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STATE OF CALIFORNIA
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A PROGRESS REPORT ON THE SERVICE LIFE OF REFLECTORIZED GUIDE SIGNS INSTALLED ON THE ROSEVILLE FREEWAY, HIGHWAY 40.

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December 1959

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MATERIALS & RESEARCH DEPARTMENT

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DIVISION OF HIGHWAYS

SACRAMENTO HEADQUARTERS

G. T. McCOY, *State Highway Engineer*

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State of California
Department of Public Works
Division of Highways
Materials and Research Department

December 1959

III-Sac-3-B
Laboratory Project
Auth. 85 - S - 6201

Mr. Frank E. Baxter
Maintenance Engineer
Maintenance Department
1120 N Street
Sacramento 14, California

2 sets of cards: authors - Calif. Div. of Hwys. Mat. & Res.; Calif. Roseville Frwy

SSMR-Signs-Illum. or Refl.
" " " " - " " - Maint. and Constr.
S + H-Types-Freeway

Dear Sir:

Submitted for your consideration is:

A PROGRESS REPORT

ON

THE SERVICE LIFE OF REFLECTORIZED GUIDE SIGNS

INSTALLED ON THE ROSEVILLE FREEWAY, HIGHWAY 40.

Study made by . . . . . Structural Materials Section
Under general direction of . . . . . J. L. Beaton
Supervised by . . . . . R. N. Field
Report prepared by . . . . . R. N. Field and R. O. Watkins

Very truly yours,

F. N. Hveem

F. N. Hveem
Materials and Research Engineer

RNF/ROW:mw
cc: JWTrask
GMWebb
FLEveritt

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I. INTRODUCTION

As requested, the following progress report on the service life of Scotchlite reflective sheeting signing material, manufactured by Minnesota Mining and Manufacturing Company (hereafter referred to as 3M) is submitted for consideration. The signs included in this study are located on the north and south bound lanes of the Roseville Freeway, U. S. Highway 40 (III-Sac-3) between Sacramento and Roseville and on adjacent access lanes.

These signs fabricated by Kresky Manufacturing Co. of Petaluma and California Metal Enameling Co. of Los Angeles were delivered to Sacramento area Maintenance Yards in December of 1955, and were installed by the Maintenance Department in the spring prior to opening the highway to traffic May 9, 1956.

The purpose of this investigation is to determine the average service life of highway signs fabricated with 3M Scotchlite sheeting as a reflective medium for backgrounds and legends.

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II. SUMMARY AND CONCLUSIONS

This investigation, along with other studies conducted by this Department, has provided evidence that a correlation exists between sunlight exposure and the rate of Scotchlite deterioration. The service life of Scotchlite sheeting is shortened in proportion to the amount of sun exposure the sign receives. This applies to shoulder-mounted as well as overhead signs.

In the vicinity of Sacramento, north facing Scotchlite signs properly coated with 3M No. 700 finishing clear, are indicated by this study to have a service life of 6 to 8 years, and south facing signs have a service life of about 5 years. This service life is predicted on the premise that the signs are properly clear coated during fabrication and every two years throughout the service life of the sign.

Some of the signs included in this study were stored in an exposed area in the Roseville Maintenance Yard during the winter of 1955, and it is reported that mud accumulated on the signs during this storage period. It is probable that, in cleaning the mud and residue from these signs, the surfaces were abraded sufficiently to penetrate the thin layer of finishing clear coat and into the Scotchlite matrix. The abrasive action of this cleansing operation prior to erection of the shoulder-mounted signs appears to have contributed to early surface crazing first noted after only 9 months exposure. As this surface damage was apparent only on the south exposed signs, it appears that deterioration was accelerated by radiant energy from the sun acting on the areas affected by the initial cleansing operation.

All overhead guide signs and shoulder-mounted signs that received a heavy roller-applied finishing clear coat during fabrication, and one field applied finishing clear coat are presently in good condition and are expected to give several years service life, the total life being dependent on the direction the sign is facing.

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III. RECOMMENDATIONS

A. Specifications for materials used in fabricating all types of highway signs using Scotchlite Reflective Sheeting as a background or legend material should be reviewed and revised to include the following:

1. For signs with Scotchlite background and legend:

   Each completed sign panel shall be protected with a finishing clear coat as recommended by the reflective sheeting manufacturer.

2. For signs with Scotchlite background and A.G.A. (American Gas Accumulator Co.) legend:

   The background material of each sign panel shall be protected with finishing clear coat prior to attaching the A.G.A. legend.

3. For signs with Porcelain Enamel Background with Scotchlite legend:

   The face and exposed edges of the cut-out letters shall receive a 3M No. 700 finishing clear coat prior to application to the porcelain enamel background.

The following provision shall apply to all Scotchlite sign materials:

The finishing clear coat may be applied by spray or roller-coat method and shall be smooth and uniform, free from runs and bubbles with a dry film thickness not less than 0.0015" nor more than 0.0025".

B. The following signs should be removed from the Roseville Freeway as early as is convenient for stripping and refurbishing with green Scotchlite background and A.G.A. legend. Four of these signs have A.G.A. legends which can be salvaged.

Sign Number	Legend
* X 3DS88	Madison Avenue use Right Lane
* X 3DS89	Madison Avenue use Right Lane
* X 3DS94	Antelope Road use Right Lane
* X 3DS95	Antelope Road use Right Lane
X 3DS103	Spruce Avenue use Right Lane
X 3DS104	Spruce Avenue use Right Lane
X 3DS109	Rocky Ridge Road use Right Lane
X 3DS110	Rocky Ridge Road use Right Lane
- - -	Roseville City Limit - Pop. 12,100 Elev. 161

* Signs with A.G.A. legend

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C. Sign washing crews should be instructed on proper cleaning procedures for Scotchlite signs.

