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MASTER

TECHNICAL STATUS REPORT

PRELIMINARY DESIGNS
PASSIVE SOLAR
MANUFACTURED HOUSING
COOP. AGR. #DE-FC02-80CS30377

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TECHNICAL STATUS REPORT
PRELIMINARY DESIGNS
PASSIVE SOLAR MANUFACTURED HOUSING
COOPERATIVE AGREEMENT NO. DE-FC02-80CS30377

FOR

U.S. DEPARTMENT OF ENERGY

BY

NATIONAL HOMES CORPORATION
LAFAYETTE, INDIANA

MAY 12, 1980

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TECHNICAL STATUS REPORT

COOPERATIVE AGREEMENT NO. DE-FC02-80CS3077

I. INTRODUCTION:

The objective of National Homes Corporation's Passive Solar Design Project is to develop a series of solar space heated homes that are both affordable and architecturally attractive in the median priced, mass housing market.

To accomplish this objective the Project Team established the following criteria to guide the development of the three preliminary designs:

1. Low additional cost for solar system.
2. Conventional architectural floor plans and elevations.
3. Conventional building materials and components.
4. Any special components must be currently available through existing building materials distribution outlets.
5. Minimum number of solar system mechanical parts.
6. Thermal storage mass requirements accomplished with conventional wall and/or floor covering materials.
7. Thermal distribution of solar energy by natural convection, or existing house HVAC system.
8. Maximum flexibility of house orientation on lot.
9. Limited homeowner participation in solar system operation.
10. Reliable and predictable solar system energy contribution.

11. Solar system must contain features that can be readily used to generate market enthusiasm.

Early evaluation of these criteria established that several types of passive solar systems were not likely to satisfy several of these objectives:

1. Solar Roof Pond Systems were discounted due to high costs, flat roof architectural style, complex mechanical operation, as well as many specialty components.
2. Thermosiphon or Convective Loop Systems were not pursued because of high cost and limited topography and site orientation.
3. Trombe walls generated a great deal of interest but were eventually considered not appropriate to pursue at this time as a result of high cost, the use of a masonry collector wall rather than wood frame, high potential for night heat loss and summer overheating without suitable movable insulation techniques available.

The two passive solar system that seemed to to comply best to our project criteria were Direct Gain Systems, and Sunspace or Solar Greenhouse Systems.

1. Direct Gain Systems offered the potential for the lowest solar system added cost, with the fewest technical problems to resolve, however, solar contribution potential is lower than for other systems studied. Direct Gain systems meet all of the project criteria to a high degree of satisfaction.

2. Indirect Gain - Sunspace or Solar Greenhouse Systems also comply with the project criteria except that the Solar Greenhouse System was evaluated as being a potential liability in a northern climate when supplemental heat would have to be provided to prevent occasional below freezing greenhouse temperatures. When the construction costs were evaluated the Solar Greenhouse System was shelved in favor of a Sunspace System. The Sunspace concept was more expensive than the Direct Gain System but less costly than the Solar Greenhouse, and offered a highly visible three point marketing approach:
- a. Sunspace as a solar furnace in winter;
 - b. Sunspace as a habitable room in spring and fall;
 - c. Sunspace as a screened porch in the summer.

Although both Direct Gain and Sunspace Systems met our criteria very well, it was determined that the stronger marketability of the Sunspace System would more than compensate for the higher cost.

National Homes Corporation has selected the Sunspace System (Model 3) to continue to develop to the completion of final working drawings.

II. THREE PRELIMINARY DESIGNS:

Model 1: This is a modification of an existing National Homes catalogue plan. Several windows have been shifted to maximize the collector area. This model provides for 3 of 4 compass

orientations of the street in relationship to the house with the flexible garage door location. This plan does not, however, optimize south facing living spaces. This 1349 square foot ranch could be built at no extra cost over the standard catalogue model. Estimated sales price: \$68,800.

Model 2: This is a newly created model which optimizes south facing living spaces with maximum glass areas and north facing buffer areas. This model also has the three directional orientation flexibility. In order to maintain the same livability as Model 1, it was necessary to add 83 square feet to Model 2. At a sales price of \$51/square foot, this 1432 square foot ranch could be said to be \$4,233 more expensive than Model 1, however, such a comparison may not be valid since Model 2 would be sold as a larger home with a separate dining room. A cost comparison of Model 1 at \$68,800 and Model 2 at \$74,100 shows a \$5,300 spread with \$4,200 for extra square footage and at least \$2,250 for the fireplace and extra interior masonry veneer, which provides both marketability and extra thermal storage mass. This makes the Model 2 value added of \$6,450 worth more than the \$5,300 added cost. The air-lock entry is also a marketing plus.

Model 3: This 1424 square foot combination Sunspace/
Direct Gain System ranch design provides the
same livability and orientation flexibility
as the other two models with one additional
feature - "The Sunroom". This "Sunroom" is an
additional 177 square feet, seasonably habitable,
completely finished but unheated space with a
concrete slab floor or optional indoor/outdoor
carpeting. Compared to Model 2 this model
provides roughly the same basic square footage
at an increased sales price for the "Sunroom"
of \$4,800 or \$27/square foot. This cost
includes \$910 for solar fans and dampers.
National Homes has determined that although
the total sales price of Model 3 is slightly
higher than we would like it to be, we also
feel that it has enough market potential to
sell as well or better than Model 2.

III. COSTS:

Costs were developed from preliminary drawings and
specifications. National Homes package costs were estimated
by our Lafayette Division Pricing Department. Field costs
and overhead, profit, etc. were estimated by a Special
Projects Manager.

All models contained the following items:

1. \$12,000 lot
2. Refrigerator
3. Range
4. Dishwasher
5. Garbage Disposal
6. \$500 Landscaping
7. Carpet & Vinyl Sheet Goods
8. Electrical Fixtures
9. R-7 Slab Insulation
10. R-38 Ceiling Insulation
11. R-13 Wall Insulation
12. R-4 Thermax Wall Sheathing
13. Triple Glazed Windows
14. Insulated Steel Doors with Storms

IV. SOLAR PARTICIPATION:

Based on the discussions thus far, National Homes is reluctant to use the cost differentials between models compared to solar performance differentials and apply a cost to benefit comparison.

Let us be satisfied that our solar participation without the night insulation option is in the 33% to 37% range for all three preliminary designs. We are also extremely proud of the 6.9 to 6.4 BTU/SF/DD figures of the three designs at a minimal cost add of \$875 to \$958 over the FHA MPS costs.

The night insulation option offers additional fuel savings in the range of 3.7% to 4.5% increased solar participation at a cost of \$1665 to \$1730.

