LA-UR -85-1283

CONF-8503103--8

Los Alamos National Laboratory is operated by the University of California for the United States Department of Energy under contract W-7405-ENG-36

LA-UR--85-1283

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TITLE PASSIVE RETROFITS FOR NAVY HOUSING

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SUBMITTED TO Solar Buildings: Realities for Today, Trends for Tomorrow
Washington, D.C.
March 18-20, 1985

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Los Alamos Los Alamos National Laboratory
Los Alamos, New Mexico 87545

PASSIVE RETROFITS FOR NAVY HOUSING*

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ABSTRACT

A project to assess and initiate passive solar energy retrofits to US Navy family housing is described. The current data base for Navy housing (ECOP), and its enhancement for passive solar purposes, is described. The passive options proposed for Navy housing are explained. The analysis goals and methods to evaluate the retrofits are discussed. An educational package to explain the retrofits is described

OVERVIEW

There are roughly 90,000 units of US Navy family housing. Programs are in progress that would eventually rehabilitate this entire housing stock to reduce energy consumption and to enhance energy security. We describe in the present paper a project aimed to begin the use of passive solar technologies within the context of these rehabilitation programs. The project has four parts: (1) an enhancement of the existing housing data base to provide for evaluating passive solar retrofits, (2) a selection of passive options pertinent to Navy housing, (3) an analysis of energy savings potentials, and (4) an educational package to explain the retrofits to housing managers.

HOUSING DATA BASE

A data base exists on the characteristics of Navy family housing. The data base is called ECO (energy conservation opportunities program) and contains data that are pertinent primarily to conservation (rather than solar) improvements. This data base is being enhanced by the addition of data pertinent to passive solar improvements. A questionnaire is being developed by which housing managers will supply the needed information. The questionnaire elicits statistical information on window distribution, building orientation, and solar access. Figure 1 illustrates the solar access portion of the questionnaire.

PASSIVE OPTIONS

In the current phase of the project, we are considering only established passive solar heating technologies: sunspace, direct gain, and Trombe wall. The initial selection of candidate retrofit options is based on certain suitability criteria related to thermal and architectural compatibility. (Other site-specific criteria related to cost-effectiveness and solar access are treated elsewhere.) A sunspace is suitable when there is an existing patio or porch slab to form the sunspace floor, an existing door for convective exchange with the adjoining room, or some other architectural opportunity such as a porch recess whose walls would be the east and west walls of the sunspace.

Direct gain options of two kinds may be suitable: one in which south windows are added or enlarged and one in which interior mass is added. The addition or enlargement of south windows is an option when other maintenance projects involve wall repairs or window replacements. When large south windows are already present, the addition of interior mass to an otherwise lightweight interior will make the solar gains more usable.

A Trombe wall may be formed by glazing an existing uninsulated heavyweight wall: brick, concrete block, or poured concrete. Only unvented Trombe walls will be considered. No grouting of hollow block cores will be done.

Passive cooling (shading, ventilation, etc.) and advanced passive heating (vapor transport, and convective diodes, etc.) are options planned for a future phase of the work.

ANALYSIS OF ENERGY SAVINGS

An analysis of the energy savings potential of each retrofit will be performed for each Navy housing location. The range of locations is illustrated in Fig. 2. Long-term average weather

*Work performed under the auspices of the US Navy.