Laboratory tests indicate that an alkaline sulphonate type detergent diluted as recommended and applied with a soft brush will not damage the Scotchlite surface. The sign surface should never be cleaned with a dry or damp cloth. In the event that scouring is necessary for cleansing, a clear coat should be sprayed immediately over the abraded areas. Scotchlite No. 700 finishing clear is available in 12 oz. pressure spray cans.

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IV. DISCUSSION

Materials

The reflective sheeting included in this study was designated by the Minnesota Mining & Manufacturing Company at the time of installation as Parkway, wide-angle, flat-top Scotchlite.

The legends on one-half of the green background guide signs are composed of white, baked enamel on aluminum A.G.A. cut-out letters with plastic reflex reflector inserts. The legends on the remainder of the signs are composed of cut-out Scotchlite letters.

Fabrication

The following signs were fabricated by Kresky Manufacturing Company of Petaluma:

4 each - Overhead guide signs with #2277 green Scotchlite background and #2270 silver Scotchlite cut-out letters.

4 each - Overhead guide signs with #2277 green Scotchlite background and A.G.A. aluminum cut-out letters.

13 each - Shoulder-mounted guide signs with #2277 green Scotchlite background and #2270 silver Scotchlite cut-out letters.

13 each - Shoulder-mounted guide signs with #2277 green Scotchlite background and A.G.A. cut-out letters.

18 each - 26" x 30" "No Turn" R15R signs with #2276 blue Scotchlite background with #2270 silver Scotchlite legend and borders.

The Scotchlite background sheeting was vacuum applied to 0.081 inch, 6061-T6 aluminum base metal which had been etched in a 6% solution of phosphoric acid. The Scotchlite legend was vacuum applied to the background material, and the completed sign panels were protected with a finishing clear coat.

All panels, not exceeding 48" wide, were roller-coated with 3M #700 finishing clear coat with 3M #711 thinner to retard drying. Because of size limitations of the roller-coating machine, it was necessary for the fabricator to use spray equipment for applying the clear coat to all panels over 48" wide. This sprayed clear coat was thinned with xylol to accelerate drying.

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In addition to the above listed signs, 56 black porcelain enamel guide signs with cut-out Scotchlite letters were fabricated by California Metal Enameling Company. The Scotchlite legend was vacuum applied to the black-matte porcelain enamel surface. No finishing clear was applied either before or after application of the legend.

Testing and Inspection:

All reflective sheeting and legend material for these signs was specified by trade name in the purchasing specifications, so inspection was limited to identification of products. Since installation, the signs have been inspected in-place every 10 to 12 weeks by personnel from this Department.

At the request of the Maintenance Department four shoulder mounted signs were brought to the laboratory for reflectance readings in February 1959. (See Exhibits 1, 2, and 3)

A complete record of each sign showing location, direction sign is facing, vandalism and traffic damage, and weathering deterioration is available for reference.

History of Signs

The signs were fabricated in November and December of 1955, delivered to the Sacramento Maintenance Yard and the Roseville Maintenance Yard late in December and erected in March and April of 1956. The highway was opened to traffic May 9, 1956.

The first deterioration of these signs was noted as "light checking of the green background" on Sign No. X 3DS90 July 1956, three months after installation. This condition was found on nine of the green shoulder-mounted signs within the first year of service. After 18 months of service moderate to severe surface checking of the background material and Scotchlite letters was reported for the above-mentioned signs.

In an attempt to prolong the service life of these signs, in November 1957 the District III sign crew roller-applied an additional heavy coat of 3M #700 clear finish of all signs with Scotchlite background.

Correlation Test:

For correlation with the freeway sign tests, a reflective sheeting exposure rack was installed on the roof of a Materials and Research Department building on March 31, 1955. Six flat-top Scotchlite test panels were positioned on the rack to face north and south in a vertical plane. These test panels were fabricated from the same materials as the signs but from different production runs. No seal coat was applied to these panels. See Exhibit 4 for reflectance readings on the test panels.

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Exhibits 5 and 6 show the severe checking and surface condition on the test panels after 4 1/2 years of south exposure.

Present Condition:

A. Overhead Signs

The overhead signs are still in good condition. The background appears darker than new green Scotchlite, but this may be the result of differences in production runs of Scotchlite. No deterioration is detectable on any of the signs facing north (south-bound lanes). The only checking noted on the south-facing signs has occurred in small areas which were missed when the last seal coat was applied (see Exhibit 7). Judging from the present condition of these signs, they may be expected to serve a minimum of 3 to 6 years more.

B. "No Turn" R15R Signs

There is some deterioration and checking of the silver cut-out letters and borders on three of these signs facing south, but there is no evidence of weather deterioration of the blue background material. These signs are mounted at the gore of the "on" ramps. There is some checking of the blue background evident on 5 of these signs, resulting from straightening the signs after being struck by traffic. Even though bent to more than 45 degrees, the signs were straightened by the sign maintenance crew and returned to service. The damage to the surface was not severe enough to require repairs.

C. Shoulder-Mounted Green Signs Facing North

There is no noticeable weathering deterioration of any of these signs. Two signs were knocked down and bent by traffic, straightened, and returned to service (see Exhibit 8). Slight checking evident in the background and legend of these signs is a result of bending and straightening of the sign.

D. Shoulder-Mounted Green Signs Facing South

Cracking and checking has progressed on 9 of the 13 signs to the extent that the letters are starting to peel off, (see Exhibit 9). The background material has checked through to the base metal on several signs. The daytime appearance of these signs is poor, and the nighttime appearance is unacceptable. Under reflected light the message is difficult to read because the background and legend appear patchy and streaked. The background color varies from green to greenish-gray, and the legend color varies from silver to gray (see Exhibit 10).

