NBSIR 78-1489

Building Regulatory Data Analysis National Solar Heating and Cooling Demonstration Program Progress Report - From Inception through September 30, 1977

Joseph Greenberg
Sandra Berry
Ileana Martinez

Building Economics and Regulatory Technology Division
Center for Building Technology
National Engineering Laboratory
National Bureau of Standards
Washington, D.C. 20234

June 1978

Prepared for

Office of Policy Development and Research
Division of Energy, Building Technology and Standards
U.S. Department of Housing and Urban Development
Washington, D.C. 20234

and

Office of the Assistant Secretary
Conservation and Solar Applications
U.S. Department of Energy
Washington, D.C. 20545

NBSIR 78-1489

BUILDING REGULATORY DATA ANALYSIS NATIONAL SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM PROGRESS REPORT - From Inception through September 30, 1977

Joseph Greenberg
Sandra Berry
Ileana Martinez

Building Economics and Regulatory Technology Division
Center for Building Technology
National Engineering Laboratory
National Bureau of Standards
Washington, D. C. 20234

June 1978

Prepared for
Office of Policy Development and Research
Division of Energy, Building Technology and Standards
U.S. Department of Housing and Urban Development
Washington, D.C. 20410

and

Office of the Assistant Secretary
Conservation and Solar Applications
U.S. Department of Energy
Washington, D.C. 20545

U.S. DEPARTMENT OF COMMERCE, Juanita M. Kreps, *Secretary*

Dr. Sidney Harman, *Under Secretary*

Jordan J. Baruch, *Assistant Secretary for Science and Technology*

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

NBSIR 78-1489

BUILDING REGULATORY DATA ANALYSIS NATIONAL SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM PROGRESS REPORT - From Inception through September 30, 1977

Joseph Greenberg
Sandra Berry
Ileana Martinez

Building Economics and Regulatory Technology Division
Center for Building Technology
National Engineering Laboratory
National Bureau of Standards
Washington, D. C. 20234

June 1978

Prepared for
Office of Policy Development and Research
Division of Energy, Building Technology and Standards
U.S. Department of Housing and Urban Development
Washington, D.C. 20410

and

Office of the Assistant Secretary
Conservation and Solar Applications
U.S. Department of Energy
Washington, D.C. 20545

U.S. DEPARTMENT OF COMMERCE, Juanita M. Kreps, *Secretary*

Dr. Sidney Harman, *Under Secretary*

Jordan J. Baruch, *Assistant Secretary for Science and Technology*

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Director*

TABLE OF CONTENTS

FIGURES

TABLES

1. INTRODUCTION

This report is prepared jointly for the Department of Housing and Urban Development (HUD) and the Department of Energy (DoE) under activities carried out by the National Bureau of Standards (NBS) relative to the National Solar Heating and Cooling Demonstration Programs. The report encompasses both the residential and commercial building demonstration programs and covers the period from project inception through September 30, 1977.

The effort expended during the period was in the identification and organization of sources of material, in the establishment of a methodology for processing data to be received from the demonstration programs relative to the building regulatory process and in the preliminary analyses of the sites selected for the early phases of the demonstration programs. In the context of this report, it is to be understood that the building regulatory process excludes zoning questions.

It had been hoped that some analysis regarding problems being encountered in the field with code officials or barriers presented by existing codes and standards would be included in this report. However, due to the scarcity of this information during the time period covered, no analysis is possible. The report, nevertheless, contains several observations relative to the building regulatory process based on informal discussions with individuals collecting questionnaire data during the conduct of the demonstration programs. In addition, the current status regarding the availability of information for both the residential and commercial programs is reported.

This report also contains a preliminary analysis of the geographical and code base distribution of the demonstration sites selected for both the residential and commercial demonstration programs. This initial analysis identifies certain inconsistencies in site selection, from a regulatory viewpoint, and recommends adjustments to be considered in subsequent cycles of the programs.

A brief literature search which addresses the problems of building regulation as related to the installation and use of solar energy systems is included as Appendix II. Although the literature cited points to codes as barriers to solar technology and advocates a performance based solution, the conclusions stated may not be supported by a subsequent analysis of the data gathered under the demonstration programs. However, judgment must be reserved until supporting data are gathered and analyzed.

2. PROJECT DESCRIPTION

The objectives of this project are to work within the data gathering mechanisms established by HUD and DoE for the solar demonstration programs and to analyze this data and identify those aspects of the building regulatory process that needlessly inhibit, impede, or otherwise adversely affect the installation of solar hot water systems and space heating and/or cooling systems. In addition, definitive information will be compiled which will provide useful input to appropriate standards generating committees, building code promulgating organizations, and regulatory jurisdictions. This detailed information will guide the building regulatory community in the United States in creating a regulatory environment which will stimulate the acceptance of the use of solar hot water systems and space heating and/or cooling systems.

In order to accomplish the above objectives, this project is designed to provide:

a. An analysis of the building regulatory waivers granted throughout the demonstration programs to gain an insight into the technical causes for these waivers, and to develop recommended solutions to alleviate these regulatory constraints by identifying those areas where additional study is required.

b. An analysis of the response by the participants in the demonstration programs as to their real or perceived regulatory problems encountered during the conduct of the programs and recommendations for proposed solutions to alleviate these real or perceived regulatory difficulties.

c. An analysis of the adverse impacts, if any, resulting from differences in various regulatory statutes by identifying these differences and providing recommended solutions. Toward this objective, "A Survey of State Legislation Relating to Solar Energy as of 1975" (NBSIR 76-1082) and "State Solar Energy Legislation of 1976: A Review of Statutes Relating to Building" (NBSIR 77-1297) will be useful in conducting this analysis.

The demonstration programs are structured in a series of cycles, with various projects being awarded for each cycle. The HUD residential demonstration program is expected to have 5 cycles, while the DoE commercial cycles probably will not exceed 4. The analyses for this study are made on a cycle-by-cycle basis, using site-specific regulatory and other related data collected under both the residential and commercial programs. In addition, the effects of varying time frames for the respective cycles will be considered to determine any regulatory impacts on later installations, if early difficulties with solar hardware and systems are encountered. Consolidated non-cycle related studies will also be prepared if meaningful assessments can be derived by such studies.

3. METHODOLOGY

The methodology for this project is formatted to take full advantage of the various data bases established by HUD and DoE for the solar demonstration programs. These overall data bases, when fully implemented, will contain a large amount of information and care must be taken to identify and capture all pertinent information so that a proper study can be made. Caution must be exercised, however, to establish a retrieval system that does not extract needless or superfluous information - a process that is costly and time consuming and one which makes the task at hand more difficult. The methodology described in this report is developed for the collection of building regulatory information, but could be used for the study of any other aspect of the solar demonstration programs. The same methodology is used for both the residential and commercial programs.

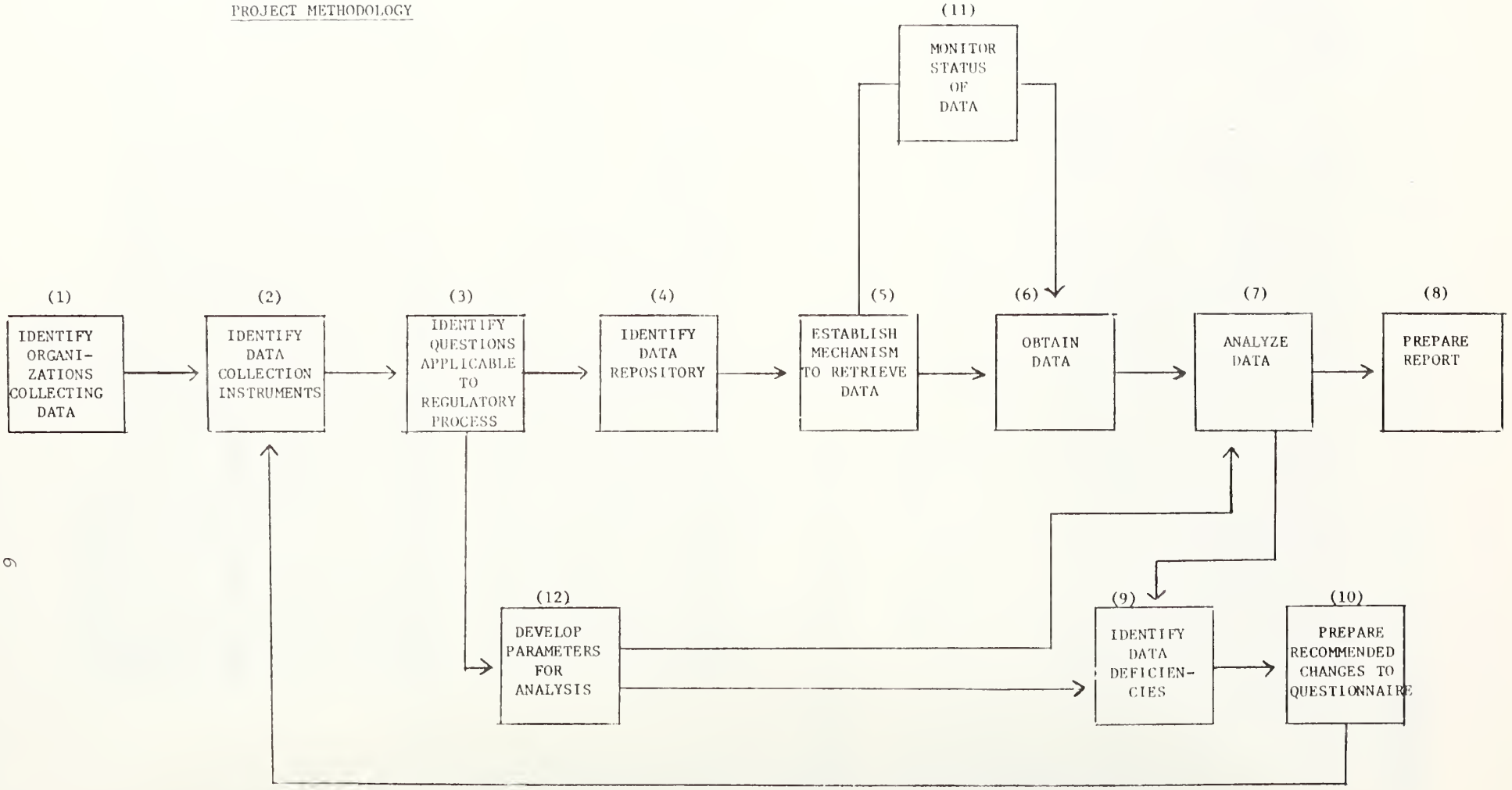
The specific methodology used is shown in flow chart form in Figure 1. The identifying numbers are keyed to the flow chart in the following description:

(1) Identify Organizations Collecting Data - Each organization collecting data for the demonstration programs is identified. A single organization is performing this function for DoE in the commercial program and several organizations are involved in the HUD residential demonstrations. An understanding of each organization, its data collecting role, and its relationships to the other organizations involved is essential.

(2) Identify Data Collection Instruments - Each data collection instrument is identified. Since each instrument varies in style, format and use, an overall understanding of these instruments is required. Care must be taken to obtain the most current data collection instrument in use and liaison was established with the administering organization so that notification is received if any changes are made to them. The NBS also expects to recommend changes (see step 10), as warranted, to the building regulatory information being collected to assure that the information received is useful to the analysis.

FIGURE 1.

PROJECT METHODOLOGY



(3) Identify Questions Applicable to the Building Regulatory Process - Each data collection instrument identified in step (2) is carefully reviewed and questions pertinent to the building regulatory process selected as a primary information source for this study. The response to these identified questions represents the limits to any analysis made in the conduct of this study. However, the narrative responses which are, in effect, open ended could contain information which is not anticipated.

(4) Identify Data Repository - Once the determination is made regarding the questions of interest, the next step is to determine the location of the completed questionnaire. In most cases, the completed questionnaire is computer coded and the information entered into the NBS Solar Data Base. In these cases, printouts prepared for general use are made available for this study or special printouts requested. In some cases where the completed source documents are not forwarded to NBS, arrangements were made to obtain this data directly from the repository custodian.

(5) Establish Mechanism to Retrieve Data - Each source of data needed for this study will have to be available for analysis. As noted in step (4), some data come directly from the NBS Solar Data Base while other data come from different sources. In either case, the frequency for the receipt of these data must be determined and a mechanism developed to obtain the data in suitable format. A balance must be achieved in querying the data source to establish a frequency that is useful to the building regulatory process study, yet not too burdensome and disruptive to the data custodian.

(6) Obtain Data - Data are received from the sources identified in step (4) using the mechanism established in step (5) at the predetermined frequency.

(7) Analyze Data - The data are aggregated and when a meaningful sample is obtained, it is analyzed. The analysis is oriented toward answering the questions addressed in the stated objectives of this project.

(8) Prepare Report - Once enough data are analyzed and meaningful trends determined, appropriate NBS publications are prepared to document these results.

(9) Identify Data Deficiencies - As data are received, deficiencies may be noted and, if not corrected, will preclude the development of reasonably reliable conclusions. Once deficiencies are identified, a feedback mechanism is set in motion to reassess the situation and take corrective action. In addition, potential data deficiencies may be identified through the development of parameters for analyses (see step 12), by reviewing the applicable questionnaires. Corrective action will be taken in this case. However, data may be of insufficient quantity to reach generally valid conclusions.

(10) Prepare Recommended Changes to Questionnaire - This is accomplished at any point when it is felt the study lacks adequate data, either as a result of an inspection of data received or as a result of data requirements identified through analysis of the source questionnaires. Recommendations are made to the data collecting organizations to modify their data collection instruments, including the rationale behind such requests.

(11) Monitor Status of Data - The collection of data by the appropriate organization is monitored so that the NBS effort is guided properly during the course of the study. Certain analyses are not started if additional data are forthcoming shortly or, conversely, analytical attempts are accomplished using only the data at hand if no additional data are anticipated.

(12) Develop Parameters for Analyses - Based on the identification of the applicable questionnaires relative to building regulations, a preliminary attempt is made to determine the most meaningful parameters to be studied and the combinations which might give the best insight into satisfying the objectives of this study. This parametric overview determines which data are important to the study. Data not identified as being included in the questonnaire are handled as noted in step (9).

4. IDENTIFICATION OF DATA SOURCES AND INSTRUMENTS APPLICABLE TO THE SOLAR REGULATORY STUDY

This section addresses the establishment of the baseline sources for this study and covers the first five (5) steps discussed under Section 3 - Methodology, and shown in Figure 1:

(1) Identify Organizations Collecting Data
(2) Identify Data Collection Instruments
(3) Identify Questions Applicable to the Building Regulatory Process
(4) Identify Data Repository
(5) Establish Mechanism to Retrieve Data

These five steps are documented, based on information available as of September 30, 1977. Any changes in data sources or to the data collection instruments that are noted during the conduct of this study will be documented in subsequent reports.

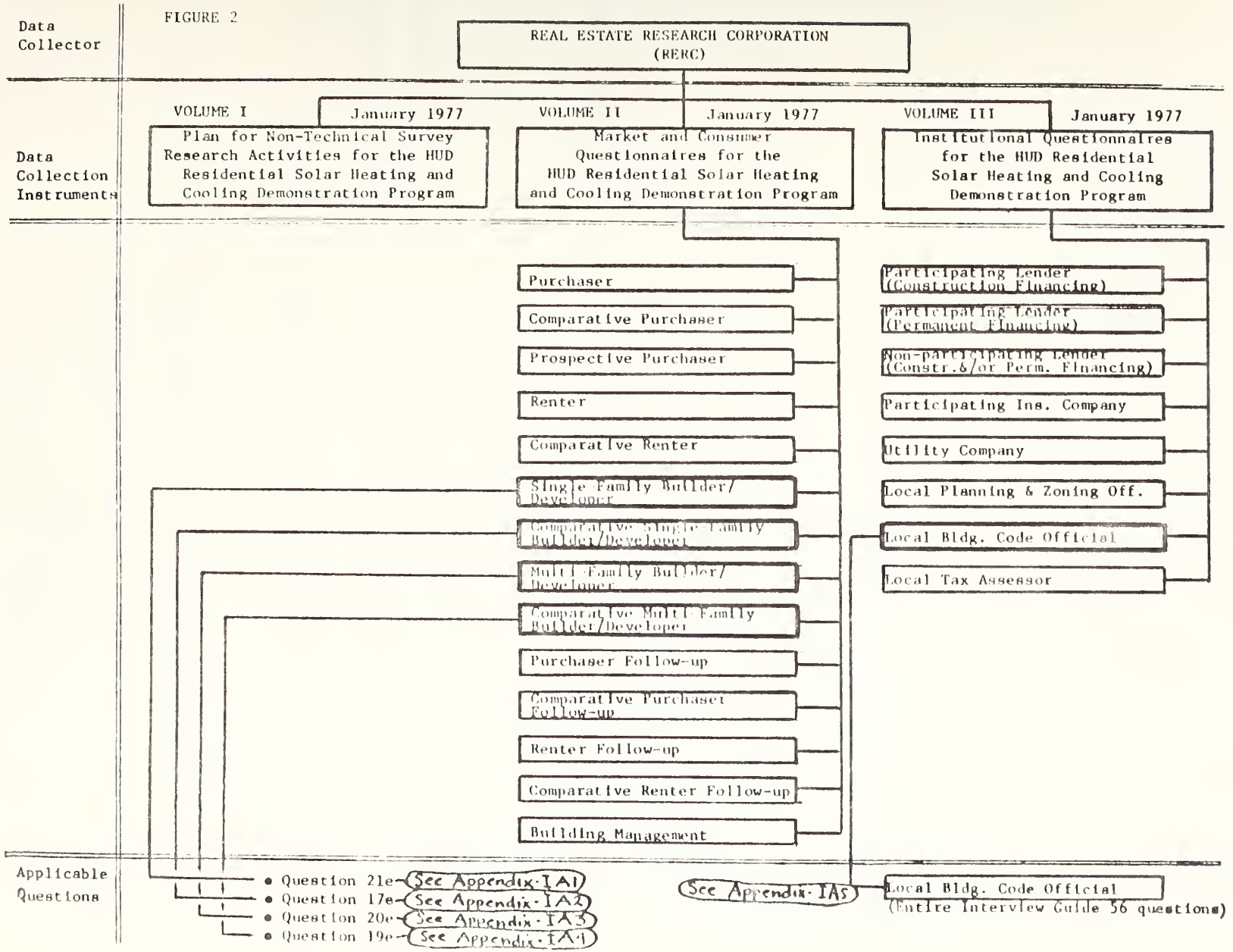
4.1 RESIDENTIAL PROGRAM

Each of the organizations involved in collecting data for the Residential Solar Demonstration Program is identified separately. The data collecting instruments are indicated and the specific questions directly applicable to the building regulatory study are identified. Appendixes are included which exhibit the instruments used and an inspection of these instruments gives an idea of the scope and depth of the questions.

4.1.1. Real Estate Research Corporation (RERC)

This organization prepared three volumes for use in the Residential Solar Demonstration Program. These volumes, dated January 1977, are all non-technical in scope and are intended to document responses to questions oriented toward marketing, the consumer, and the institutional sectors. The general layout of these volumes is illustrated in Figure 2. A control mechanism is built into several of the questionnaires in that visits are planned to

FIGURE 2


Data Collector
REAL ESTATE RESEARCH CORPORATION (RERC)
Data Collection Instruments
VOLUME I
January 1977
Plan for Non-Technical Survey Research Activities for the HUD Residential Solar Heating and Cooling Demonstration Program
VOLUME II
January 1977
Market and Consumer Questionnaires for the HUD Residential Solar Heating and Cooling Demonstration Program
VOLUME III
January 1977
Institutional Questionnaires for the HUD Residential Solar Heating and Cooling Demonstration Program
Purchaser
Comparative Purchaser
Prospective Purchaser
Renter
Comparative Renter
Single Family Builder/ Developer
Comparative Single-Family Builder/Developer
Multi-Family Builder/ Developer
Comparative Multi-Family Builder/Developer
Purchaser Follow-up
Comparative Purchaser Follow-up
Renter Follow-up
Comparative Renter Follow-up
Building Management
Participating Lender (Construction Financing)
Participating Lender (Permanent Financing)
Non-participating Lender (Constr.&/or Perm. Financing)
Participating Ins. Company
Utility Company
Local Planning & Zoning Off.
Local Bldg. Code Official
Local Tax Assessor
Applicable Questions
• Question 21e- See Appendix-IA1
• Question 17e- See Appendix-IA2
• Question 20e- See Appendix-IA3
• Question 19e- See Appendix-IA4
See Appendix-IA5
Local Bldg. Code Official
(Entire Interview Guide 56 questions)

comparative organizations (i.e., organizations that are not directly involved in the Residential Solar Demonstration Program) so that there is the potential to analyze the perceived differences in reactions by the different organizations to a similar situation. For example, a solar demonstration builder is asked if he has had any trouble in processing his plans and specifications through a particular code approval process. The reactions of other builders regarding their experiences with the same code officials on non-solar related activities are also obtained. Although not all sites are visited, the questionnaires are answered in sets and data are gathered for all information pertinent to a site. To illustrate, if a particular site is to be visited at all, the builder, comparative builder, code official, tax assessor, etc., are all contacted and the respective questionnaires completed.

