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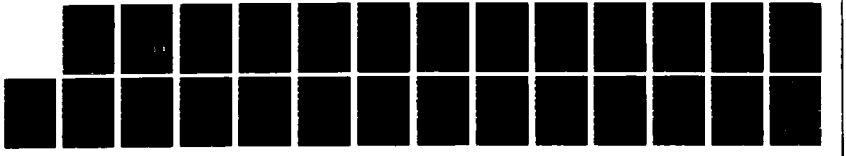

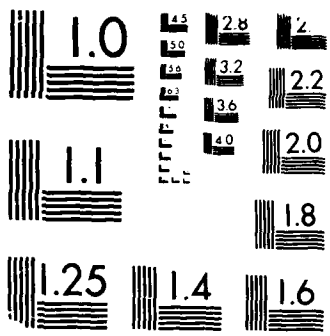

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February 1988

US Army Corps
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Four-Year Summary of Fort Irwin, CA, Family Housing Comparison Test: Operation and Maintenance Costs of Manufactured vs. Conventionally Built Units

by
Robert D. Neathammer

Congress directed the construction of 200 units of manufactured/factory-built housing at Fort Irwin, CA, in 1982 to see if this method of construction will cost less than conventional housing, yet still provide durable housing commensurate with contemporary housing standards.

Congress directed the Department of Defense (DOD) to conduct a fair and reliable study that will compare the operation and maintenance (O&M) costs of manufactured housing to those of conventional housing. DOD will report to Congressional committees on the conditions and parameters under which this test was conducted and the results of the test after the housing has been in use for 5 years.

To compare these two types of construction properly, DOD must reliably identify O&M costs and user satisfaction. Differences in O&M costs must be identified and the reasons for those differences determined.

This is the fourth of four interim reports on the progress of the study. USA-CERL will provide a yearly summary for each of FY84-FY88. A final report covering the first 5 years of O&M costs will be written at the end of FY89.

No conclusions or inferences should be made as to which type of construction has the lowest O&M costs until the final 5-year summary is complete.

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FOREWORD

This research was conducted for the U.S Army Engineering and Housing Support Center (EHSC), under Intra Army Orders (IAOs) from Fort Irwin and Headquarters, U.S. Army Forces Command, dated 22 August 1983, 19 September 1983, 14 May 84, 15 January 1985, 15 November 1985, and 10 December 1986. The EHSC Technical Monitor was Mr. Alex Houtzager, CEHSC-HM.

The work was performed by the Facility Systems Division (FS), U.S. Army Construction Engineering Research Laboratory (USA-CERL). The Principal Investigator was Mr. Robert Neathammer. Assistance was provided by Mr. Robert Doerr, Mr. Thomas Napier, Ms. Mary Chionis, Mr. William Dolan, Mr. John Shonder, Mr. Victor Storm, and Ms. Darcy Weber. Mr. Michael J. O'Connor is Acting Chief of USA-CERL-FS. The USA-CERL technical editor was Ms. Jane Andrew, Information Management Office.

COL Norman C. Hintz is Commander and Director of USA-CERL, and Dr. L. R. Shaffer is Technical Director.

CONTENTS

FOUR-YEAR SUMMARY OF FORT IRWIN, CA, FAMILY HOUSING COMPARISON TEST: OPERATION AND MAINTENANCE COSTS OF MANUFACTURED VS. CONVENTIONALLY BUILT UNITS

1 INTRODUCTION

Background

Congress believes that use of manufactured (factory built) military housing, rather than conventionally built units, will result in lower overall costs, but still provide durable housing that meets contemporary housing standards. To verify this belief, Congress directed the Department of Defense (DOD) to construct 200 units of manufactured housing at Fort Irwin, CA, for comparison with conventionally built housing.[1]

The manufactured units were to be constructed to meet Federal Manufactured Housing Construction and Safety Standards (FMHCSS); however, upgrades in certain criteria were required to bring them into conformance with DOD standards. These areas include space criteria, energy efficiency, fire and life safety, and durability of certain materials and components. The Fort Irwin study will compare the impact of the modified FMHCSS versus standard DOD criteria, except for the essential criteria listed above.