V. CONCLUSIONS:

National Homes feels that both Model 2 and Model 3 are marketable designs in our specific market situation. National Homes plans to continue development of Model 3 as the final design for this project since we feel that it has the most market potential.

VI. PHASE II AND III PRELIMINARY PROPOSAL:

Although this does not constitute an official proposal for Phase II and III of this program, National Homes Corporation would like to share some of our current ideas on what we think is the most logical sequence of steps to successfully accomplish the full market potential of passive solar systems in the mass housing market.

Our overall goal is to develop the expertise to incorporate passive solar design concepts into all of our models as we have with energy efficient exterior building envelopes. National Homes knows that thousands of median cost, well insulated, moderate passive solar participation homes will conserve far more of our nation's energy resources than the handful of expensive and sophisticated active, hybrid and/or passive custom solar homes that could be built in this limited market.

National Homes is therefore interested in a Phase III effort to develop working drawings for 5 to 7 additional direct gain (like Model 2) and Sunspace (like Model 3) models for inclusion into an eight page color passive solar home catalogue.

National Homes would develop a complete passive solar marketing program around these 6 to 8 models. Marketing tools would include anticipated regional solar performance data. Regional seminars would be conducted to introduce and explain this passive solar concept to our builder network. The anticipated cost of this Phase III effort is around \$100,000 with National Homes assuming a 10% cost sharing.

Phase II activities would consist of a \$1,000 credit against the package price of any of these passive solar homes over a six month period. Maximum 50 builders with one or two credits per builder. National Homes would provide the builders with all the marketing tools necessary to sell these passive solar homes. In return for the \$1,000 credit the builder would be required to provide cost information and a marketing report upon the sale of each of these 50 homes. National Homes would consider cost sharing this \$50,000 plus \$10,000 printing and follow-up administrative cost on a 10% cost sharing basis.

NORTH ELEVATION

MODEL ①

nhm

NATIONAL HOMES, MANUFACTURING CO.
401 S. EARL AVENUE, LAFAYETTE, IND. 47904

REVISIONS

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DATE

DWN. BY

SCALE

SOUTH ELEVATION

EAST

WEST

MODEL ①

REVISIONS

© NATIONAL HOMES CORPORATION

DATE _____ SCALE _____

DWN. BY _____

nhmc

NATIONAL HOMES MANUFACTURING CO.
401 S. EARL AVENUE, LAFAYETTE, IND. 47904

SECTION THRU LIVING RM. & ENTRY

MODEL ①

nhmc

NATIONAL HOMES MANUFACTURING CO
401 S EARL AVENUE, LAFAYETTE, IND 47904

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DATE _____ SCALE _____
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nhmc
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401 S EARL AVENUE, LAFAYETTE, IND 47904

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DATE _____ SCALE _____
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REVISIONS

NORTH ELEVATION

MODEL ②

REVISIONS

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SCALE

DATE

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401 S EARL AVENUE LAFAYETTE, IND 47904

SOUTH ELEVATION

WEST

EAST

MODEL ②

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SECTION THRU LIVING RM.

MODEL ②

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NORTH ELEVATION

MODEL ⑤

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DATE

SCALE

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 401 S EARL AVENUE
 ALABAMA 360 47904

SOUTH ELEVATION

WEST

EAST

MODEL ③

REVISIONS

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DATE _____ SCALE _____

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SECTION THRU SUNROOM AND LIVING ROOM

MODEL

③

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DATE _____ SCALE _____

DWN. BY _____

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NATIONAL HOMES MANUFACTURING CO.
401 S. EARL AVENUE, LAFAYETTE, IND. 47904

3/26/80

1349 Sq.Ft. Living Area
 445 Sq.Ft. Garage
 2 Baths
 Cathedral Ceiling-L.R.

PASSIVE SOLAR HOME
 MODEL #1

DESCRIPTION OF WORKESTIMATE

Permits - Sewer and Water Fees	\$ 270
Survey	75
Clear-Grade-Fill and Clean Lot	480
Foundation (Labor and Materials)	4,375
Soil Treatment	50
Carpentry - Framing Labor	2,640
Plumbing (Incl. Sewer and Water Connection)	1,775
Electric (Incl. Meter Base and Mast	1,585
Electric Fixtures	400
Heat and Air Conditioning	2,070
Insulation - Labor	95
Roofing - Labor	260
Drywall - Labor and Material	2,334
Carpentry - Trim Labor	560
Install Garage Door	70
Install Gutters	77
Masonry (Fireplace and Walls)	-
Kitchen Appliances	1,324
Painting	944
Walks and Drive - Labor and Material	1,236
Carpet and Vinyl	1,821
Bath Mirrors	162
Clean Interior	90
Grading and Landscaping	450
Miscellaneous	432
Total	\$23,575
National Homes Package	20,114
Total	\$43,689
Profit, Overhead, Marketing, Financing	13,106
	\$56,795
Land Cost	12,000
ESTIMATED SALES PRICE	<u>\$68,795</u>

OPTION: IS High R Shade

<u>Material</u>	<u>Labor</u>	<u>Total</u>
\$1,575	\$135	\$1,710

3/26/80

1432 Sq.Ft. Living Area
 480 Sq.Ft. Garage
 2 Baths (1 Split)
 Fireplace and Masonry Walls

PASSIVE SOLAR HOME
MODEL #2

DESCRIPTION OF WORK

ESTIMATE

Permits - Sewer and Water Fees	\$ 275
Survey	75
Clear-Grade-Fill and Clean Lot	480
Foundation (Labor and Materials)	4,585
Soil Treatment	50
Carpentry - Framing Labor	2,780
Plumbing (Incl. Sewer and Water Connection)	1,825
Electric (Incl. Meter Base and Mast)	1,630
Electric Fixtures	420
Heat and Air Conditioning	2,085
Insulation - Labor	105
Roofing - Labor	275
Drywall - Labor and Material	2,485
Carpentry - Trim Labor	640
Install Garage Door	70
Install Gutters	75
Masonry (Fireplace and Walls)	1,419
Kitchen Appliances	1,324
Painting	1,002
Walks and Drive - Labor and Material	2,234
Carpet and Vinyl	1,933
Bath Mirrors	187
Clean Interior	90
Grading and Landscaping	450
Miscellaneous	496
Total	\$26,990
National Homes Package	20,756
Total	\$47,746
Profit, Overhead, Marketing, Financing	14,324
	\$62,070
Land Cost	12,000
ESTIMATED SALES PRICE	<u>\$74,070</u>