It is significant that the remaining four signs in this group are in fair condition and may possibly last another two years. These signs were clear coated by the roller method as they

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were less than 48 inches wide. Further evidence of the value of a heavy clear coat is found in connection with the center panels of two south-facing, shoulder-mounted Rocky Ridge Road signs. The original plans specified a total sign length that was 24" less than required to maintain standard spacing of the legend. The 144" panels were split at the center and a two foot center section was added. The center panels received a heavier roller-applied clear coat while the side panels were clear coated by spray applications. The background and letters on these narrow center panels are in much better condition than the larger side panels (see Exhibits 11 and 12).

E. Black Porcelain Enamel Signs with Scotchlite Letters

The porcelain surface is in excellent condition. Although the edges of the Scotchlite letters peeled and curled within the first 5 months of service, the letters are still firmly adhering to the porcelain surface. The peeling is limited to the outer 1/32" and does not detract from the legibility of the sign.

The checking of these letters is evident on signs facing south and west as shown in Exhibit 13. No checking was evident on any of the north facing signs (see Exhibit 14).

An example of deterioration and failure of a Scotchlite legend on porcelain enamel is shown in Exhibit 15. The sign was installed June 7, 1950, on VII-LA-23-E facing due west. By November 1954, the Scotchlite legend had completely failed and a new legend was applied by Cal-Metal Enameling Company. Exhibit 15 shows the present condition of this refurbished sign after an additional 4 years exposure.

F. Condition of Legends

The A.G.A. enameled cut-out aluminum letters with reflector buttons show no signs of weathering or deterioration. Less than 1% of the reflectors and none of the letters have required replacement. Because each letter is attached separately, the reflector button damaged by a flying rock can be readily replaced.

The condition of the Scotchlite letters and numbers vary, but in general, when applied to a Scotchlite background, the legend has the same rate of deterioration as the background material. The condition of the Scotchlite message on porcelain enamel is covered above.

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V. VARIABLES AFFECTING THE EARLY FAILURE OF THE SCOTCHLITE

Nine of the thirteen green-background signs facing south need replacing now. All the causes of this early failure are difficult to determine exactly, but the following known variables undoubtedly affected the service life:

A. Method of Applying the Clear Coat

All the sign panels showing early failures were clear coated by the spray method. There is no evidence of accelerated deterioration on any of the roller-coated panels. This difference apparently is not due to the method of application but is rather due to the fact that the roller method results in a thicker coating. The protection the heavy roller-applied coat provides is particularly evident on the Rocky Ridge Road signs, where the center panels are in considerably better condition than the larger side panels (see Exhibits 11 and 12).

B. Sunlight Exposure

All the panels that show early failure are on the north-bound lanes facing between S 15° and S 28° W, and thus are exposed to late morning and afternoon sun. The signs facing northerly in the south-bound lanes, exposed only to the early morning sun, are in good condition.

Similarly, the Scotchlite letters on black porcelain signs facing north are still in good condition, while those exposed to afternoon sunlight are checking and cracking (see Exhibits 13 and 14).

C. Washing

All shoulder-mounted signs were washed approximately three times a year with a soft brush using an alkaline sulphonate type detergent. The overhead signs were not washed.

When inspecting the south-facing shoulder and overhead mounted signs that received the heavy protective clear coats, it was noted that the shoulder-mounted signs are not in as good condition as the overhead signs. Since these signs received the same sun exposure and clear coat, washing is probably the only variable which can account for this difference.

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VI. FUTURE WORK

Observations on these signs will be continued and any additional information will be reported later.

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Exhibit I

REFLECTANCE OF GREEN SCOTCHLITE ROSEVILLE FREEWAY SIGNS

Sign No.	Legend	Direction Facing	Condition of Scotchlite in Various Areas	Specific Intensity cp/ft-c/ft^2	1958 Specs.
X 3DS99	Douglas Ave. Use Right Lane	North	Background, no checking Background, no checking Under AGA Letter, no checking	4.9 4.9 4.2	4.2
X 3DS89	Madison Ave. Use Right Lane	South	Background, severe checking Background, checking Under AGA Letter, no checking	0.9 2.1 4.2	4.2
- - -	Roseville City Limits	North	Background, no checking Background, no checking	4.9 5.1	4.2
- - -	Roseville City Limits	South	Background, checking Background, checking	2.1 2.3	4.2

Reading taken February 16, 1959, after two years and ten months of service, and after field application of clear coat.