The study is being conducted during the first 5 years the housing units are occupied with initial occupancy on some units starting in February 1983. The study compares 200 two-bedroom manufactured units to 144 two-bedroom, conventionally built units. All but 20 of the conventionally built units are enlisted personnel quarters. Those 20 were built for company grade officers but are used for enlisted personnel. DOD has presented the conditions and parameters of this test to Congress and will report the study results at the end of the test.

To properly compare manufactured versus conventional housing, the study addresses operation and maintenance (O&M) costs and user satisfaction for both types of housing. The study identifies not only the differences, if any, in O&M costs, but also the reasons for the differences and their importance for future construction criteria, construction methods, and occupant satisfaction.

Objective

This report's objective is to summarize the O&M costs and the occupant satisfaction data for both conventionally built and manufactured housing from construction through September 1987. First year data were reported in USA-CERL

[1] Report No. 97-44, *Military Construction Authorization Act* (House of Representatives Committee on Armed Services, 1982), pp 8-9.

Interim Report (IR) P-85/14,[2] second year data in USA-CERL IR P-86/06,[3] and third year data in USA-CERL IR P-87/10.[4]

Approach

The first step was to develop data collection and data analysis procedures. The cost comparisons and analyses for this study were established in USA-CERL Special Report (SR) P-140, *Fort Irwin Housing Comparison Test.*[5] The data is collected, summarized, and reported yearly.

Scope

Costs are limited to buildings themselves; sidewalks, driveways, streets, lawns, playgrounds, and utility lines outside the buildings are not included. Also, the replacement costs of refrigerators, dishwashers, ranges, and utility meters are excluded. Costs do not include the contractor's overhead and profit.

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[2] R. D. Neathammer, *Fort Irwin, CA, Family Housing Comparison Test: Operation and Maintenance Costs of Manufactured vs. Conventionally Built Units,* Interim Report (IR) P-85/14/ADA159740 (U.S. Army Construction Engineering Research Laboratory [USA-CERL], 1985).

[3] R. D. Neathammer, *Fort Irwin, CA, Family Housing Comparison Test; Operation and Maintenance Costs of Manufactured vs. Conventionally Built Units,* IR P-86/06/ ADA175995 (USA-CERL, 1986).

[4] R. D. Neathammer, *Three-Year Summary of Fort Irwin, CA, Family Housing Comparison Test; Operation and Maintenance Costs of Manufactured vs. Conventionally Built Units,* IR P-87/10/ ADA180001 (USA-CERL, 1987).

[5] M. J. O'Connor, *Fort Irwin Housing Comparison Test,* Special Report (SR) P-140/ ADA130349 (USA-CERL, 1983).

2 REVIEW OF TEST PLAN

This section gives a short review of the test plan and the final data analyses. Data is being collected in two areas: O&M costs and occupant satisfaction.

USA-CERL SR P-140 detailed the cost data collection plan and analysis methods. Four basic questions on costs will be answered:

1. Are the average annual O&M costs significantly different?
2. If different, where are they significantly different?
3. Why do the costs differ?
4. What criteria, design features, etc., need to be changed as a result?

Overall maintenance costs and utility costs will be compared separately. If significant differences are found, it will be important to determine their causes.

In addition to the overall cost comparison, the maintenance costs for major building components will be compared. These comparisons will provide more detail about where and why cost differences occur.

Costs to restore each unit to a comparable level of "new plus fair wear and tear" will be determined at the end of the test period. This will be done under the guidance of the Fort Irwin DEH and the Los Angeles District Office of the Corps of Engineers.

In addition to cost comparisons, occupant satisfaction with the overall apartments and each physical part of the unit will also be compared for the two types of construction. The questions used to determine this factor are given in USA-CERL IR P-85/14, Appendix F. When occupant satisfaction differs for a building component, that component will be evaluated to determine the reason for the difference.

One maintenance practice may affect the test results and will be accounted for in the final evaluation. No "routine" or "preventive" maintenance was performed through 30 September 1986, although the contractor originally planned to do so. That is, no seasonal maintenance on the heating/cooling systems was done--no periodic filter changes, etc. This may impact the breakdown repairs of these systems. However, the effect should not bias the test, as both type of units were treated the same. "Preventive" maintenance is done when occupants move out: then a team inspects the unit and either performs minor maintenance or writes a work order (WO) to have work done. Since 30 September 1986, Dynalectron has been performing scheduled maintenance (called cyclic maintenance). The workers check all building components and perform needed repairs.