In addition to showing the three volumes to be used, Figure 2 illustrates the various questionnaires contained in each volume. (Volume I, incidentally, contains no questions.) There is a separate questionnaire containing numerous questions oriented toward "The Purchaser," "The Comparative Purchaser," "The Prospective Purchaser," etc., and these questionnaires are listed on the chart. Each questionnaire was reviewed to identify those questions containing useful input to this study. The questions of interest are identified in Figure 2 and given in Appendix I-Section A. Of the 14 questionnaires contained in Volume II, only four (4) questionnaries are directly relevant to codes and standards. Furthermore, only one question within each of those four (4) questionnaires relate to regulatory concerns. In Volume III, only one questionnaire of the eight (8) identified is of interest. However, this questionnaire, "Local Building Code Official," is of interest in its entirety--all 56 questions. Appendix I-Section A consists of the pages of the RERC interview guide which contain all the questions applicable to this study.

To receive the initial input to this study, contact was made with RERC at the following location:

Real Estate Research Corporation
72 West Adams
Chicago, Illinois 60603

Arrangements were made with RERC to receive the initial data on an ad hoc basis. Subsequent data could be received by tapping the NBS computerized Solar Data Base, but initial efforts indicate some delay may be encountered. This delay is due to the time lag between the period the data are collected and the time required to code, transmit, input, and retrieve the data from the system.

Section 5 of this report discusses the status of the data actually available as of this reporting period.

4.1.2. American Institute of Architects Research Corporation (AIA/RC)

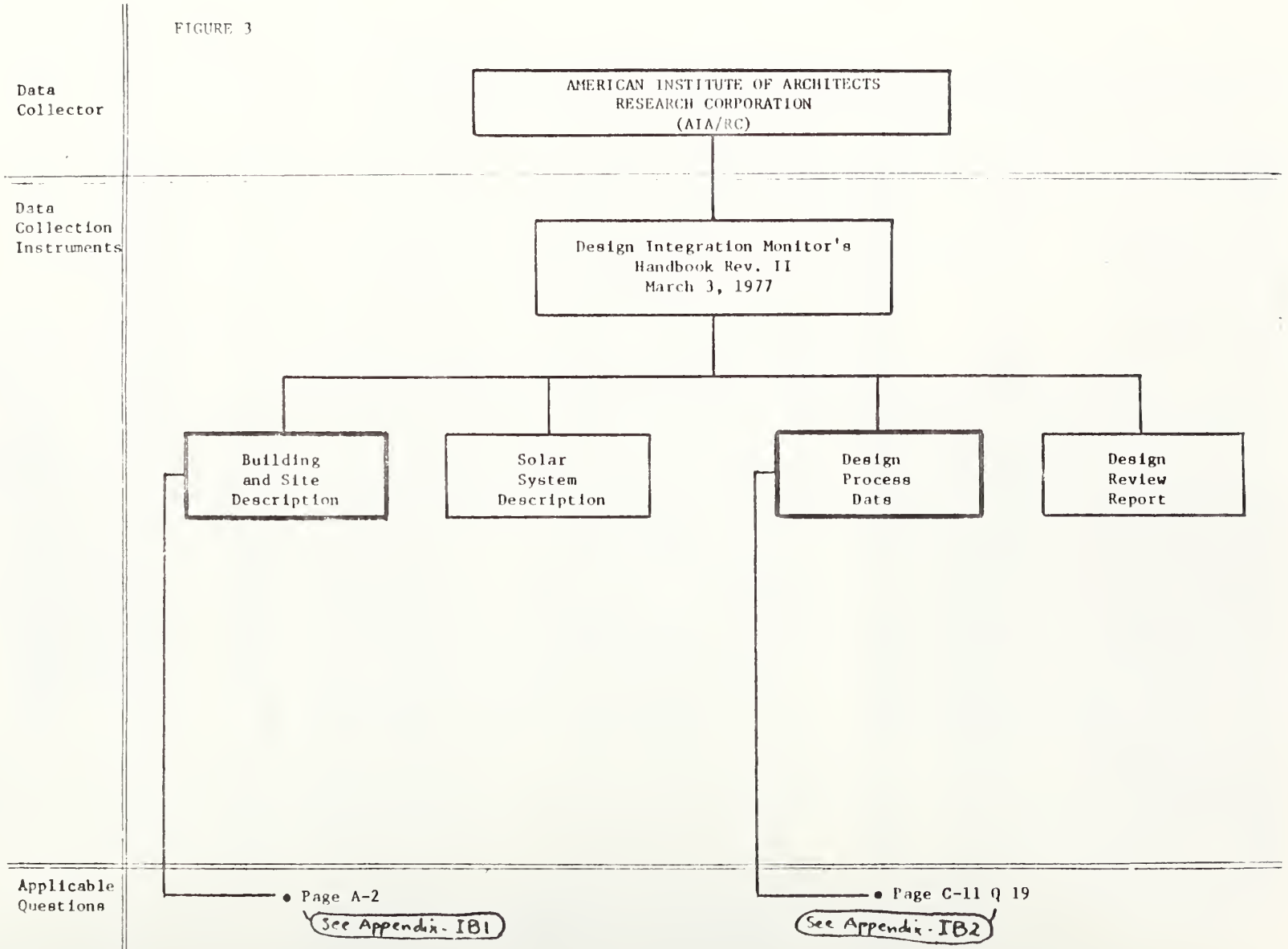
This organization developed a Design Integration Monitor's Handbook, dated March 3, 1977. The handbook is divided into four (4) sections (see Figure 3) and is oriented toward collecting a major portion of the technical data for the Residential Solar Demonstration Program. Information collected by AIA/RC using these forms is limited to those sites which have been fully instrumented to collect detailed technical data. The data collected are coded by AIA/RC and the coded sheets sent for input into the NBS Solar Data Base.

As noted in Figure 3, only two (2) sections of the four (4) that make up the Design Integration Monitor's Handbook are applicable to this study and each of the questionnaires contain only one question which provides data. Appendix I-Section B shows these questions.

Contact was made with AIA/RC regarding this study. The original completed questionnaires are maintained at:

American Institute of Architects Research
Corporation
1735 New York Avenue
Washington, D.C. 20006

FIGURE 3


Data Collector
AMERICAN INSTITUTE OF ARCHITECTS
RESEARCH CORPORATION
(AIA/RC)
Data Collection Instruments
Design Integration Monitor's
Handbook Rev. II
March 3, 1977
Building and Site Description
Solar System Description
Design Process Data
Design Review Report
Applicable Questions
• Page A-2
See Appendix-IB1
• Page C-11 Q 19
See Appendix-IB2

A visit was made to AIA/RC and it was determined that data relative to this study can be easily obtained by periodically searching the files where the originals of the completed questionnaires are kept. These data, of course, could be obtained through the NBS Solar Data Base. However, there would be a time lag from the time the data are received until the data are coded and inserted into the NBS Solar Data Base. The file search method for collecting these data from AIA/RC is quick, is not sensitive to errors in coding, and requires a minimum of effort by AIA/RC personnel. This method will be tried unless AIA/RC finds that it is interfering with its operations, in which case, the data will be extracted from the NBS Solar Data Base.

Section 5 of this report discusses the status of the data actually available as of this reporting period.

4.1.3. U.S. Department of Housing and Urban Development/Boeing

Additional documents identified as containing data pertinent to the Residential Solar Demonstration Program are the Grantee Reports. Inspection of these reports reveals that only one question (in Report No. 3 - Construction Report) is of interest for this study. Figure 4 indicates the four (4) individual reports comprising the Grantee Reports and Appendix I-Section C shows the single question in Report No. 3 - Construction Report - that is directly applicable to this study.

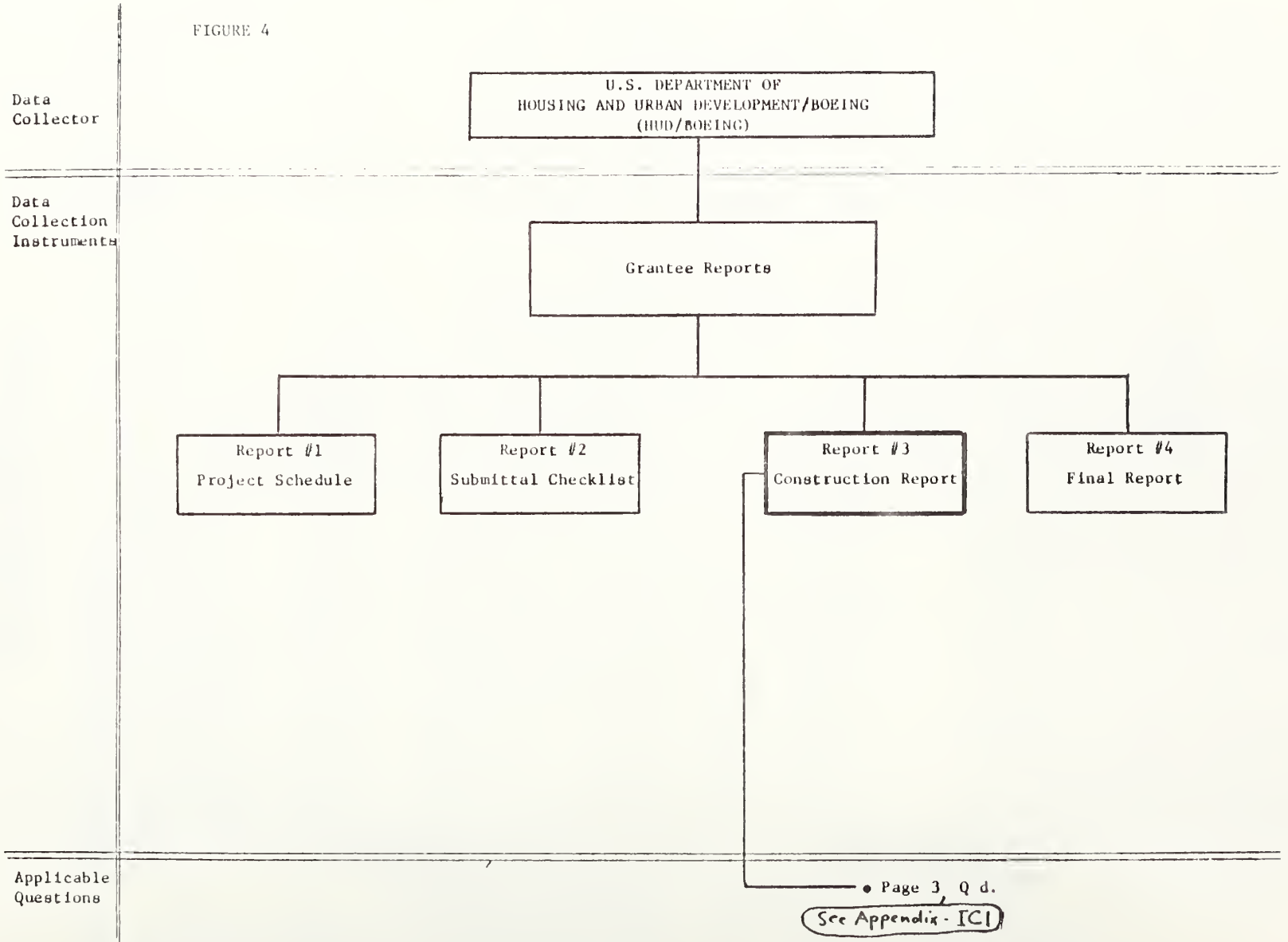
Coding sheets are submitted for inclusion into the NBS Solar Data Base, and are used in obtaining input to this study. The status of these data is discussed in Section 5.

4.2. COMMERCIAL PROGRAM

A single organization is collecting data from the Commercial Solar Demonstration Program, namely:

PRC Energy Analysis Company
8130 Boone Boulevard
McLean, Virginia 22101

FIGURE 4

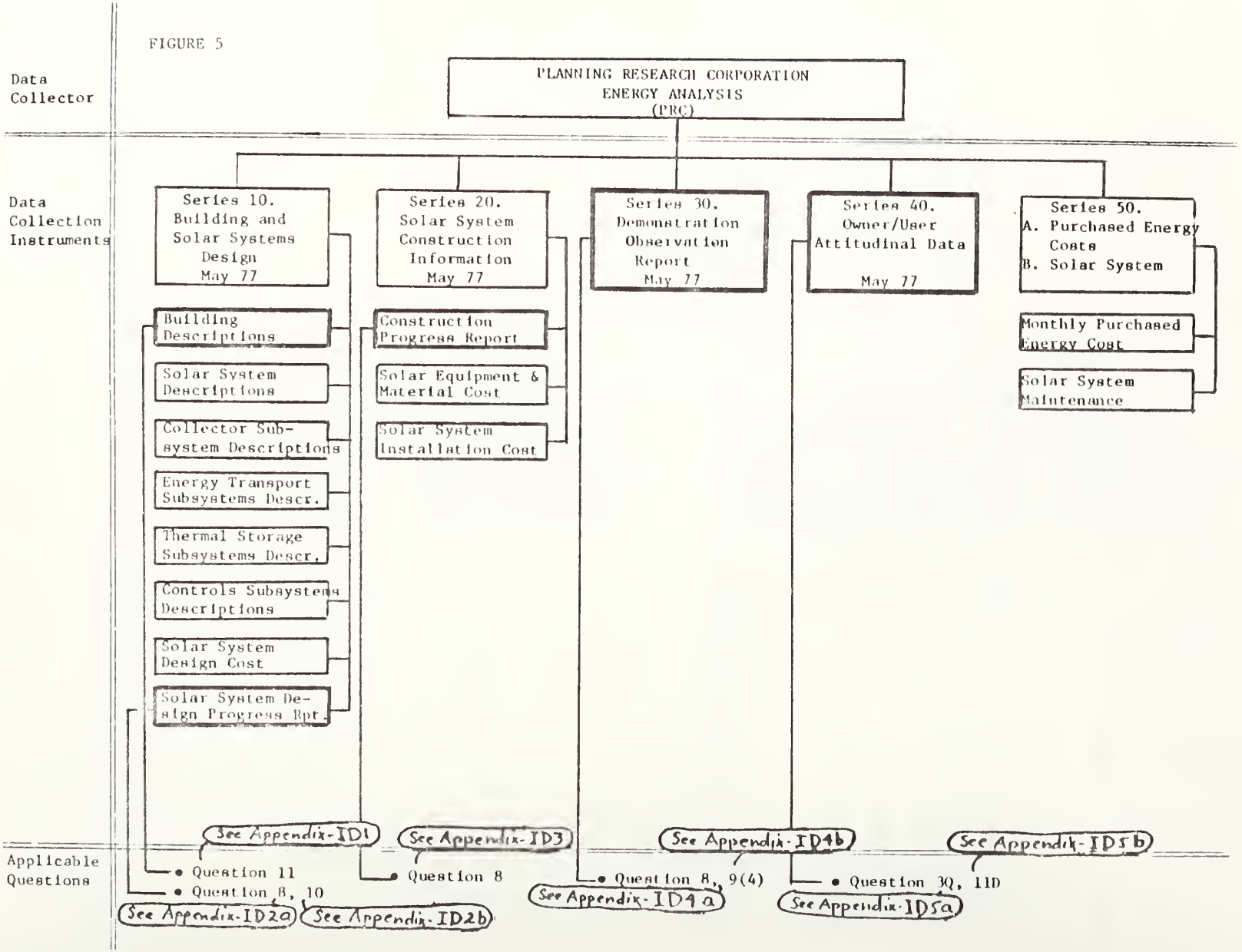

Data Collector
U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT/BOEING (HUD/BOEING)
Data Collection Instruments
Grantee Reports
Report #1 Project Schedule
Report #2 Submittal Checklist
Report #3 Construction Report
Report #4 Final Report
Applicable Questions
• Page 3 Q d.
See Appendix - IC1

The PRC developed five (5) data collection instruments (dated May 1977) which are packaged as a series of documents. These documents are shown in Figure 5 and the questions applicable to this study are identified. In the various documents, a total of nine (9) questions identified in Appendix I-Section D are of interest. Many of these questions are narrative in format and do not lend themselves to computerized tabulation.

The data collected by PRC are not coded for inclusion in the NBS Solar Data Base, and NBS deals directly with PRC to obtain the data. Contact was made with PRC and arrangements established so that information needed for this study is extracted by PRC onto a format developed by NBS for this purpose. If this mode of operation becomes too burdensome to PRC, alternative means will be developed.

Section 5 of this report discusses the status of the data available regarding building regulations for the commercial demonstration program as of September 30, 1977.

FIGURE 5


Data Collector
PLANNING RESEARCH CORPORATION
ENERGY ANALYSIS
(PRC)
Data Collection Instruments
Series 10. Building and Solar Systems Design May 77
Series 20. Solar System Construction Information May 77
Series 30. Demonstration Observation Report May 77
Series 40. Owner/User Attitudinal Data May 77
Series 50. A. Purchased Energy Costs B. Solar System
Building Descriptions
Solar System Descriptions
Collector Subsystem Descriptions
Energy Transport Subsystems Descr.
Thermal Storage Subsystems Descr.
Controls Subsystems Descriptions
Solar System Design Cost
Solar System Design Progress Rpt.
Construction Progress Report
Solar Equipment & Material Cost
Solar System Installation Cost
Monthly Purchased Energy Cost
Solar System Maintenance
Applicable Questions
See Appendix-ID1
• Question 11
• Question 8, 10
See Appendix-ID2a
See Appendix-ID2b
See Appendix-ID3
• Question 8
See Appendix-ID4a
• Question 8, 9(4)
See Appendix-ID4b
• Question 3Q, 11D
See Appendix-ID5a
See Appendix-ID5b

5. STATUS OF DATA

This section reports on the status of questionnaire data and corresponds to step (11) on the Project Methodology Chart (Figure 1) as described in Section 3. Each organization identified in Section 4 was contacted and asked to provide the status of responses for the questions identified as pertinent to the building regulatory study. Arrangements were made with these organizations to receive these data on an ad hoc basis with a more formal arrangement to be definitized at a later date.

To organize the data for future analysis and maintain a system which could include studies with time as a variable, information is presented on a cycle-by-cycle basis. This is possible because each demonstration cycle is sequential and falls within a specified time frame. The status of information available is tabulated by cycle. Because of the limited data available, it must be emphasized that this report makes no attempt to analyze the regulatory environment relative to the demonstration program but rather presents the data base available as of September 30, 1977. As the data base expands, analyses will be made and as the data gathering is completed, final results will be presented in subsequent reports.

5.1. RESIDENTIAL PROGRAM

The information available for the Residential Solar Demonstration Program as of the end of this reporting period is shown in Tables 1 and 2 for Cycles 1 and 2 respectively. The data include some general information (following the Solar Grant Summary format), as well as the status of the availability of completed questionnaires. The general information includes:

1. Project Location

   State
   City

2. Grantee

3. Housing Type

   SFD - Single Family Detached
   SFA - Single Family Attached
   GAL - Garden Apartment and Low Rise
   MFM - Multi-family Medium Rise
   MFH - Multi-family High Rise

4. Construction

   New/Retrofit

5. Number of Units

6. System Type

   H - Heating
   H/C - Heating and Cooling
   W - Hot Water

7. Kind of System

   A - Active
   P - Passive

The specific information shown on the remainder of each chart indicates the organization collecting the data and the exhibit description used throughout this report to identify each solar regulatory related question. Only those sites that are part of the demonstration program as of September 30, 1977, are given and subsequent iterations will not include any sites that are eliminated from the demonstration program. Special analyses will be made of situations, if any, where the sites were eliminated because of regulatory issues.

Table 1 illustrates the data available for Cycle 1 of the Residential Solar Demonstration Program. As can be noted, there are 41 grantees identified and most of the available data are from the HUD Grantee Reports (Appendix I-Section C1). This question, in effect, queries the grantee on the code in force by the local jurisdiction. These responses are not of great value in this analysis because the codes applicable to that site can be obtained from other sources, although data from the grantee may give some indication as to the builder's understanding of the local building code. (A preliminary study, using data from non-demonstration sources is included in Section 6 of this report.)

