enter in the boxes below.

1	2a	2b
$\boxed{}$	$\boxed{92}$	$\boxed{185}$
Potential heating savings by reducing drafts	Potential heating savings by perimeter insulation	Potential heating savings by whole floor insulation

Chart C-39 (Form To Be Completed During Lesson)

Points of Emphasis	Manual Page	Chart No.
<p>(Continued from page 33)</p> <p>(f) Job Book page 6: Heat Losses by Conduction Through Uninsulated Walls</p> <ol style="list-style-type: none"> (1) Enter perimeter and height of outside walls from page 2. Multiply to obtain gross wall area. Subtract sum of areas of windows and doors from pages 2 and 3 to determine net wall area. (2) Insert district heating factor from page 3. (3) From Table 1 on page 9 of the job book, obtain R value for each material in walls. Add these R values to obtain composite value for the walls. Round off to nearest tenth of unit. (4) Use these factors to determine the required heating units, and enter on bottom line. (5) In a similar manner, determine potential heating units based on an R value of well-insulated walls equal to 15. (6) Subtract to determine potential heating savings, and enter on bottom line. <p>(Lesson continued on page 37)</p>		C-40

Lesson Plan 5b. Home Weatherization in Four Steps Step 2: Calculation

Lesson Plan 5b

Home Weatherization in Four Steps

Step 2: Calculation

from Job Book,
page 7

Project RetroTech

Home Weatherization
Job Book

Heat Losses by Conduction Through Uninsulated Walls

(Partially insulated frame walls cannot normally be further insulated.)

R Value of Outside Walls

Uninsulated frame walls usually have a total R value around 3.0 no matter what type of interior finish or siding treatment is present. If the wall is of different construction list all materials in the wall in the table on right, starting from inside and including air spaces within the wall. Insert R value for each component from Table 1.

Material	Thickness (inches)	R Value
Interior surface	-	0.08
GYPSUM BOARD	3/8	.32
AIR SPACE	3 1/2	.91
SHEATHING	3/4	1.00
ASBESTOS SHINGLES	1/4	.13
Outside surface	-	0.17
Total R value		3.21

FILL IN
AT JOB SITE

IT CHECKS

$$\boxed{122} \times \boxed{8} = \boxed{976}$$

Total perimeter of outside wall ft. Total height of outside wall ft. Gross wall area sq. ft.

$$\boxed{976} - \boxed{158} = \boxed{818}$$

Gross wall area sq. ft. Total area of all windows and doors from sketches on pages 2 and 3 Net wall area sq. ft.

$$\boxed{818} \times \boxed{1.5} \div \boxed{3.2} = \boxed{383}$$

Net wall area District heating factor Total R Value Heating units required

Potential Savings by Insulation

Fully insulated frame walls should have an R value of 15. If this were so for this building, the wall heat loss would be:

$$\boxed{818} \times \boxed{1.5} \div \boxed{15} = \boxed{82}$$

New wall area (from box above) District heating factor R value Potential heating units

Subtract the potential heating units from those now required and enter here

Type of Heat Loss	Potential Heating Savings
Conduction Through Uninsulated Walls	301

Chart C-40 (Form To Be Completed During Lesson)

Points of Emphasis	Manual Page	Chart No.
<p>(Continued from page 35)</p> <p>(d) Job Book page 7: Conduction and Infiltration Through Single-Glass Windows</p> <ol style="list-style-type: none"> (1) Use sketches on page 2 to fill in table to determine total area of single-glass windows. (2) Enter district heating factor from page 3. (3) Use these factors to determine the required heating units (based on $R = 1$), and enter on bottom line. (4) Determine the potential heating savings as instructed, and enter on bottom line. <p>End of Lesson No. 5B (Lesson No. 5C starts on page 39)</p>		<p>C-41</p>

Lesson Plan 5b.