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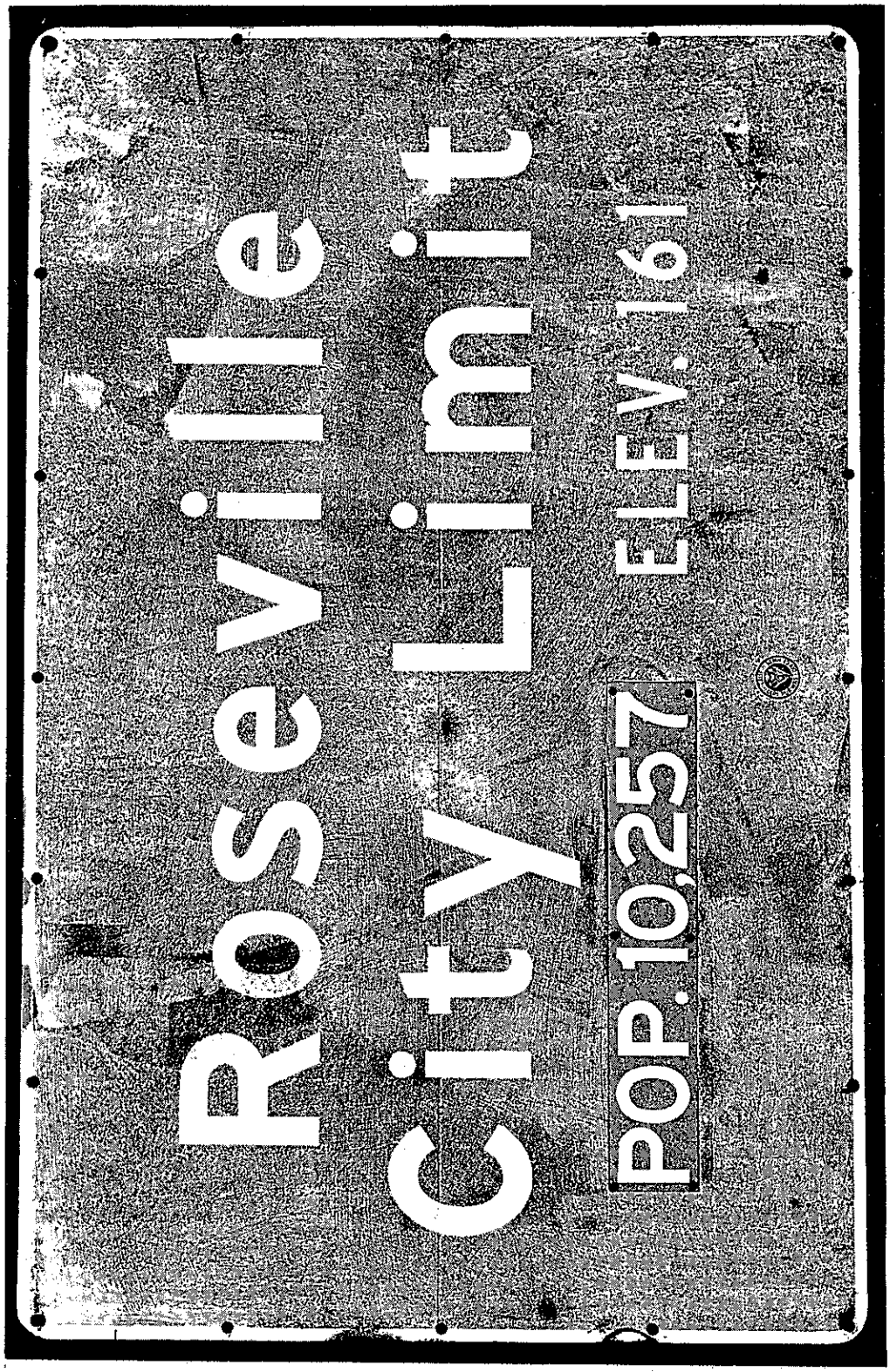

Nighttime appearance of South facing sign showing surface condition and loss of reflectance after approximately three years of service.

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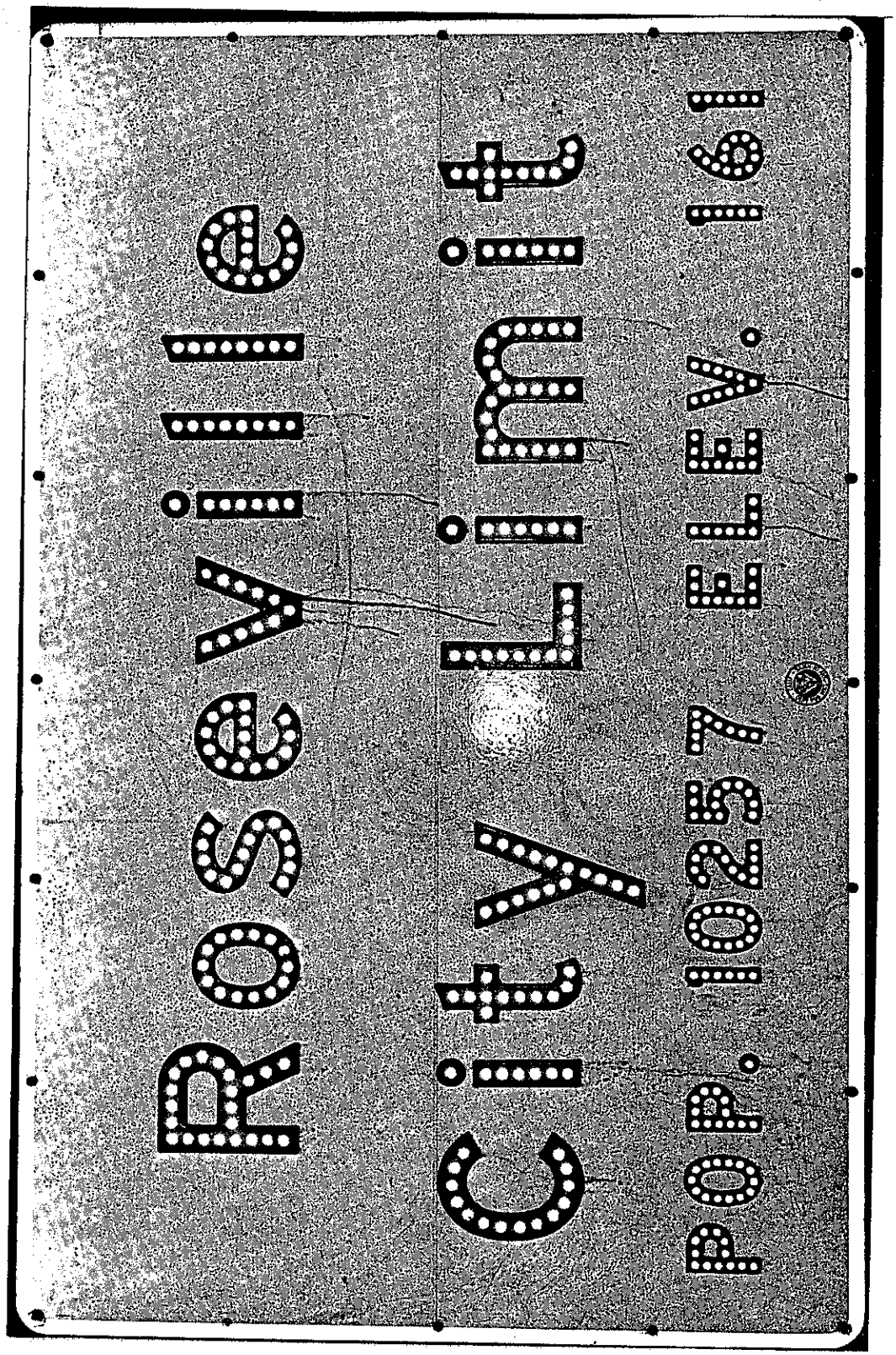