TABLE 1. RESIDENTIAL PROGRAM. REGULATORY DATA SUMMARY. CYCLE 1

PROJECT LOCATION		GRANTEE	HOUSING TYPE					CONSTRUCTION TYPE		NO. OF UNITS	SYSTEM TYPE			KIND OF SYSTEM		AVAILABILITY OF REGULATORY DATA AS OF SEPT. 30, 1977 (INDICATED BY X)							
																RE/RC					AIA		HUD
STATE	CITY		SFD	SFA	GAL	MEM	MFH	NEW	RETRO		H	H/C	W	A	P	A1*	A2*	A3*	A4*	A5*	B1*	B2*	C1*
CA	Camarillo	Leisure Tech. of CA		X				X		4			X	X		X				X			X
	Santa Clara	City of Santa Clara	X					X		5	X		X	X									X
	Selma	Self-Help Enterprises	X					X		5		X			X								
CO	Aurora	Perl-Mack Enterprises, Inc.	X					X		1		X	X	X									X
	Boulder	Stonebraker Investments			X			X		8	X		X	X									X
	Colorado Springs	City of Colorado Springs		X				X		12	X		X	X									X
	Fort Collins	ECO-ERA, Inc.	X					X		2	X		X	X						X			X
	Fort Collins	Solar Engr. Constr. Co.	X					X		1	X		X	X									X
	Pueblo	City of Pueblo	X					X		5			X	X									X
	Westminster	Waverly Homes	X					X		1	X			X									X
FL	Coral Gables	Babcock Company	X					X		3			X	X			X			X			X
	St. Petersburg	City of St. Petersburg			X				X	4			X	X									X
GA	Atlanta	Hooker Barnes, Inc.	X					X		1	X		X	X									
	Dacula	Winford Lindsey	X					X		1	X		X	X									X
	Shanandoah	Peachtree Homes	X					X		1		X	X	X						X			X
IL	Vernon Hills	United Development Co.		X				X		4	X		X	X						X			X
MT	Browning	The Blackfeet Tribe	X					X		5	X		X	X									
NJ	Blackwood	Korman Corporation	X					X		1	X		X	X									X
	Newark	Newark Hsg. Authority		X				X		6	X		X	X									
	Old Bridge	Jespa Enterprises	X					X		1	X		X	X									X
NM	Santa Fe	Wayne Nichols Communico	X					X		1	X		X	X						X			X
NY	Buffalo	Innovative Bldg. Systems	X					X		1	X		X	X									X
	LaGrangeville	Solar Structures, Inc.	X					X		1	X		X	X									X
OK	Okmulgee	Creek Nation Hsg. Authority	X					X		5	X		X	X									
OR	Ashland	Vincent L. Oredson	X					X		1	X		X	X									X
PA	Philadelphia	Drexel University			X				X	5			X	X									
	Philadelphia	University of PA		X				X		1	X		X	X									

* Refers to Exhibits in Appendices

TABLE 1. RESIDENTIAL PROGRAM. REGULATORY DATA SUMMARY. CYCLE 1 -- CONTINUED

PROJECT LOCATION		GRANTEE	HOUSING TYPE					CONSTRUCTION TYPE		NO. OF UNITS	SYSTEM TYPE			KIND OF SYSTEM		AVAILABILITY OF REGULATORY DATA AS OF SEPT. 30, 1977 (INDICATED BY X)							
																REHC					A1A		HUD
STATE	CITY		SFD	SFA	GAL	MFH	MFH	NEW	RETRO		H	H/C	W	A	P	A1*	A2*	A3*	A4*	A5*	B1*	B2*	C1*
PR	Rio Pedras	P.R. Urban Renewal Corp.			X			X		12			X	X									
RI	Newport	Church Community Corp.	X					X		1	X		X	X									X
SC	Columbia	Cambridge Development Group		X				X		2	X		X	X									X
	Greenville	Hello Thermics, Inc.	X					X		1	X			X		X	X			X			X
TX	Dallas	W. Brown Custom Bldrs.	X					X		1	X		X	X		X				X			X
	Lubbock	Gordon Deering	X					X		1	X		X	X									X
	San Antonio	San Antonio Ranch, LTD	X					X		1		X	X	X									
UT	Salt Lake City	Ferracor Utah	X					X		1	X			X									X
VA	Berryville	Ritter Bldgs. Inc.	X					X		1	X		X	X						X			X
	Vienna	The Yeonas Co.	X					X		1			X	X						X			X
	Virginia Beach	Sir Galahad Co.	X					X		1	X		X	X									X
VT	Brookline	Grassey Brook Village			X			X		10	X		X	X									
WI	Milwaukee	University of Wisconsin	X						X	1	X		X	X									
	Summit	Friedman, Rosen & Zien	X					X		1	X		X	X		X	X			X			X

* Refers to Exhibits in Appendices

TABLE 2. RESIDENTIAL PROGRAM. REGULATORY DATA SUMMARY. CYCLE 2

PROJECT LOCATION		GRANTEE	HOUSING TYPE					CONSTRUCTION TYPE		NO. OF UNITS	SYSTEM TYPE			KIND OF SYSTEM		AVAILABILITY OF REGULATORY DATA AS OF SEPT. 30, 1977 (INDICATED BY X)							
																RE.RL					A1A		HUD
STATE	CITY		MFD	SFA	GAL	MFM	MFH	NEW	RETRO		H	H/C	W	A	P	A1*	A2*	A3*	A4*	A5*	B1*	B2*	C1*
AL	Huntaville	Cheater West, Inc.	X					X		0	X		X	X							X	X	
	Madison	Housing Development Co.		X				X		5			X	X									
AZ	Mayer	Kauffman, Herbert L.		X				X		5	X		X		X								
CA	Davis	Corbett, Michael N.			X				X	10			X	X									
	Donner	Ca. Engy. Res. & Div. Com.	X						X	1	X		X	X									
	Hemet	Blue Skies Radiant Homes	X					X		2	X		X	X							X	X	
	Los Angeles	Ca. Engy. Res. & Div. Com.	X						X	1			X	X									
	Manchester	Mendocino Coast Properties	X					X		1	X		X	X									
	Palo Alto	Colorado Park Mng. Corp.			X				X	60			X	X									
	Prairie Creek	Ca. Engy.Res. & Div. Comm.	X						X	1	X		X	X									
	San Bernadino	San Bern. W. Side Comm.Div.	X						X	10	X		X	X									
	San Diego	Ca. Engy. Res. & Div. Comm.	X						X	1			X	X									
	San Diego	Facilities Dev. Co.			X			X		31			X	X							X	X	
	Sonoma Coast	Ca. Engy. Res. & Dev. Comm.	X						X	1	X		X	X									
CO	Boulder	University of Colorado				X			X	95	X		X	X									
"	Boulder	Bell, Erwin J.	X					X		1	X		X	X									
	Boulder	Wonderland Hill Dev. Corp.		X				X		35	X		X	X									
	Boulder	Naumonn, Robert C.		X				X		2	X		X	X									
	Denver	Perl-Mack Enterprises	X					X		25	X		X	X							X	X	
	Evergreen	Vickermon, David L., Inc.	X					X		0	X		X	X									
	Granada	CO Rural Mng. Dev. Corp.	X						X	18			X	X									
CT	Cheatre	J. Capone Constr. Co.		X				X		4	X		X	X									
D.C.	Washington	Forest City Dillon Inc.					X	X		108			X	X									
FL	Gretna	Town Council, City of Gretna	X					X		16	X		X	X									
	Winter Springs	Florida Gas Co.	X					X		1		X	X	X							X		
GA	Clarkston	F. E. Fortenberey & Sons, Inc.	X					X		6	X		X	X									
	Cohutta	Contemporary Homes, Inc.	X					X		1			X	X									

* Refers to Exhibits in Appendices

TABLE 2. RESIDENTIAL PROGRAM. REGULATORY DATA SUMMARY. CYCLE 2 -- CONTINUED

PROJECT LOCATION		GRANTEE	HOUSING TYPE					CONSTRUCTION TYPE		NO. OF UNITS	SYSTEM TYPE			KIND OF SYSTEM		AVAILABILITY OF REGULATORY DATA AS OF SEPT 30, 1977 (INDICATED BY X)							
																REHC					A1A		HUD
STATE	CITY		PUD	SFA	GAL	MFM	MFH	NEW	RETRO		H	H/C	W	A	P	A1*	A2*	A3*	A4*	A5*	B1*	B2*	C1*
	Commerce	Wilbanks Lamar	X					X		1			X	X									
	Dalton	Dalton Hsg. Authority		X				X		12			X	X									
	Dalton	Owens & Park, Inc.	X					X		1			X	X									
	Lawrenceville	Fairview Bldrs. Wendford Linn	X					X		3	X		X	X									
	Macon	Fenilworth Manor, Inc.					X		X	80			X	X									
	Ringold	Brown, Wilburn Inc.	X					X		2			X	X									
	Swainsboro	Unified Development Inc.		X				X		1	X		X	X									
HI	Ewa Beach	Finance Realty Co. Ltd.	X					X		5			X	X									
	Honolulu	Hei Wai Wong				X		X		55			X	X							X	X	
	Waipahu	Hawaii Hsg. Authority			X				X	19			X	X									
IA	West Des Moines	Spence-Urbon & Asso.	X					X		1	X		X	X	X								
	West Des Moines	Spence-Urbon & Asso.	X					X		1			X										
ID	Pocatillo	IAS Div. & Construction	X					X		1	X			X									
IN	Greenwood	Moulder Corp.	X					X		1	X		X	X							X	X	
KS	Sharonce	Byram, John C.	X					X		1	X		X	X							X	X	
"	Stillwell	DU-Mac Investment Co.																			X	X	
LA	Baton Rouge	E. Baton Rough Parish Hsg.		X					X	2		X	X	X									
MA	Greenfield	Greenfield Hsg. Authority			X				X	16			X	X									
	Marion	Town of Marion	X					X		12	X		X	X									
	Northhampton	Exec. off./Comm. & Dev.	X						X	1	X		X	X									
MD	Columbia	Evans, J. D.	X					X		4	X		X	X							X	X	
	Columbia	Development Tech., Inc.	X					X		2	X		X	X									
	Columbia	FHS, Inc.	X					X		1	X		X	X	X								
ME	Perry	Pleasant Point Hsg. Authority	X						X	1	X		X	X									
MI	Almena TWP	Lion Enterprises	X					X		1	X		X	X	X								
	Battle Creek	Battle Creek Hsg. Authority					X		X	150			X	X									
	Flint	City of Flint		X				X		6		X	X	X									

* Refers to Exhibits in Appendices

TABLE 2. RESIDENTIAL PROGRAM. REGULATORY DATA SUMMARY. CYCLE 2 -- CONTINUED

PROJECT LOCATION		GRANTEE	HOUSING TYPE					CONSTRUCTION TYPE		NO. OF UNITS	SYSTEM TYPE			KIND OF SYSTEM		AVAILABILITY OF REGULATORY DATA AS OF SEPT. 30, 1977 (INDICATED BY X)							
																REHC					AIA		HUD
STATE	CITY		SFD	SPA	GAL	MFH	MFH	NEW	RETRO		H	H/C	W	A	P	A1*	A2*	A3*	A4*	A5*	B1*	B2*	C1*
MN	Eden Prairie	Houston Constr., Inc.	X				X			1	X		X	X							X	X	
	Esko	Red Barn Realty, Inc.	X					X		1	X		X	X	X								
	Minneapolis	Gridley Constr. Co.	X					X		1	X		X	X									
	Minneapolis	Creek Associates				X		X		77	X		X	X									
MO	Tomaro Oaks	Wren, Oscar P. Jr.	X					X		1	X		X	X	X						X	X	
MT	Big Tock	Dealgu Constr. Asso.	X					X		1	X		X	X									
NC	Asheville	Thomson & Asso.	X					X		2			X	X									
	Cary	Robuck, Frank Jr.	X					X		1			X	X									
	Durham	Durham Hsg. Authority			X			X		18		X	X	X									
	Pittsboro	Mongeau, Beatrice		X				X		3	X		X	X	X								
	Raleigh	Ecological Bldrs., Inc.	X					X		1	X		X	X									
	Winston-Salem	CLS Constr. Co.	X					X		5			X	X									
NH	East Derry	Fletcher-Myers, Inc.	X					X		1	X		X	X									
	Harrisville	Total Environmental Actions	X					X		1	X		X	X	X								
	North Conway	Kearsarge Bldg. Co.,Inc.		X				X		5	X		X	X									
NJ	Cherry Hill	Jos. Barnews & Sons, Inc.	X					X		1	X		X	X									
	Dover	Dover Hsg. Authority				X			X	61			X	X									
	S. Brunswick TWP	Raritan Valley Comm. Dev.		X				X		8			X	X									
NM	Albuquerque	Albuquerque W. Solar Ind.				X		X		101	X		X	X							X	X	
	Albuquerque	Homes by Marilynno	X					X		2	X		X	X							X	X	
	Santa Fe	Stanley Asso.	X					X		1	X		X	X									
	Santa Fe	Communico	X					X		1	X		X		X								
NY	Bedford	DWS Holdings, Inc.								6	X		X	X									
	Bronx	Peoples Dev. Corp.				X			X	28			X	X									
	Chester	Suntech Homes, Inc.	X					X		1	X		X	X							X	X	
	Long Island	Pinewood Manor Inc.	X					X		1	X			X									
	Malta	Stewart-Tule-Mitchell Corp.	X					X		1	X		X	X							X	X	

* Refers to Exhibits in Appendices

TABLE 2. RESIDENTIAL PROGRAM. REGULATORY DATA SUMMARY. CYCLE 2 -- CONTINUED

PROJECT LOCATION		GRANTEE	HOUSING TYPE					CONSTRUCTION TYPE		NO. OF UNITS	SYSTEM TYPE			KIND OF SYSTEM		AVAILABILITY OF REGULATORY DATA AS OF SEPT. 30, 1977 (INDICATED BY X)							
																RERC					AIA		HUD
STATE	CITY		SFD	SFA	GAL	MFM	MFH	NEW	RETRO		H	H/C	W	A	P	A1*	A2*	A3*	A4*	A5*	B1*	B2*	C1*
OH	Butler-Hamilton	Lucke & Strassel Bldrs.	X					X		1	X		X	X									
	Hubbard, Others	Homes by Stan-Lim, Inc.	X					X		4	X		X	X									
OR	Coos Bay	Twin City Bldrs. Inc.	X					X		1	X		X	X									
PA	Northampton TWP	Gigliotti Corp.	X					X		1	X		X	X									
	Penn Valley	Filton, William Inc.	X					X		1	X		X	X	X								
	Pittsburgh	Contemporary Import/Export		X				X		4	X		X	X									
SC	Greenville	Hello Thermics, Inc.	X					X		6	X		X	X							X	X	
	Hilton Head Island	Solar Dev. Assc.	X					X		2	X		X	X									
	Myrtle Beach	Miles & Teal Bldrs.	X					X		1			X	X									
	St. Mathews	Phillips/Kaurle/Adams/ Branham	X					X		12	X		X	X							X	X	
SD	Lake Andes	S. Central Comm. Action Prog.		X				X		4		X			X								
TN	Chattanooga	Ralston Homes, Inc.	X					X		1			X	X									
	Knoxville	Redmon Lynn	X					X		2			X	X									
	Knoxville	Ramsden, Richard	X					X		1			X	X									
	Knoxville	R. H. Sinclair Constr. Co.	X						X	1			X	X									
	Knoxville	D. K. Dossett	X					X		5				X									
	Knoxville	Architectural Developers, Inc	X					X		3			X	X									
TX	Austin	Colleges Houses			X				X	80		X	X	X							X	X	
	Austin	Univ. of TX/Austin			X				X	12		X	X	X									
	Lubbock	Doering, Gordon	X					X		1		X	X	X									
VA	Dumfries	L. I. Construction, Inc.	X					X		1	X		X	X									
VT	Waitsfield	Greenmoss Bldrs., Inc.	X					X		1	X		X	X	X						X	X	
WA	Seattle	Wash. Natural Gas Co.	X					X		1	X		X	X									
WI	Lake Park Estate	Kuck, Theodore A.	X					X		1	X		X	X									
	Rice Lake	William C. Burdick	X					X		1	X		X	X	X								

* Refers to Exhibits in Appendices

It can also be noted that only four (4) builders' questionnaires (Appendix I-Section A1) and three (3) comparative builders' questionnaires are available, and the two sets do not exactly coincide. There are, however, eleven (11) Local Building Code Official questionnaires (Appendix I-Section A5) available and this is encouraging as these questionnaires will be a major source of input to subsequent studies. No data are identified as being available from AIA/RC (Appendix I-Section B) for Cycle 1.

With regard to Cycle 2 (Table 2), the only data identified as being available through September 30, 1977, are twenty (20) sets of AIA/RC data (Appendix I-Section B). No tabulation is presented for Cycle 3 and subsequent cycles as no data are identified. Charts for subsequent cycles indicating available data will be prepared, when appropriate.

5.2. COMMERCIAL PROGRAM

The information available for the commercial demonstration program as of the end of this reporting period is shown in Table 3 for Cycle 1. These data, following a PRC format, include some general information and the status of the availability of completed questionnaires. The general information includes:

1. Project Location

   State
   City

2. Collector Manufacturer

3. Building Type

   AH - Apartment, High Rise
   AL - Apartment, Low Rise
   AU - Auditorium, concert hall, convention center, theater
   BC - Bowling center
   BR - Bar, nite club
   CF - Cafeteria
   CH - Church
   DR - Dormitory
   DS - Department Store
   ED - Educational facility (class rooms, lecture halls, etc.)
   FS - Fire Station

GS - Gymnasium, sports arena
CL - Health Facility, clinic
HO - Health Facility, hospital
NS - Health Facility, nursing home
HM - Hotel/Motel
IH - Industrial Building, Heavy
IL - Industrial Building, Light
LA - Laboratory
LB - Library
ML - Shopping Mall
OH - High rise office building, over 3 story
OL - Low rise office building, 1 to 3 story
PO - Post Office
PS - Police Station
RT - Restaurant
SS - Small Store
VS - Variety Store
SM - Supermarket
WH - Warehouse

4. Kind of System

N - New
R - Retrofit

5. Collector Type

C - Concentrating
F - Flat Plate
P - Passive
T - Tubular

6. Collector Medium

A - Air
L - Liquid
S - Steam

7. System Type

H - Heating
C - Cooling
W - Hot Water

The specific information shown on the remainder of each chart indicates the exhibit description used throughout this report to identify each regulatory related question in the PRC questionnaire package. Again, only current sites are included in each chart and subsequent iterations will eliminate those sites that are no longer a part of the demonstration program.

Also included are those sites established under National Science Foundation grants, prior to the DoE Commercial Solar Demonstration Program.

As can be noted, there are fifty (50) sites identified with some data available for fourteen (14) of these sites. Analysis of these data will begin once received by NBS. Data are not available for subsequent cycles; charts will be prepared by cycle at the appropriate time.