3 DESCRIPTION OF THE FAMILY HOUSING UNITS

Manufactured Housing Units (MHUs)

These 200 units consist of 50 two-story fourplexes. Each upper unit has a balcony-porch and each lower one has a patio with privacy fencing. Each unit has a refrigerator, gas range, gas water heater, garbage disposal, central air conditioning, and gas-fired forced-air furnace (all provided by the contractor). Each unit has two bedrooms, a kitchen, living-dining area, family room, one bathroom, utility room, and a one-car garage. There are two units on each level.

Initial occupancy was:

61 units	Dec 83
7 units	Jan 84
64 units	Feb 84
57 units	Apr 84
9 units	May 84
2 units	Jun 84

Conventionally Built Units (CBUs)

The 144 units consist of 13 sixplexes, 6 fiveplexes, and 9 fourplexes, all two-story buildings. Each unit has two bedrooms, a kitchen, living-dining area, family-room, one bathroom, utility room, and a one-car garage. The fourplexes have two units on each level. There are two units on the second story in the five- and sixplexes with the additional unit(s) on the first level. The CBUs also have a one-car garage, refrigerator, gas range, gas water heater, garbage disposal, central air conditioning, and gas-fired forced-air furnace.

A detailed description of all units can be found in the Los Angeles District Office report.[6]

Initial occupancy was:

8 units	Feb 83
28 units	Mar 83
38 units	Apr 83
31 units	May 83
23 units	Jun 83
14 units	Jul 83
2 units	Aug 83

[6] *Fort Irwin Family Housing Study—A Report on Manufactured/Factory-Built Housing and Site-Built Housing, Fort Irwin, CA* (U.S. Army Corps of Engineers, Los Angeles District, September 1984).

4 DATA COLLECTION PROCEDURES

Data collected in this study and their level of detail were discussed in USA-CERL SR P-140. That report requires that data be collected at such a level of detail that any differences found between the two types of construction can be explained. Appendix A in IR P-85/14 lists the housing units and their identification numbers used in the data collection.

Data Collection

Discussions were held with the technical monitor, Engineering and Housing Support Center (EHSC) representatives, the FORSCOM HQ representative, Fort Irwin personnel, and representatives of the base operations contractor, Boeing Services International (BSI), to establish the best methods of collecting the data. For O&M data, USA-CERL designed report forms (Appendix B of IR P-85/14). BSI was contracted to segregate all service orders for maintenance for the test units and report cost data to USA-CERL through the Fort Irwin Directorate of Engineering and Housing (DEH) on a monthly basis.

BSI was contracted to read gas and electric meters at the end of each month and report similarly.

Self-help data reports* and occupancy data were to be forwarded quarterly.

An occupant satisfaction questionnaire was to be given to each vacating family with a mail-back envelope to USA-CERL.

A new contractor, Dynalectron, became the base operations contractor effective 1 October 1986. They are performing the same services described above.

Data Verification

USA-CERL is verifying the reported data several ways. Each WO document is checked against the reported data forwarded by the contractor. Discrepancies are resolved on verification visits to Fort Irwin. Additionally, the contractor has set up separate accounting codes for the two groups of units and the total billed is compared to the total obtained from summing over all the individual WO data.

On meter readings, USA-CERL developed a computer program to compare monthly readings. When apparently erroneous data occurs, the contractor is notified and corrections are made.

*Self-help is a program whereby occupants obtain supplies and materials from a central warehouse to make minor repairs themselves.

Data Analysis

Maintenance Costs

These costs are reported on a unit-month basis and yearly basis. The data are also summarized by building component to determine if one or more components for one of the types of units has large maintenance costs. If so, an effort will be made to determine why these costs occur, i.e., what criteria or design features should be reviewed/changed.

Cost differences will probably be caused by material quality, installation, differences inherent to manufactured or conventional construction and possible errors in specifications for the two projects.

Warranty work referred to the construction contractor was not included in the cost comparison since no cost data are available or applicable, as it is not a cost to the government. However, the cost of a service call to assess a problem is included.

Energy Consumption

Gas and electricity consumption are reported on a unit-month basis and a yearly basis. Since most of the MHUs were not completed until May 1984, prior energy consumption data for the CBUs will not be used in comparisons. (Energy consumption comparisons are only valid for the same time frame because of varying weather conditions.)

