NATIONAL BUREAU OF STANDARDS REPORT

10 520

FIELD TEST OF EXTERIOR HOUSE PAINTS

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Office of the Chief of Engineers, U. S. Army
Directorate of Civil Engineers, U. S. Air Force
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U.S. DEPARTMENT OF COMMERCE
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[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
4212441	January 21, 1971	10 520

FIELD TEST OF EXTERIOR HOUSE PAINTS

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Field Tests of Exterior House Paints

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Introduction

One of the objectives of a protective coatings project sponsored jointly by the Air Force, Army and Navy is to study the performance and other characteristics of new and improved organic coating systems. A need for such information in the specific field of exterior house paints was apparent to the Tri-Service Committee on Protective Coatings. Accordingly, authorization was given in 1964 to proceed with such a study on a limited, field-scale basis.

By the fall of 1964 a site had been arranged for, specific buildings had been selected, a decision had been made on the paints to be included, the surfaces had been prepared and the prime coat applied. Unforeseen delays occasioned by failure of the contractor to remove all loose paint until he was forced to do so in accordance with contract terms and some unseasonal weather prevented application of finish coat paints until the Spring of 1965.

Inspections of the exposed paints were conducted at periodic intervals as explained later. This report was prepared following five years' exposure.

Materials

Six exterior house paints and one primer were selected for inclusion in the study. They were as follows: (See next page)

House paint top coats

(1) Proprietary acrylic latex

(2) Proprietary vinyl latex

(3) Fed. Spec. TT-P-105 (oil base-titanium, zinc)

(4) Proprietary water-thinned oil paint (emulsified)

(5) Proprietary water-thinned oil paint (solubilized)

(6) Mil. Spec. MIL-P-52324 (MO) (long oil-isophthalic alkyd)

House paint primer

(1) TT-P-25a (oil-base, zinc-free)

All of the proprietary paints were first-line products purchased from paint manufacturers of established technical competence. The specification paints were similarly obtained from reliable sources. All paints were purchased in a white color and were applied without modification for a portion of the experiment. In order to obtain some information on tint retention all six white paints were also tinted to match Color 30279 of Federal Standard No. 595. The color may be described as a light brown. The same universal tinting color was used for all paints.

Exposure Plan

The buildings chosen for the test were all family housing units located at Fort Meade, Maryland. Three of them were four-family housing structures which had been converted from troops'

barracks. The horizontal wooden siding on these buildings was the widely used flat grain southern yellow pine. Paint had deteriorated to a condition similar to that illustrated in Figure I. In order to have a wood with better paint-holding properties represented, the paints were also applied to a six-family, two-story, redwood Capehart housing unit. The siding in this instance was of the vertical type and it had been finished with a clear coating that was badly weathered. As shown in Figure II, the grain pattern of the redwood siding was random and there was rusting of exposed nail heads. Edge grain siding structures which would have provided the maximum in paintability were not available for the tests.

The general plan of establishing the field test consisted of three phases. The first phase, surface preparation, contemplated removal of loose, flaking and scaling paint. Firmly bonded paint was to be left in place. While this rather reasonable, practical preparation for painting was explained and agreed to by the contractor in a pre-award conference it nevertheless became the source of a delay in the program as mentioned earlier. There was no problem with the redwood surfaces, but the yellow pine siding required a second effort with scraper and mechanical sander before the surface was deemed to meet contract requirements.

Prime coating with Fed. Spec. TT-P-25a paint, the second phase of the operation, proceeded uneventfully in good weather. Application was by brush at a spreading rate of approximately 450 square feet per gallon.

The time interval between the application of prime and finish coat paints referred to earlier was unfortunate in the sense that it represented a departure from planning. However, all paints were exposed to the same conditions and one product that was in the nature of a control paint, (TT-P-105), performed approximately as expected despite the delay. Also, a visual inspection of the prime coated areas prior to topcoating was reassuring. While there was some non-uniformity of gloss, water splashed on the various areas did not appear to be absorbed.