TABLE 3. COMMERCIAL PROGRAM. REGULATORY DATA SUMMARY. CYCLE 1

PROJECT LOCATION		COLLECTOR MANUFACTURER	BUILDING TYPE	KIND OF SYSTEM		COLLECTOR TYPE				COLLECTOR MEDIUM			SYSTEM TYPE			AVAILABILITY OF REGULATORY DATA AS OF SEPT. 30, 1977 (INDICATED BY X)							
STATE	CITY			N	R	C	F	P	T	A	L	S	H	C	W	D1*	D2a*	D2b*	D3*	D4a*	D4b*	D5a*	D5b*
AL	Montevallo	PPG	OL	X			X				X		X	X									
AZ	Tempe	Southwest Std.	LD	X			X				X												
CA	El Toro	Unitepan	AL		X		X				X				X	X	X	X	X	X	X		
	Fresno	Ying Manufacturing	BL		X		X				X				X								
	Irwine	Owens-Illinois	ED		X				X		X		X	X									
	Mill Valley	Solar Utilities	LA	X			X				X				X	X	X	X	X				
	San Francisco	Chamberlain	OH		X		X				X		X										
	Santa Clara	Ametek	AU	X			X				X		X	X		X	X	X	X	X	X		
	South Lake Tahoe	Western Energy	FS		X		X				X												
	Uplands	Lennox-Honeywell	AL	X			X				X					X	X	X	X	X	X		
CT	Hamden		AL	X			X				X		X										
	Stamford	Sunworks	OL		X		X				X		X										
FL	Coral Gables		ED											X									
	Lake Buena Vista	AAI	OL	X					X		X		X	X	X								
	Nassau County	Northrup	AU	X					X		X		X	X									
GA	Atlanta	PPG	ED		X		X				X		X	X	X								
	Shenandoah	Revere	GS	X			X				X		X	X	X	X	X	X	X				
IA	West Branch	Solaron	GS	X			X			X			X		X	X	X	X	X				
KY	Louisville	GDI/Solaron	OL		X		X				X		X		X	X	X	X	X				
LA	Baton Rouge	Lennox-Honeywell	GS		X		X				X		X										
MA	Dorchester	General Electric	ED		X		X				X		X										
MD	Annapolis	NER-TECH	HM		X		X				X				X								
	Baltimore	Revere	AU	X			X				X												
	Cockeysville	AAI	ED		X	X					X		X	X									
	Silver Spring	TA	OL		X				X		X		X										
	Timonium	AAI	ED		X		X				X		X										
MI	OKEMOS	Revere	HO	X			X				X				X								
MN	Blue Earth	Solar	IH	X			X				X												

* Refers to Exhibits in Appendices

TABLE 3. COMMERCIAL PROGRAM. REGULATORY DATA SUMMARY. CYCLE 1 -- CONTINUED

PROJECT LOCATION		COLLECTOR MANUFACTURER	BUILDING TYPE	KIND OF SYSTEM		COLLECTOR TYPE				COLLECTOR MEDIUM			SYSTEM TYPE			AVAILABILITY OF REGULATORY DATA AS OF SEPT. 30, 1977 (INDICATED BY X)							
STATE	CITY			N	R	C	F	P	T	A	L	S	H	C	W	D1*	D2a*	D2b*	D3*	D4a*	D4b	D5a*	D5b*
MN	Brooklyn Center	Honeywell	FD		X		X				X		X		X								
	Minneapolis	Ametek	LB		X		X				X		X										
	St. Paul	Lennox-Honeywell	HM	X			X			X													
MO	Kansas City	Solaron	FS	X			X			X			X										
NC	Charlotte	General Electric	FD	X			X				X					X	X	X	X	X	X		
NH	Manchester	Kalwall	WH		X			X		X													
NJ	Basking Ridge	General Electric	AU	X			X				X		X	X		X	X	X	X				
	Lumberton	Sunworks	IL	X			X				X												
NM	Las Cruces	Miromit/Northrup	LA		X		X				X		X	X									
	Nambe	LASL	AU	X			X			X			X	X	X								
OH	Troy	Owens-Illinois	LB	X					X		X		X										
PR	Canovanas	Owens-Illinois	IL						X		X			X									
SC	Greenwood	PPG	OL	X			X				X		X		X	X	X	X	X	X	X		
SD	Mount Rushmore	Lennox-Honeywell	AU		X		X				X		X	X		X	X	X	X	X	X		
TX	Austin	Northrup	OL	X		X					X		X	X		X	X	X	X				
	San Antonio	Northrup	GS		X	X					X		X		X	X	X	X	X				
VA	Leesburg	ENER-TECH	FD	X			X				X				X								
	Lynchburg	Terrell Moseley	OL				X				X		X		X								
	Warrenton	Olin Brass	FD		X		X				X		X										
VI	St. Thomas	Northrup	HM		X	X					X			X		X	X	X	X	X	X		
WA	Richland	General Electric	OL	X			X				X		X	X									
WV	Charleatown	PPG	FD	X			X				X		X	X									

* Refers to Exhibits in Appendices

6. ANALYSIS OF CODE DATA

This preliminary analysis is made to assess the adequacy of the sites selected for the demonstration programs from a building regulatory point of view. Sites can be selected on a technical basis alone to demonstrate various solar systems in different climatic environments, but consideration must also be given to the regulatory thrust of this program. In this regard, the site locations selected for the demonstration program are analyzed for balance from a regulatory perspective and recommendations suggested for future site selection in subsequent demonstration cycles.

Since very little questionnaire data are available, this study is being made independently of the demonstration program data. As the location of the sites are known, code information can be obtained for those locations from sources not dependent on the demonstration program. From one of these sources[1], an overview of statewide and major city building codes is presented in Figure 6. The map is distorted from the usual geographic presentation to depict the size of the states as determined by population. States with regulatory codes based on the three nationally recognized model codes are shown, as well as states with their own codes and states that have adopted no statewide code. In addition, code information is also shown for major cities. A tabulation is included in the legend to indicate the number of states and major cities in each category.

6.1. RESIDENTIAL SOLAR DEMONSTRATION SITES

6.1.1 Distribution of Sites

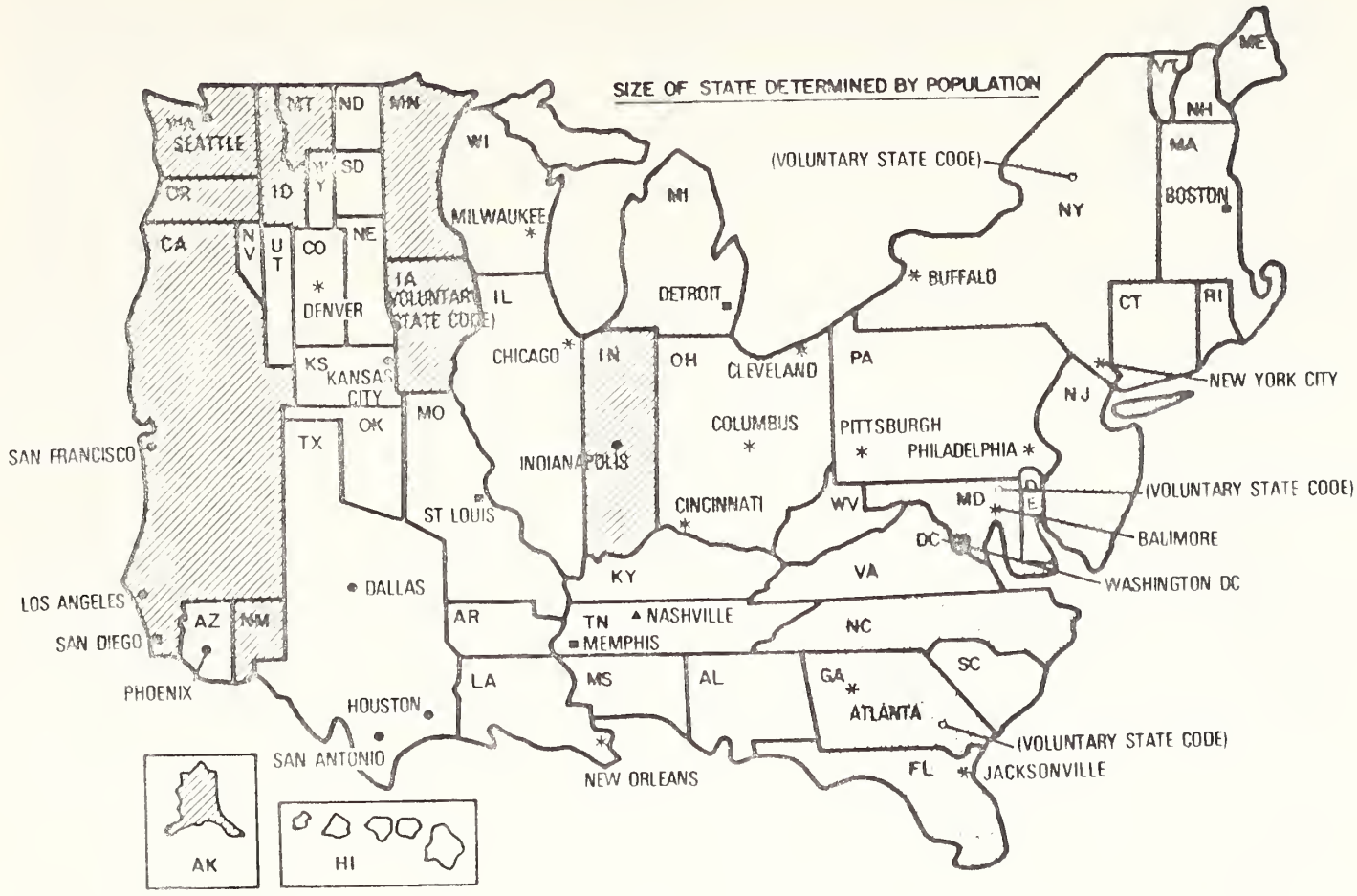
A large number of sites were selected for the Solar Demonstration Program on the basis of various criteria. This section reviews the distribution of the location of these sites from one of these criteria, the building regulatory viewpoint. A non-representative mix of site locations may provide

---

[1] NBSIR 77-1390 - A Preliminary Examination of Building Regulations Adopted by the States and Major Cities, Patrick W. Cooke and Robert M. Eisenhard.

Figure 6

STATEWIDE AND MAJOR CITY BUILDING CODES: TECHNICAL BASIS FOR REGULATIONS IN EXISTENCE



LEGEND

STATES	CITIES	
(10)	● (10)	UNIFORM BUILDING CODE (ICBO)
(7)	■ (4)	BASIC BUILDING CODE (BOCA)
(6)	▲ (1)	STANDARD BUILDING CODE (SBCC)
(3)	★ (15)	JURISDICTIONS WITH OWN CODE
(25)		NO STATEWIDE CODE ADOPTED

NOTE: Figures in parentheses indicate number of [illegible]

inadequate data to present a total and meaningful comparison. Moreover, the conclusion reached may not be general in nature but biased and misleading.

The overview which follows attempts to provide general information relative to residential site selection for the 3 cycles already awarded. Table 4 is a tabulation of the various sites, by cycle, and state, indicating whether the sites are retrofit sites or new sites. This breakdown is desirable for any future analysis regarding codes as applied to new construction and/or existing building construction.

Using the data shown on the population map (Figure 6), the building code applicable to each state is identified. However, it is recognized that the states listed as having no statewide code may in fact contain jurisdictions which predominantly use a version of one of the nationally recognized model codes. For the purposes of this study, these states are grouped separately.

The data tabulated in Table 5 shows that of the 50 States, ten (20%) are covered by the Uniform Building Code (UBC); seven (14%) by the Basic Building Code (BBC); three (6%) by the Southern Building Code (SBC); three (6%) by a State building code; and 27 (54%) by no statewide code.

This type of analysis does not take population into account and since the more densely populated states are better candidates for the exploitation of solar energy (all other matters being equal), the analysis must somehow be weighted by population.

A tabulation was added to Table 5 to show the various percentages of population affected by the model codes. This indicates that 20 percent of the population is influenced by the Uniform Building Code; 17 percent by the Basic Building Code; 8 percent by the Southern Building Code; 16 percent by a state code; and 39 percent of the population live in states that have not adopted a statewide code. These percentages, summarized in Table 6, are selected as the comparison baseline.

TABLE 4. RESIDENTIAL PROGRAM
SITES PER CYCLE AND MODEL CODE BASE

STATE	POPUL. (mill)	NUMBER OF SITES IN CYCLE				NEW SITES IN CYCLE				RETROFIT SITES IN CYCLE				BUILDING CODE BASED ON			STATE	* NONE
		1	2	3	Total	1	2	3	Total	1	2	3	Total	UBC	BBC	SBC		
AL	3.4	0	2	1	3	0	2	1	3	0	0	0	0					X
AK	0.4	0	0	0	0	0	0	0	0	0	0	0	0	X				
AR	2.1	0	0	0	0	0	0	0	0	0	0	0	0					X
AZ	1.8	0	1	2	3	0	1	2	3	0	0	0	0					X
CA	19.7	3	11	9	23	3	3	8	14	0	8	1	9	X				
CO	2.2	7	7	11	25	7	5	10	22	0	2	1	3					X
CT	3.0	0	1	4	5	0	1	3	4	0	0	1	1		X			
DE	0.5	0	0	1	1	0	0	1	1	0	0	0	0					X
FL	6.7	2	2	5	9	1	2	1	4	1	0	4	5			X		
GA	4.5	3	9	1	13	3	8	0	11	0	1	1	2			X		
HI	0.7	0	3	1	4	0	2	0	2	0	1	1	2					X
IA	2.8	0	2	2	4	0	2	2	4	0	0	0	0	X				
ID	0.7	0	1	2	3	0	1	1	2	0	0	1	1	X				
IL	11.0	1	0	3	4	1	0	3	4	0	0	0	0					X
IN	5.1	0	1	10	11	0	1	9	10	0	0	1	1	X				
KS	2.2	0	2	2	4	0	2	2	4	0	0	0	0					X
KY	3.1	0	0	2	2	0	0	2	2	0	0	0	0					X
LA	3.6	0	1	0	1	0	0	0	0	0	1	0	1					X
MA	5.6	0	3	15	18	0	1	12	13	0	2	3	5		X			
MD	3.9	0	3	3	6	0	3	3	6	0	0	0	0		X			
ME	1.0	0	1	3	4	0	0	1	1	0	1	2	3					X
MI	8.8	0	3	4	7	0	2	4	6	0	1	0	1		X			
MN	3.8	1	4	3	8	1	4	3	8	0	0	0	0	X				
MO	4.6	0	1	6	7	0	1	5	6	0	0	0	0					X
MS	2.3	0	0	0	0	0	0	0	0	0	0	0	0					X
MT	0.7	1	1	4	6	1	1	4	6	0	0	0	0	X				
NC	5.6	0	6	4	10	0	6	4	10	0	0	0	0			X		
ND	0.6	0	0	1	1	0	0	1	1	0	0	0	0					X
NE	1.5	0	0	3	3	0	0	3	3	0	0	0	0					X
NH	0.7	0	3	4	7	0	3	4	7	0	0	0	0					X
NJ	7.1	3	3	2	8	3	2	0	5	0	1	2	3		X			
NM	1.0	1	4	5	10	1	4	5	10	0	0	0	0	X				
NV	0.5	0	0	1	1	0	0	1	1	0	0	0	0					X
NY	18.0	2	5	8	15	2	4	2	8	0	1	6	7				X	
OH	10.5	0	2	8	10	0	2	8	10	0	0	0	0				X	

* These states may contain jurisdictions which predominantly use a version of one of the nationally recognized model codes.

TABLE 4. RESIDENTIAL PROGRAM
SITES PER CYCLE AND MODEL CODE BASE -- CONTINUED

STATE	POPUL. (mill)	NUMBER OF SITES IN CYCLE				NEW SITES IN CYCLE				RETROFIT SITES IN CYCLE				BUILDING CODE BASED ON			STATE	* NONE
		1	2	3	Total	1	2	3	Total	1	2	3	Total	UBC	BBC	SBC		
OK	2.5	1	0	2	3	1	0	2	3	0	0	0	0					X
OR	2.0	1	1	2	4	1	1	2	4	0	0	0	0	X				
PA	11.7	2	3	8	13	1	3	5	9	1	0	3	4					X
RI	0.9	1	0	1	2	1	0	1	2	0	0	0	0		X			
SC	2.5	2	4	3	9	2	4	3	9	0	0	0	0					X
SD	0.7	0	1	2	3	0	1	2	3	0	0	0	0					X
TN	3.8	0	6	2	8	0	5	2	7	0	1	0	1					X
TX	11.0	3	3	5	11	3	1	2	6	0	2	3	5					X
UT	1.0	1	0	3	4	1	0	3	4	0	0	0	0					X
VA	4.5	3	1	4	8	3	1	3	7	0	0	1	1		X			
VT	0.4	1	1	1	3	1	1	1	3	0	0	0	0					X
WA	3.4	0	1	1	2	0	1	1	2	0	0	0	0	X				
WI	4.4	2	2	6	10	1	2	5	8	1	0	1	2				X	
WV	1.7	0	0	2	2	0	0	1	1	0	0	1	1					X
WY	0.4	0	0	0	0	0	0	0	0	0	0	0	0					X
TOTALS		41	105	172	318	38	83	138	259	3	22	34	59	10	7	3	3	27
DC	0.7	0	1	0	1	0	1	0	1	0	0	0	0					X
PR	2.9	1	0	0	1	1	0	0	1	0	0	0	0					X
VI	0.6	0	0	0	0	0	0	0	0	0	0	0	0					X
TOTALS		42	106	172	320	39	84	138	261	3	22	34	59	-	-	-	-	-

* These states may contain jurisdictions which predominantly use a version of one of the nationally recognized model codes.

TABLE 5. RESIDENTIAL PROGRAM. BUILDING CODE DISTRIBUTION

CODE	NO. OF STATES	% OF STATES COVERED BY CODE	STATE/POP.	TOTAL POP. (IN MILLIONS)	% OF POP. COVERED BY CODE	NO. OF DEMONSTRATION SITES	% OF DEMONSTRATION SITES COVERED BY CODE
UBC (ICBO)	10	20	CA 19.7 IN 5.1 MN 3.8 WA 3.4 IA 2.8 OR 2.0 NM 1.0 ID 0.7 MT 0.7 *AR 0.4	39.6	20	71	22
BBC (BOCA)	7	14	MI 8.8 NJ 7.1 MA 5.6 VA 4.5 MD 3.9 CT 3.0 RI 0.9	33.8	17	54	17
SBC (SBCC)	3	6	FL 6.7 NC 5.6 GA 4.5	16.8	8	32	10
STATE CODE	3	6	NY 18.0 OH 10.5 WI 4.4	32.9	16	35	11
NO STATE-WIDE CODE **	27	54	PA 11.7 IL 11.0 TX 11.0 MO 4.6 TN 3.8 LA 3.6 AL 3.4 KY 3.1 OK 2.5 SC 2.5 *MS 2.3 CO 2.2 KS 2.2 *AR 2.1 AZ 1.8 WV 1.7 NE 1.5 ME 1.0 UT 1.0 HI 0.7 NH 0.7 SD 0.7 ND 0.6 DE 0.5 NV 0.5 VT 0.4 *WY 0.4	77.5	39	126	40
TOTALS:	50	100%		200.6	100%	318	100%

NOTE: This information does not include Puerto Rico (one site), District of Columbia (one site), Virgin Islands (no site).

* These states do not have residential sites.

** These states may contain jurisdictions which predominantly use a version of one of the nationally recognized model codes.

Code	% Population Covered by Code	% of Demonstration Site Covered by Code
UBC	20	22
BBC	17	17
SBC	8	10
State Code	16	11
No State-wide Code*	39	40
Total	100	100

* These states may contain jurisdictions which predominantely use a version of one of the nationally recognized model codes.

Table 6. Residential Program
Summary of Code Distribution

It appears, from Table 6, that a reasonable overall selection of sites was made for the residential demonstration program, although more sites were chosen from UBC, SBC, and states that have no statewide code at the expense of states that have written their own state codes.

The distribution of the number of sites by state population is charted in Figure 7, where the number of sites for a particular location is plotted against the population of the state. In Figure 7, the states are identified by a code-related symbol. However, the site/population distribution is code-independent. As such, this graph serves the dual purpose of showing the overall distribution and, upon closer scrutiny, identifies the code used in the state.

The general premise postulated is that, from a regulatory viewpoint, more demonstration sites should be selected from the most populated states.

To facilitate this analysis, a diagonal line was initally added to the chart with a slope representing the number of sites to be included in the demonstration based on the population percentage and the total number of sites in the demonstration program to date. Since California has approximately 9.8% of the national population, it is reasoned that 9.8% of the sites should be in California or a total of 31 of the 317 sites currently comprising cycles 1, 2, and 3. The line was drawn from the origin through the coordinates representing 31 sites and a population of 19.7 million. (Although the coordinates are off-scale in Figure 7 to give greater detail to the actual sites plotted, the slope indicated uses the methodology described above.)

The resulting slope, however, is not unique to California, but in effect is a constant slope for all states for the total number of sites in the cycles plotted. However, since each state cannot have a fractional number of sites, it is more appropriate to have a band-width (represented by the shaded portion of the graph) than a single line which would in most cases represent fractional sites for a particular state. This whole-integer band-width turns out to be 2 sites wide. For this study, however, the band-width was doubled to a 4 site-wide dimension as representing a more reasonable area for analysis purposes, although any reasonable band-width would be appropriate and offer similar conclusions.

By viewing this presentation, and also referring back to the percentage summary shown in Table 6, the following recommendations are offered with regard to site selection for the remaining cycles.