Occupancy Effects

Occupancy data are also being collected. These data are analyzed to ensure that both types of units have a similar distribution of occupants during the 5 years (ages, numbers). If required, these data will be correlated with O&M costs to help explain differences in costs.

Self-Help Data

These data are summarized to see if maintenance costs are affected.

Occupant Satisfaction Survey

Data from the questionnaires are analyzed to determine any differences in satisfaction with the two types of units.

5 WHOLE HOUSE ENERGY TESTS

Three whole house energy tests were performed immediately upon completion of construction on a sample of units from each type of construction. Appendices C and D of IR P-85/14 give details.

House Tightness

The number of air changes per hour were measured with the following results:

Type	No. Units	Average Air Change Per Hour	Standard Deviation
CBU	15	13.0	1.06
MHU	12	10.9	2.67

There is a statistically significant difference between the two types of construction, with the MHUs being more airtight, on the average.

Furnace Efficiency

The furnace efficiency results were as follows:

Type	No. Units	Average Efficiency (%)	Standard Deviation (%)
CBU	13	66.2	6.24
MHU	16	79.3	3.36

The furnace efficiencies of the MHUs were significantly higher than those of the CBU.

Wall Heat Transfer Characteristics

This parameter was not measured for the CBU because of unfavorable weather during the testing period. This parameter was *calculated* for both types of construction using the designed wall construction. These data are given in Appendices C and D of IR P-85/14 and are summarized below:

Type	No. Units	Average Heat Loss (Btu/hr-°F)	Standard Deviation (Btu/hr-°F)
CBU	16	310	51
MHU	15	237	58

6 OPERATION AND MAINTENANCE (O&M) COSTS

Overall Costs

The total housing unit-months and maintenance costs through September 1987 are shown below in Table 1. (Maintenance includes all types of repairs and "preventive maintenance" performed. See **Scope**, p 6, for costs excluded from the analysis.)

Table 1

Total Unit/Month Costs

Type	No. Unit Months	Total Cost ($)	Cost/Unit/ Month ($)	Cost/Unit/ Year ($)
MHU	8620	181,209	21.02	252
CBU	7711	159,145	20.64	248

Table 1 reflects all data collected through September 1987. However, the CBUs are 10 months older than the MHUs, on the average. So to get a better comparison, the costs for the *first* 3 years, 8 months for each type are shown in Table 2.

Table 2

Unit/Month Costs in First 3 Years, 8 Months

Type	No. Unit Months	Total Cost ($)	*Cost/Unit/ Month ($)*	*Cost/Unit/ Year ($)*
MHU	8620	181,209	21.02	252
CBU	6415	120,976	18.86	226

Discussion

There has been a large increase in M&R costs during FY88. This is illustrated below in Table 3.

Table 3

Increase in M&R Costs

Date	MHU ($)	CBU ($)
Construction - 30 September 1986	104,599	107,715
1 October 1986 - 30 September 1987	76,611	51,431

This is attributable to two factors: (1) the increase in interior painting as many units were vacated for the first time or required painting on change of occupancy, and (2) the large number of cyclic maintenance WOs.

Costs per unit have been increasing over time. Figure 1 shows the cost/unit/month for ages 12 to 41 months, illustrating this trend.