Home Weatherization

in Four Steps

Step 2:

Calculation

Chart C-41

[illegible]

Lesson Plan 5b. Home Weatherization in Four Steps Step 2: Calculation

from Job Book,
page 8

Heat Losses by Conduction and Infiltration Through Single-Glass Windows

Home Weatherization
Job Book

Project RetroTech

Area of Single Glass Windows:
(Assuming R = 1 for single glass)

Width	x	Height	x	Number	=	Area
6'	x	4'	x	1	=	24
5'	x	4'	x	1	=	20
3'	x	4'	x	6	=	72
Total sq. ft.						116

If this Job Book covers a sample house determine the potential heat savings for single glass.

$$\boxed{116} \times \boxed{1.5} = \boxed{174}$$

Total sq. ft. District heating factor Heating units required

Potential Saving by Adding Storm Windows

Adding storm windows will cut the conduction heat loss by half and will probably save half again by reducing infiltration, i.e. cut heat loss to 25%. Calculate the potential heating units below.

$$\boxed{174} \times .25 = \boxed{44}$$

Heating units now required with single glass Potential Heating Units

Subtract the potential heating units from those now required and enter here

Type of Heat Loss	Potential Heating Savings
Conduction and Infiltration Through Single Glass Windows	130

Chart C-41 (Form To Be Completed During Lesson)

Points of Emphasis		Manual Page	Chart No.
1.	Step 3 — Evaluation of the Data <p>The Summary Table on pages 10 and 11 of the Job Book is used to evaluate the cost effectiveness of the various possible weatherization measures and to determine a priority ranking.</p> <p>(1) Enter the potential heating savings from the boxes at the bottom of pages 4 to 7 on the appropriate lines in column 5.</p> <p>(2) Estimate the cost of materials for each possible weatherization measure in Column 1, entering the unit cost (cost/ft² or other unit) of the materials and the quantity on which the estimate is based. The unit cost should be an approximation of the average cost across the geographical area covered by the building type.</p> <p>(Lesson continued on page 41)</p>		C-42 C-43 C-44 C-45 C-46

Lesson Plan 5c. Home Weatherization in Four Steps Step 3: Evaluation

Chart C-42

FOUR-STEP PROCESS

1. INSPECTION OF
THE BUILDING
2. CALCULATION OF
HEAT LOSSES
3. EVALUATION OF
THE DATA

ENCLOSURE MAIL/REGISTRATION PROMOTRY LIST				
No. _____ in _____		by Jack B. Reference No. _____		
(Working Type)				
Priority	Category of Mail	Classification/Reference	Agreement/Allowable Date of Receipt	# of Mail in the "Special Delivery" category of mail is indicated in the "Special Delivery" column
1	General Mail Matter	See Jack Board	---	
2				
3				
4				
5				
6				
7				
8				
9				
10				

Step 3 — Evaluation of the Data

- (3) Enter the installation labor cost for each measure in Column 2. This allows for the additional cost of installing the materials so a true cost of the weatherization measure can be obtained.

Standard reference guides which list building construction costs can be used to determine installation labor costs. Chart 56 shows typical material costs and installed costs for Spring 1979.

- (4) Add the total material cost to the labor cost for each weatherization measure to find Total Cost and enter in Column 3.

- (5) Enter the expected life of each proposed weatherization measure in Column 4 and enter the cost per heating unit for the fuel actually being used (from page 3) in Column 6. Then determine the lifetime savings due to each proposed weatherization measure by multiplying the figure in Column 4 by the figure in Column 5, and the product by the figure in Column 6. Enter the answers in Column 7.

- (6) The Benefit:Cost ratio for each weatherization measure is then calculated by dividing the figure in Column 7 (savings due to the measure) by the figure in Column 3 (total cost of the measure) and is entered in Column 8.