Finish coat application comprised the third phase of the exposure test program. This involved painting one half of each of the three barracks buildings with one of the six white test paints and then applying the same paints tinted to a light brown color to each family unit of the Capehart building. Airless spray application was planned for the six top coats, but difficulties were encountered in having the two latex paints wet the primer properly when using this method. Brush application was, therefore, resorted to for these two products whereas the other four paints were spray applied.

In summary, six different white exterior house paints were applied over the same TT-P-25a primer on a previously painted yellow pine substrate; the same six paints tinted to a light brown color were applied to primed redwood siding which had previously been varnished and weathered to the point where refinishing was required.

A general view of one of the converted barracks buildings after repainting in 1965 is given in Figure III. One paint was applied to the left half of the structure and another to the right half. Two similar buildings in the same area were used for the other four paints. A portion of the six-family Capehart unit is illustrated in Figure IV. Three of the tinted paints were exposed in the area shown in the photograph and the other three paints in a continuation of the building off to the right of the photograph.

Finally, a brief word about the Fort Meade location may be of interest. Fort George G. Meade lies about 15 miles to the northeast of Washington, D. C. and is in a generally rural area. Weather conditions are probably not greatly different from those of Washington, D. C. The climatoligical summary for the latter area published by the Environmental Science Services Administration reads in part, as follows:

> "Summers are warm and humid and winters mild; generally pleasant weather prevails in the spring and autumn. The coldest weather occurs in late January and early February. The warmest weather occurs late in July. There are no pronounced wet and dry seasons. Thunderstorms during the summer months, often bring s udden and heavy rain showers and may be attended by damaging winds, hail or lightning. Snow accumulations o f more than 10 inches are relatively rare. " The daily minimum normal temperature for February is given as 29.4°F; the daily maximum normal temperature for July is 87.0°F. The normal total precipitation for a year is approximately 41 inches.

Observations

Inspections of the painted areas were conducted at three-month intervals. Entries were made on Exposure Record forms developed by the Federation of Paint Technical Societies. Chalk readings were obtained with the Jacobsen Chalk Tester and reported in terms of the standards illustrated in the Exposure Standards Manual of the aforementioned Federation. Since deterioration was greatest on the south side of the structures the records were kept on that basis. Recorded values represented average conditions to the extent that these could be estimated. No particular problem was encountered in assigning estimated values for general appearance and in determining representative chalking figures. However, failures such as checking, cracking and peeling often varied so much within a given test area that there appeared to be no valid basis for arriving at "average" values. The presence of occasional "bad" boards contributed to this problem. As a consequence, readings of the grossly variable types of failure were discontinued when their doubtful value became apparent. Cracking and peeling failures are reflected in general appearance ratings.

Ratings of the six paints on a yearly basis for general appearance and chalk resistance on yellow pine and redwood substrates are given in Tables 1, 2, 3 and 4. The general appearance rating

includes consideration of uneven color retention of the tinted paints on the Capehart dwellings. Where this change occurred it resulted in a mottled appearance of the coating as illustrated in Figure V, which was taken after five years' exposure; the trend was first observed, however, after three years. Uneven color retention was associated in Paints Nos. 1, 3, 4 and 5 with hair-line cracks in the dark-colored areas; the No. 2 paint also showed this type of cracking but it alone maintained a largely uniform dark color over the entire area. Paint No. 6 was largely uniform in color after 3 3/4 years, but showed slight to moderate fading. The general appearance of white paints after five years is shown in Figure VI.

In addition, Paint No. 5 on the converted barracks began to show undereave peeling in less than two years exposure and became progressively worse during the five year test. Paint No. 4 was the only other coating to experience this problem. In this instance, however, peeling was not observed until nearly four years of exposure and it did not approach after five years the serious condition shown by No. 5 at that time. Undereave peeling of Paints No. 1, 2, 3 and 6 was either non-existent or negligible. Figure VII illustrates the extent of undereave peeling of Paint No. 5 after 5 years.

Conclusions and Recommendations

Generally satisfactory performance during the period of exposure was exhibited by four of the six house paints tested. Two of these paints were proprietary--an acrylic latex and a vinyl latex--and two of them were specification products - Fed. Spec. TT-P-105 and Mil. Spec. MIL-P-52324. The two proprietary water-thinned oil-base materials did not perform up to the standard of the other four and, it is believed, should be eliminated from future consideration. It is understood that these products are no longer commercially available, which is probably significant.