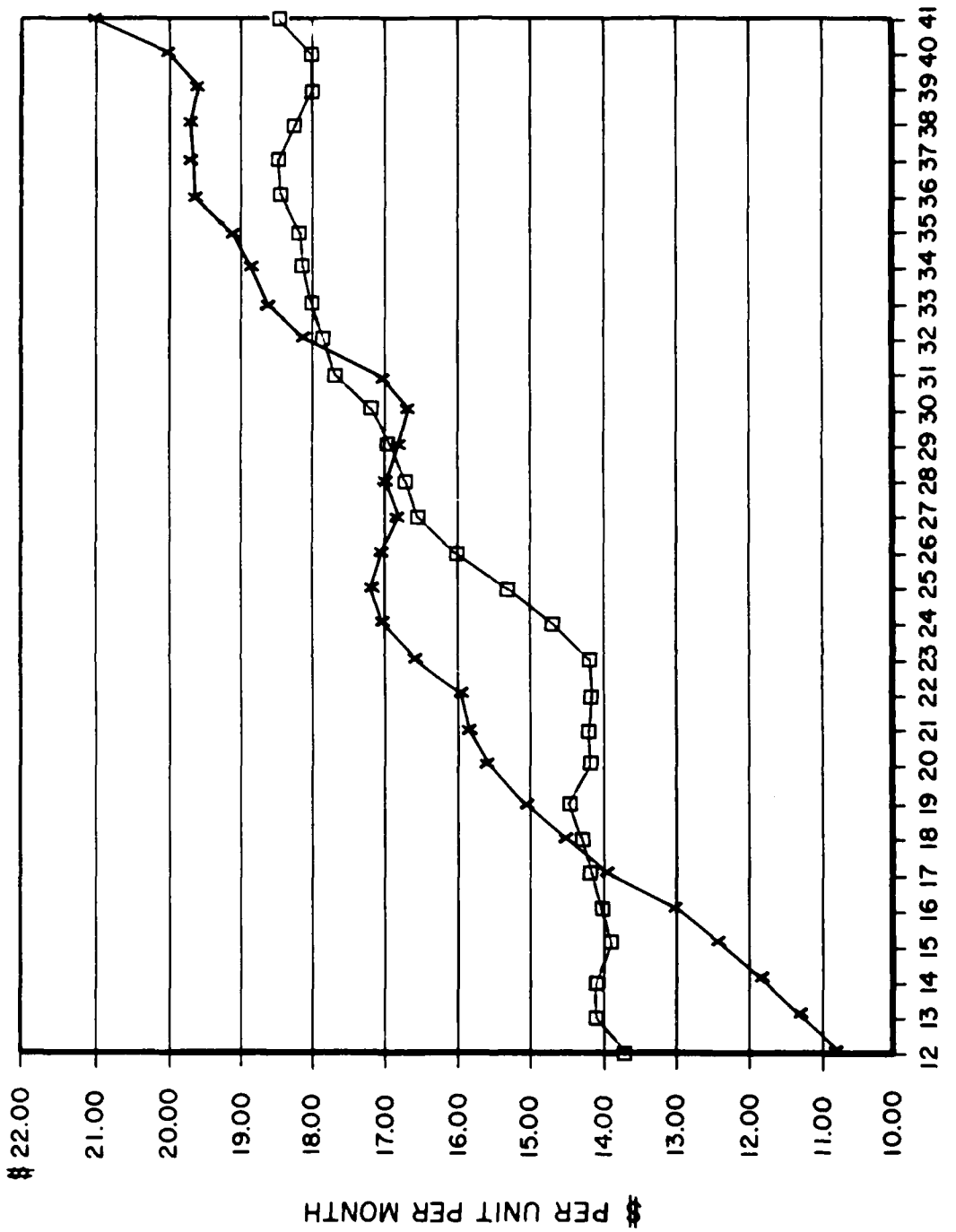

Figure 1. Cost per unit over time.

Frequencies of Maintenance Per Housing Unit

For the MHUs, the number of WOs for a housing unit ranges from 5 to 75. For the CBUs, the range is 10 to 77. Table 4 lists the frequencies.

Table 4

Frequency of Maintenance Actions Since Units Were Occupied

CBU		MHU	
No. of WOs	No. of Units With These Totals	No. of WOs	No. of Units With These Totals
70-79	4	70-79	4
60-69	7	60-69	9
50-59	22	50-59	10
40-49	32	40-49	49
30-39	45	30-39	58
20-29	27	20-29	42
10-19	7	10-19	23
7	0	7	1

It should be noted that the "number of work orders" is in fact a dummy number. When a change of occupancy occurs, numerous building components are repaired--there is one official WO number but each component action is considered a WO for analysis purposes. This can be seen in Table 5.

Table 5

Components of Work Orders

	MHU			CBU		
Date	Number Component Actions	Number WOs	Average Number WOs/Units	Number Component Actions	Number WOs	Average Number WOs/Units
Start - 30 September 1984	855	850	4	1266	1248	9
1 October 1984 - 30 September 1985	1441	1256	6	1084	878	6
1 October 1985 - 30 September 1986	1767	1228	6	1256	815	6
1 October 1986 - 30 September 1987	2989	1547	8	2028	1011	7
Totals	7052	4881	24	5634	3952	27

Maintenance Per Component

Table 6 lists the frequencies of work orders and costs per building component, where the frequency or cost is at least 2 percent of the total number of WOs or total cost, respectively.