Uniform Building Code Sites - Table 6 indicates a slightly higher number of UBC sites than desirable. In attempting to approach 20 percent of the sites, in total, emphasis could be placed on selecting some sites in Washington and more in California (because these States fall below the band-width shown in Figure 7) and conversely, few sites, if any, should be selected in New Mexico and Montana. The selection of sites in Arkansas (no sites identified in the first three residential demonstration cycles) could also be considered.

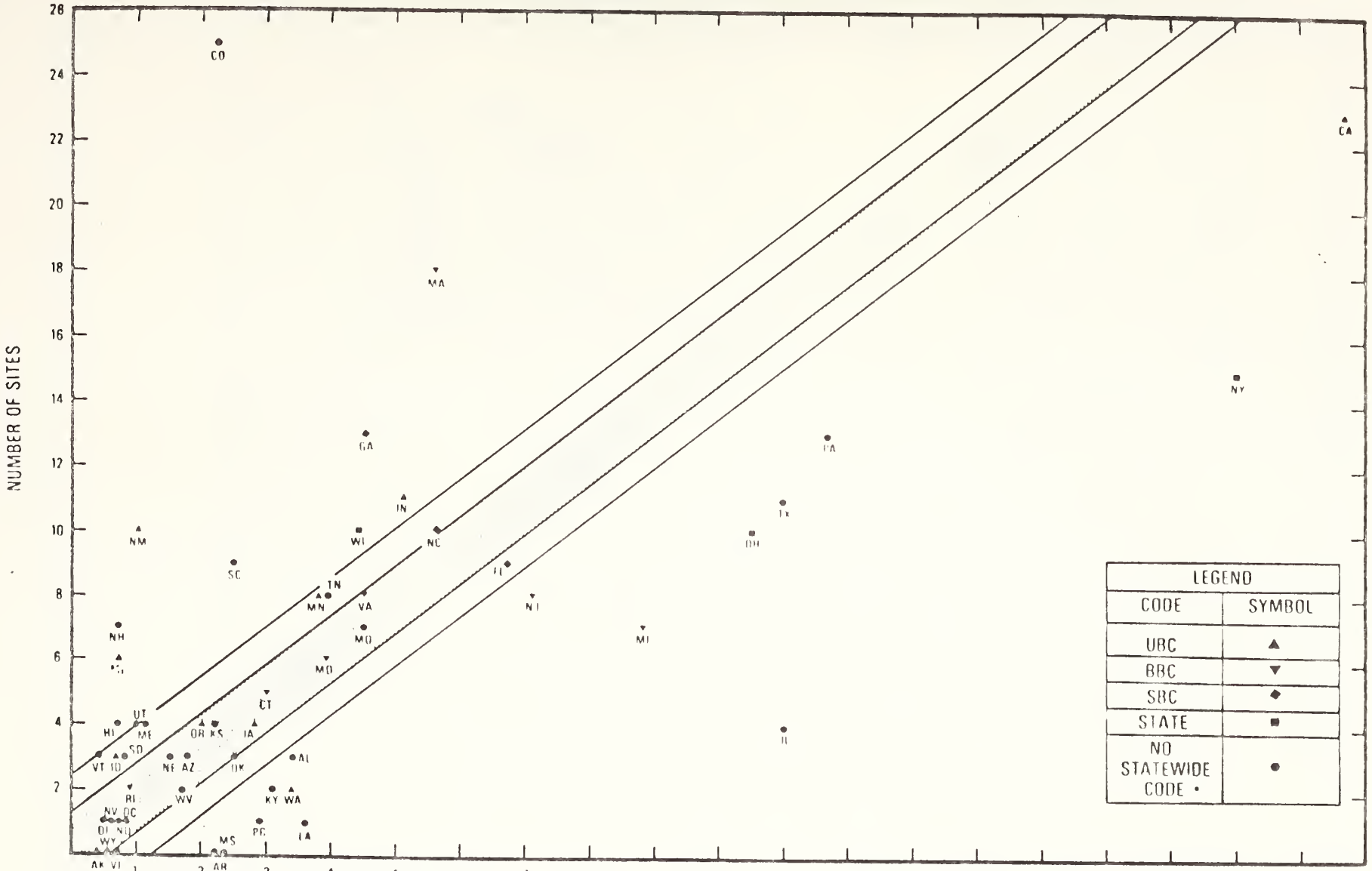
Basic Building Code Sites - Table 6 indicates a good balance of the Basic Building Code sites in relation to the overall number of sites, but within that number the distribution could be adjusted slightly to provide better coverage. For example, a heavier selection of sites could be considered for Michigan and perhaps New Jersey for subsequent cycles, while Massachusetts with its 18 sites appears to have a sufficient number of sites for the overall demonstration program.

Standard Building Code Sites - The number of Standard Building Code sites is greater than desired, as indicated in Table 6, and adjustments could be made in site selection. In reducing the number of sites selected for the next cycles, fewer sites could be selected in Georgia, while the number of sites in Florida and North Carolina seem adequate for the first three cycles.

State Code Sites - The sites using state codes are the least represented from an overall point of view. A heavier selection of sites from New York would be in order, and some consideration should be given to increasing the number of sites in Ohio, while, of course, increasing the overall number of these sites from this group of states.

No Statewide Code Sites - Although the twenty-seven (27) no code states seem to be represented adequately as a group, as indicated in Table 6, a study of Figure 7 indicates an inconsistent distribution as witnessed by the number of states falling outside the band-width established. Obviously, Colorado, with its 25 sites should not be a candidate for additional installations. New Hampshire and South Carolina fall outside of the band-width and could not be assigned too many additional sites. On the other hand, Kentucky, Puerto Rico, Louisiana, Texas, Pennsylvania, and certainly Illinois are site shy in relation to the overall population scheme. Mississippi, Arkansas, and Wyoming have no sites at all-a situation which could be considered in the next demonstration cycle.

FIGURE 7. RESIDENTIAL PROGRAM. SITE/POPULATION DISTRIBUTION. CYCLES 1, 2, 3 (Total new and retrofit sites)



* These states may contain jurisdictions which predominantly use a version of one of the nationally recognized model codes.

6.1.2. Distribution of New and Retrofit Sites (Residential Program)

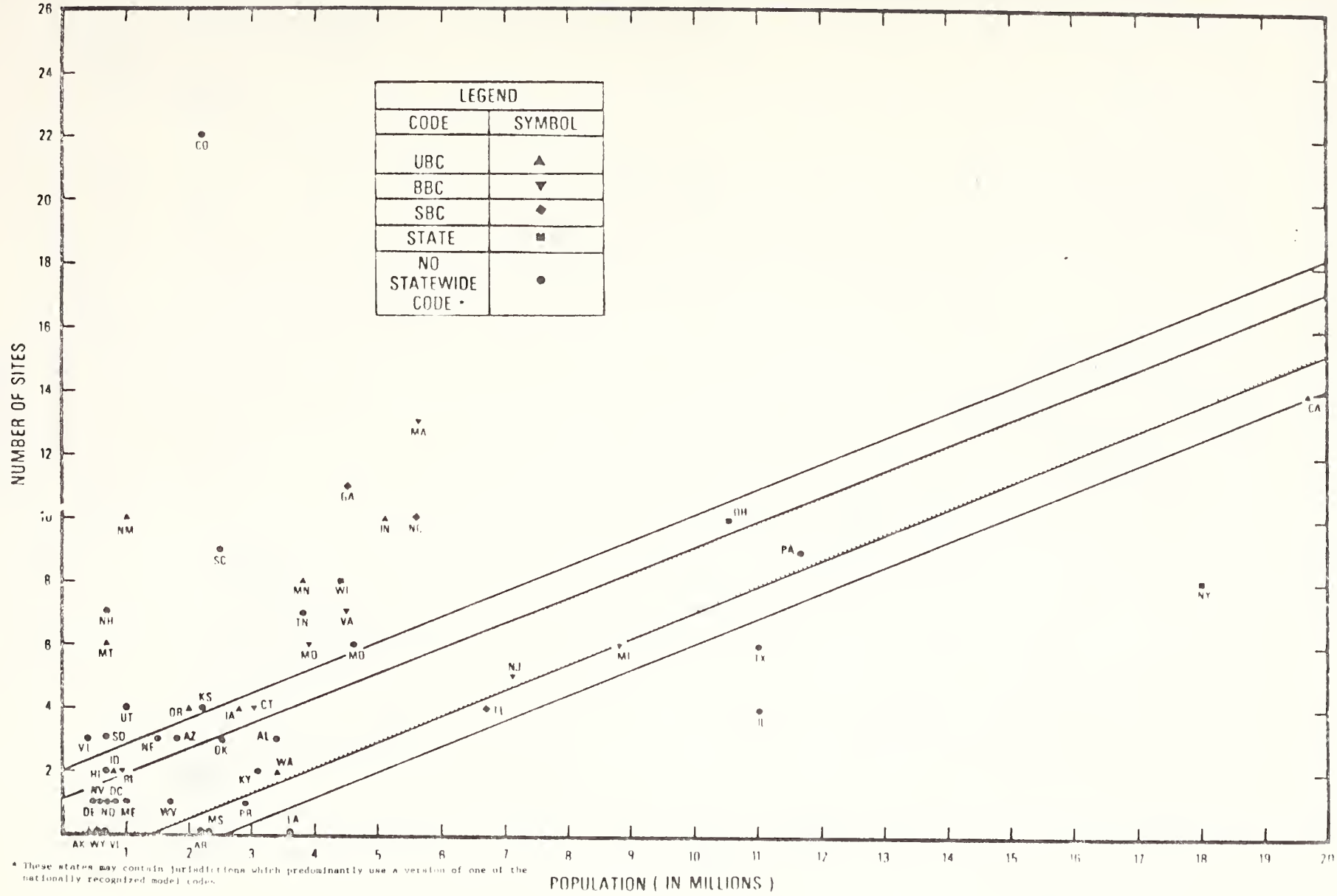
Since building regulations present different problems to the builders of new buildings as compared to the builder who must retrofit an existing building, it is also important to determine a proper mix of these units if any meaningful conclusions are to be reached. There are five states which have no new solar sites; however, there are a disproportionate twenty-nine states that have no retrofit solar sites. Based on these figures, it is recommended that greater emphasis be placed on the selection of retrofit units and that the demonstration be conducted in states that have no sites presently assigned.

Figures 8 and 9 indicate the distribution of sites on a population basis for new and retrofit sites.

The new site distribution chart (Figure 8) includes a band-width constructed as previously described. The basis for this slope, however, is the premise that new sites should constitute 50% of the demonstration program and retrofit sites the other 50%. From Figure 8, it appears that Colorado, Massachusetts, New Mexico, South Carolina, New Hampshire, Montana, Tennessee, Minnesota, Wisconsin, Virginia, Indiana, North Carolina, and Georgia perhaps contain too many new sites while Texas, Illinois, and certainly New York could be said to be low on new demonstration sites.

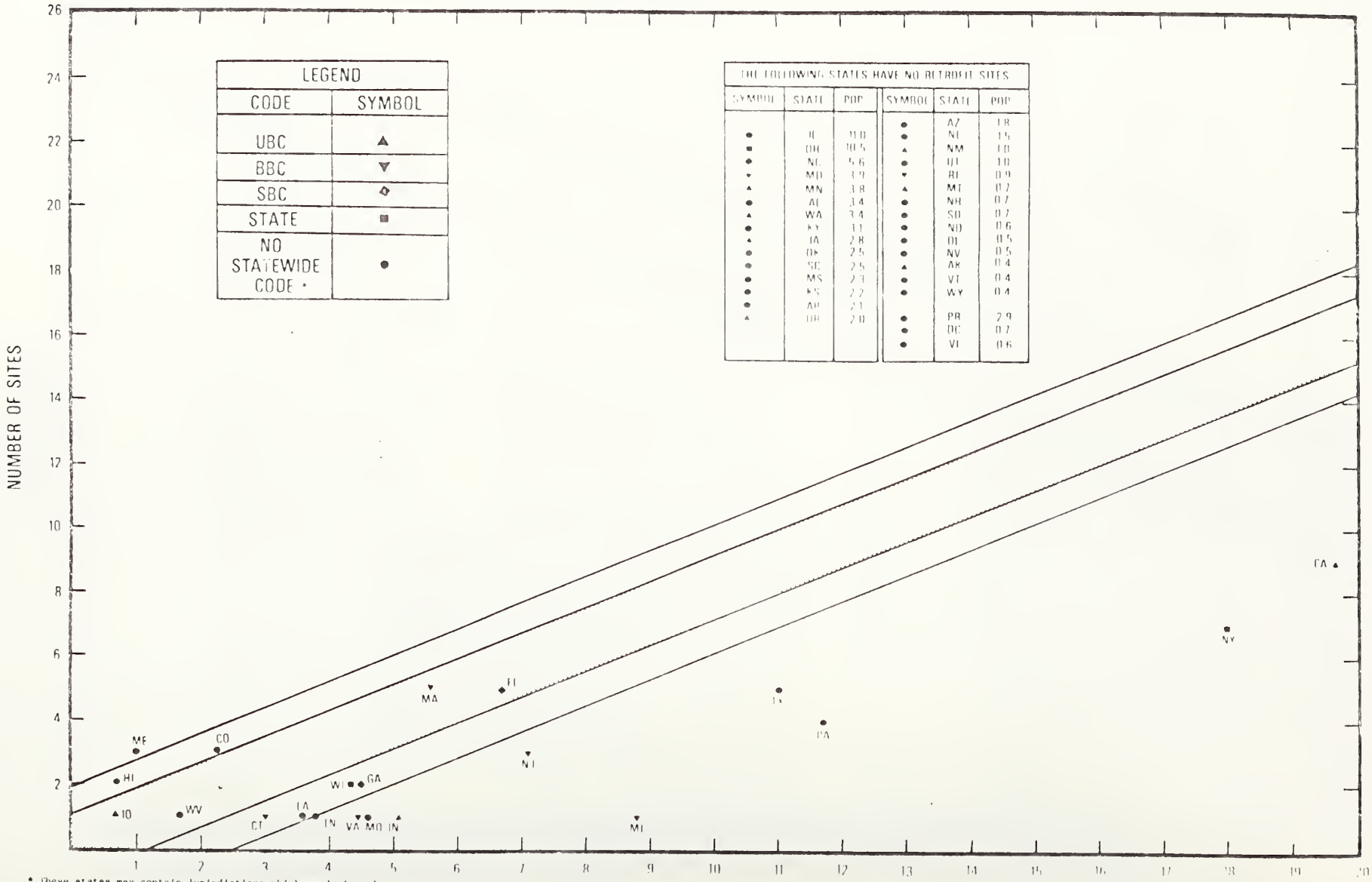
A plot of retrofit sites compared to population is also made and included in Figure 9 and a band-width added using the slope as described previously under new sites. It is recommended that retrofit demonstration sites be selected in at least some states that presently contain none and perhaps additional retrofit demonstration sites be assigned to Indiana, New Jersey, Michigan, Texas, Pennsylvania, New York and California.

FIGURE 8. RESIDENTIAL PROGRAM. SITE/POPULATION DISTRIBUTION. CYCLES 1, 2, 3 (Total new sites)



* These states may contain jurisdictions which predominantly use a version of one of the nationally recognized model codes.

FIGURE 9. RESIDENTIAL PROGRAM. SITE/POPULATION DISTRIBUTION. CYCLES 1, 2, 3 (Total retrofit sites)



* These states may contain jurisdictions which predominantly use a version of one of the nationally recognized model codes.

6.1.3. Conclusion

Although a reasonable overall distribution of demonstration sites presently exists, it is recommended that subsequent cycles be used to adjust demonstration site locations, as indicated, to more closely approach the population distribution of the United States. It is recognized that the above recommendations are offered to provide the baseline for subsequent definitive regulatory studies and that other conditions, such as technical, climatological, geographical, political, and operational concerns may override the recommendations offered. However, the regulatory component of this project should be considered, and given appropriate priority.

6.2. COMMERCIAL SOLAR DEMONSTRATION SITES

6.2.1 Distribution of Sites

This part of the report reviews the distribution of the solar energy commercial sites selected for the demonstration program and the adequacy of the distribution for subsequent analyses of regulatory problems. The methodology used is similar to that described under the residential demonstration program with some changes in approach, as appropriate, as it is recognized that the commercial program differs from the residential program with respect to types of installations, numbers of units, and variety of applications.

The basis for this analysis is a tabulation in Table 7 of the various states showing the distribution of the units per cycle for both cycles 1 and 2. As is done for the residential study, the applicable codes are indicated from data contained in NBSIR 77-1390. Again, it is recognized that the states listed as having no statewide code may in fact contain jurisdictions which predominantly use a version of one of the nationally recognized model codes. However, for the purposes of this study, these states are grouped separately.

The data tabulated in Table 8 are developed using the same methodology as described in the residential section. It shows the number of states

TABLE 7. COMMERCIAL PROGRAM
SITES PER CYCLE AND MODEL CODE BASE

STATE	POPUL. (mill)	NUMBER OF SITES IN CYCLE			NEW SITES IN CYCLE			RETROFIT SITES IN CYCLE			BUILDING CODE BASED ON			STATE	* NONE
		1	2	Total	1	2	Total	1	2	Total	UBC	BBC	SBC		
AL	3.4	1	2	3	1	1	2	0	1	1					X
AK	0.4	0	0	0	0	0	0	0	0	0	X				
AR	2.1	0	0	0	0	0	0	0	0	0					X
AZ	1.8	1	0	1	1	0	1	0	0	0					X
CA	19.7	8	11	19	3	8	11	5	3	8	X				
CO	2.2	0	4	4	0	3	3	0	1	1					X
CT	3.0	2	4	6	1	3	4	1	1	2		X			
DE	0.5	0	0	0	0	0	0	0	0	0					X
FL	6.7	3	3	6	3	1	4	0	2	2			X		
GA	4.5	2	1	3	1	1	2	1	0	1			X		
HI	0.7	0	1	1	0	0	0	0	1	1					X
IA	2.8	1	1	2	1	0	1	0	1	1	X				
ID	0.7	0	0	0	0	0	0	0	0	0	X				
IL	11.0	0	2	2	0	1	1	0	1	1					X
IN	5.1	0	2	2	0	1	1	0	1	1	X				
KS	2.2	0	4	4	0	4	4	0	0	0					X
KY	3.1	1	0	1	0	0	0	1	0	1					X
LA	3.6	1	0	1	0	0	0	1	0	1					X
MA	5.6	1	4	5	0	2	2	1	2	3		X			
MD	3.9	5	3	8	1	3	4	4	0	4		X			
ME	1.0	0	0	0	0	0	0	0	0	0					X
MI	8.8	1	3	4	1	2	3	0	1	1		X			
MN	3.8	4	2	6	3	2	5	1	0	1	X				
MO	4.6	1	2	3	1	2	3	0	0	0					X
MS	2.3	0	0	0	0	0	0	0	0	0					X
MT	0.7	0	1	1	0	1	1	0	0	0	X				
NC	5.6	1	1	2	1	1	2	0	0	0			X		
ND	0.6	0	0	0	0	0	0	0	0	0					X
NE	1.5	0	1	1	0	1	1	0	0	0					X
NH	0.7	1	2	3	0	1	1	1	1	2					X
NJ	7.1	2	2	4	2	1	3	0	1	1		X			
NM	1.0	2	3	5	1	2	3	1	1	2	X				
NV	0.5	0	0	0	0	0	0	0	0	0					X
NY	18.0	0	5	5	0	3	3	0	2	2				X	
OH	10.5	1	2	3	1	1	2	0	1	1				X	

* These states may contain jurisdictions which predominantly use a version of one of the nationally recognized model codes.

TABLE 7. COMMERCIAL PROGRAM
SITES PER CYCLE AND MODEL CODE BASE -- CONTINUED

STATE	POPUL. (mill)	NUMBER OF SITES IN CYCLE			NEW SITES IN CYCLE			RETROFIT SITES IN CYCLE			BUILDING CODE BASED ON			STATE	* NONE
		1	2	Total	1	2	Total	1	2	Total	UBC	BBC	SBC		
OR	2.5	0	0	0	0	0	0	0	0	0					X
OR	2.0	0	0	0	0	0	0	0	0	0	X				
PA	11.7	0	0	0	0	0	0	0	0	0					X
RI	0.9	0	0	0	0	0	0	0	0	0			X		
SC	2.5	1	0	1	1	0	1	0	0	0					X
SD	0.7	1	2	3	0	2	2	1	0	1					X
TN	3.8	0	2	2	0	1	1	0	1	1					X
TX	11.0	2	2	4	1	2	3	1	0	1					X
UT	1.0	0	2	2	0	1	1	0	1	1					X
VA	4.5	3	1	4	2	1	3	1	0	1		X			
VT	0.4	0	1	1	0	1	1	0	0	0					X
WA	3.4	1	0	1	1	0	1	0	0	0	X				
WI	4.4	0	2	2	0	2	2	0	0	0				X	
WV	1.7	1	1	2	1	0	1	0	1	1					X
WY	0.4	0	1	1	0	1	1	0	0	0					X
TOTALS		48	80	128	28	56	84	20	24	44	10	7	3	3	27
DC	0.7	0	0	0	0	0	0	0	0	0					X
PR	2.9	1	0	1	1	0	1	0	0	0					X
VI	0.6	1	0	1	0	0	0	1	0	1					X
TOTALS		50	80	130	29	56	85	21	24	45	-	-	-	-	-

* These states may contain jurisdictions which predominantly use a version of one of the nationally recognized model codes.