Nighttime appearance of North facing sign showing the good condition of the Scotchlite after approximately three years service. The runs occurred when applying the second seal coat.

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Exhibit 4

REFLECTANCE VALUES OF SACRAMENTO TEST RACK PANELS *

	0°		10°		20°		30°		40°		45°	
	1955	1959	1955	1959	1955	1959	1955	1959	1955	1959	1955	1959
Red Specifications **	8.2		5.4		4.6		3.4		2.2		1.7	
Red, South-Facing	13.0	0.8	10.0	0.7	8.0	0.5	6.0	0.4	3.0	0.3	2.0	0.3
Red, North-Facing	14.0	13.4	9.0	9.0	8.0	8.0	6.0	6.0	3.0	3.0	2.0	2.0
Yellow Specifications **	15.4		13.6		10.6		6.9		3.8		2.5	
Yellow, South-Facing	20.0	2.8	17.0	2.5	11.0	2.0	7.0	1.3	3.0	0.8	2.0	0.6
Yellow, North-Facing	19.0	13.4	16.0	12.7	11.0	9.4	6.0	5.4	3.0	2.7	2.0	2.0
Silver Specifications ***		40.0		35.0		27.0		19.0		11.5		7.8
Silver, South-Facing	73.0	5.2	63.0	5.1	45.0	4.3	28.0	2.9	15.0	1.6	9.4	1.2
Silver, North-Facing	70.0	37.5	61.0	35.2	33.0	23.8	20.0	12.7	14.5	6.0	9.3	7.4

* Candlepower per foot candle per square foot.

** Service and Supply Specifications dated Dec. 1955 and Aug. 1959 for minimum reflectance values.

*** Service and Supply Specifications dated Aug. 1959 for minimum reflectance values.

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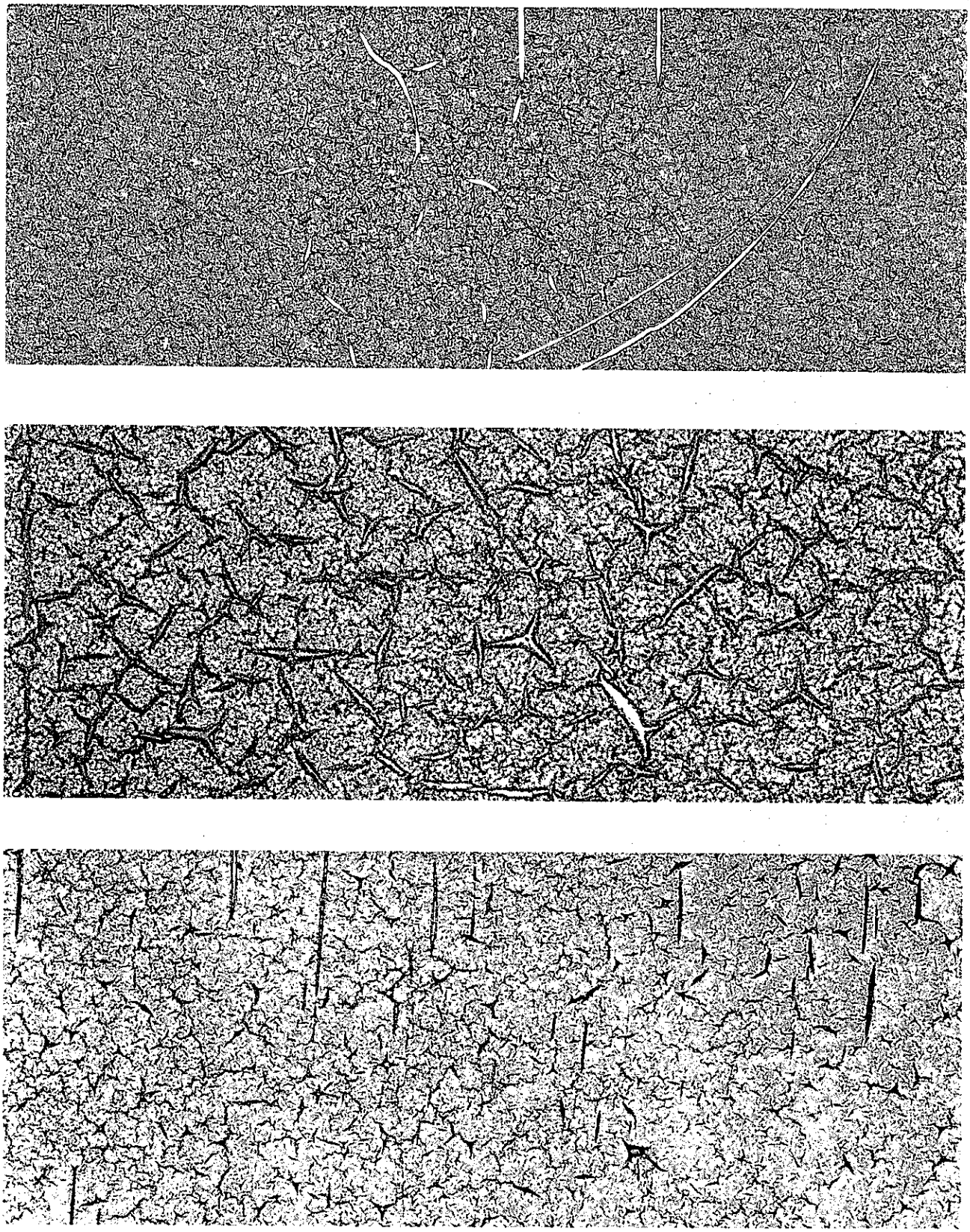