C-44

C-44

C-45

C-45

**Lesson Plan 5c.
Home
Weatherization
in Four Steps
Step 3:
Evaluation**

Lesson Plan 5c. Home Weatherization in Four Steps Step 3: Evaluation

from Job Book,
pages 10 and 11

Summary Table for Priority Rating of Weatherization Measures

Fill out the Summary Table at the right by entering the fuel cost per heating unit from p. 3 in Column 4, and the Potential Heating Savings from pp. 4-8 in Column 5. Enter the estimated material cost for the required changes in Column 1, the appropriate installation factor in Column 2 and the expected life of each Weatherization measure in Column 4. From these figures determine the Total Cost and Lifetime Savings from each measure, and then in Column 6 calculate the Benefit: Cost Ratio. Finally, in column 9, rank the weatherization measures in order of cost effectiveness.

Source of Heat Loss	Weatherization Measure Required to Minimize Heat Loss	Unit Cost of Material (\$/sq ft)	Quantity of Material (sq. ft.)	1 Total Material Cost Unit Cost x Quantity (\$)	2 Labor Cost to Install (if appropriate)	3 Total Cost (Col 1 + Col 2) (\$)
General Waste of Heat	See separate Job Order Sheet	—	—	—	—	Usually Small
Uninsulated Ceilings (from p. 4)	Insulate to Local Standard of R = 30 (ADD R. 25)	.33	924	305	76	381
Partially Insulated Ceilings (from p. 4)	Insulate to Local Standard of R = 30 (ADD R. 20)	.23	924	213	75	288
Exposed Floors (from block 1 page 5)	Reduce Exposure factor to 0.5				NOT	APPL
*Uninsulated Perimeter (from block 2a page 5)	Insulate perimeter with R=5 or better USE DUCT WRAP	.22	366	81	49	130
*Uninsulated floors (from block 2b page 5)	Insulate floor with R=11 or better (INCLUDING MESH)	.19	924	176	264	440
Uninsulated Walls (from p. 6)	Insulate Wall to R=15	.22	818	180	270	450
Single Glass Windows (from p. 7)	Add Glass Storm Windows	2.00	116	232	0	232
	Other:					

*Only one of these alternate measures is usually applied to a specific building. See Weatherization Manual for details.

Chart C-44 (Form To Be Completed During Lesson)

**Summary Table
for
Priority Rating
of
Weatherization
Measures**

3 Total Cost (Col 1 + Col 2) (\$)	4 Expected Life of Weatherization Measure (years) OR Expected Life of Bldg., which- ever is least	5 Potential Heat Savings from bottom of pages 4-8 (Heating Units/ year)	6 Fuel Cost per Heating Unit (from page 3) (\$/MU)	7 Lifetime Savings due to Weatherization Measure (Col 4 x Col 5 x Col 6) (\$)	8 Benefit: Cost Ratio (Col 7 + Col 8)	9 Order of Cost Effec- tiveness
Usually Small	—	Usually Substantial	—	—	Usually Favorable	1
381	20	374	.60	4488	11.78	2
288	20	93	.60	1116	3.88	7
APPLICABLE TO THIS TYPE — — — — —						
130	20	92	.60	1104	8.49	3
440	20	185	.60	2220	5.05	6
450	20	301	.60	3612	8.03	4
232	20	130	.60	1560	6.72	5

Lesson Plan 5c. Home Weatherization in Four Steps Step 3: Evaluation

from Job Book,
pages 10 and 11

Chart C-45 (Form To Be Completed During Lesson)