By referring to Tables 1 and 2 covering the performance of white repaints on southern yellow pine it will be seen that the MIL-P-52324 product received top rating for general appearance, but that this was achieved at the expense of moderately heavy chalking. Fed. Spec. TT-P-105 was next in general appearance although it did not remain as white as the MIL-P-52324. Its resistance to chalking (7) was high compared with that (4) of the Military Specification paint.

Both latex paints also performed adequately on southern yellow pine. In general appearance they were slightly below the first two; in chalk resistance the vinyl latex was equal to the TT-P-105 and the acrylic latex was rated higher than the

MIL-P-52324 but lower than the TT-P-105.

Tables 3 and 4 report observations of general appearance and chalk resistance, respectively, of tinted house paints on previously coated redwood vertical siding. In arriving at conclusions concerning these paints it should be remembered that the water-thinned oil-base materials are no longer under consideration and that the MIL-P-52324 paint has been exposed a shorter length of time than the others (see footnote to Table 3). This leaves three paints to consider at this time.

Of these three paints, the vinyl latex rates highest in general appearance, due in large measure to considerably more uniform color retention than both the acrylic latex and the TT-P-105. Chalk resistance of both latexes was good (8) with the TT-P-105 slightly lower (7).

The tinted MIL-P-52324 paint had only 3 3/4 years of exposure when the other paints had reached the 5 year stage. At that time it had a high rating (9) for general appearance but was gradually dropping in chalk resistance (7). If a bit of speculation based on performance up to now is in order, it is considered likely that this paint will continue to show good appearance after five years exposure. Indications are that tint retention, though good, will not equal that of the vinyl latex but be better than the others in regard to uniformity of the tint.

A number of conclusions and recommendations can be advanced as a result of this study, from other information gleaned during observations of paint problems at military installations and from recent developments in the coatings field.

First of all the reader is reminded that while this investigation was limited to repainting problems, much can be accomplished in new construction that will lead to better paint performance. This is not the place to list all of these factors, but it is important to recognize that the repainting problem can be substantially minimized by careful attention to such design considerations as proper venting of attics and crawl spaces, the placement of vapor barriers on the warm side of stud spaces, the use of flashing where indicated, and the selection of wood siding with good paint holding properties. Edge grain western red cedar, California redwood, and northern white pine have been shown to be capable of lengthening paint life but may be at a disadvantage because of cost, availability, or other reasons.

In the present study surface preparation is believed to have contributed significantly to the relatively good performance of four of the paints tested. Admittedly, a reasonable degree of surface preparation is not easy to attain and, as reported earlier, the problem arose in this investigation. It is strongly urged that government agencies not tolerate the

slap-dash procedures employed by some contractors. Also it is felt that the mere statement in a contract that "all loose, flaking or scaling paint shall be completely removed" does not provide assurance that this objective will be achieved. A pre-contract award conference in which the intent of the phrase is made clear and a follow-up inspection before any painting is permitted should eliminate poor surface preparation as a factor in unsatisfactory paint performance. It might not be amiss to restate that the requirement is not considered to be an impractical or unreasonable one since firmly bonded paint need not be removed. It does involve a step in good painting practice, however, that some contractors will not take unless carefully supervised.

Experience in this study indicates also the desirability of utilizing the fairly recent recommendations of Schurr and Van Loo [1/] with regard to the control of undereave peeling. This consists simply of copious rinsing of the area to remove water-soluble degradation products that can cause adhesion problems. A garden hose is suggested as the most convenient means of doing this. Light sanding may precede the washing operation to facilitate the removal of dirt and soluble salts but rinsing is regarded

1/ Schurr, G. G. and Van Loo, M., Journal of Paint Technology, 39, No. 506, 128 (1967).

as the essential step.