OPTION: IS High R Shade
Material Labor Total
 \$1,500 \$165 \$1,665

3/26/80

PASSIVE SOLAR HOME
MODEL #3

1424 Sq.Ft. Living Area
556 Sq.Ft. Garage
2 Baths (1 Split)
Cathedral Ceiling-B.R.#1,
L.R. & Sun Room
Fireplace and Masonry Walls

DESCRIPTION OF WORKESTIMATE

Permits - Sewer and Water Fees	\$ 280
Survey	75
Clear-Grade-Fill and Clean Lot	480
Foundation (Labor and Materials)	4,685
Soil Treatment	50
Carpentry - Framing Labor	2,920
Plumbing (Incl. Sewer and Water Connection)	1,825
Electric (Incl. Meter Base and Mast)	1,720
Electric Fixtures	450
Heat and Air Conditioning	2,130
Solar Damper	566
Insulation - Labor	105
Roofing - Labor	285
Drywall - Labor and Material	2,550
Carpentry - Trim Labor	670
Install Garage Door	70
Install Gutters	82
Masonry (Fireplace and Walls)	1,035
Kitchen Appliances	1,324
Painting	997
Walks and Drive - Labor and Material	1,366
Carpet and Vinyl	1,922
Bath Mirrors	187
Clean Interior	90
Grading and Landscaping	450
Miscellaneous	487
Total	\$26,801
National Homes Package	23,124
Total	49,925
Profit, Overhead, Financing, Marketing	14,978
	64,903
Land Cost	12,000
ESTIMATED SALES PRICE	<u>\$76,903</u>

OPTION: IS High R Shade

<u>Material</u>	<u>Labor</u>	<u>Total</u>
\$1,550	\$180	\$1,730

PASSIVE SOLAR HOME
OVERHEAD - FINANCING - PROFIT

% Direct Costs (includes lot cost)

3½% Field overhead (includes but not limited to):

1. Payroll taxes and fringe benefits for hourly employees
2. Field office rental
3. Storage area rental
4. Utilities for above areas
5. Truck and equipment costs
6. Small tools and supplies
7. Callbacks
8. Field supervision salaries
9. Miscellaneous

7% Sales overhead (includes but not limited to):

1. Sales office rental and costs
2. Utilities on above
3. Model display carrying costs (interest, decoration, etc.)
4. Model display costs (cleaning, touch-up, etc.)
5. Signs and signs rental
6. Media advertising
7. Brochures and pass out material
8. Commissions
9. Sales supervision salaries
10. Miscellaneous

2½% Administrative overhead (including but not limited to)

1. Supervision salaries
2. Payroll taxes and fringes for administrative personnel and other salaried personnel
3. Insurance (all kinds except builders risk per unit)
4. Legal
5. Bookkeeping & accounting costs
6. Office rental
7. Utilities for office
8. Miscellaneous

% Direct Costs (includes lot cost)

6% Financing costs (does not include "points" on mortgage amount. Some of these costs are often paid directly by buyer):

1. FHA-VA fees
2. Final survey
3. Abstract and/or title insurance
4. Legal or escrow fees
5. Construction interest
6. Recording fees
7. Transfer fees

11% Profit

**Londe
Parker
Michels
Consultants**

**Energy
Conservation

Solar Energy
Utilization**

Preliminary Design Report

on

**PASSIVE AND HYBRID SOLAR
MANUFACTURED HOUSING AND BUILDINGS
PHASE I
PROGRAM OPPORTUNITY NOTICE DE-PN02-79CS30143**

for

**NATIONAL HOMES MANUFACTURING COMPANY
LAFAYETTE, INDIANA**

May 2, 1980

INTRODUCTION

The goal of the preliminary design process was to investigate three Passive Solar Manufactured Home options. The options are presented as three separate models.

Model 1 consists of a conventional model which has been modified to optimize Passive Solar energy without using new materials or adding extra cost.

Model 2 utilizes new design concepts and existing construction materials to increase the Passive Solar contribution for little extra cost.

Model 3 consists of new Passive Design concepts and materials to optimize the Passive Solar contribution at a moderate cost increase.

One of these models will be selected as a candidate for Phase II: construction.

The attached appendix contains those calculations that support the Passive Solar thermal performance estimates for these three models.

METHODOLOGY

A. Heating Loads

The heating loads for each model have been established using standard ASHRAE calculations procedures. The loads are expressed three ways:

1. BTU's/design hour
2. BTU's/degree day
3. BTU's/(DD*SqFt)

It is assumed that these designs will be built with slab on grade construction. There are two ASHRAE techniques available for calculating the heat loss from the combined slab edge and foundation wall. These methods leave some room for judgment in calculating heat loss. Our calculations include both methods, for establishing a range of heat loss. In addition, our calculations include an analysis of performance with and without night insulating shades for the windows. This dynamic insulating technique is cost effective for the homeowner, but may add significantly to the first cost of the purchased unit. Since the insulating shades can significantly affect the overall heat loss of the building, it also impacts on the

solar fraction. Therefore, the solar fraction for each model has been calculated with and without insulating shades for each of the two ASHRAE heat loss calculation procedures for a slab on grade. These values are summarized in Table 1.

B. Solar Calculations

The calculation for solar performance of the three model homes is based on long term average insolation, on a vertical surface, and it uses a modified degree day calculation procedure similar to that developed by Balcomb. The method has been developed and tested over the last five years by Londe-Parker-Michels and is documented in the Appendices of Solar Energy Utilization by Tim Michels.

As a simplified calculation technique, the method is designed to be a conservative predicting tool. As a result, it is expected that dynamic modeling should produce results that indicate better solar performance than this tool will predict.

C. Mass

Simplified methods of estimating necessary thermal mass for Passive Solar homes are not well developed or well tested. This is a function of the fact that it is a multi-variable system. There are two basic kinds of mass: directly irradiated mass and non-irradiated mass.

The charging rates and discharging rates of non-irradiated mass are somewhat open to question. Most modeling techniques assume that the thermal mass of the house has a single lumped capacitance that is not in direct sunlight. (This applies to the concept of internal mass as distinct from a thermal storage wall.) Over the last five years, Londe-Parker-Michels has been using a simplified calculation technique for estimating the effectiveness of internal mass capacitance. A full discussion of this technique is documented as part of Chapter 5 in Solar Energy Utilization. Summary calculation techniques, that illustrate the methodology, are attached as Appendices to this report.

RESULTS

General Comments

National Homes is presenting three of the designs that it has investigated. In general the designs are direct gain type Passive Solar systems that will utilize the mass of the concrete floor as a primary storage area, with double drywall ceilings acting as additional thermal capacitance. Model 1 represents the current state of designs for National

Homes. There has been no architectural redesign to orient living spaces to the south side of the building. Designs for Models 2 and 3 represent an architectural reorganization of space so that the house, in general, faces the south.