Lesson Plan 5c.
Home
Weatherization
in Four Steps
Step 3:
Evaluation

Points of Emphasis	Manual Page	Chart No.
<p>Step 3 — Evaluation of the Data</p> <p>(7) Rank the cost effectiveness of all the weatherization measures by comparing the figures for Benefit: Cost Ratio. Reducing general heat waste is always regarded as cost effectiveness and is already entered as No. 1 in Column 9. The weatherization measure calculated in Column 8 to have the highest Benefit Cost (i.e. to save the most per dollar spent) is then entered as No. 2 in Column 9. The next most cost effective measure is No. 3, and so on. Any measure which has a Benefit: Cost ratio less than 1.0 will probably cost more than it saves over its lifetime and should be evaluated very carefully at the local level before being included on the Recommended List.</p> <p>(8) Transfer the information on source of heat loss, appropriate weatherization measures and unit material costs for cost effective measures in priority order from the Summary Table onto the Recommended Weatherization Priority List on the lower half of page 11. Enter the building type and area covered (e.g. statewide or sub-area by name) in the appropriate spaces.</p> <p>Part II. The Building Check and Job Order Sheet</p> <p>This folder provides basic ordering and control information for the various weatherization jobs which may be performed on a building. Each section of the sheet is designed to allow the person first checking the building to determine which of the ranked measures are feasible for that particular building and to develop ordering information and work instructions for the installation crew.</p> <p>The sheet can be used intact or individual blocks may be pasted up for duplication, to provide a "camera ready" form which covers the pre-selected weatherization measures. If a specific measure in a block is not to be undertaken, it may be omitted from the duplicated form.</p>		<p>C-45</p> <p>C-46</p> <p>C-47 C-48 C-49 C-50 C-51</p>

Lesson Plan 5c. Home Weatherization in Four Steps Step 3: Evaluation

from Job Book,
page 11

Recommended Weatherization Priority List

Enter the various sources of heat loss and appropriate weatherization measures from the Summary Table above in priority order in the list at right. This is the order of importance of weatherization measures in a building of the type examined regardless of size or age. A copy of this list should be included in the local Building Check and Job Order Sheet for this type of building.

RECOMMENDED WEATHERIZATION PRIORITY LIST				
for <u>SAMPLE RANCH HOUSE</u> (building/type)		<u>LEAST MASS.</u> area/address		by Job Book Reference No. <u>1</u>
Priority	Source of Heat Loss	Weatherization Measure Required	Approximate Allowable Unit Cost of Materials	If Not for a Typical Building check if item is included on Job Order Sheet or note reason for omission
1	General Heat Waste	See Job Sheet	-	✓
2	UNINSUL. CEILINGS	ADD R-26	33¢/FT ²	✓
3	UNINSUL. PERIMETER	ADD DUCT WRAP	22¢/FT ²	✓
4	UNINSULATED WALLS	BLOWN-IN CELLULOSE	22¢/FT ²	OMIT 49 PT. NOT AVAILABLE
5	SINGLE GLASS WINDOWS	ADD STORM WINDOWS	92.00/FT ²	✓
6	UNINSULATED FLOORS	ADD ROL RUM MATN	19¢/FT ²	✓
7	PARTLY INSUL. CEILINGS	ADD R-20	23¢/FT ²	✓
8				
9				

*If this building had been on piers instead of a foundation, perimeter treatment priority could have changed, and a re-evaluation would be necessary.

Chart C-46 (Form To Be Completed During Lesson)