Regular inspection of the painting operation itself is taken for granted. While this is not the place to set forth these responsibilities in detail, a few reminders may be in order. These include verification that the specified material is being used and that it is being properly mixed before application. Thinning, if allowed at all, should not exceed specification limits. Proper spreading rate and good workmanship, regardless of the manner of application (brush, spray, roller), should be looked for. Finally, weather conditions should be good for painting which, in general, visualizes a dry day with the temperature in approximately the 50° to 90°F range and wind velocity below 15 miles per hour.

Future Plans

In planning future activities consideration should be given to the inclusion of paint types that are reasonably new, but which have some favorable background usage sufficient to justify their selection.

Among possible products that come to mind are basic silicate white lead primers for control of staining type woods, latest versions of oil and/or alkyd modified latex house paints and various copolymer latex combinations now being offered such as those of the vinyl acetate-ethylene type. On new wood particularly, pretreatment with a water-repellent wood preservative would be of

interest where the entrance of water has lead to such problems as decay, stain, blistering, cracking and peeling. Other products may also be considered.

Acknowledgements

This investigation was supported by the Department of the Air Force, Directorate of Civil Engineering; Department of the Army, Corps of Engineers and by the Department of the Navy, Naval Facilities Engineering Command. Liaison was through the Tri-Service Committee on Protective Coatings. We wish to acknowledge also the assistance of the engineering and maintenance staff at Fort Meade, Maryland without whose cooperation this study would not have been possible. Messrs, F. E. Young, Jr., R. V. Bona and J. H. Hammond were especially helpful.

Thanks are due in addition to Mr. H. I. Salmon of this Bureau who was active in the early phases of the project.

Table 1

General Appearance

White House Paints

on

Southern Yellow Pine

Type	Years				
	1	2	3	4	5
Acrylic latex	9	9	8	6	5
Vinyl latex	9	9	8	7	5
F.S. TT-P-105	9	7 [1/]	7	7	7
Emulsified oil base	9	9	7	5	4
Solubilized oil base	9	9	8	5	3
MIL-P-52324	9	9	9	8	8

[1/] This rating due largely to dirt collection

Key to numerical ratings for general appearance:

Number	Adjective
10	Perfect
8	Good
5	Intermediate
3	Poor
2	Poorest conceivable

Table 2

Chalk Resistance

White House Paints

on

Southern Yellow Pine

Type	Years				
	1	2	3	4	5
Acrylic latex	10	9	7	6	5
Vinyl latex	10	10	9	8	7
F.S. TT-P-105	10	9	7	7	7
Emulsified oil base	10	8	6	5	5
Solubilized oil base	8	8	7	5	4
MIL-P-52324	6	7	6	4	4

Key to numerical ratings for chalking:

Number	Adjective
10	Absent
8	Slight
5	Intermediate
3	Bad
0	Complete failure

Table 3

General Appearance

Tinted House Paints

on

Redwood

Type	Years				
	1	2	3	4	5
Acrylic latex	9	9	8	7	7
Vinyl latex	9	-	9	9	9
F.S. TT-P-105	9	9	9	8	7
Emulsified oil base	8	8	7	6	5
Solubilized oil base	9	9	9	7	7
MIL-P-52324	10	10	9	9 1/	-

1/ This reading applies to 3 3/4 years exposure. There is less exposure data on this material because of difficulty in obtaining the Class 2 tint-base product.

Key to numerical ratings for general appearance:

Number	Adjective
10	Perfect
8	Good
5	Intermediate
3	Poor
0	Poorest conceivable

Table 4

Chalk Resistance

Tinted House Paints

on

Redwood

Type	Years				
	1	2	3	4	5
Acrylic latex	10	9	9	8	8
Vinyl latex	10	-	9	8	8
F.S. TT-D-105	10	9	9	8	7
Emulsified oil base	10	9	9	7	8
Solubilized oil base	10	9	9	8	8
MIL-P-52324	10	9	8	7 1/	-

1/ 3 3/4 years

Key to numerical ratings for chalking:

Number	Adjective
10	Absent
8	Slight
5	Intermediate
3	Bad
0	Complete failure

FIGURES

Fig. I - Appearance of converted barracks before repainting (U. S. Army photograph).

Fig. II - Appearance of Capehart housing before recoating.