A. Model 1

Model 1 is based on the thermal performance of a thermal shield unit as produced by National Homes. The modifications to this design entail the selective moving of glass from east and west and north orientations to the south. This approach produces a unit that is estimated to have a solar performance of between 33 and 41%, depending on the slab heat loss estimation techniques and whether or not insulating shades are used. Except for the added cost of the optional shades, this unit should add no additional cost to the present production cost of the National Homes model on which it is based. The heating loads for Model 1 vary from 6.9 to 5.3 BTU's/(DD*SQFT). Peak heating loads for Model 1 vary between 19,700 and 25,400 BTU's per hour.

B. Model 2

Model 2 represents an attempt to make some architectural changes for energy conservation. In addition to the changes for conservation, there are additional efforts to enhance the solar performance by utilizing additional glass and adding mass in some of the primary living spaces. The primary conservation effort entails the addition of an air lock entry at the front door. Efforts to enhance the solar performance include the addition of 12% more glass to the south wall, compared to Model 1; and the addition of a four inch masonry veneer on interior walls of the living room and the inclusion of a masonry hearth for added mass. The estimate of solar performance for Model 2 varies from 34.4% to 42.8%, depending on heat loss from the slab and addition of insulating shades for the glass. These changes represent moderate increases in both cost and amenities for Model 2 as compared to Model 1. Heat loss calculations estimate that the demand of Model 2 will vary between 6.72 and 5.21 BTU's/(DD*SQF). The rate of peak heating demand is estimated to vary between 21,100 and 27,200 BTU's per hour.

C. Model 3

Model 3 represents some significant architectural changes to enhance the Solar Passive performance of the design. A dynamic space called a sun room has been added to the overall square footage of the building. This sun room will function as additional living space when temperatures permit. The sun room will have an exposed concrete floor that will act as storage mass in conjunction with the

concrete floors of the rest of the house. As the sun room heats up, the heat will be vented into the living spaces. There will be options for the venting mechanism as follows:

1. Automatic controlled dampers; and
2. Through manual operation of a sliding glass door.

Additional characteristics include a cathedral ceiling in the master bedroom. This high space should allow for some overheating without compromising comfort in the people zone.

Model 3 is estimated to have a Passive Solar performance of between 37.4 and 44.6%. The estimated heat loss may vary between 6.4 and 5.5 BTU's/(DD*SQFt). The peak heating load may vary between 21,600 and 26,500 BTU's per hour. These values, again, are a function of heat loss from slab and the use or non-use of insulating shades.

HEAT LOSS MATRIX

METHOD 1. (SLAB HEAT LOSS)¹

METHOD 2. (SLAB HEAT LOSS)²

	Without night insul ³	% Solar	With night insul ³	% Solar	Without night insul ³	% Solar	With night insul ³	% Solar
MODEL 1.								
146 s.f. coll'r								
BTU/H	25386	33.0%	21905	37.5%	23219	35.7%	19738	41.0%
BTU/DD	8959		7731		8195		6966	
BTU/S.F./DD	(6.90)		(5.96)		(6.31)		(5.37)	
MODEL 2.								
163.7 s.f.								
BTU/H	27227	34.4%	23494	39.0%	24845	37.3%	21113	42.8%
BTU/DD	9609		8292		8768		7452	
BTU/S.F./DD	(6.72)		(5.80)		(6.13)		(5.21)	
MODEL 3.								
175.4 s.f.								
BTU/H	26527	37.4%	23731	41.1%	42398	40.2%	21602	44.6%
BTU/DD	9362		8376		8611		7624	
BTU/S.F./DD	(6.41)		(6.03)		(6.20)		(5.49)	

Notes:

1. Heat Loss from slab ASHRAE 1977 Fundamentals, p. 24.5, Table 3.
2. Heat Loss from slab ASHRAE 1977 Fundamentals, p. 24.4, Table 7.
3. Assumes double glazing for south glass, triple elsewhere.

Collector areas normalized to equivalent direct gain area.

TABLE 1

APPENDIX

PROJECT: NATIONAL HOMES LPM 48

WORKSHEET #1.

CLIMATIC DATADATE: 5.1.80

LOCATION	NAME: <u>INDIANAPOLIS</u>		
	LATITUDE: <u>39° 4'</u>	LONGITUDE: <u>86° 2'</u>	ELEVATION: <u>793 FT</u>

DESIGN CONDITIONS	WINTER	SUMMER
	DESIGN TEMP. (97.5% ASHRAE F23) <u>+2 °F</u>	DESIGN TEMP. (2.5% ASHRAE F23) <u>90/74</u>
	AVERAGE ^{WINTER} TEMP. (McGraw-Hill, page 23) <u>39.6</u>	MEAN DAILY RANGE (ASHRAE F23) <u>22 °F</u>
	GROUND TEMP. AMPLITUDE (ASHRAE F24.5) <u>20 °F</u>	EQUIVALENT FULL LOAD HRS (ASHRAE) <u>600-1600</u>

MONTHLY	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL
AVERAGE AMBIENT AIR TEMPERATURE	21.9	30.7	39.7	52.3	62.2	71.7	75	73.2	66.3	55.7	41.7	30.9	52.3
1. IR RADIATION (VERT.) KCAL/FT.²/DAY	966	959	933	658	504					1330	1169	1023	
HEATING DEGREE DAYS	1113	949	809	432	177	39	-	-	90	316	723	1051	5699
WIND: AVERAGE SPEED AND DIRECTION													
COOLING DEGREE DAYS													
MEAN % OF POSSIBLE SUNSHINE (CLIMATE ATLAS)	41	47	49	55	62				68	64	48	39	59

1. DOES NOT INCLUDE ALBEDO

LPM 48.30
PROJECT: NATIONAL HOMES - MODEL #1

WORKSHEET # 6

DATE: MAY 2, 1980

SOLAR FRACTION SHORT FORM

A	DEGREE DAYS
B	INCIDENT RADIATION, SOUTH FACING VERTICAL SURFACE (BTU'S/FT ² -DAY)
C	DAYS/MONTH
D	BTU'S/FT ² -MONTH (B×C)
E	NORMALIZE TO JANUARY = $\frac{\text{EACH MONTH D}}{\text{JANUARY D}}$
F	COLLECTOR AREA = DIRECT GAIN FT ² 146 × .50 (EFFICIENCY) = 73 + GREENHOUSE FT ² × .40 + TROMBE FT ² × .33
G	JANUARY BTU'S GAIN (D×F)
H	HOUSE LOAD (BTU/D.D.) (FROM WORKSHEET #3)
I	JANUARY SOLAR COMPENSATED DEGREE DAYS ($\frac{G}{H}$)
J	USABLE SOLAR COMPENSATED DEGREE DAYS (E×I LISTED ≤ A)
K	SOLAR FRACTION (%) ($\frac{100 J}{A}$) ($\frac{100 J \text{ ANNUAL}}{A \text{ ANNUAL}}$)