Chart C-51

Chart C-52

Lesson Plan 5c. Home Weatherization in Four Steps Step 3: Evaluation

Project RetroTech Home Weatherization Charts **CHART 51**

JOB ORDER		Estimated Quantity	Estimated Cost (\$)	Actual Quantity	Actual Cost
WIND WINDOWS					
FIRST FLOOR					
1	WINDY 1/2" height	1	1.00		
2	WINDY 1/2" height	1	1.00		
3	WINDY 1/2" height	1	1.00		
4	WINDY 1/2" height	1	1.00		
5	WINDY 1/2" height	1	1.00		
6	WINDY 1/2" height	1	1.00		
7	WINDY 1/2" height	1	1.00		
8	WINDY 1/2" height	1	1.00		
9	WINDY 1/2" height	1	1.00		
10	WINDY 1/2" height	1	1.00		
11	WINDY 1/2" height	1	1.00		
12	WINDY 1/2" height	1	1.00		
SECOND FLOOR					
1	WINDY 1/2" height	1	1.00		
2	WINDY 1/2" height	1	1.00		
3	WINDY 1/2" height	1	1.00		
4	WINDY 1/2" height	1	1.00		
5	WINDY 1/2" height	1	1.00		
6	WINDY 1/2" height	1	1.00		
7	WINDY 1/2" height	1	1.00		
8	WINDY 1/2" height	1	1.00		
9	WINDY 1/2" height	1	1.00		
10	WINDY 1/2" height	1	1.00		
11	WINDY 1/2" height	1	1.00		
12	WINDY 1/2" height	1	1.00		
Total Cost: 24.00					
MECHANICAL OPTIONS					
Any FURNACE EFFICIENCY IMPROVEMENT possible?					
Other:					
Brought forward from p. 1					
Brought forward from p. 1					
Total Estimated Cost: 24.00					
Total Actual Cost: 24.00					

Project RetroTech Home Weatherization Charts **CHART 52**

D.O.E. Weatherization Program
U.S. Department of Energy
BUILDING CHECK AND JOB ORDER SHEET

Read this on this sheet provided for entering and general information for the various weatherization jobs on a building. The sheet can be used before, or after the jobs are completed, or in the interim when approved by the State and DOE, for identification to provide a "summary report" form for a specific building type. If a specific measure is a check to be made, it may be omitted from the diagramed form.

Building Inspection of building, enter any one which does not apply or is already accomplished. Fill in appropriate information for jobs to be done.