Fig. III - Converted barracks after repainting (U. S. Army photograph)

Fig. IV - Capehart housing after repainting (U. S. Army photograph)

Fig. V - Capehart housing after 5 years exposure (U. S. Army photograph)

Fig. VI - Converted barracks after 5 years exposure (U. S. Army photograph)

Fig VII - Undereave peeling (U. S. Army photograph)

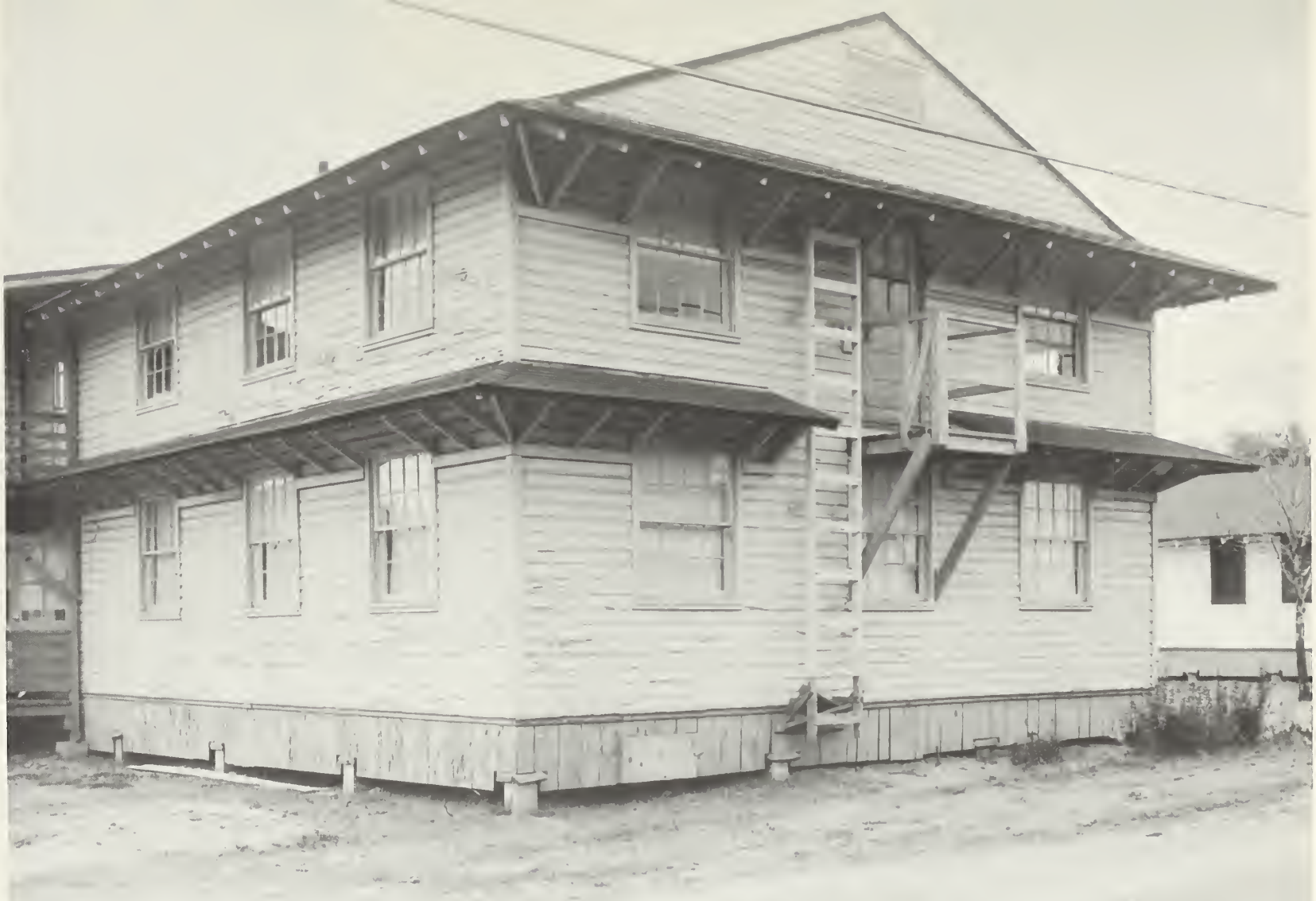

FIGURE I. Appearance of converted barracks before repainting.