Flat-top Scotchlite - 4 1/2 years South exposure on Sacramento Test Rack. Top to bottom: Red, Yellow, Silver

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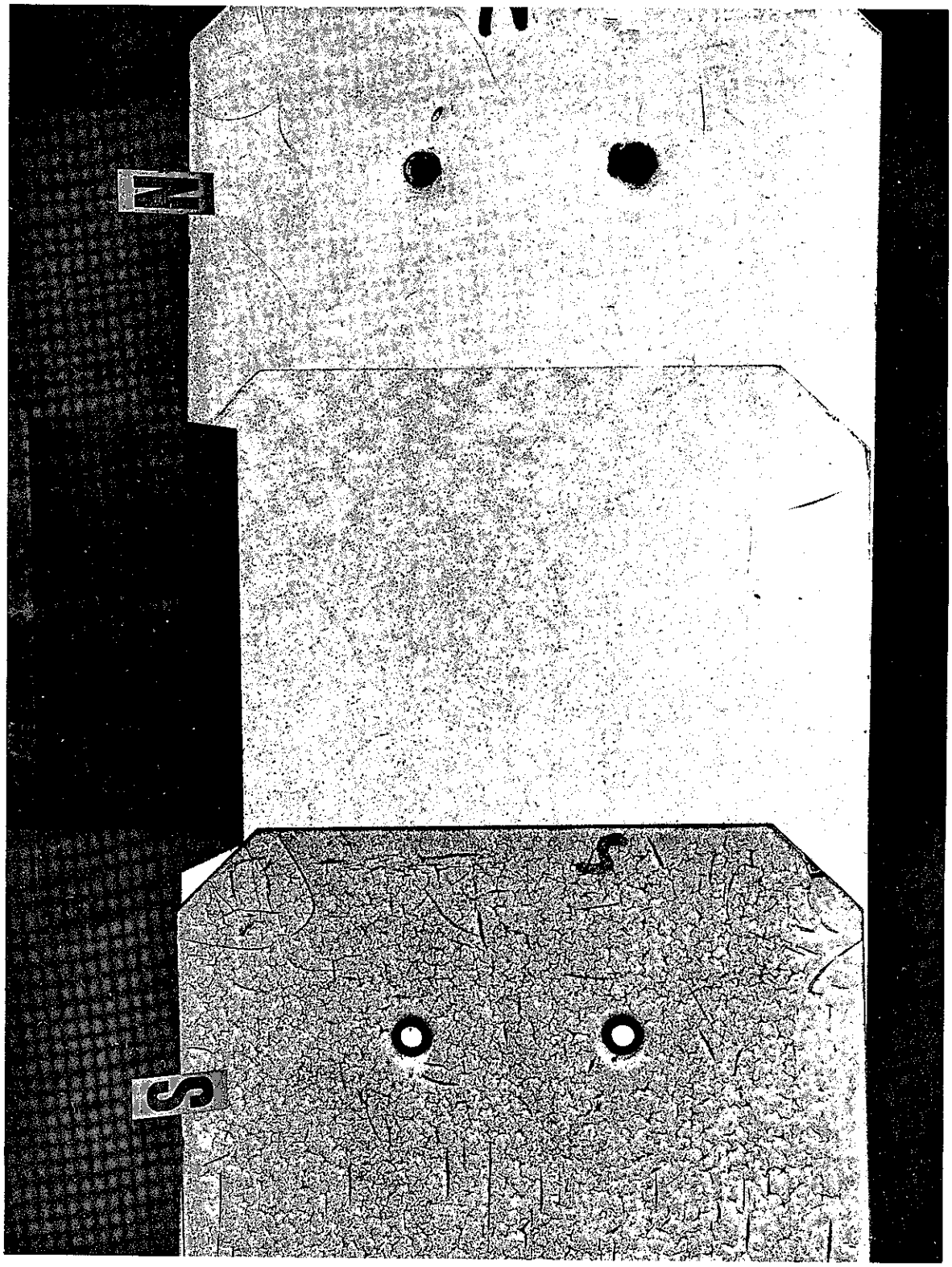

Silver Flat-top Scotchlite: Nighttime appearance after 4 1/2 years exposure on Sacramento Test Rack. Top to bottom: North exposed, unexposed control panel, south exposed.