RECOMMENDED WEATHERIZATION PRIORITY LIST

By State: MASS By Job Order Reference No. 1

Priority	Measure	Estimated Quantity	Estimated Cost (\$)	Actual Quantity	Actual Cost
1	Uninsulated Attic Floor	1	1.00		
2	Uninsulated Crawl Space	1	1.00		
3	Uninsulated Basement	1	1.00		
4	Uninsulated Garage	1	1.00		
5	Uninsulated Porch	1	1.00		
6	Uninsulated Driveway	1	1.00		
7	Uninsulated Stairs	1	1.00		
8	Uninsulated Roof	1	1.00		
9	Uninsulated Siding	1	1.00		
10	Uninsulated Foundation	1	1.00		
11	Uninsulated Windows	1	1.00		
12	Uninsulated Doors	1	1.00		
13	Uninsulated Porch	1	1.00		
14	Uninsulated Driveway	1	1.00		
15	Uninsulated Stairs	1	1.00		
16	Uninsulated Roof	1	1.00		
17	Uninsulated Siding	1	1.00		
18	Uninsulated Foundation	1	1.00		
19	Uninsulated Windows	1	1.00		
20	Uninsulated Doors	1	1.00		
21	Uninsulated Porch	1	1.00		
22	Uninsulated Driveway	1	1.00		
23	Uninsulated Stairs	1	1.00		
24	Uninsulated Roof	1	1.00		
25	Uninsulated Siding	1	1.00		
26	Uninsulated Foundation	1	1.00		
27	Uninsulated Windows	1	1.00		
28	Uninsulated Doors	1	1.00		
29	Uninsulated Porch	1	1.00		
30	Uninsulated Driveway	1	1.00		
31	Uninsulated Stairs	1	1.00		
32	Uninsulated Roof	1	1.00		
33	Uninsulated Siding	1	1.00		
34	Uninsulated Foundation	1	1.00		
35	Uninsulated Windows	1	1.00		
36	Uninsulated Doors	1	1.00		
37	Uninsulated Porch	1	1.00		
38	Uninsulated Driveway	1	1.00		
39	Uninsulated Stairs	1	1.00		
40	Uninsulated Roof	1	1.00		
41	Uninsulated Siding	1	1.00		
42	Uninsulated Foundation	1	1.00		
43	Uninsulated Windows	1	1.00		
44	Uninsulated Doors	1	1.00		
45	Uninsulated Porch	1	1.00		
46	Uninsulated Driveway	1	1.00		
47	Uninsulated Stairs	1	1.00		
48	Uninsulated Roof	1	1.00		
49	Uninsulated Siding	1	1.00		
50	Uninsulated Foundation	1	1.00		
51	Uninsulated Windows	1	1.00		
52	Uninsulated Doors	1	1.00		
53	Uninsulated Porch	1	1.00		
54	Uninsulated Driveway	1	1.00		
55	Uninsulated Stairs	1	1.00		
56	Uninsulated Roof	1	1.00		
57	Uninsulated Siding	1	1.00		
58	Uninsulated Foundation	1	1.00		
59	Uninsulated Windows	1	1.00		
60	Uninsulated Doors	1	1.00		
61	Uninsulated Porch	1	1.00		
62	Uninsulated Driveway	1	1.00		
63	Uninsulated Stairs	1	1.00		
64	Uninsulated Roof	1	1.00		
65	Uninsulated Siding	1	1.00		
66	Uninsulated Foundation	1	1.00		
67	Uninsulated Windows	1	1.00		
68	Uninsulated Doors	1	1.00		
69	Uninsulated Porch	1	1.00		
70	Uninsulated Driveway	1	1.00		
71	Uninsulated Stairs	1	1.00		
72	Uninsulated Roof	1	1.00		
73	Uninsulated Siding	1	1.00		
74	Uninsulated Foundation	1	1.00		
75	Uninsulated Windows	1	1.00		
76	Uninsulated Doors	1	1.00		
77	Uninsulated Porch	1	1.00		
78	Uninsulated Driveway	1	1.00		
79	Uninsulated Stairs	1	1.00		
80	Uninsulated Roof	1	1.00		
81	Uninsulated Siding	1	1.00		
82	Uninsulated Foundation	1	1.00		
83	Uninsulated Windows	1	1.00		
84	Uninsulated Doors	1	1.00		
85	Uninsulated Porch	1	1.00		
86	Uninsulated Driveway	1	1.00		
87	Uninsulated Stairs	1	1.00		
88	Uninsulated Roof	1	1.00		
89	Uninsulated Siding	1	1.00		
90	Uninsulated Foundation	1	1.00		
91	Uninsulated Windows	1	1.00		
92	Uninsulated Doors	1	1.00		
93	Uninsulated Porch	1	1.00		
94	Uninsulated Driveway	1	1.00		