FIGURE II. Appearance of Capehart housing before recoating.

U. S. Army Photograph

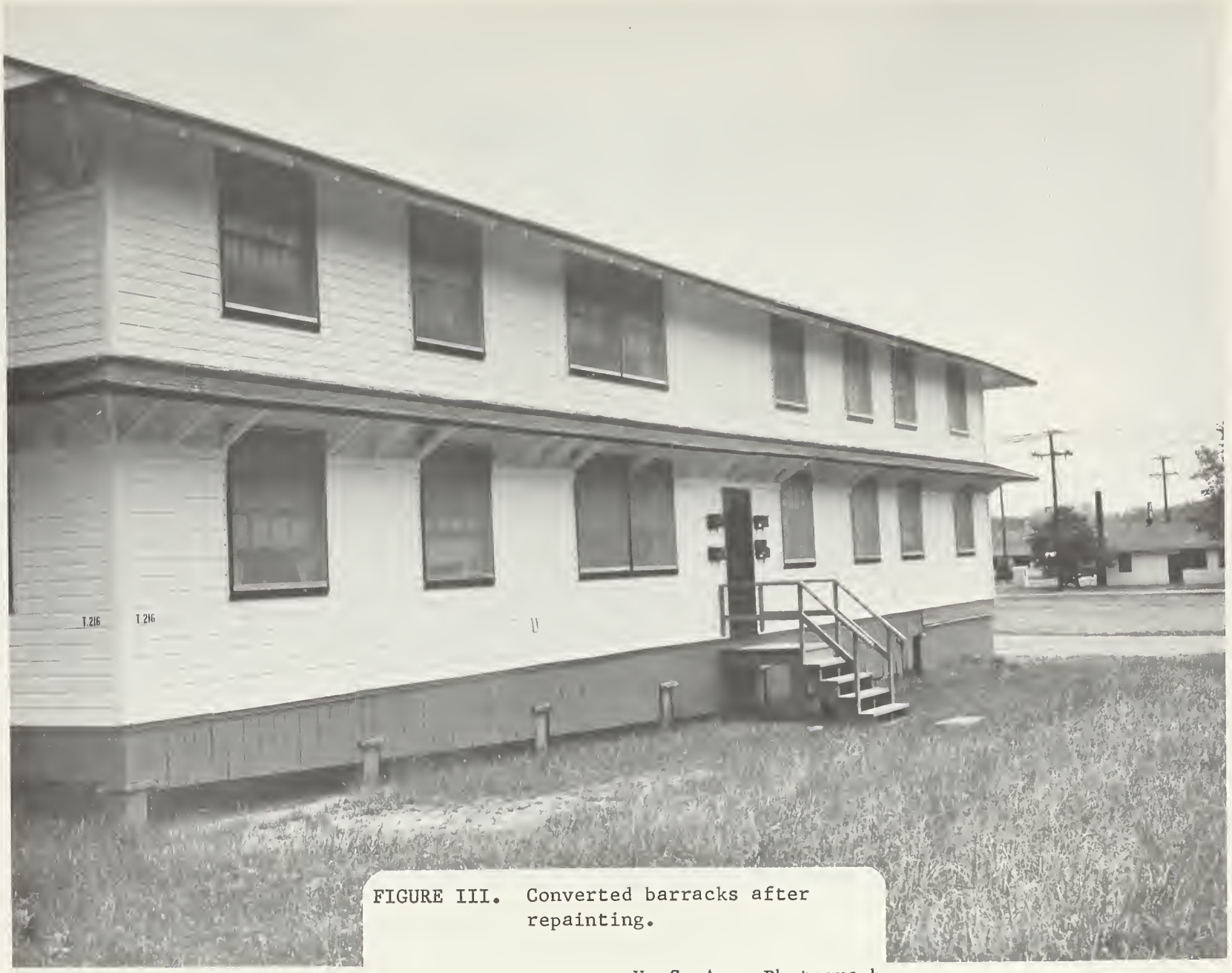

FIGURE III. Converted barracks after repainting.