Self-Help Repairs

Total self-help costs to date (not included in the overall costs shown above) are $467 for MHUs and $370 for CBUs. (The self-help program was discontinued at the end of FY85.)

Table 6

Maintenance Actions Performed Per Component (Percent of WOs by Component)

Component No.	Description	Maintenance/Repair Actions		Cost ($)	
		CBU	MHU	CBU	MHU
		(N=5634)*	(N=7052)	(Total= 159,146)	(Total= 181,209)
0101	Roofing Surface	42 (1%)	145 (2%)	2416 (2%)	10449 (6%)
0104	Gutters and Downspouts	155 (3%)	184 (3%)	2050 (1%)	2526 (1%)
0206	Exterior Doors and Frames	229 (4%)	377 (5%)	4400 (3%)	8263 (5%)
0207	Storm and Screen Doors	235 (4%)	214 (3%)	5421 (3%)	6914 (4%)
0209	Stormwindows and Screens	108 (2%)	----**	2295 (1%)	----
0212	Interior Drywalls	87 (2%)	118 (2%)	2436 (2%)	2197 (1%)
0214	Interior Doors	429 (8%)	394 (6%)	9683 (6%)	6655 (4%)
0220	Garage Door	262 (5%)	161 (2%)	6208 (4%)	3061 (2%)
0301	Resilient Flooring	----	136 (2%)	----	3040 (2%)
0401	Paint, Walls and Ceilings	89 (2%)	71 (1%)	20444 (13%)	17623 (10%)
0601	Heating Plant	85 (2%)	----	2504 (2%)	----
0602	Heating Motors, Blwrs, Pumps	43 (1%)	60 (1%)	3080 (2%)	3941 (2%)
0607	Heating Controls	100 (2%)	----	4093 (3%)	----
0608	Other Heating	205 (4%)	275 (4%)	3182 (2%)	3691 (2%)
0701	A/C Coils, Comp., Cond.	24 (.4%)	----	4542 (3%)	----
0702	A/C Motors, Blowers, Pumps	57 (1%)	66 (1%)	4560 (3%)	2749 (2%)
0704	A/C Refrigerant	278 (5%)	141 (2%)	10811 (7%)	5729 (3%)
0706	A/C Controls	58 (1%)	----	2738 (2%)	----
0707	Other Cooling	237 (4%)	240 (3%)	3635 (2%)	3715 (2%)
0801	Water Heater	122 (2%)	164 (2%)	3133 (2%)	6106 (3%)
0803	Piping, Supply	89 (2%)	196 (3%)	2716 (2%)	6581 (4%)
0804	Faucets and Shower Heads	186 (3%)	408 (6%)	4068 (3%)	7981 (4%)
0805	Lavatories	174 (3%)	277 (4%)	2738 (2%)	6628 (4%)
0806	Water Closets	361 (6%)	464 (7%)	7126 (4%)	9402 (5%)
0807	Bathtub/Shower Unit	----	150 (2%)	----	3127 (2%)
0904	Wall Receptacles	103 (2%)	173 (2%)	1328 (1%)	2581 (1%)
0906	Light Fixtures	368 (7%)	242 (3%)	6669 (4%)	3798 (2%)
1001	Garbage Disposal	155 (3%)	237 (3%)	3301 (2%)	4015 (2%)
1002	Dishwasher	160 (3%)	295 (4%)	6080 (4%)	8142 (4%)
1003	Range	312 (6%)	495 (7%)	8675 (5%)	10644 (6%)
	Total	4753 (84%)	5683 (81%)	140,332 (88%)	149,558 (83%)
	Others (Less) than 2%	881 (16%)	1369 (19%)	18,814 (12%)	31,651 (17%)

*N = Number of WOs.
**---- = Less than 2%.

7 ENERGY COSTS

Comparisons of gas and electricity consumption began in May 1984, since most MHUs were not occupied before then.

Electricity Consumption

The average usage (kWh) per housing unit is shown in Table 7. For the 41-month period, an MHU used an average total of 32,108 kWh while a CBU used an average of 31,451 kWh. This is a difference of 657 kWh ÷ 41 months = 16.0 kWh/month. At the December 1987 rate of $0.0807/kWh an MHU cost $1.29 more than a CBU for electricity per month.

Gas Consumption

The type of gas used is liquid propane. The average monthly usage (cu ft) per housing unit is shown in Table 8.