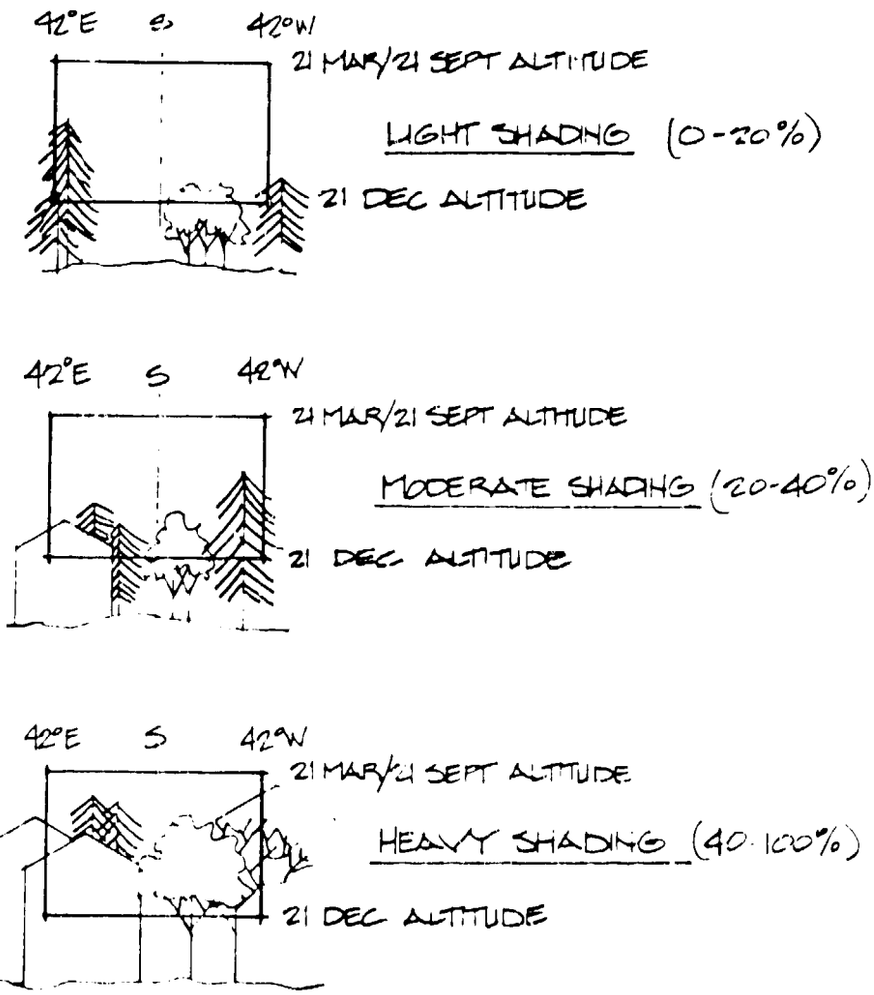

Fig. 1. Sample from housing questionnaire. The illustration defines three levels of shading in terms of a simplified solar access "window." Respondents will give the numbers of buildings in each category.

and solar radiation data from the nearest available location will be used.

Expected energy savings will be calculated as a difference between estimated energy consumption for space heating in a building as is and estimated energy consumption after the retrofit. Certain standard conditions will be assumed for the retrofits such as south orientation and good solar access. The penalty in energy savings for nonstandard conditions will also be quantified.

The expected energy savings will be expressed in a sufficiently generic fashion to permit local flexibility in applying the recommended options and in evaluating the resulting savings. In particular, we will express the energy savings per unit of added passive solar aperture area rather than the total energy savings produced by a retrofit of a particular aperture area. Likewise, in the case of interior mass enhancement for direct gain, we will express the energy savings per unit of added mass surface area.

For retrofits that depart from certain standard conditions, we will provide sensitivity data that can be used to correct the expected energy savings. Data will be provided on the effect of site shading, off-south azimuth, added thermal storage mass in sunspaces, and nonstandard mass properties in Trombe walls.

The analysis method will be the monthly solar load ratio (SLR) method developed at Los Alamos[1] and its enhancements developed especially to address alternate mass conditions in direct gain and Trombe wall systems.[2,3]

EDUCATIONAL PACKAGE

Of critical importance to the large-scale adoption of the recommended passive options is the cooperation of the local family housing managers and other key players in the housing system. Accordingly, a major part of the current project is the preparation of educational materials to help ex-

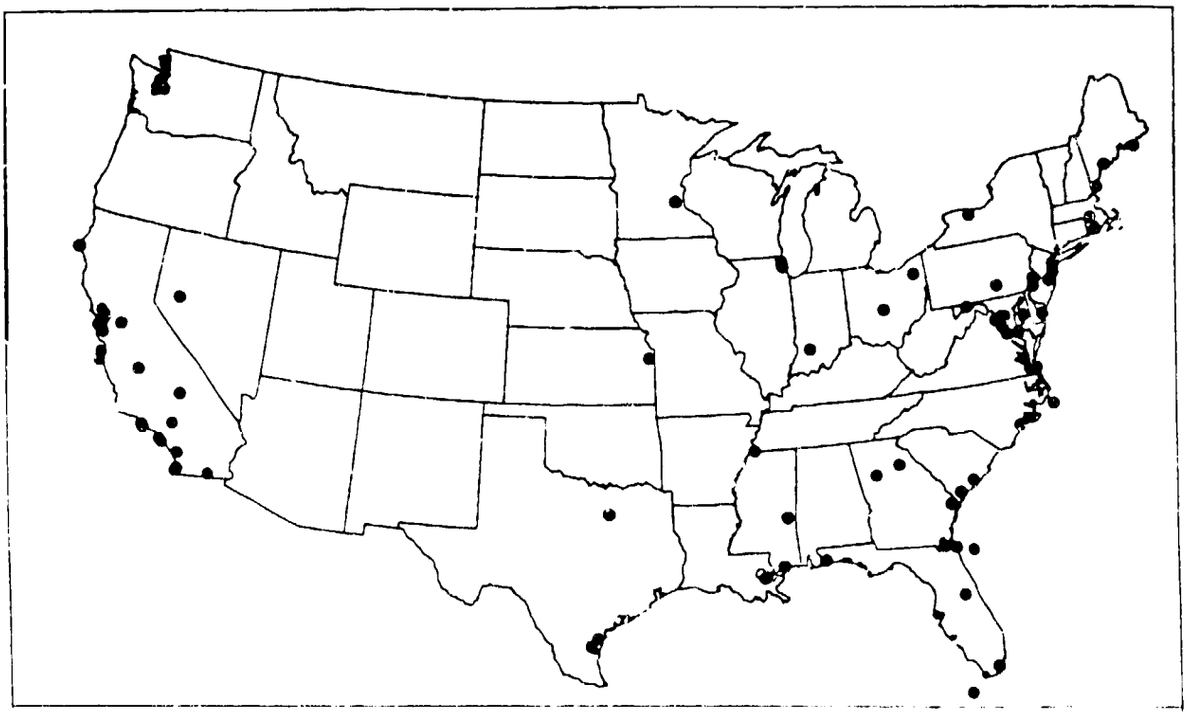

Fig. 2. US Navy housing locations.