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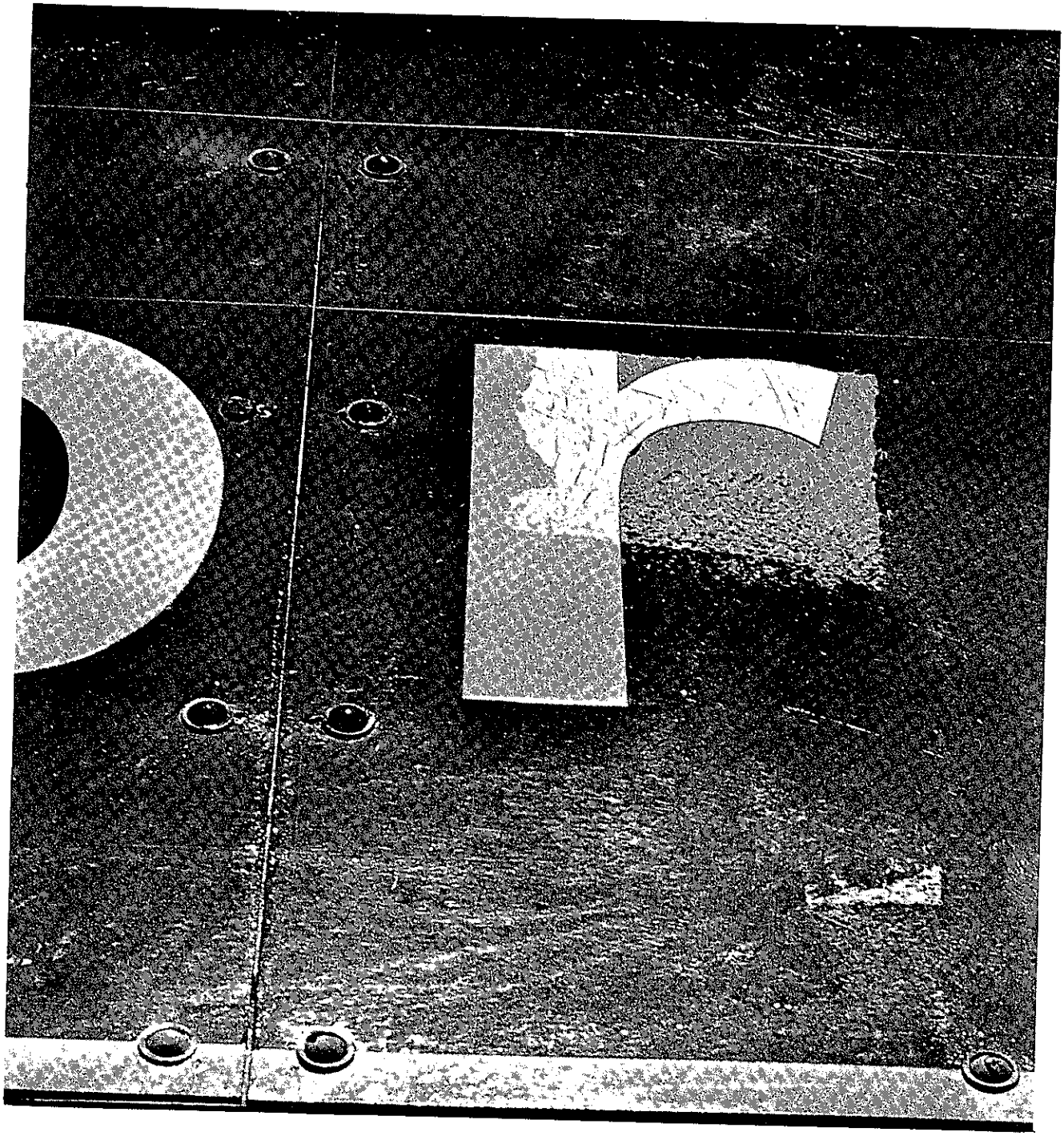

Overhead, South exposed sign showing weathering in area not protected by field applied clear-coat.

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Severely damaged sign straightened by field crew and immediately returned to service. Damaged areas are not noticeable to passing motorists, day or night.

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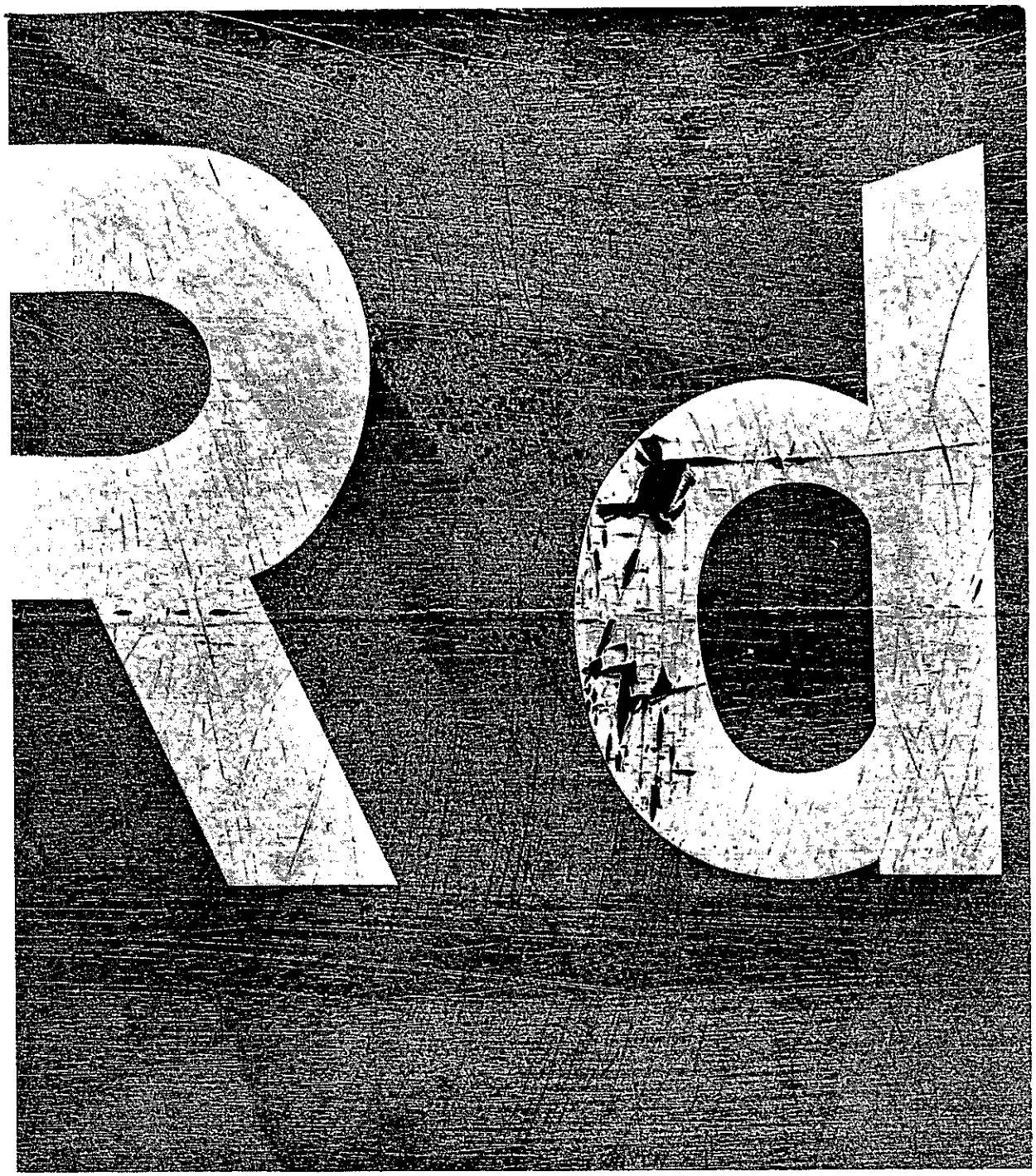