TABLE 8. COMMERCIAL PROGRAM. BUILDING CODE DISTRIBUTION

CODE	NO. OF STATES	% OF STATES COVERED BY CODE	STATE/POP.	TOTAL POP. (IN MILLIONS)	% OF POP. COVERED BY CODE	NO. OF DEMONSTRATION SITES	% OF DEMONSTRATION SITES COVERED BY CODE
UBC (ICBO)	10	20	CA 19.7 IN 5.1 MN 3.8 WA 3.4 IA 2.8 OR 2.0 NM 1.0 ID 0.7 MT 0.7 *AK 0.4	39.6	20	35	27
BBC (BOCA)	7	14	MI 8.8 NJ 7.1 MA 5.6 VA 4.5 ME 3.9 CT 3.0 *RI 0.9	33.8	17	31	24
SBC (SBCC)	3	6	FL 6.7 NC 5.6 GA 4.5	16.8	8	11	9
STATE CODE	3	6	NY 18.0 OH 10.5 WI 4.4	32.9	16	10	8
NO STATE-WIDE CODE **	27	54	*PA 11.7 IL 11.0 TX 11.0 MO 4.6 TN 3.8 LA 3.6 AL 3.4 KY 3.1 *OR 2.5 SC 2.5 *MS 2.3 CO 2.2 KS 2.2 *AR 2.1 AZ 1.8 WV 1.7 NE 1.5 *ME 1.0 UT 1.0 HI 0.7 NH 0.7 SD 0.7 *ND 0.6 *DE 0.5 *NV 0.5 VT 0.4 *WY 0.4	77.5	39	41	32
TOTALS:	50	100%		200.6	100%	128	100%

NOTE: This information does not include Puerto Rico (one site), District of Columbia (no site), Virgin Islands (one site).

* These states do not have commercial sites.

** These states may contain jurisdictions which predominantly use a version of one of the nationally recognized model codes.

covered by each code, the corresponding population and the number of sites. The information is summarized in Table 9.

Code	% Population Covered by Code	% of Demonstration Sites Covered by Code
UBC	20	27
BBC	17	24
SBC	8	9
State Code	16	8
No State-wide Code*	39	32
Total	100	100

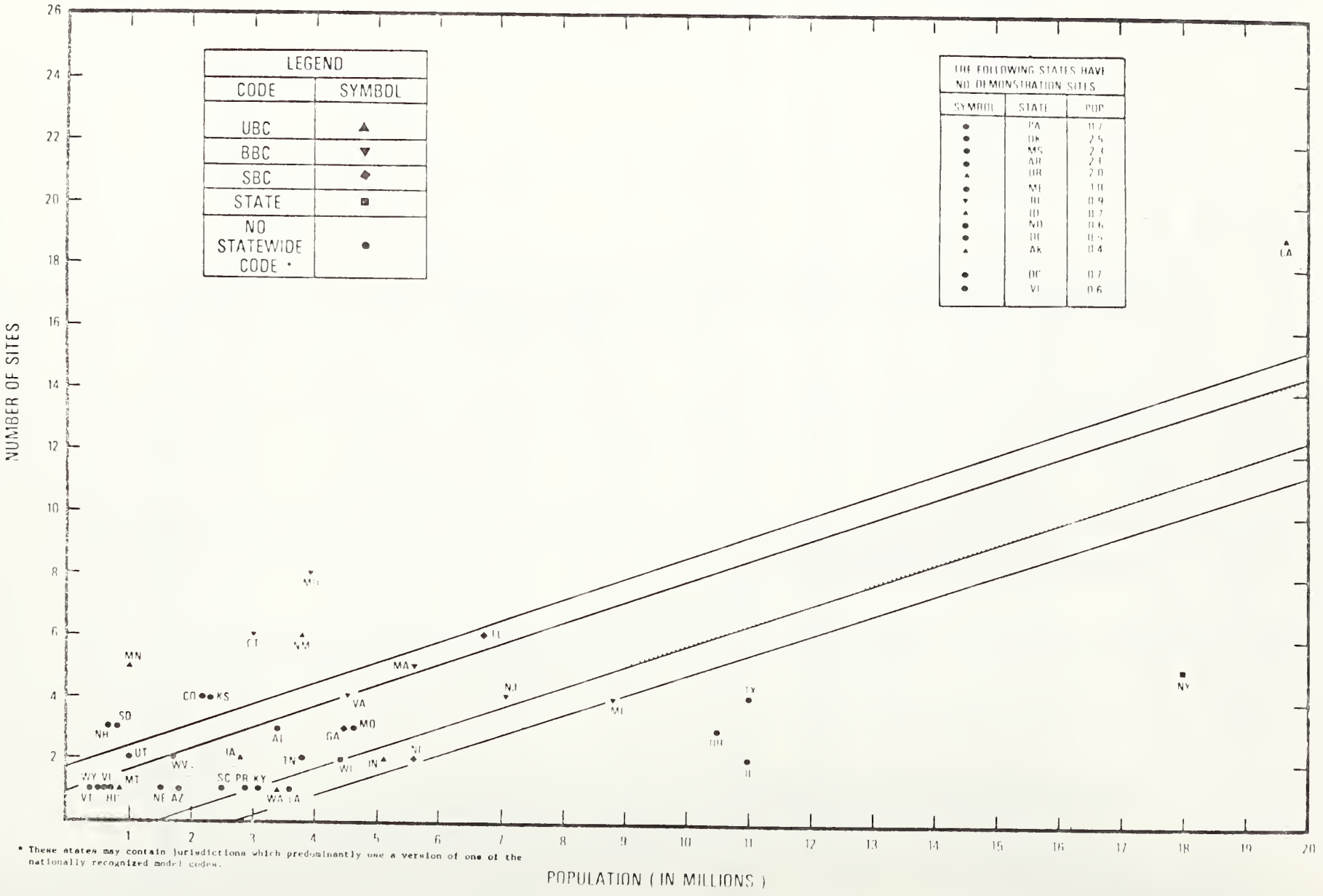
* These states may contain jurisdictions which predominantely use a version of one of the nationally recognized model codes.

Table 9. Commercial Program
Summary of Code Distribution

This comparison reveals a disproportionate mix of commercial sites, as compared to the percentage of population covered by each code with the exception of the Standard Building Code sites. The Uniform Building Code states seem to have too many sites, while the states with no statewide code and states that have their own code are site deficient, from a codes and standards viewpoint. Subsequent site selection could, of course, alleviate this situation.

To further analyze the distribution of the commercial demonstration sites, a site/population distribution (Figure 10) is made as described in the residential section of this report. Again, a band-width of four sites is

FIGURE 10. COMMERCIAL PROGRAM. SITE/POPULATION DISTRIBUTION. CYCLES 1, 2 (Total new and retrofit sites)



* These states may contain jurisdictions which predominantly use a version of one of the nationally recognized model codes.

constructed using a slope appropriate for the total number of sites in the commercial program to indicate a reasonable tolerance for site distribution, but as indicated previously, any reasonable band-width will give basically the same results. Comments and recommendations concerning the commercial sites are given by applicable codes:

Uniform Building Code Sites - A disproportionate number of sites fall into this category. Sites selected for subsequent cycles could be proportionately fewer than selected for the first two cycles. New Mexico, Minnesota and California may also contain a sufficient number of sites for the entire demonstration and a more desirable choice would be to select sites in Oregon, Indiana, and Arkansas, which contain no commercial sites.

Basic Building Code Sites - The number of Basic Building Code sites is also excessive when compared to the percentage of the population covered by the Basic Building Code. Figure 10 leads to the recommendation of not selecting Maryland or Connecticut for additional sites, as well as reducing the total number of sites to be selected for subsequent demonstration cycles.

Standard Building Code Sites - The total percentage and the distribution of sites basing their regulations on the Southern Building Code seems reasonable, and no changes are recommended.

State Code Sites - The selection of sites within these states should be emphasized during subsequent cycles if a good mix of code data is to be obtained. Additional sites could be chosen in Ohio and certainly New York.

No Statewide Code Sites - These states also need emphasis for site selection during the remainder of the commercial demonstration program. From an inspection of the site/population distribution (Figure 10), the states with no commercial sites should be prime candidates; namely Arizona, Delaware, Maine, Mississippi, North

Dakota, Oklahoma, the District of Columbia, the Virgin Islands and certainly Pennsylvania. Additional sites in Illinois and Texas are also recommended.

Again, it must be stated that these suggestions are made with regard to developing an adequate distribution for regulatory analysis purposes. Compelling reasons could change this distribution if technical, climatological, geographical, political, or operational concerns are warranted. In addition, it is recognized that commercial solar demonstration sites may be difficult to establish in certain states.

No analysis is made regarding the mix of new and retrofit sites. Such an analysis is meaningless at this time, because of the relatively small number of sites in the commercial demonstration program; however, for subsequent site selection, an attempt to achieve a proper balance of new and retrofit sites could be considered.

6.2.2. Distribution of Building Type

Another parameter examined is the distribution of building types (occupancy) within the commercial solar demonstration program. A larger variety of building types over a wide distribution of locations is desirable. These could demonstrate various technologies and applications and lay the groundwork to assess any regulatory difficulties encountered because of building usage.

The sites selected for demonstration cycles 1 and 2 are tabulated along with building type (see Table 10). From this tabulation it appears that educational facilities (ED) and low rise office buildings, one to three stories (OL), are more than adequately represented. It would, of course, be impossible (or perhaps even undesirable) to demonstrate each building type in each state; however, a more homogeneous matrix should be developed through subsequent site/building selection. Perhaps dormitories (DR), department stores (DS), shopping malls (ML), post offices (PO), and supermarkets (SM) can be represented if the other parameters affecting site selection can also be satisfied.

TABLE 10. COMMERCIAL PROGRAM - BUILDING TYPES BY STATE IN CYCLES 1 AND 2

STATE	POPUL. (in mill.)	AH	AL	AU	BC	BR	CF	CH	DR	DS	ED	FS	GS	CL	HO	NS	HM	IH	IL	LA	LB	ML	OH	OL	PO	PS	RT	SS	VS	SM	WH	OTHER
AL	3.4															1			1					1								
AK	0.4																															
AR	2.1																															
AZ	1.8										1																					
CA	19.7		2	1			1				4	2	1					1	1	1	2		2	1								
CO	2.2										2													1								
CT	3.0		1	1											1									3								1
DE	0.5																															
FL	6.7			1							1								1				1	1					1			
GA	4.5										1		1											1								
HI	0.7										1																					
IA	2.8										1		1																			
ID	0.7																															
IL	11.0			1							2																					
IN	5.1										1																					
KS	2.2										1													2					1			
KY	3.1																							1								
LA	3.6												1																			
MA	5.6			1							2				1									1								
MD	3.9			1							4	1				1	1							1								
ME	1.0										1													1								
MI	8.8										1				1																	
MN	3.8			1							1						1	1			1											1
MO	4.6										1	1												1								
MS	2.3																															
MT	0.7																							1								
NC	5.6										1													1								
ND	0.6																															
NE	1.5																							1								
NH	0.7										1													1							1	
NJ	7.1			1													1		1								1					
NM	1.0			1																1				2				1				
NV	0.5																															
NY	18.0										1										1			2					1			
OH	10.5										1										1			1								

TABLE 10 CONTINUED

STATE	POPUL. (in mill.)	AH	AL	AU	BC	BR	CF	CH	DR	DS	ED	FS	GS	GL	HO	NS	HM	IH	IL	LA	LB	ML	OH	OL	PO	PS	RT	SS	VS	SM	WH	OTHER
OK	2.5																															
OR	2.0																															
PA	11.7																															
RI	0.9																															
SC	2.5																							1								
SD	0.7			1							1									1												
TN	3.8																			1				1								
TX	11.0												1											2				1				
UT	1.0																	1		1				1								
VA	4.5										2				1																	
VT	0.4																							1								
WA	3.4																							1								
WI	4.4										1													1								
WV	1.7										2																					
WY	0.4																							1								
TOTALS		0	3	10	0	0	1	0	0	0	34	4	5	0	4	2	4	2	7	2	5	0	3	33	0	0	1	1	4	0	1	2
DC	0.7																															
PR	2.9																		1													
VI	0.6																1															
TOTALS		0	3	10	0	0	1	0	0	0	34	4	5	0	4	2	5	2	8	2	5	0	3	3	0	0	1	1	4	0	1	2

BUILDING TYPE

AH - Apartment, High Rise
AL - Apartment, Low Rise
AU - Auditorium, concert hall, convention center, theater
BC - Bowling Center
BR - Bar, nite club
CF - Cafeteria
CH - Church
DR - Dormitory
[illegible]

FS - Fire Station
GS - Gymnasium, sports arena
CL - Health Facility, clinic
HO - Health Facility, hospital
NS - Health Facility, nursing home
HM - Hotel/Motel
IH - Industrial Building, Heavy
IL - Industrial Building, Light
LA - Laboratory
LB - Library

ML - Shopping Mall
OH - High Rise Office Building, over 3 story
OL - Low Rise Office Building, 1 to 3 story
PO - Post Office
PS - Police Station
RT - Restaurant
SS - Small Store
VS - Variety Store
SM - Super Market

6.2.3. Conclusion

The distribution of sites for the first two cycles of the commercial demonstration program with respect to codes and standards is not generally in accord with the population distribution of the United States. Moreover, consideration should be given to diversifying the selection of building type to demonstrate a broader mix of application. It is, therefore, recommended that subsequent commercial demonstration sites be selected to bring greater balance, if the technical, climatological, geographical, political, and operational concerns can also be satisfied.

7. PRELIMINARY RESULTS AND FUTURE ACTIONS

Most of the data identified in Section 5 were not received as of the closing date of this report. As indicated, contacts were made with all appropriate data collecting organizations and arrangements were made to receive these data. Upon receipt, data will be reviewed and the rest of the methodology shown in Figure 1 implemented, including the analysis (step 7), the identification of data deficiencies (step 9), the preparation of changes to questionnaires (step 10), and the preparation of reports (step 8). The development of parameters for analysis (step 12) is, of course, not dependent upon the receipt of data and can progress independently.

Although very limited data have been received, informal discussions with individuals in the field indicate that very few problems are perceived in the regulatory area. If these perceptions are correct, does this mean that:

(1) There are no problems with existing regulations and they are not, and will not be a barrier to the development of solar applications as a viable source of non-depletable energy?

or,

(2) Problems do not exist because the individual jurisdictions have confidence in the system being installed because they have the endorsement and are under the sponsorship of the Federal Government.

or,

(3) The local jurisdictions are not perceptive enough to know they might have problems because they do not really understand the solar systems being installed (and there is a 100 percent auxiliary backup)? Will they over-react, in a regulatory sense, in subsequent installations if presently installed systems start to fail and complaints are received?

It is anticipated that as this program develops and hard data are received, an insight into the solar regulatory system will be achieved and enlightened answers to the above questions forthcoming. On the other hand, attempting to

develop meaningful conclusions in the field of codes and standards from data based on a Federally-funded demonstration program may be futile or not effective. It might be more productive to collect data from a more "real world situation" by not relying on demonstration data at all, but rather on collecting data from independent builders of solar installations and analyzing their regulatory difficulties. An attempt will be made to address these issues in subsequent reports.

8. SUMMARY

As noted, the reporting period covered by this document is dominated by initial planning and preparation to receive and analyze building regulatory data. The time frame covered is such that the data collection effort expended by the various organizations was just starting to become effective as the initial flow of data appeared. The next thrust in this program, as the data flow increases and the data base broadens, is the effective gathering of these data and the initiation of preliminary analyses with feedback to the data collection system, as required, to assure a meaningful overall assessment.

APPENDIX I

SECTIONS A, B, C, D

APPENDIX I

SECTION A

Selected Questions from RERC Data Collection Instruments Relative to Codes and Standards

Appendix Reference		
	Volume II	
I. A1	Single Family Builder/Developer	Question 21e
I. A2	Comparative Single Family Builder/Developer	Question 17e
I. A3	Multifamily Builder/Developer	Question 20e
I. A4	Comparative Multifamily Builder/Developer	Question 19e
	Volume III	
I. A5	Local Building Code Official	Entire Questionnaire (56 Questions)

21. Did you have any problems with the following during the planning and construction phase of the project?

		Yes	No
a.	Getting construction loans		
	for development	1	2
	for solar houses	1	2
	If yes, please explain _____		
b.	Getting permanent financing		
	for development	1	2
	for solar houses	1	2
	If yes, please explain _____		
c.	Getting zoning approval		
	for development	1	2
	for solar houses	1	2
	If yes, please explain _____		
d.	Getting site plans approved		
	for development	1	2
	for solar houses	1	2
	If yes, please explain _____		
e.	Obtaining approval from building inspectors		
	for development	1	2
	for solar houses	1	2
	If yes, please explain _____		
f.	Getting solar equipment	1	2
	If yes, please explain _____		

Appendix IA1 - Single Family Builder/Developer

II. PHASE OF DEVELOPMENT

A. Construction Phase

Now, I'd like to ask you a few questions about the construction phase of the development and the houses:

17. Did you have any problems with the following during the planning and construction phase of the project?

		Yes	No
a.	Getting construction loans for development:	1	2
	If yes, please explain: _____ _____		
b.	Getting permanent financing for development	1	2
	If yes, please explain _____ _____		
c.	Getting zoning approval for development:	1	2
	If yes, please explain _____ _____		
d.	Getting site plans approved for development	1	2
	If yes, please explain _____ _____		
e.	Obtaining approval from building inspectors for development	1	2
	If yes, please explain _____ _____		

Appendix IA2 - Comparative Single Family Builder/Develope

20.

		Yes	No
b.	Getting permanent financing		
	for development	1	2
	for solar apt.	1	2
	If yes, please explain		
	_____		
	_____		
c.	Getting zoning approval		
	for development	1	2
	for solar apt.	1	2
	If yes, please explain		
	_____		
	_____		
d.	Getting site plans approved		
	for development	1	2
	for solar apt.	1	2
	If yes, please explain		
	_____		
	_____		
e.	Obtaining approval from building inspectors		
	for development	1	2
	for solar apt.	1	2
	If yes, please explain		
	_____		
	_____		
f.	Getting solar equipment	1	2
	If yes, please explain		
	_____		
	_____		
g.	Securing servicing for the solar units	1	2
	If yes, please explain		
	_____		
	_____		
h.	Securing warrantees for the solar systems	1	2
	If yes, please explain		
	_____		
	_____		

Appendix IA3 - Multi-Family Builder Dereloper

II. PHASE OF DEVELOPMENT

A. Construction Phase

Now, I'd like to ask you a few questions about the construction phase of the development and the rental units:

19. Did you have any problems with the following during the planning and construction phase of the project?

		Yes	No
a.	Getting construction loans for development	1	2
	If yes, please explain		
b.	Getting permanent financing for development	1	2
	If yes, please explain		
c.	Getting zoning approval for development	1	2
	If yes, please explain		
d.	Getting site plans approved for development	1	2
	If yes, please explain		
e.	Obtaining approval from building inspectors for development	1	2
	If yes, please explain		

Appendix IA4 - Comparative Multi-Family Builder/Developer

___/___/___ ___/___ ___/___ ___
(Cycle ident.) (Grant ident.) (Surveyee ident.) (Data Source)

Respondent ID# (Circle one)

Participating Construction Lender	BA	Alternative Utility	BF
Participating Permanent Lender	BB	Local Planning/Zoning Official	BG
Non-Participating Lender	BC	Local Building Code Official	BH
Participating Insurance Co/Agency	BD	Local Tax Assessor	BJ
Auxiliary Utility	BE		

HUD GRANT NO. ___ ___ ___ ___

LOCAL BUILDING CODE OFFICIAL INTEPVIEW GUIDE

NAME OF RESPONDENT _____

TITLE _____

NAME OF AGENCY/DEPARTMENT _____

JURISDICTION _____

ADDRESS _____

TELEPHONE _____

DATE OF INTERVIEW _____

NAME OF INTERVIEWER _____

(Detach after completing Interview)

Appendix IA5

__/__/__ __/__ __/__ __

Real Estate Research Corporation
7101 17TH STREET N.W. • WASHINGTON D.C. 20036

LOCAL BUILDING CODE OFFICIAL INTERVIEW GUIDE

INTRODUCTORY STATEMENT

Real Estate Research Corporation is conducting a study of market acceptance of solar energy in residential dwelling units for the U.S. Department of Housing and Urban Development. This research effort is part of a national demonstration program for residential solar heating and cooling. Part of our research is focused on the role of institutions which may or may not be involved in the development of solar energy in residential construction. In order to assess institutional response to solar energy we are talking to representatives of banks, savings and loans, planning and zoning officials, tax assessors, utility companies, and others. Essentially, we are interested in finding out what these institutions think about solar, what impact, if any, solar development would have on the institution, and whether their existing or projected policies would have a material impact on the development of solar.