95	Uninsulated Stairs	1	1.00		
96	Uninsulated Roof	1	1.00		
97	Uninsulated Siding	1	1.00		
98	Uninsulated Foundation	1	1.00		
99	Uninsulated Windows	1	1.00		
100	Uninsulated Doors	1	1.00		
101	Uninsulated Porch	1	1.00		
102	Uninsulated Driveway	1	1.00		
103	Uninsulated Stairs	1	1.00		
104	Uninsulated Roof	1	1.00		
105	Uninsulated Siding	1	1.00		
106	Uninsulated Foundation	1	1.00		
107	Uninsulated Windows	1	1.00		
108	Uninsulated Doors	1	1.00		
109	Uninsulated Porch	1	1.00		
110	Uninsulated Driveway	1	1.00		
111	Uninsulated Stairs	1	1.00		
112	Uninsulated Roof	1	1.00		
113	Uninsulated Siding	1	1.00		
114	Uninsulated Foundation	1	1.00		
115	Uninsulated Windows	1	1.00		
116	Uninsulated Doors	1	1.00		
117	Uninsulated Porch	1	1.00		
118	Uninsulated Driveway	1	1.00		
119	Uninsulated Stairs	1	1.00		
120	Uninsulated Roof	1	1.00		
121	Uninsulated Siding	1	1.00		
122	Uninsulated Foundation	1	1.00		
123	Uninsulated Windows	1	1.00		
124	Uninsulated Doors	1	1.00		
125	Uninsulated Porch	1	1.00		
126	Uninsulated Driveway	1	1.00		
127	Uninsulated Stairs	1	1.00		
128	Uninsulated Roof	1	1.00		
129	Uninsulated Siding	1	1.00		
130	Uninsulated Foundation	1	1.00		
131	Uninsulated Windows	1	1.00		
132	Uninsulated Doors	1	1.00		
133	Uninsulated Porch	1	1.00		
134	Uninsulated Driveway	1	1.00		
135	Uninsulated Stairs	1	1.00		
136	Uninsulated Roof	1	1.00		
137	Uninsulated Siding	1	1.00		
138	Uninsulated Foundation	1	1.00		
139	Uninsulated Windows	1	1.00		
140	Uninsulated Doors	1	1.00		
141	Uninsulated Porch	1	1.00		
142	Uninsulated Driveway	1	1.00		
143	Uninsulated Stairs	1	1.00		
144	Uninsulated Roof	1	1.00		
145	Uninsulated Siding	1	1.00		
146	Uninsulated Foundation	1	1.00		
147	Uninsulated Windows	1	1.00		
148	Uninsulated Doors	1	1.00		
149	Uninsulated Porch	1	1.00		
150	Uninsulated Driveway	1	1.00		
151	Uninsulated Stairs	1	1.00		
152	Uninsulated Roof	1	1.00		
153	Uninsulated Siding	1	1.00		
154	Uninsulated Foundation	1	1.00		
155	Uninsulated Windows	1	1.00		
156	Uninsulated Doors	1	1.00		
157	Uninsulated Porch	1	1.00		
158	Uninsulated Driveway	1	1.00		
159	Uninsulated Stairs	1	1.00		
160	Uninsulated Roof	1	1.00		
161	Uninsulated Siding	1	1.00		
162	Uninsulated Foundation	1	1.00		
163	Uninsulated Windows	1	1.00		
164	Uninsulated Doors	1	1.00		
165	Uninsulated Porch	1	1.00		
166	Uninsulated Driveway	1	1.00		
167	Uninsulated Stairs	1	1.00		
168	Uninsulated Roof	1	1.00		
169	Uninsulated Siding	1	1.00		
170	Uninsulated Foundation	1	1.00		
171	Uninsulated Windows	1	1.00		
172	Uninsulated Doors	1	1.00		
173	Uninsulated Porch	1	1.00		
174	Uninsulated Driveway	1	1.00		
175	Uninsulated Stairs	1	1.00		
176	Uninsulated Roof	1	1.00		
177	Uninsulated Siding	1	1.00		
178	Uninsulated Foundation	1	1.00		
179	Uninsulated Windows	1	1.00		
180	Uninsulated Doors	1	1.00		
181	Uninsulated Porch	1	1.00		
182	Uninsulated Driveway	1	1.00		
183	Uninsulated Stairs	1	1.00		
184	Uninsulated Roof	1	1.00		
185	Uninsulated Siding	1	1.00		
186	Uninsulated Foundation	1	1.00		
187	Uninsulated Windows	1	1.00		
188	Uninsulated Doors	1	1.00		
189	Uninsulated Porch	1	1.00		
190	Uninsulated Driveway	1</			