plain the proposed retrofits. The materials will have a strong graphic and architectural flavor. They will convey the ideas that the retrofits will make houses more attractive and livable, will be practical to construct with ordinary materials and techniques, will function in easily understood ways, and will save energy. Some examples of the graphics being prepared are conceptual designs of selected retrofits compared with the building as is (see Fig. 3 for an example); selected construction details such as sunspace summer vents, brick veneers for interior direct gain mass enhancement, and a Trombe wall glazing attachment system; illustrations of passive performance concepts such as convective heat flow from a sunspace, a diurnal storage cycle in interior direct gain mass, and diffusive heat flow through a Trombe wall; and bar charts and maps showing energy savings for various locations and retrofit options.

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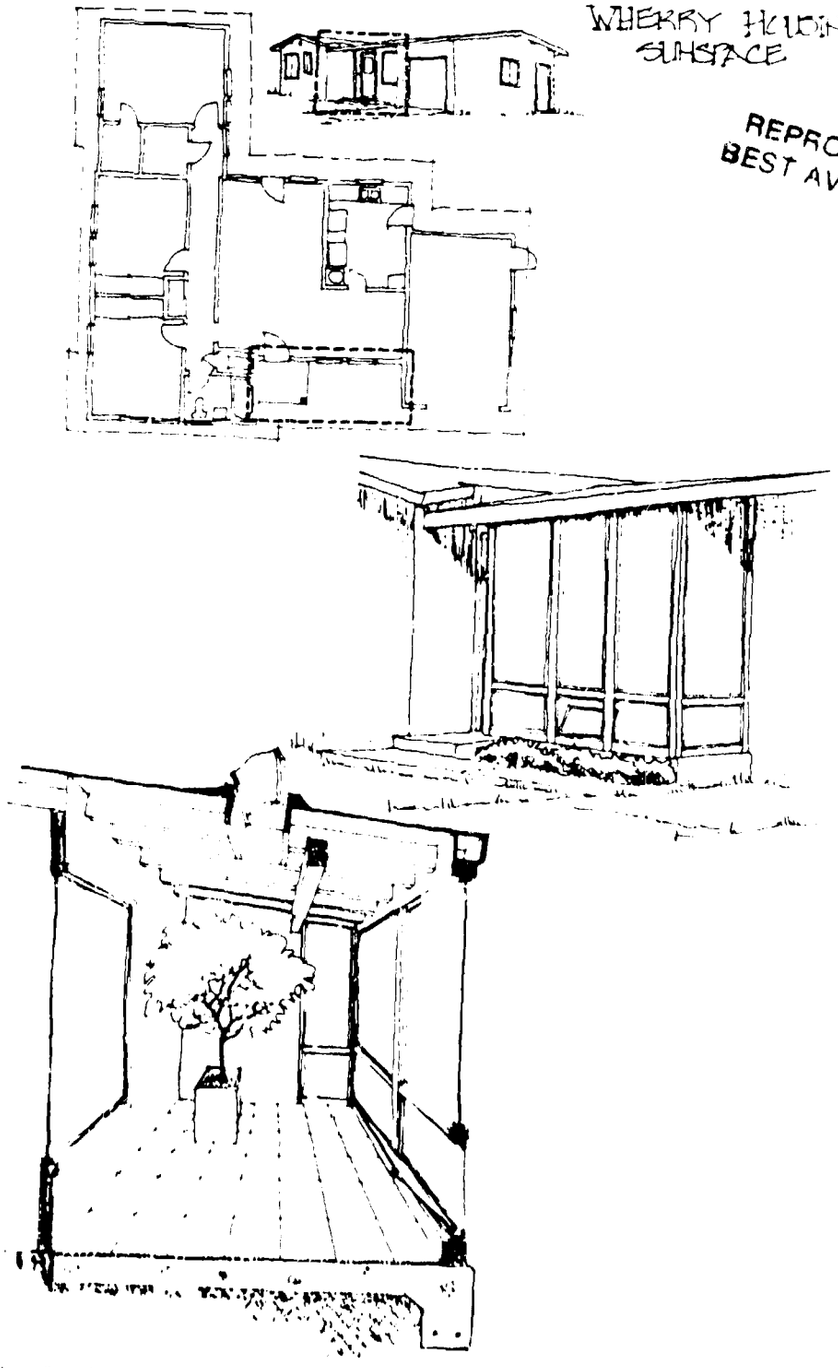

Fig. 3. Conceptual design for a sunspace retrofit to Wherry Housing.