___/___/___ ___/___ ___/___ ___

LOCAL BUILDING CODE OFFICIAL INTERVIEW GUIDE

I. PROFILE OF BUILDING CODE ADMINISTRATION

1. Where is your department located within the government's organizational structure?

2. This department is part of what level of government?

City	1
City/County	2
Regional	3
Other; specify_____	

3. How many inspectors do you have in the department? _____ EXACT

4. Does your department have (an) established building code(s)?

Yes	1
No	2 (skip to Q.8)
Don't know/not applicable	3 (skip to Q.8)
Did not answer	4 (skip to Q.8)

5. What is (are) the name(s) of the code(s)?

6. On what code(s) is (are) it (they) modeled?

BOCA -- Basic	1
AIA -- National	2
SBCC -- Southern	3
ICBO -- Uniform	4
IAPMO -- Uniform Plumbing	5
NFPA -- NEC and life safety	6
ANSI	7
FHA-MPS	8
Other; specify_____	
Don't know/not applicable	9

7. How closely does (do) your code(s) conform to the model code(s)?

Modeled with some variations	1 (skip to Q.9)
Mandatory minimum	2 (skip to Q.9)
Mandatory	3 (skip to Q.9)
Don't know	4 (skip to Q.9)
Does not apply	5 (skip to Q.9)
Other, specify _____	

8. If not, how are buildings and structures evaluated with regard to public health and safety?

II. EXPERIENCE WITH DEMONSTRATION PROGRAM

Recently, the U.S. Department of Housing and Urban Development provided a local builder with a grant to install a solar system in one (or more) of his residential units.

9. Are you familiar with the solar house(s)/apartment(s) that was (were, built with a federal grant in your jurisdiction?

Yes	1
No	2 (skip to Q.21)

10. Were any waivers requested to accommodate the solar system?

Yes	1
No	2 (skip to Q.12)
Don't know/not applicable	3 (skip to Q.12
Did not answer	4 (skip to Q.12
Other; specify	

If yes, please explain _____

_____

_____

11. Were these waivers granted?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	

Please explain _____

_____

_____

12. Were any design changes required prior to approval?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	

If "yes", please explain _____

_____

13. Were system approvals handled in the normal manner by regulatory personnel or did special considerations prevail? Please explain.

14. Was special training needed for regulatory staff or field inspectors?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	

If "yes", please explain

15. Were job site inspections handled in a normal way or by special personnel? Please explain.

16. Were any additional job site inspections necessary?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	

If "yes", please explain

17. Did it take longer to process the solar application than it would have for conventional property?

Yes	1
No	2 (skip to Q.19)
Don't know/not applicable	3 (skip to Q.19)
Did not answer	4 (skip to Q.19)
Other, specify_____	

If "yes", please explain_____
_____
_____

18. If the time factor was increased, would this hold true for future residential applications using solar energy systems?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify_____	

Please explain_____
_____
_____

19. Did the fact that the solar unit(s) was (were) funded by a federal grant impact the approval process?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify_____	

If "yes", please explain_____
_____
_____

20. Would the process have differed for a solar unit built outside of the demonstration project?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	

If "yes", please explain _____

III. BUILDING CODE AND SOLAR SYSTEMS APPLICATION IN GENERAL

21. Has your office/agency reviewed or processed any applications for building permits for other solar units in this jurisdiction?

Yes	1
No	2 (skip to Q.31)
Don't know/not applicable	3 (skip to Q.31)
Did not answer	4 (skip to Q.31)

If "yes", how many and what type of units were they?_____
_____
_____

22. Were any waivers requested to accommodate the solar system(s)?

Yes	1
No	2 (skip to Q.24
Don't know/not applicable	3 (skip to Q.24
Did not answer	4 (skip to Q.24,
Other; specify	

If "yes", please explain_____
_____
_____

23. Were these waivers granted?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	

Please explain_____
_____
_____

24. Were any design changes required prior to approval?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	

If "yes", please explain

25. Were system approvals handled in the normal manner by regulatory personnel or did special considerations prevail? Please explain.

26. Was special training needed for regulatory staff or field inspectors?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	

If "yes", please explain

27. Were job inspections handled in a normal way or by special personnel? Please explain.

28. Were any additional job site inspections necessary?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify_____	

If "yes", please explain_____
_____
_____

29. Did it take longer to process the solar application than it would have for conventional property?

Yes	1
No	2 (skip to Q.31)
Don't know/not applicable	3 (skip to Q.31)
Did not answer	4 (skip to Q.31)
Other; specify_____	

If "yes", please explain_____
_____
_____

30. If the time factor was increased, would this hold true for future residential applications using solar energy systems?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify_____	

Please explain_____
_____
_____

IV. SOLAR ENERGY SYSTEMS IMPACT ON BUILDING CODE

31. Does your code contain provisions for solar systems installation?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify_____	

If "yes", please explain these provisions. (Interviewer obtain copies).

_____
_____
_____

32. Has your department studies the question of the potential impact of solar energy systems on the building code?

Yes	1
No	2 (skip to Q.35)
Don't know/not applicable	3 (skip to Q.35)
Did not answer	4 (skip to Q.35)
Other; specify_____	

33. What were the conclusions of the study? (Interviewer try to obtain copy of study).

_____
_____
_____
_____
_____

34. As a result of this study, have procedures or regulations been modified or changed to facilitate the installation of solar energy systems in residential developments?

Yes	1 (skip to Q.36)
No	2 (skip to Q.36)
Don't know/not applicable	3 (skip to Q.36)
Did not answer	4 (skip to Q.36)
Other; specify_____	

Please explain_____
_____
_____

35. Would such a study be useful?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	

36. Are you seeking organizational certification (product approval) of a solar energy system as a prerequisite to issuing a building permit?

Yes	1
No	2 (skip to Q.38)
Don't know/not applicable	3 (skip to Q.38
Did not answer	4 (skip to Q.38
Other; specify	

If "yes", please explain what type of approval would be necessary:

37. To which organization(s) would you look for product approval?

38. What kinds of solar energy systems would have problems meeting code requirements? Why?

39. Does this jurisdiction require compliance with FHA-MPS?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify_____	

40. Would there by building code problems in retrofitting a solar system in an older structure?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify_____	

If "yes", please explain_____
_____
_____

41. Apart from normal differences, would any unique considerations prevail for a multifamily vs. single-family solar residence?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify_____	

If "yes", please explain_____
_____
_____

42. About how long does it take to get a major building code change approved? Please explain.

43. Is enabling legislation necessary in order to amend or modify the building code?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	

If "yes", please explain the nature of this legislation and the administrative process

44. Are there administrative rules and regulations which could impede the widespread acceptance of solar energy systems in residential development?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	

If "yes", please explain

V. BUILDING CODE AND ENERGY CONSERVATION

45. Would you say that the existing building code tends to encourage or discourage energy conservation?

Encourage	1
Discourage	2
No impact	3 (skip to Q.47)
Don't know/not applicable	4 (skip to Q.47)

46. In what way does the code encourage (or discourage) energy conservation?

_____
_____
_____
_____

47. Does the building department have an established energy conservation program that it promotes among builders in the area?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	_____

If "yes", please describe the program: _____
_____
_____

48. Does an energy conservation program exist within the city/county government?

Yes	1
No	2
Don't know/not applicable	3
Did not answer	4
Other; specify	_____

If "yes", please describe the program and its relation to the building department: _____
_____
_____

VI. KNOWLEDGE AND ATTITUDES RE: SOLAR ENERGY SYSTEMS

49. How knowledgeable are you and the others in your department/agency about residential solar energy systems?

Very knowledgeable	1
Somewhat knowledgeable	2
Slightly knowledgeable	3
Not at all knowledgeable	4
Don't know	5
Did not answer	6
Other; specify_____	

50. What is the educational background and training of the staff available to process applications dealing with solar energy systems in residential development?

51. Where did you learn about solar energy systems?

Newspaper	1
Popular magazines	2
Trade publications	3
Professional journals	4
Television	5
Radio	6
Other; specify_____	

52. In your position, what major barriers do you see today regarding building codes which may impede the installation of solar energy systems in your jurisdiction?

53. What problems do you foresee regarding building codes for the future application of residential solar energy systems in this jurisdiction?

54. Please identify specific areas where assistance to the building official might be required for solar applications:

(Note to interviewer: cite these as examples)

	Check
Training of Evaluators Inspectors	1
Manuals of Accepted Practice	2
Inspection Guidelines	3
Certification	4
Technical Support/Additional Staff	5
Model Codes/Ordinances	6

Others; please explain _____

_____

_____

55. What specific kinds of information do you need to make a better decision regarding solar systems applications in residential development?

56. To which of the following sources would you normally look for building code issues related to solar energy systems? Please rank them by order of importance.

	Rank
Trade Publications	____
Banks	____
Developers	____
Manufacturers	____
National/Local Associations	____
Universities & Independent Organizations	____
Government Agencies	____
Other; specify_____	

Note to Interviewer: Obtain copies of all building code regulations and related materials applicable for solar energy systems in residential development.

END OF INTERVIEW

Time elapsed_____

Comments_____

_____

_____

_____

APPENDIX I

SECTION B

Selected Questions From AIA/RC Data Collection Instruments Relative to Codes and Standards

Appendix Reference		
I. B1	Building and Site Description	Page A-2
I. B2	Design Process Data	Page C-11; Question 19

TYPE OF SOLAR SYSTEM INTEGRATION

.. The design is:
( ) a new design
( ) an adaptation of an existing design
( ) a retrofit, original building completed, 19 ___.

REGULATORY CODES

. The applicable codes are:
( ) state
( ) local
( ) other (specify) _____

NAME OF STATE OR LOCAL CODE/REGULATION

	Edition (Year)
. Building _____	_____
. Mechanical _____	_____
. Electrical _____	_____
. Plumbing _____	_____
. Other _____	_____

MODEL CODES WHICH ARE THE BASIS FOR REGULATIONS

NOTE: Use abbreviations from below

	Edition (Year)
. Building _____	_____
. Mechanical _____	_____
. Electrical _____	_____
. Plumbing _____	_____
. Other (specify) _____	_____

Abbreviations

ICBO - Uniform
BOCA - Basic Building Code
SBCC - Southern Building Code
AIA - National Building Code
HUD - Minimum Property Standards
NON - None
OTH - Other (specify) _____

Appendix IB1 - Building and Site Description

BUILDING DESIGN

18. Did the use of solar energy affect the specifications normally used by the builder/developer?
( ) no (go to Q.19) ( ) yes. How were they affected and why?

How: _____

Why: _____

19. Did the governing building code or other regulations affect the design of the building specifically relate to the use of solar energy?
( ) no (go to Q.20) ( ) yes. What was the effect?

_____

_____

20. Did the cost of the solar system affect the design of the building?
( ) no (go to Q.21) ( ) yes. What was the effect?

_____

_____

21. Was energy conservation considered during the design process?
( ) no
( ) yes, the building was designed to require _____% less energy for space heating than buildings normally built by the builder/developer.
Why was this done? Was it a direct result of the use of solar energy?

_____

_____

_____

What techniques, methods, products or devices were used?

_____

_____

_____

( ) yes, other (specify what, why and how) _____

_____

_____

_____

_____

C - 11

Appendix I B2 - Design Process Data

APPENIDX I

SECTION C

Selected Questions From HUD/Boeing Data Collection Instruments Relative to Codes and Standards

Appendix Reference		
I. C1	Report No. 3, Construction Report	Page 3; Question Qd

Q d. Building Code:

1) Name of Local Building Code: _____

_____

2) Is this code based on a National Model Code:

Yes ( ); No ( )

If "Yes", which Model Code: _____

_____

e. Back-up System Energy

1) Back-up system energy used. Name & Address of Utility Company or Supplier

a. Gas ( ) _____

b. Electric ( ) _____

c. Fuel Oil ( ) _____

d. Other ( ) _____

Identify type: (Propane, Wood, Coal, etc.) _____

2) Rate Structure requested: _____

_____

3) Rate Structure granted: _____

_____

4) Current Cost of Fuel Oil or other: _____

5) Experience (including problems, if any) in obtaining back-up energy: _____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix IC1 - Report #3 · Construction Report

APPENDIX I

SECTION D

Selected Questions From PRC Data Collection Instruments Relative to Codes and Standards

Appendix Reference		
	Series 10	
I. D1	Building Description	Question 11
I. D2a	Solar System Design Progress Report	Question 8
I. D2b		Question 10
	Series 20	
I. D3	Construction Progress Report	Question 8
	Series 30	
I. D4a	Demonstration Observation Report	Question 8
I. D4b		Question 9(4)
	Series 40	
I. D5a	Owner/User Attitudinal Data	Question 3g
I. D5b		Question 11d

NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING

BUILDING DESCRIPTION

11. REGULATORY CODES

State ☐ ST Local ☐ LO

Other(specify)_____

Name of State or Local Code/ Regulation — Edition

Building_____ Year_____

Mechanical_____ Year_____

Electrical_____ Year_____

Plumbing_____ Year_____

Other(specify)_____ _____

Model Codes which are the basis for Regulation (Use abbreviations in Table 3)

Edition(year)

Building_____ _____

Mechanical_____ _____

Electical_____ _____

Plumbing_____ _____

Other(specify)_____ _____

12. A. Number of Stories

Above Ground AG____

Below Ground BG____

B. Total Height Above Ground____FT

C. Conditioned Floor Area

Total ____FT^2

Using Solar Energy ____FT^2

D. Exterior Wall Geometry (Total Area)

Walls ____FT^2

Door Openings ____FT^2

Windows ____FT^2

E. Roof

Flat ☐ FL

Sloped ☐ SL Pitch Angle____°

F. Attic: Ventilated No ☐ 0 Yes ☐ 1

G. Crawl Space: Vented No ☐ 0 Yes ☐ 1

13. BUILDING VENTILATION RATES

Mechanical, heating ____Changes/hr

Mechanical, cooling ____Changes/hr

Natural, heating ____Changes/hr

Natural, cooling ____Changes/hr

14. INTERNAL HEAT RELEASE (MAXIMUM LOAD)

Occupants ____BTU/hr

Lighting ____BTU/hr

Appliance & Equipment ____BTU/hr

15. HVAC SYSTEM OPERATION CHARACTERISTICS

A. Number of Zones_____

B. Type: Perimeter ☐ P Interior ☐ I

Other(Specify)_____

C. System Designation_____(See Table 4)

D. Principle of Operation (Check One)

Heating-Cooling-Off ☐ HCO

Air Volume Variation ☐ AVV

Air Mixing Control ☐ AMC

Temperature Variation ☐ TVA

Other(specify)_____

E. Heat Dissipating Devices (Check One)

Evaporative Condenser ☐ EC

Air-Cooled Condenser ☐ AC

Cooling Tower ☐ CT

Other(specify)_____

F. Energy Conservation and Recovery Devices_____(See Table 5)

G. System Operating Temperature Set Points

	Heating:	Cooling:
Day	____°F____ hrs/day	____°F____ hrs/day
Night	____°F____ hrs/day	____°F____ hrs/day
Weekend	____°F____ hrs/day	____°F____ hrs/day

Appendix -ID1

NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING

SOLAR SYSTEM DESIGN PROCESS REPORT

1. PROJECT IDENTIFICATION NO	2. PROJECT TITLE	3. DATE MO DAY YR

4. DEMONSTRATION PROJECT LOCATION:

Street _____

City _____ State _____ Zip _____

5. SOLAR SYSTEM DESIGN CONTRACTOR

Name _____

Project Manager _____

Telephone No. (___) _____

6. A & E CONTRACTOR (IF DIFFERENT FROM ABOVE)

Name _____

Project Manager _____

Telephone No (___) _____

7. SOLAR SYSTEM FUNCTION (CHECK ONE)

Hot Water (Domestic or Service)	☐ HW
Space Heating	☐ H
Space Cooling	☐ C
Heating & Cooling	☐ HC
Heating & Hot Water	☐ HHW
Cooling & Hot Water	☐ CHW
Heating, Cooling & Hot Water	☐ HCHW

8. DESCRIBE BRIEFLY THE METHODOLOGY AND STANDARDS USED TO DEVELOP THE DESIGN CRITERIA FOR THE SCHEMATIC DESIGN PHASE. IDENTIFY THE EFFECTS OF REGULATORY CONSTRAINTS, ENERGY CONSERVATION CONSIDERATIONS AND OTHER UNIQUE FACTORS AS APPROPRIATE.

Appendix-ID2a

NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING

SOLAR SYSTEM DESIGN PROCESS REPORT

9. A. BRIEFLY DESCRIBE ANY SYSTEM JUSTIFICATION AND TRADE-OFF STUDIES UNDERTAKEN IN THE SCHEMATIC DESIGN PHASE AND/OR THE DESIGN DEVELOPMENT PHASE

B. IDENTIFY GOVERNING CODE _____

10. PROBLEMS & SOLUTIONS (DESCRIBE THOSE PROBLEMS ENCOUNTERED DURING DESIGN AND INTEGRATION OF SOLAR SYSTEM ESPECIALLY IN THE FOLLOWING AREAS: PERFORMANCE STANDARDS, BUILDING CODES, LAND USE, ZONING, SUN ACCESS, INSURANCE, AESTHETICS. ALSO DESCRIBE HOW THESE WERE ALLEVIATED)

11. SYSTEM SAVINGS & PAYBACK PERIOD (ATTACH WORKSHEETS OF COMPUTATIONS)

A. Estimated cost of Solar System & Auxiliary System	(A) $ _____	
B. Estimated cost of Conventional Energy System	(B) $ _____	
C. Incremental cost of Solar System (C) = (A) - (B)	(C) $ _____	
D. Estimated cost of Solar System Operation (including Auxiliary Energy)	(D) $ _____	/YEAR
E. Estimated cost of Conventional System Operation	(E) $ _____	/YEAR
F. Energy cost savings (F) = (E) - (D)	(F) $ _____	/YEAR
G. Simple Payback Period (C)/(F)	(G) _____	YEARS

PREPARED BY:

Appendix -ID2b

NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING

CONSTRUCTION PROGRESS REPORT

8. DESCRIBE EXPERIENCE & PROBLEMS IN OBTAINING APPROVALS

9. DESCRIBE FINANCIAL INSTITUTION'S APPROACH IN ASSIGNING VALUE TO SOLAR SYSTEM

10. DESCRIBE SOLAR SYSTEM RELATED CONSTRUCTION/INSTALLATION PROBLEMS

Appendix - ID3

NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING

DEMONSTRATION OBSERVATION REPORT

1. PROJECT IDENTIFICATION NO	2. PROJECT TITLE	3. DATE MO DAY YR

4. SITE INSPECTOR

Name _____

Org Name _____

Street _____

City _____ State _____ Zip ____

Telephone No (__)_____

5. OTHER PERSONS CONTACTED (Name & Organization)

A. Name _____

Org _____

B. Name _____

Org _____

C. Name _____

Org _____

6. PROJECT SCHEDULE COMMENTS (Describe project status and report anticipated schedule slippages, if any)

7. COMMENTS REGARDING SOLAR SYSTEM INSTALLATION

8. LEGAL AND INSTITUTIONAL COMPLIANCE CONCERNS (Including building codes, sun rights, financial, etc.)

9. COMMENTS ON PERFORMANCE OF MANUFACTURING/SUPPLIER AND INSTALLER (Special assistance, delivery, quality)

Appendix -ID4a

NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING

DEMONSTRATION OBSERVATION REPORT

9. LOCAL INTEREST IN SOLAR ENERGY (Please check one box for each item. Check unknown if the basis for observation does not exist)

	Unknown	Little	Moderate	Strong
Public	☐	☐	☐	☐
Builder/Developer	☐	☐	☐	☐
HVAC/Architect	☐	☐	☐	☐
Regulatory Authorities	☐	☐	☐	☐
Financial Community	☐	☐	☐	☐
Media (TV, radio, newspaper)	☐	☐	☐	☐
Other _____	☐	☐	☐	☐
_____	☐	☐	☐	☐

10. COMMENTS ON SYSTEM STARTUP (Initial Operation)

11. REMARKS OF THE SITE INSPECTOR

PREPARED BY:

Appendix -ID4b

NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING

OWNER/USER ATTITUDINAL DATA

1. PROJECT IDENTIFICATION NO	2. PROJECT TITLE	3. DATE MO DAY YR

3. WHEN CONSIDERING SOLAR ENERGY SYSTEMS, THE FOLLOWING FACTORS USUALLY INFLUENCE THE DECISION-MAKER. PLEASE INDICATE HOW YOU VIEW THEM AT THE PRESENT TIME BY CHECKING ONE BOX FOR EACH FACTOR.