Lesson Plan 5c. Home Weatherization in Four Steps Step 3: Evaluation

Chart C-55

Project RetroTech Home Weatherization Charts CHART 55

JOB ORDER	Estimated Quantity	Estimated Cost (\$)	Actual Quantity	Actual Cost
ADDITIONAL NECESSARY ITEMS Also note repairs necessary to protect or supplement the weatherization measures: Use: <u>REPAIR ROOF NEAR CHIMNEY</u> — 5.00				
MECHANICAL OPTIONS Are FINANCE EFFICIENCY MEASURES (ENERGY AUDIT) (AIR SEALING) (DUCT CLEANING) (FURNACE IS DIRTY) Other:				
Subtotal		5.00		
Brought forward from p2		106.60		
Brought forward from p2		511.50		
		723.10		
Total Estimated Cost			Total Actual Cost	

Chart C-56

Home Weatherization Charts CHART 56

Appendix
EXAMPLES OF TYPICAL MATERIAL COSTS AND INSTALLED COSTS 1979

Weatherization	Material	Material Cost	Installed Cost
Attic			
Insulating Ceiling	R=11	14¢/FT ²	21¢/FT ²
Adding R-value as fiberglass bats to recommended level	R=20	23¢/FT ²	31¢/FT ²
	R=25	33¢/FT ²	41¢/FT ²
	R=30	36¢/FT ²	45¢/FT ²
Floor Treatments			
1. Applying Draft Proofing (perimeter of house + 3 ft. width approx.)		2.5¢/FT ²	3.0¢/FT ²
2. Insulating perimeter (perimeter of house + 3 ft. width approx.)			
A. Using rigid insulation cemented inside skirting or wall	R=4	12¢/FT ²	30¢/FT ²
PLUS Gypsum board covering		11¢/FT ²	22¢/FT ²
for fire protection in basements			
B. Using fiberglass rolls draped from inside sill	R=11	14¢/FT ²	28¢/FT ²
C. Using duct wrap with extra strength face	R=8	22¢/FT ²	35¢/FT ²
3. Insulating Floors			
Adding R=11 fiberglass rolls	R=11	14¢/FT ²	35¢/FT ²
also mesh support		5¢/FT ²	12.5¢/FT ²
Insulating Frame Walls (blown in cellulose to add R=11)		22¢/FT ²	55¢/FT ²
Adding Storm Windows (purchased with installation included)		\$2.00/FT ²	\$2.00/FT ²

Points of Emphasis	Manual Page	Chart No.
<p>Step 3 — Evaluation of the Data</p> <p>An example of a partly completed Building Check and Job Order Sheet for a similar building to the example used in the Manual appears in Charts 53-56. Note that the order of blocks on the sheet has been arranged to coincide with the priority ranking for the type of building. At the end of each page the estimated costs can be carried forward to check if allowable Weatherization funds will be expended before the list of measures is completed. If this is the case measures should be eliminated, starting with the lowest priority items, until the estimated cost is within the funding limit.</p> <p>The entries on the sample sheet are from the building inspection. When the installation crew does the work the crew chief will enter the actual quantities of materials used, so the Total Actual Cost can be obtained.</p> <p>Use of the Building Check and Job Order Sheet</p> <ol style="list-style-type: none"> (1) Conduct an inspection of the building to determine which weatherization measures are applicable. (2) Enter the estimated quantity of materials and cost in the spaces provided. (3) Determine which measures can be installed within the cost guidelines of the program as provided by the State. Priority will be given to general heat waste measures. (4) The Sheet can be used as an ordering form. (5) Enter the actual expenditures for measures installed. (6) File the completed sheet in the appropriate client file. <p>Optional Chart Material Costs and Installation Factors</p> <p>A list of typical material costs and installation factors current in Spring 1979 appears as Chart 56. It can be used to demonstrate the figures used to complete the Summary Table and Recommended Weatherization Priority List (Charts 45-47).</p>		<p>C-52 C-53 C-54 C-55</p> <p>C-56</p>

Lesson Plan 5c.

Home Weatherization

in Four Steps

Step 3: Evaluation

Lesson Plan 5d.
Home
Weatherization
in Four Steps
Step 4:
Installation

Points of Emphasis		Manual Page	Chart No.
2.	Final step in weatherization process is installation of materials. Training of personnel working on weatherization crews will be handled at the state or program level.	13	C-57

Chart C-57

**FOUR-STEP
PROCESS**

- 1. INSPECTION OF
THE BUILDING**
- 2. CALCULATION OF
HEAT LOSSES**
- 3. EVALUATION OF
THE DATA**
- 4. INSTALLATION OF
THE MATERIALS**