← WINTER →																				
	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	ANNUAL										
A		316	723	1051	1113	949	809	432	177	5570										
B		1330	1169	1023	966	959	933	658	504	FOR WINTER										
C	30	31	30	31	31	28	31	30	31											
D	(10 ⁴)	4.12	3.51	3.17	2.99	2.69	2.89	1.77	1.56											
E		1.38	1.17	1.06	1.0	.9	.97	.66	.52											
				F	73															
				G	2.18×10 ⁶															
				H	8195 _A	8959 _B	6966 _C	7731 _D												
KEY				I	266	243	313	282												
J	A	C	(316)	(316)	311	366	282	332	266	313	239	282	258	304	176	207	138	163	1986	2283
	B	D	(316)	(316)	284	330	257	299	243	282	219	254	236	274	160	186	126	147	1841	2058
K										28.1									35.7	41.0
																			33.0	37.5

COMMENTS: SEE SHT #3 FOR LOAD VARIATIONS.

HEAT LOSS WORKSHEET

WORKSHEET # 3

BUILDING SECTION	SECTION #	A AREA (FT ²)	B U-VALUE		C TEMPERATURE DIFFERENCE	D BTU/HOUR (DESIGN)		E BTU/DD. (DEGREE DAY)	COMMENTS
				W/INSUL SHADE			W/INSUL SHADE		
1. WINDOWS & DOORS	1. S	146	.58	.28	68°F	5758	2780		
	2. N+E (NOV)	43.5	.36	.19		1065	562		
	3. DOOR	20	.128			174			
2. CEILINGS	1. ALL HEATED.	1298	.026		68	2295			
	2.								
	3.								
3. WALLS	1. EXPOSED	846	.064 ↓		68	3682			
	2. BUFFERED	197				34	211		
	3. "	72				23	105		
	4. CATHEDRAL CEILING SIDES	95				68	413		
4. FLOORS	1. PERIMETER	131 LIN. FT.	U = .245/LIN. FT.		68*	3073			FUND. 1977 ASHRAE p 24.4 p 24.5 *68°F USED AS SAFETY FACTOR
	2.		40 BTU/LIN FT			5240			
	3.								
		VOLUME (FT ³)	AIR CHANGES PER HOUR	TEMPERATURE DIFFERENCE	BTU/HOUR (DESIGN)	BTU/DD (DEGREE DAY)	COULD BE 32.7°F		
	CONSTANT					D x 24 ÷ 68			
5. INFILTRATION	.018	10,528	0.5	68	6443				
				INSUL SHADE	W/O	WITH	W/O	WITH	
TOTALS				P24.4 SLAB	23219	19738	8195	6966	
				P24.5 SLAB	25386	21905	8959	7731	

PROJECT: LPM 48.30. NATIONAL HOMES MODEL #1

WORKSHEET #7

DATE: MAY 2, 1980

MASS STORAGE

SUGGESTED HOURS OF STORAGE* (FOR MINIMUM HEAT OVERFLOW IN JANUARY)			
SOLAR FRACTION-AVERAGE JANUARY (DECIMAL)	FROM SOLAR SAFETY WORKSHEET	0.281	A.
DEGREE DAYS IN JANUARY (AVERAGE)	FROM CLIMATE DATA	X 1113	B.
DAYS IN JANUARY		÷ 31	C.
PERCENT SUNSHINE IN JANUARY (DECIMAL)	FROM CLIMATE DATA	÷ .41	D.
MAXIMUM DAILY SOLAR INPUT (%/DAY)		= 24.6	E.
6- USABLE JANUARY SUNSHINE HOURS, HEAT GOES TO OFFSET LOAD, NO STORAGE REQ.		$E \div (D \div 31) \times 24 - 6 =$	
HOURS OF STORAGE		10.4	F.

REQUIRED MASS: FOR AVERAGE JANUARY HEAT LOSS WITH MAX. SUNSHINE			
HOUSE LOAD (BTU/DO)	FROM HEAT LOSS WORKSHEET	8959 HIGH B	G. 6966 LOW C
DAILY AVERAGE JANUARY D.D. (65 - AVG JAN °F)	FROM CLIMATE DATA OR JAN D.D. / 31	X 35.9	H. 35.9
HOURS OF STORAGE REQUIRED	LINE F/24 (ABOVE)	X 0.43	I. 0.43
STORAGE (HEAT CAPACITANCE) REQUIRED		= 138300.	J. 107534.

AVAILABLE MASS CAPACITANCE (IF TOTAL AVAILABLE MASS CAPACITANCE IS LESS THAN STORAGE REQUIRED, (J ABOVE), ADDITIONAL MASS IS NEEDED)							
LOCATION	K. POUNDS	L. SPECIFIC HEAT	M. ΔT (COMPOD)	N. (K·L·M)	O. LATENT HEAT	P. (K·O)	Q. (N + P)
1. SOUTH ROOM SLAB	36015	.22	15	118850			118850
2. NORTH ROOM SLAB	58065	.22	5	63870			63870
3. DRYWALL							
4.							
5.							
6.							
7.							
8.							
TOTAL (AVAILABLE CAPACITANCE) =							

LPM 48.30

DATE: MAY 2, 1980

WORKSHEET # 6

SOLAR FRACTION SHORT FORM

A	DEGREE DAYS
B	INCIDENT RADIATION, SOUTH FACING VERTICAL SURFACE (BTU'S/FT ² -DAY)
C	DAYS/MONTH
D	BTU'S/FT ² -MONTH (B×C)
E	NORMALIZE TO JANUARY = $\frac{\text{EACH MONTH D}}{\text{JANUARY D}}$
F	COLLECTOR AREA = DIRECT GAIN FT ² 163.2 × .50 (EFFICIENCY) 82 + GREENHOUSE FT ² × .40 + TROMBE FT ² × .33
G	JANUARY BTU'S GAIN (D×F)
H	HOUSE LOAD (BTU/D.D.) (FROM WORKSHEET #3)
I	JANUARY SOLAR COMPENSATED DEGREE DAYS ($\frac{G}{H}$)
J	USABLE SOLAR COMPENSATED DEGREE DAYS (E×I LISTED ≤ A)
K	SOLAR FRACTION (%) ($\frac{100 J}{A}$) ($\frac{100 J \text{ ANNUAL}}{A \text{ ANNUAL}}$)