U. S. Army Photograph

FIGURE IV. Capehart housing after painting.

U. S. Army Photograph

FIGURE V. Capehart housing after 5 years exposure.

U. S. Army Photograph

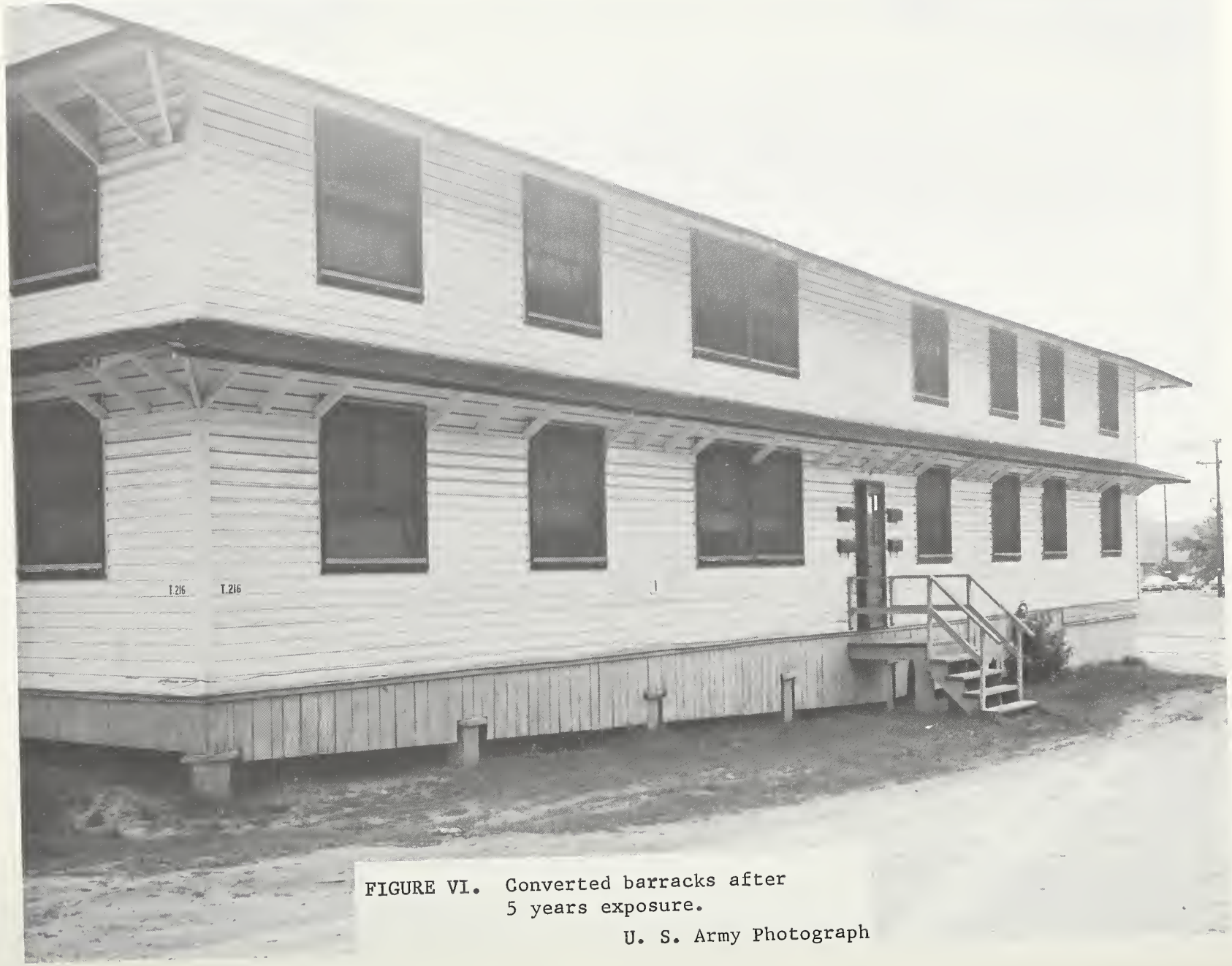

FIGURE VI. Converted barracks after 5 years exposure.