	Non Restrictive	Restrictive	Highly Restrictive
A. High first cost of Solar System	☐	☐	☐
B. Difficulty in obtaining financing for Solar	☐	☐	☐
C. Estimated cost and time required for maintenance	☐	☐	☐
D. Actual cost and time required for maintenance	☐	☐	☐
E Increased property taxes	☐	☐	☐
F. Uncertain appreciate of the property with solar system	☐	☐	☐
G. Possibility of solar system being made economically obsolete by availability of less expensive and higher performing equipment	☐	☐	☐
H. Safety and Security of the Solar System	☐	☐	☐
I. Space requirements of Solar System	☐	☐	☐
J. Availability of parts, components & personnel	☐		
K. Willingness of the building trade to adopt Solar Energy	☐	☐	☐
L. Availability of data on performance reliability and maintainability of Solar Systems	☐	☐	☐
M. Societal factors, such as views of neighbors and community	☐	☐	☐
N. Aesthetic considerations, attractiveness & appearance	☐	☐	☐
O. Difficulty in obtaining insurance for Solar System	☐	☐	☐
P. Cost of insurance	☐	☐	☐
Q. Regulatory compliance, building codes, zoning, etc.	☐	☐	☐
R. Other (Specify)	☐	☐	☐

4. SOLAR SYSTEM OFFERS THE FOLLOWING ADVANTAGES. PLEASE INDICATE YOUR VIEWS BY CHECKING ONE BOX FOR EACH FACTOR.

	NONE	MINOR	MAJOR
A. Savings on utility bills	☐	☐	☐
B. Hedge against ever rising fuel prices	☐	☐	☐
C. Insurance against fuel shortages/outages	☐	☐	☐
D Environmentally clean & inexhaustible energy	☐	☐	☐

Appendix - ID5a

NATIONAL PROGRAM FOR SOLAR HEATING AND COOLING

OWNER/USER ATTITUDINAL DATA

8. PLEASE CHARACTERIZE YOUR ATTITUDE TOWARD SOLAR ENERGY

	Neutral	Moderate Support	Strong Support
A. At time of project initiation (commitment to build/install solar system)	☐	☐	☐
B. After System is operational	☐	☐	☐

9. DID YOU ENCOUNTER ANY SPECIFIC PROBLEMS BECAUSE THE BUILDING HAS SOLAR ENERGY SYSTEM (IF YES, DESCRIBE THEM IN ADDITIONAL SPACE PROVIDED BY IDENTIFYING ITEM NUMBERS 9A, 9B, ETC.)

A Obtaining financing	NO ☐ 0	YES ☐ 1
B. Public, private interest groups, neighbors attitudes	NO ☐ 0	YES ☐ 1
C. Obtaining insurance	NO ☐ 0	YES ☐ 1

10. WOULD YOU CHOOSE A SOLAR ENERGY BUILDING IF YOU WERE TO START OVER AGAIN

NO ☐ 0 YES ☐ 1

IF NO, PLEASE DESCRIBE BRIEFLY.

11. PLEASE INDICATE THE LEVEL OF LOCAL INTEREST IN SOLAR ENERGY BY THE FOLLOWING SECTORS. CHECK UNKNOWN IF THE BASIS FOR OBSERVATION DOES NOT EXIST

	Unknown	None	Moderate	Strong
A. Public	☐	☐	☐	☐
B Building/developer	☐	☐	☐	☐
C. HVAC/architects	☐	☐	☐	☐
D. Regulator authorities	☐	☐	☐	☐
E. Financial community	☐	☐	☐	☐
F. Utility compan.	☐	☐	☐	☐
G. Insurance companies	☐	☐	☐	☐
H News media (TV, radio, newspaper)	☐	☐	☐	☐
I. Other (Specify)	☐	☐	☐	☐

Appendix - ID5b

APPENDIX II

LITERATURE SURVEY

1. INTRODUCTION

The purpose of this literature survey was to determine the perceived constraints identified as barriers to the installation and use of solar energy systems as contained in published reports, trade magazines, professional journals, newspapers, etc. The identification of barriers and constraints to acceptance of solar energy systems in residential development is one of the objectives of the HUD Solar Demonstration Program[1].

The publications surveyed do not specifically document constraints, but generally discuss problems which could inhibit the use of solar energy systems. Discussions are focused on the long-standing premise that prescriptive codes inhibit innovation and that the only reasonable solution to effective solar codes is the performance approach.

Another perceived difficulty is the lack of standards in the solar area, but this problem should be resolved as the solar industry matures with the development of a full range of standards, test procedures, accepted practices, etc.

Other perceived problems, although isolated and speculative at this time, should be confirmed or dismissed as data are collected and analyzed during the Solar Demonstration Program.

2. PERFORMANCE STANDARDS

The "Solar Heating and Cooling Demonstration Act of 1974" calls for the development of interim performance criteria for solar heating and combined solar heating and cooling components and systems to be used in residential

---

[1] "Plan for Non-Technical Survey Research Activities for the HUD Residential Solar Heating and Cooling Demonstration Program" - Volume I, p. 9, Real Estate Research Corporation, January 1977.

dwellings, and for interim performance criteria for the dwellings themselves. The key word in these provisions is "performance."

Over the years, various public and private committees, commissions, task forces, etc., established to study the impacts of building standards and codes on innovative technologies have recommended that standards and codes be written to stress the performance approach rather than a specification approach; e.g., performance statements specify the intent, the quantifiable goal to be achieved through design solutions as contrasted with the specification (prescriptive) approach which specifies the design solution to be adopted.

Some such early reports are those of the National Commission on Urban Problems[2] and various committee reports of the National Conference of States on Building Codes and Standards, Inc. (NCSBCS). These reports cited a need for a system which unleashes our innovative and entrepreneurial genius and whereby standards of performance, based upon objectives and scientific methods, are set by bodies with high reputation and prestige. As the performance concept becomes incorporated in building construction regulations, the full potential of expanded research in building technology can be made generally available; and (standards) must be performance-oriented to the extent practical and where current knowledge is inadequate as a basis for performance criteria, research must be undertaken.

One of the major difficulties impeding utilization of solar technology was said by its early users to be a lack of usable and reliable performance information from solar product manufacturers and also the absence of a set of user requirements to define how solar buildings should perform. The early users also believed that the development and adoption of a set of industry-wide performance standards and tests would help to facilitate widespread utilization.

---

[2] "Building the American City," U.S. National Commission on Urban Problems (Douglas Commission), December 1968.

A study conducted by the AIA Research Corporation[3] notes that there are few building codes which directly affect use of solar energy; however, the possibility exists that they may develop into a barrier--either by being too prescriptive or by establishment of performance requirements which cannot reasonably be met.

Although dealing with energy conservation generally, and not solar energy in particular, a report prepared by the National Bureau of Standards for the Federal Energy Administration[4] states that further problems with enforcing the performance-based type of standards may develop because of difficulties in making objective judgments in the field. This report also cites a need for assistance in the area of product and equipment acceptance.

In referring to a report[5] developed by ERDA (now incorporated into the Department of Energy), the Energy Research Digest cites "the absence of nationally-recognized performance criteria" as one of six barriers to the introduction of new products. This report criticizes prescriptive standards as "antithetical to the development of new and innovative products."

A study done by TRW Systems Group[6] cited as a result of its analysis one conclusion to be that performance-oriented rather than prescriptive codes will be required in the solar energy area, but that no major technical

---

[3] "Early Use of Solar Energy in Buildings. A Study of Barriers and Incentives to Widespread Use of Solar Heating and Cooling Systems. Summary Report to the National Science Foundation", May 1976.

[4] NBSIR 77-1259, "Building Energy Conservation Program--A Preliminary Examination of Regulatory Activities at the State Level," Robert M. Eisenhard and Patrick W. Cooke, June 1977.

[5] Energy Research Digest, April 25, 1977, pp. 5-6.

[6] "Solar Heating and Cooling of Building" (Phase 0), pp. 2-8, 2-9, 7-55, 7-56, 11-3, 11-4, TRW Systems Group, May 1974.

obstacles are foreseen. It states that codes do not provide incentives or opportunities, and the infrastructure problems relating to building codes will have to be identified and overcome. It continued with, "As pressure is brought to bear on code-writing authorities to improve the semantics of model codes...the better chance there is for entry of solar energy systems into the building construction market."

Solar energy programs, projects and performance criteria may be the first phase--the initial occurrence--of the development and/or revision of building standards and codes toward a more performance-oriented system.

3. BUILDING STANDARDS AND CODES

With the enactment of the Solar Demonstration Act came numerous studies relative to the use of solar energy as a feasible alternative to fossil fuels. The majority of these studies cite present building standards and codes as barriers to solar energy utilization. Articles published in newspapers, trade journals, etc., also cite codes as barriers to new technology in general, and solar technology in particular. Excerpts from four such articles are:

1. Contractor Magazine of June 1, 1977, noted that early results from a New England solar project, which installed solar heating systems in 100 residences, pointed to problems resulting from a lack of standards for installing solar equipment and from a lack of standards for design and manufacturer of such equipment.

2. The Christian Science Monitor of August 27, 1976, reports the tangle of building codes and real estate tax laws needs sorting out to encourage domestic solar energy.

3. The Washington Post of April 3, 1977, in an article relative to solar technology, states that obstacles remain--such as some 30,000 independent building code jurisdictions in the U.S., all of which have their own rules about what can and cannot be used in construction.

4. In an article of the Engineering News-Record of February 24, 1977, entitled "Simmering solar heating market awaits cost-effective products", building codes are cited as a significant barrier to widespread use (of solar energy).

Prior to actual selection of the HUD residential and DoE commercial demonstration sites, various studies of building standards, building codes, zoning laws, etc., were conducted so as to identify any obvious problems which may affect the demonstration programs.

A study conducted by the American Institute of Architects Research Corporation[7] under a National Science Foundation grant was partially based on the assumption that the importance of potential barriers to the widespread use of solar energy can only be fully understood over time as they clearly emerge.

A survey of some 3,000 architects, although inconclusive because of insufficient response, revealed that architects believe one of the most formidable barriers to the adoption of solar technologies in design is building code restrictions. In speaking on the subject of innovation, this study[8] states that very few innovations really offer substantial economic advantage to the building project as a whole, and rarely does the stated advantages of an innovation overcome the increased sense of risk associated with it.

The second volume of a May 1976 study[9], analyzing personal contacts of on-site visits and telephone inquiries made of over 900 persons in some

---

[7] "Early Use of Solar Energy in Buildings. A Study of Barriers and Incentives to Widespread Use of Solar Heating and Cooling Systems, Summary Report to the National Science Foundation", May 1976.

[8] Solar Heating and Cooling of Buildings, Phase 0, "Feasibility and Planning Study" - Final Report, General Electric Company, May 1974.

[9] "A Location Matrix Plan for the Residential Solar Heating and Cooling Demonstration Program," Arthur D. Little, Inc., May 1976.

way connected with the building community, revealed that a model code is used by about 3/4 of the metropolitan areas in the United States and the code issue would be insignificant if solar systems were designed to minimize code problems and are coupled with an effort to make modifications, where necessary. However, a few areas were found where specific local code provisions would impede installation and use of solar systems.

The study suggested that more problems are apt to materialize in congested urban areas than in rapid growth areas, which are more open to innovative technologies.

Although some areas of existing codes might be interpreted as applicable to solar HVAC equipment, one study[10] suggests that ERDA should encourage the model code organizations to establish regulations relating to solar, separate from the actual model code documents. These separate regulations will provide clear-cut building construction requirements. It suggests that much of the confusion associated with interpreting and judging existing codes, probably will be eased by the addition of such regulations to the model codes.

Although a Federally-funded solar demonstration program is mandated by the "Solar Heating and Cooling Act of 1974," the Energy Research and Development Administration stressed that participation by state and local government is important as these groups will be involved in revising the building codes to accommodate innovative technologies.[11]

---

[10] "General Electric Company Survey to Define Import of Statewide Building Codes on Solar HVAC Systems", Commercial Buildings Space Division, General Electric Company, July 1976.

[11] ERDA report to Congress and the President--A National Plan for Energy Research Development and Demonstration, "Creating Energy Choices for the Future," pp. VII-3, ERDA - 48, Volume 1 and 2, June 28, 1975.

A report prepared under a National Science Foundation Grant[12], summarizes that a significant fraction of the U.S. energy budget can be provided by solar energy and that to encourage use of solar energy requires investigation and revision, if necessary, of land use, zoning restrictions and building codes. It further states that "Freedom is essential for further advancement in the field of solar energy utilization."

It states that traditionally, new code provisions or interpretations develop as an outgrowth of reactions either to unfavorable events or fear of unfavorable events.

4. CODES AND PRODUCT APPROVALS

A very comprehensive study previously referenced[8] revealed that in spite of the recent upsurge in interest in solar technologies because of the energy crisis, experience suggests that the rapid commercial development, introduction, and diffusion of solar technologies within the construction industry will not be a simple matter. It also suggests that to the extent that innovation is not compatible with laws and regulations, professional practices, building department approval processes, etc., barriers to its use will appear.

In a study[13] dealing with a specific product for use in a solar energy system, the building industry is referred to as fragmented, and made up of groups, some of which encourages and some of which discourages innovation. The product is cited as an innovation in the building industry which must be introduced to and accepted by it.

---

12 "Solar Heated Residence Annual Research Report," (Colorado Springs, Colorado); pp. 91, 92, 147, 153, July 1975, James D. Phillips.

13 "Phase Zero - Goal Study for the Technical and Economic Evaluation of the Compound PARABOLIC Concentration Concept Applied to Solar, Thermal and Photovoltaic Conditions," Bechtel Corporation, June 1975, pp. 7-6, 1-3.

One study[14] states that a lack of proper regulation also may present a barrier to acceptance of solar technology. However, it adds that present building codes themselves will not prohibit the installation of solar systems.

The first volume of a previously mentioned report[9], prepared for HUD relative to the demonstration program, cites standards and code constraints. However, this report reflects the attitude that builder support can overcome many of the obvious constraints. Obstacles presented by zoning and code authorities are often cited as the most significant factor in resisting the introduction of new products--this report disagrees with these statements. In the economic area, the report states "If the economic performance of solar systems is favorable, there will be an incentive for potential participants in the industry, from manufacturer to consumer, to overcome whatever constraints may exist."

The following quote from reference[9] sums up the issue of building codes as the barrier or the constraint to utilization of solar energy:

> "If the (solar) systems, through product testing, meet established specifications, are proven through experience to be reliable, and are compatible with current regulations, and if procedure modifications are pursued, the constraints should not be significant."

---

[14] Inter-Technology Corporation Proposed System Level Plan for Solar Heating and Cooling Commercial Building, National Solar Demonstration Program, Volume I, May 1976.

APPPENDIX III

BUILDING REGULATORY PROCESS

1. BACKGROUND

A building code is a legal document which sets forth requirements to protect the public health, safety and general welfare as related to the construction and occupancy of buildings and structures. The building code development process in the United States is quite complex. Building codes are normally enacted into law by local governments exercising the police power of the state delegated to them for this purpose. One consequence of this is a considerable diversity of substantive provisions among the thousands of locally-enacted codes. This is true even though three-quarters of locally-enacted codes are based on one of the nationally recognized model codes. Possible reasons for this diversity are:

- local governments frequently alter provisions of the model codes;
- local codes are infrequently updated;
- the model codes are not uniform; and,
- some municipalities write their own codes.

Except for some of the largest cities, drafting of building codes in the United States is accomplished by the model code organizations and allied groups.

The first model building code was published in 1905 by the National Board of Fire Underwriters (now the American Insurance Association - AInA) to guide municipalities concerned with reducing the fire hazard in and about buildings. This is now known as the National Building Code, which is drafted by engineers of AInA with assistance from many sources.

The first model code prepared by building officials was the Uniform Building Code developed in 1927 by the Pacific Coast Building Officials (now ICBO). This Code is currently used extensively on the West Coast and in the Central Midwest. The Southern Building Code Congress International, Inc., recognizing the unique problem affecting construction in the South, prepared the Standard Building Code in 1945. This is the dominant building

code in the Southern States. The Basic Building Code was first published in 1950 by the Building Officials and Code Administrators International, Inc. and is extensively used in the Upper Midwest, New England and the Middle Atlantic States.

BOCA, ICBO and SBCC consider annual code revisions and publish completely new code editions every three years. Generally, this allows the model codes to be up-to-date and permits the use of most new materials and new techniques in building construction. Two other important functions provided by these model code organizations are those of plan review and product approval. Product approval allows a manufacturer to get a single approval, which can generally apply in all locations where the model code is used.

2. BUILDING CODES AT STATE AND LOCAL LEVELS

Within the past several years, many states have assumed more active roles in writing, promulgating and enforcing building codes. A growing minority of states have withdrawn virtually all authority to enact building codes from their respective municipalities. They exercise their building code authority in various ways. Some states have mandatory statewide codes, but in several states their adoption by localities is voluntary. The application of the codes also varies since they may include minimum requirements only or may include both maximum and minimum requirements. When a statewide minimum code is provided, the locality is free to adopt stricter requirements; however, for the minimum/maximum type, the locality must secure state approval of its proposed change on the basis of some unusual condition or special need.

Statewide code enforcement is usually delegated to the local authority with some supervision, training and assistance from the state. Within single municipalities, the authority to enforce codes may be fragmented among different departments without coordinated supervision. These considerations cause quite a variation among localities in the interpretation of similar code requirements.

NBS-114A (REV. 11-77)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBSIR 78-1489	2. Gov't Accession No.	3. Recipient's Accession No.

4. TITLE AND SUBTITLE
Building Regulatory Data Analysis - National Solar Heating & Cooling Demonstration Program

5. Publication Date
June 1978

6. Performing Organization Code

7. AUTHOR(S)
J. Greenberg, S. A. Berry, I. M. Martinez

8. Performing Organ. Report No.

9. PERFORMING ORGANIZATION NAME AND ADDRESS

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

10. Project/Task/Work Unit No.

11. Contract/Grant No.

12. Sponsoring Organization Name and Complete Address *(Street, City, State, ZIP)*
Department of Housing & Urban Development
Division of Energy, Bldg. Tech. & Standards
Office of Policy Development & Research
Washington, D.C. 20410

Department of Energy
Division of Solar Application
Washington, D.C. 20545

13. Type of Report & Period Covered
Interim

14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

This is a progress report detailing the activities and other preliminary work accomplished in analyzing the availability of codes and standards data associated with the HUD and DoE Solar Energy Demonstration Programs. The report delineates the methodology used and an assessment of the availability of collected data as of September 30, 1977. Also included is an analysis of the site locations chosen for the early cycles of the program and a brief literature search which addresses the problems of building regulations as related to the installation and use of solar energy systems.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*
Codes and standards; demonstration program; solar energy; solar regulatory system.

18. AVAILABILITY

☐ Unlimited

☒ For Official Distribution. Do Not Release to NTIS

☐ Order From Sup. of Doc., U.S. Government Printing Office Washington, D.C. 20402, SD Stock No. SN003-003

☐ Order From National Technical Information Service (NTIS) Springfield, Virginia 22151

19. SECURITY CLASS (THIS REPORT)	21. NO. OF PAGES
UNCLASSIFIED	
20. SECURITY CLASS (THIS PAGE)	22. Price
UNCLASSIFIED	

USCOMM-DC 66035-P78