[illegible]

COMMENTS:

HEAT LOSS WORKSHEET

WORKSHEET #3

BUILDING SECTION	SECTION #	A AREA (FT ²)	B U-X-VALUE	C TEMPERATURE DIFFERENCE	D BTU/HOUR (DESIGN)	E BTU/DD (DEGREE DAY)	COMMENTS
					INSUL SHADE		
1. WINDOWS & DOORS	1. S	163.7	.58 .28		6456 3116		
	2. N+E+W	34	.36 .19	68°F	832 439		
	3. DOOR	20	.128		174		
2. CEILINGS	1. ALL HEATED	1430	.026	68	2528		
	2.						
	3.						
3. WALLS	1. EXPOSED	932	.064	68	4056		
	2.		↓	34	420		
	3. BUFFERED	193					
	4.						
4. FLOORS	1. EXP. PERIMETER	144 LIN. FT	.345	68*	3378		ASHRAE p 24.4
	2.		← 40 BTU/LIN FT →		5760		ASHRAE p 24.5
	3.			*SEE MODEL #1			1977 FUND.
		VOLUME (FT ³)	AIR CHANGES PER HOUR	TEMPERATURE DIFFERENCE	BTU/HOUR (DESIGN)	BTU/DD (DEGREE DAY)	
	CONSTANT					DX 24 ÷ 68	
5. INFILTRATION	.018	11440	0.5	68	7001		
				INSUL SHADE	W/O WITH	W/O WITH	
TOTALS				SLAB	P 24.4 P 24.5	24845 21112 27227 23494	8768 7451 9609 8292

PROJECT: LPM 48.30 NATIONAL HOMES MODEL #2

WORKSHEET #7

DATE: MAY 2, 1980

MASS STORAGE

SUGGESTED HOURS OF STORAGE* (FOR MINIMUM HEAT OVERFLOW IN JANUARY)			
SOLAR FRACTION-AVERAGE JANUARY (DECIMAL)	FROM SOLAR FAIR WORKSHT.	0.296	A.
DEGREE DAYS IN JANUARY (AVERAGE)	FROM CLIMATE DATA	X 1113	B.
DAYS IN JANUARY		÷ 31	C.
PERCENT SUNSHINE IN JANUARY (DECIMAL)	FROM CLIMATE DATA	÷ .41	D.
MAXIMUM DAILY SOLAR INPUT (%/DAY)		= 25.9	E.
6- USABLE JANUARY SUNSHINE HOURS HEAT GOES TO OFFSET LOAD. NO STORAGE REQ. HOURS OF STORAGE		$[E ÷ (B ÷ 31) × 24] - 6 =$ 11.3	F.

REQUIRED MASS: FOR AVERAGE JANUARY HEAT LOSS WITH MAX. SUNSHINE			
HOUSE LOAD (BTU/DD)	FROM HEAT LOSS WORKSHT	9609 HIGH D	G.
DAILY AVERAGE JANUARY DD (65-AVG JAN. °F)	FROM CLIMATE DATA OR JAN DD/54	X 35.9	H.
% OF DAY STORAGE REQUIRED (DECIMAL)	LINE F/24 (ABOVE)	X .47	I.
STORAGE (HEAT CAPACITANCE) REQUIRED		= 162132.	J.
			125720.

AVAILABLE MASS CAPACITANCE (IF TOTAL AVAILABLE MASS CAPACITANCE IS LESS THAN STORAGE REQUIRED, (J ABOVE), ADDITIONAL MASS IS NEEDED)							
LOCATION	K. POUNDS	L. SPECIFIC HEAT	M. ΔT (COMFORT)	N. (K × L × M)	O. LATENT HEAT	P. (K × O)	Q. (N + P)
1. SOUTH ROOM SLAB	47426	.22	15	156500			156500
2. NORTH ROOM SLAB	39933	.22	5	43920			43920
3. BRICK VENEER	8553	.22	15	28220			28220
4. DRYWALL							
5.							
6.							
7.							
8.							
TOTAL: (AVAILABLE CAPACITANCE) =							

LPM 48.30
PROJECT: NATIONAL HOMES - MODEL # 3

WORKSHEET # 6

DATE: MAY 2, 1980

SOLAR FRACTION SHORT FORM

A	DEGREE DAYS
B	INCIDENT RADIATION, SOUTH FACING VERTICAL SURFACE (BTU'S/FT ² -DAY)
C	DAYS/MONTH
D	BTU'S/FT ² -MONTH (B×C)
E	NORMALIZE TO JANUARY = $\frac{\text{EACH MONTH D}}{\text{JANUARY D}}$
F	COLLECTOR AREA = DIRECT GAIN FT ² 866 × .50 (EFFICIENCY) 43.3 + GREENHOUSE FT ² 111 × .40 44.4 + TROMBE FT ² × .33 87.7
G	JANUARY BTU'S GAIN (D×F)
H	HOUSE LOAD (BTU/D.D.) (FROM WORKSHEET #3)
I	JANUARY SOLAR COMPENSATED DEGREE DAYS ($\frac{G}{H}$)
J	USABLE SOLAR COMPENSATED DEGREE DAYS (E×I LISTED ≤ A)
K	SOLAR FRACTION (%) ($\frac{100 J}{A}$) ($\frac{100 J \text{ ANNUAL}}{A \text{ ANNUAL}}$)

← WINTER →										
	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	ANNUAL
A		316	723	1051	1113	949	809	432	177	5570
B		1330	1169	1023	966	959	933	658	504	FOR WINTER
C	30	31	30	31	31	28	31	30	31	
D	(10 ⁴)	4.12	3.51	3.17	2.99	2.69	2.89	1.77		
E		1.38	1.17	1.06	1.0	.9	.97	.66	.52	
KEY				F	88					
				G	2.63 × 10 ⁶					
				H	8611 _A	9362 _B	7624 _C	8375 _D		
				I	306	281	345	314		
				J	A C (316) (316)	35B 404	324 366	306 345	275 311	297 335
	B D (316) (316)	329 367	298 333	281 314	253 283	273 305	185 207	146 163	2081 2280	
K					31.0					40.2 44.6
										37.4 41.1

COMMENTS:

HEAT LOSS WORKSHEET

BUILDING SECTION	SECTION #	A AREA (FT ²)	B U X-VALUE	C TEMPERATURE DIFFERENCE	D BTU/HOUR (DESIGN)	E BTU/DD (DEGREE DAY)	COMMENTS
1. WINDOWS & DOORS	1. S (BEDROOMS) S (LIVING RM) 2. N+E+W 3. DOOR	86.6 68.2 28.9 20	.58 .58 .36 .128	68 34 68 68	3415 1345 707 174	1649 649 373	SUNSPACE HAS ADDITIONAL SOUTH GLASS/KAL WALL OF 111 FT ²
2. CEILINGS	1. ALL HEATED 2. 3.	1401	.026	68	2488		
3. WALLS	1. EXPOSED 2. BUFFERED 3. 4. CATHEDRAL SIDE WALLS	899 381 231	.064 ↓	68 34 68	3912 829 1005		
4. FLOORS	1. PERIMETER 2. 3.	128.7 FT ¹	.345 BTU/(L.F.F) 40 BTU/L.F	68*	3019 5148		ASHRAE p24.4 ASHRAE p24.5 77 FUNDAMENTALS
				* SEE COMMENTS MODEL #1			
		VOLUME (FT ³)	AIR CHANGES PER HOUR	TEMPERATURE DIFFERENCE	BTU/HOUR (DESIGN)	BTU/DD (DEGREE DAY)	
	CONSTANT M _{CP}					D x 24 ÷ 68	
5. INFILTRATION	.018	12262	0.5	68 INSUL SHADE	7504 W/O WITH	W/O WITH	
TOTALS				SLAB P24.4 P24.5	24398 21602 26527	21602 9362 8375	

DATE: MAY 2, 1980

MASS STORAGE

SUGGESTED HOURS OF STORAGE* (FOR MINIMUM HEAT OVERFLOW IN JANUARY)			
SOLAR FRACTION-AVERAGE JANUARY (DECIMAL)	FROM SOLAR FRAC WORKSHT.	0.31 ^{BEST}	A.
DEGREE DAYS IN JANUARY (AVERAGE)	FROM CLIMATE DATA	X 1113.	B.
DAYS IN JANUARY		÷ 31	C.
PERCENT SUNSHINE IN JANUARY (DECIMAL)	FROM CLIMATE DATA	÷ .41	D.
MAXIMUM DAILY SOLAR INPUT (°F/DAY)		= 27.1	E.
6-usable JANUARY SUNSHINE HOURS HEAT GOES TO OFFSET LOAD. NO STORAGE REQ. HOURS OF STORAGE		$[E ÷ (B ÷ 31) × 24] - 6 =$ 12.1	F.

REQUIRED MASS: FOR AVERAGE JANUARY HEAT LOSS WITH MAX. SUNSHINE			
HOUSE LOAD (BTU/60)	FROM HEAT LOSS WORKSHT	9362 ^{HIGH} B	G.
DAILY AVERAGE JANUARY DD (65-AVG JAN. °F)	FROM CLIMATE DATA OR JAN DD/°F	X 35.9	H.
% OF DAY STORAGE REQUIRED (DECIMAL)	LINE F/24 (ABOVE)	X .504	I.
STORAGE (HEAT CAPACITANCE) REQUIRED		= 169392.	J.

AVAILABLE MASS CAPACITANCE (IF TOTAL AVAILABLE MASS CAPACITANCE IS LESS THAN STORAGE REQUIRED, (J ABOVE), ADDITIONAL MASS IS NEEDED)							
LOCATION	K, POUNDS	L, SPECIFIC HEAT	M, ΔT (COMFORT)	N, (K·L·M)	O, LATENT HEAT	P, (K·O)	Q, (N + P)
1. SOUTH 6" SLAB	29163	.22	15	96240			96240
2. NORTH 6" SLAB	45756		5	50330			50330
3. SUNROOM	12385		15	40870			40870
4. L.R. 6" SLAB	19720	↓	10	43380			43380
5. DRYWALL							
6.							
7.							
8.							
TOTAL: (AVAILABLE CAPACITANCE) =							

NATIONAL HOMES CORPORATION
401 Earl Avenue
Lafayette, Indiana

INTERIM REPORT/PRELIMINARY DESIGN STAGE
PASSIVE SOLAR HOMES MARKETING APPROACH

National Homes Company's Passive Solar Homes Marketing Approach will be based on non-solar houses similar in appearance to homes acceptable in the marketplace by builders and homebuyers.

Accordingly, the designs will not initially include radical changes that are not already proven in the marketplace. Also, the homes designed by National Homes will be not too difficult to build by any experienced builder. They will be in a price range that is affordable in today's economy, and will cost only a moderate amount above non-Passive Solar designed homes.

Our philosophy is that more energy will be saved by having a volume of homes built that offer moderate to substantial energy savings -- than having a handful of homes built that might offer the "ultimate" in energy savings, but which do not capture the builder's or the homebuying public's imagination.

It is strongly believed that simply having windows on the south side of a "standard" house, plus a few other features, will not excite either the builders or the public. Therefore, Model #1 offers little opportunity for a success story as a Passive Solar Home, although it can be built with a minimum cost increase above "standard" plans (perhaps 1% increase).

In Marketing Model #1, we would develop a program that highlights both the solar and non-solar energy saving features:

- (1) Engineer/Architects placement of the home on the lot for maximum solar usage.
- (2) Proper levels of insulation in ceiling, walls and floor.
- (3) Thermal doors.
- (4) Insulated windows with Thermal-break.
- (5) Energy conserving heating equipment (properly sized).
- (6) Heat Pump/Air Conditioning selected for cost-effectiveness.
- (7) Check thermostats for energy cost-savings.
- (8) 4-way protection against air leaks -- weatherstripping, caulking, seals & gaskets.
- (9) Shading provided by roof overhangs, working shutters, sunscreens and awnings, trees, shrubs and hedges.
- (10) Band joist insulation.
- (11) Properly located and insulated ducts and pipes.
- (12) Ceiling baffles and adequate natural ventilation.

Since model #1 is not a substantial departure from standard designs, it will be the easiest for builders and homebuyers to adjust to -- and will have appeal as cost-effective, quality built energy-saving home with passive solar features.

When the floor plan is one that creates more south-facing windows, the Passive Solar efficiency of the home is vastly improved. This can be clearly pointed-out to prospective buyers.

However, there is still a limit to how excited the prospective buyer will be when the builder "explains" the greater efficiency of this type Passive Solar Home. Accordingly, Model #2 will be hard to get either builders or buyers excited about building or buying, even though the increased costs will perhaps be less than 3%, some of which is for the partial earth berms.