U. S. Army Photograph

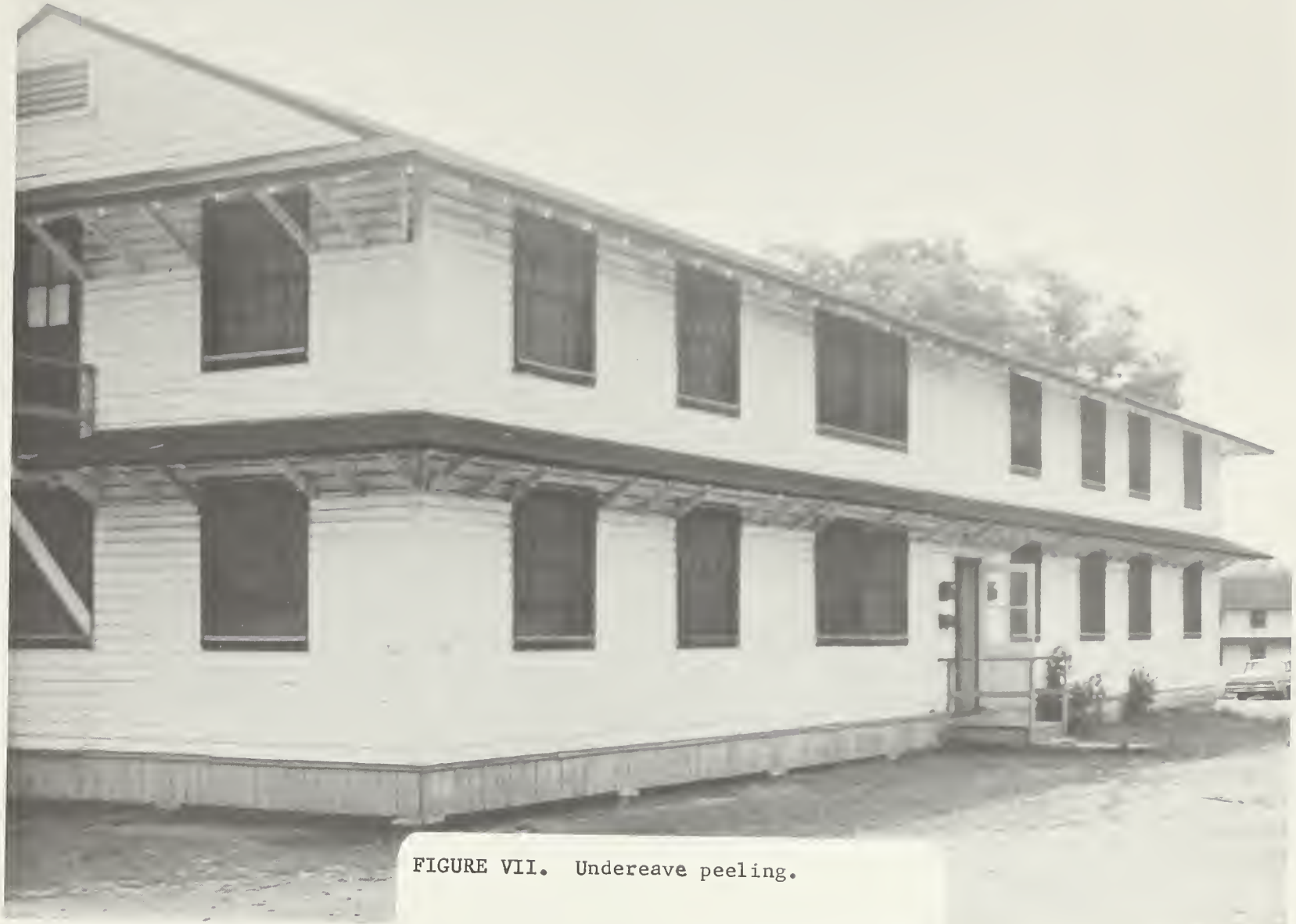

FIGURE VII. Undereave peeling.

U. S. Army Photograph


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