For the 41-month period, an MHU used an average total of 62,180 cu ft while a CBU used an average total of 58,760. This is a difference of 3320 cu ft ÷ 41 months = 81 cu ft/month. At the December 1987 cost of $0.01256 cu ft an MHU cost $1.02 more than a CBU for gas per month.

Cost Comparison Summary

For the 3 years ending in September 1987 the 3-year averages for dwelling unit energy consumption and cost are given in Table 9. The MHU on the average have cost $20 more per year for gas and electricity.

Comments

The data in Chapter 5 (better air tightness and higher furnace efficiencies for the MHUs) would indicate the MHUs should use less energy than the CBUs. However, detailed energy simulations (performed at USA-CERL using the Building Loads Analysis and System Thermodynamics program) indicate three design/construction features negate these two measured variables: the MHUs have more window/door glass area; the MHUs have single-pane glass while the CBUs have thermal-pane; and the CBUs are built on a slab (which modulates heating/cooling demands) while the MHUs are built on a crawl space. The final report of this project will give complete details. Meanwhile, no conclusions should be drawn until the 5 year analysis is completed.

At the end of the study, energy consumptions of individual units will be compared. Any units with extremely high consumptions over several occupants will be checked to try to determine the cause.

Table 7

Monthly Electricity Consumption (kWh)

Month	MHU	CBU
May 84	780	704
Jun 84	1007	959
Jul 84	1218	1170
Aug 84	1263	1132
Sep 84	1001	907
Oct 84	557	582
Nov 84	445	433
Dec 84	486	471
Jan 85	484	463
Feb 85	427	417
Mar 85	423	444
Apr 85	633	549
May 85	679	661
Jun 85	1179	1013
Jul 85	1451	1425
Aug 85	1420	1312
Sep 85	643	700
Oct 85	574	610
Nov 85	525	547
Dec 85	514	492
Jan 86	507	482
Feb 86	447	434
Mar 86	465	465
Apr 86	468	484
May 86	828	789
Jun 86	1148	1070
Jul 86	1280	1270
Aug 86	1520	1335
Sep 86	746	857
Oct 86	572	633
Nov 86	460	451
Dec 86	571	607
Jan 87	500	510
Feb 87	429	512
Mar 87	474	492
Apr 87	592	646
May 87	665	679
Jun 87	1038	1060
Jul 87	1174	1282
Aug 87	1460	1247
Sep 87	1035	1142

Table 8

Monthly Gas Consumption (cu ft)

Month	MHU	CBU
May 84	900	710
Jun 84	680	640
Jul 84	570	530
Aug 84	620	590
Sep 84	580	530
Oct 84	1410	1110
Nov 84	2400	2070
Dec 84	3560	3180
Jan 85	3540	3220
Feb 85	2940	2780
Mar 85	2700	2390
Apr 85	1460	1270
May 85	960	820
Jun 85	610	570
Jul 85	620	580
Aug 85	660	670
Sep 85	700	650
Oct 85	1050	880
Nov 85	2670	2410
Dec 85	2840	2560
Jan 86	2540	2400
Feb 86	2260	2120
May 86	1700	1680
Apr 86	1380	1360
May 86	910	890
Jun 86	560	650
Jul 86	600	730
Aug 86	610	720
Sep 86	840	830
Oct 86	1210	1110
Nov 86	1750	1580
Dec 86	3320	3090
Jan 87	3390	3310
Feb 87	2580	2670
Mar 87	2510	2530
Apr 87	1070	1160
May 87	800	800
Jun 87	660	790
Jul 87	630	690
Aug 87	620	670
Sep 87	600	640

Table 9

Three-Year Summary of Energy Consumption

	MHU		CBU	
Unit	Gas	Electricity	Gas	Electricity
Average Consumption/Year	19610 cu ft	8948 kWh	18587 cu ft	8860 kWh
Average Cost/Year	$246	$722	$233	$715

8 OCCUPANT SATISFACTION

One part of the study assesses occupants' satisfaction with their housing. Use of lower cost housing for Army personnel would be questionable if it created morale problems. A questionnaire developed at USA-CERL and approved by FORSCOM, EHSC, and HQUSACE is given in Appendix F of IR P-85/14.