In Marketing Model #2, National Homes would develop an extensive program outlining the energy saving solar features as well as the non-solar features of planned quality-constructions that makes for energy saving features:

- (1) Engineer/Architects placement of the home on the lot for maximum solar usage.
- (2) Proper levels of insulation in ceiling, walls and floor.
- (3) Thermal doors.
- (4) Insulated windows with Thermal-break.
- (5) Energy conserving heating equipment (properly sized).
- (6) Heat Pump/Air Conditioning selected for cost-effectiveness.
- (7) Check thermostats for energy cost-savings.
- (8) 4-way protection against air leaks -- weatherstripping, caulking, seals & gaskets.
- (9) Shading provided by roof overhangs, working shutters, sunscreens and awnings, trees, shrubs and hedges.
- (10) Band joist insulation.
- (11) Properly located and insulated ducts and pipes.
- (12) Ceiling baffles and adequate natural ventilation.

- (13) Storm windows and doors.
- (14) Whole-house fans.
- (15) Hot-water savers.
- (16) Solar water heating option.
- (17) Vestibule entryway.
- (18) Fireplace.
- (19) Masonry walls in living room.
- (20) Solar window-wall for bedrooms and living room.

Model #2 has many passive solar designs that are readily apparent to homebuilders and home buyers. To market this model, National Homes would make it easy for builders to understand these features and be able to quickly point them out to homebuyers through sales office displays, wall posters, silent salesman cards, brochures, etc. These features will have appeal to cost-conscious and energy-conscious people.

In National Homes Marketing Approach to Passive Solar Homes, it is believed that education of the builder and prospective homebuyers is important. But even more important, from a marketing viewpoint, is the excitement of builders and prospective homebuyers about the advantages to them in Passive Solar Homes -- whether as a builder, or as a homebuyer.

National Homes Marketing Approach to Passive Solar Homes will be to:

- (1) Educate builders as to specific Passive Solar Homes.

- (2) Avoid conflicting or confusing information about Passive Solar Homes.
- (3) Prepare and furnish builders straightforward information about what Passive Solar Homes can and cannot accomplish.
- (4) Explain the few risks/liability a builder has in Passive Solar Homes in future years -- as compared to the greater risks/liability a builder has in active solar homes.
- (5) Prepare complete sales office displays, wall posters, brochures and sales literature, radio and newspaper and advertising explaining specific Passive Solar Homes and the advantages of these specific homes to homeowners.
- (6) Help builders hold grand openings, publicity, and get sales for the specific Passive Solar Homes they will be building.

In accomplishing this successful marketing of specific Passive Solar Homes, Model #3 offers the best opportunity because:

It contains specifications to excite builders and prospective homebuyers:

- (a) A sunroom (collection area).
- (b) Concrete floor area (absorber area).

- (c) A masonry hearth (storage mass).
- (d) Furnace and duct system (distribution method).
- (e) Drapes and thermostats (heat regulation devices).
- (f) An air-lock entry.
- (g) North buffer-zones and south-facing living area.

Additionally, it will contain our recommended Thermo-Shield requirements of ceiling and wall insulation, eave overhangs, thermal glass windows and doors, insulated steel entry door, floor insulation, etc. Total added costs will probably be in the neighborhood of 5% above the cost of "standard" houses.

To justify the added costs, we will actively promote the features of Model #3 to homebuyers. This will involve pointing out these features including:

- (1) Engineer/Architects placement of the home on the lot for maximum solar usage.
- (2) Proper levels of insulation in ceiling, walls and floor.
- (3) Thermal doors.
- (4) Insulated windows with Thermal-break.
- (5) Energy conserving heating equipment (properly sized).
- (6) Heat Pump/Air Conditioning selected for cost-effectiveness.
- (7) Check thermostats for energy cost-savings.
- (8) 4-way protection against air leaks -- weatherstripping, caulking seals & gaskets.

- (9) Shading provided by roof overhangs, working shutters, sunscreens and awnings, trees, shrubs and hedges.
- (10) Band joist insulation.
- (11) Properly located and insulated ducts and pipes.
- (12) Ceiling baffles and adequate natural ventilation.
- (13) Storm windows and doors.
- (14) Whole-house fans.
- (15) Hot-water savers.
- (16) Solar water heating option.
- (17) Vestibule entryway.
- (18) Fireplace.
- (19) Masonry walls in living room.
- (20) Solar window-wall for bedrooms and living room.
- (21) Projected operating cost savings of this Passive Solar Home vs "standard" homes of the same size.
- (22) Lender information to justify the extra initial cost of homes -- through long-term savings in operation costs.
- (23) Absence of a "system failure" risk in Passive Solar Homes.
- (24) The Solar Sunroom -- and how it adds a "new dimension" to make affordable homes even more affordable to live in.
- (25) Dampered grills above and below windows at Solar Sunroom.
- (26) Kalwall Exterior Panels at Solar Sunroom.
- (27) Optional skylights for added energy-savings.

While any house has certain limited Passive Solar characteristics, we plan to build and sell National's Passive Solar Homes in such a manner that the public will not only like them -- but will demand them in sufficient volume to result in sizable savings in fuel and energy costs.

DOE PASSIVE SOLAR PROJECT

I. CHANGE IN SPECS - THERMO-SHIELD VS. FHA MPS

<u>Item</u>	<u>Passive Models</u>	<u>FHA MPS</u> ①	<u>Δ Cost</u>
Ext. Walls	.05 U	.07 U	1/2" Thermax
Ceiling	.025 U	.03 U	R-38 vs. R-30
Windows	Triple	Double	Storm Windows

II. EXTRA COST FOR INCREASED THERMAL INSULATION

<u>Item</u>	<u>Model 1</u>	<u>Model 2</u>	<u>Model 3</u>
Thermax Sheathing ②	\$ 280	\$ 297	\$ 326
Ceiling Insulation ③	108	115	114
Storm Windows	<u>285</u>	<u>286</u>	<u>297</u>
Builder Cost	\$ 673	\$ 698	\$ 737
30% Mark-Up	<u>202</u>	<u>209</u>	<u>221</u>
Sales Price	<u>\$ 875</u>	<u>\$ 907</u>	<u>\$ 958</u>

III. BTUH SAVED WITH EXTRA THERMAL INSULATION ①

<u>Item</u>	<u>Model 1</u>	<u>Model 2</u>	<u>Model 3</u>
Walls BTUH	924	883	1074
Ceiling BTUH	524	542	539
Windows BTUH	<u>4184</u>	<u>4119</u>	<u>3353</u>
Total BTUH	<u>5632</u>	<u>5544</u>	<u>4966</u>
Annual BTU	<u>17996</u>	<u>17715</u>	<u>15868</u>

NOTE ①: Indianapolis, Indiana = 5699 HDD with gas heat

NOTE ②: Thermax vs. Fiberboard = \$1.77/l.f.

NOTE ③: R-38 batts vs. R-30 batts = \$.08/s.f.