A copy of the questionnaire with a mail-back envelope (to USA-CERL) is given to each vacating family by the contractor approximately 2 weeks before they leave. The family is encouraged to complete and mail it back when they vacate.

Through September 1987, 248 of 705 vacating occupants (35 percent) returned questionnaires. This response rate is considered low. Special surveys were done in September 1984, April 1985, and June 1986 of all families who had lived in their quarters at least 1 year. Of these, 122 (52 percent) returned questionnaires.

For analysis purposes, only occupants who had lived in their quarters for at least 12 months were considered, since they would have been through both heating and cooling seasons.

The responses from occupants of the two types of units were compared by performing cross tabulations. The following paragraphs show results for key questions and for questions for which occupants of the two housing types differed significantly (95 percent confidence). There were 155 responses from occupants of CBU and 143 for MHU.

Q5. How would you rate the condition of your quarters?

	Excellent	Better than Average	Average	Below Average	Poor
CBU	23%	42	34	1	0
MHU	20	40	33	6	1

No statistically significant difference was found in responses between occupants of the two housing types.

Q6. In general, how satisfied have you been with these quarters?

	Very Satisfied	Satisfied	Dissatisfied	Very Dissatisfied
CBU	25%	64	9	2
MHU	25	61	14	0

No significant difference was found.

Q7E. In general, are you satisfied with your kitchen cabinets?

	Satisfied	Not Satisfied	No Opinion
CBU	73%	24	3
MHU	90	10	0

There was a difference between CBU and MHU occupants.

Q7J. In general, are you satisfied with living/dining room floors?

	Satisfied	Not Satisfied	No Opinion
CBU First Floor	60%	38	2
CBU Second Floor	89	9	2
MHU First Floor	63	34	3
MHU Second Floor	73	23	4

There was a statistically significant difference between first and second floor occupants of the two housing types. Second floor units have carpet while first floor units have tile/vinyl. Second floor occupants were more satisfied.

Q7J1. How would you rate cleanability of living/dining room floors?

	Easy to Clean	Hard to Clean	No Opinion
CBU First Floor	54%	42	4
CBU Second Floor	74	12	14
MHU First Floor	72	19	9
MHU Second Floor	55	29	16

There was a statistically significant difference between occupants of CBU and MHU for cleanability of living/dining room floors, caused by the CBU first floor occupants' responses.

Q7K. In general, are you satisfied with the bedroom floors?

	Satisfied	Not Satisfied	No Opinion
CBU First Floor	67%	33	0
CBU Second Floor	96	0	4
MHU First Floor	70	28	2
MHU Second Floor	80	17	3

There was a statistically significant difference: second floor (carpet) occupants were more satisfied.

Q7K1. How would you rate cleanability of bedroom floors?

	Easy to Clean	Hard to Clean	No Opinion
CBU First Floor	60%	39	1
CBU Second Floor	75	9	16
MHU First Floor	73	19	8
MHU Second Floor	67	16	17

There was a statistically significant difference between first floor and second floor occupants for cleanability of bedroom floors with more first floor occupants (vinyl/tile) rating it as hard to clean.

Q7M. In general, are you satisfied with the interior walls?

	Satisfied	Not Satisfied	No Opinion
CBU First Floor	50%	49	1
CBU Second Floor	69	29	2
MHU First Floor	69	29	2
MHU Second Floor	71	24	5

There was a statistically significant difference: more dissatisfaction was shown by CBU first floor occupants.

Q7M1. How would you rate the cleanability of the interior walls?

	Easy to Clean	Hard to Clean	No Opinion
CBU	43%	47	10
MHU	55	30	15

There was a statistically significant difference: the CBU occupants rated walls as harder to clean.

Q9-10. There was no difference between CBU and MHU for noise/odor annoyance from other quarters.

9 RESULTS TO DATE

This interim report has presented results of the O&M and occupant satisfaction data collection for conventionally built and manufactured housing units at Fort Irwin, CA. The data cover a 4-year period from construction through September 1987. Through the first 3 years, 8 months of occupancy there is less than 12 percent ($26) difference per unit in yearly maintenance and repair costs between the two types of units; energy costs for the MHU are higher than for the CBU (about $20/year per unit); and occupants of the two types of units are equally satisfied with their apartments.

Through September 1987 the occupancy rates for the two groups are very similar: CBU, 98.3 percent; and MHU, 98.0 percent.

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