South exposed Scotchlite, shoulder-mounted sign, showing peeling of the legend after 3 1/2 years service.

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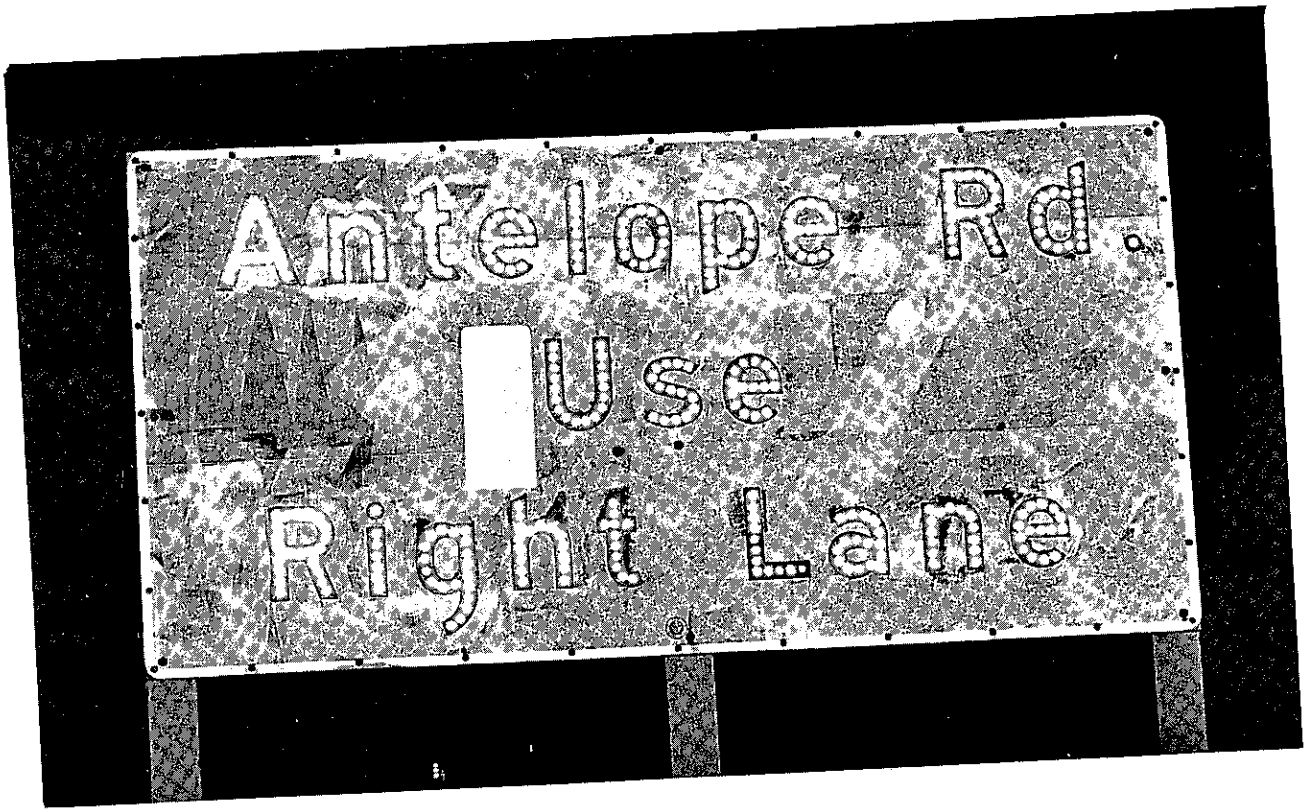

South exposed, shoulder-mounted signs showing patchy appearance under reflected light. The bright area on each sign is a green Scotchlite Laboratory control panel. The last two letters in "Lane" on bottom sign are Silver Scotchlite Laboratory control letters.

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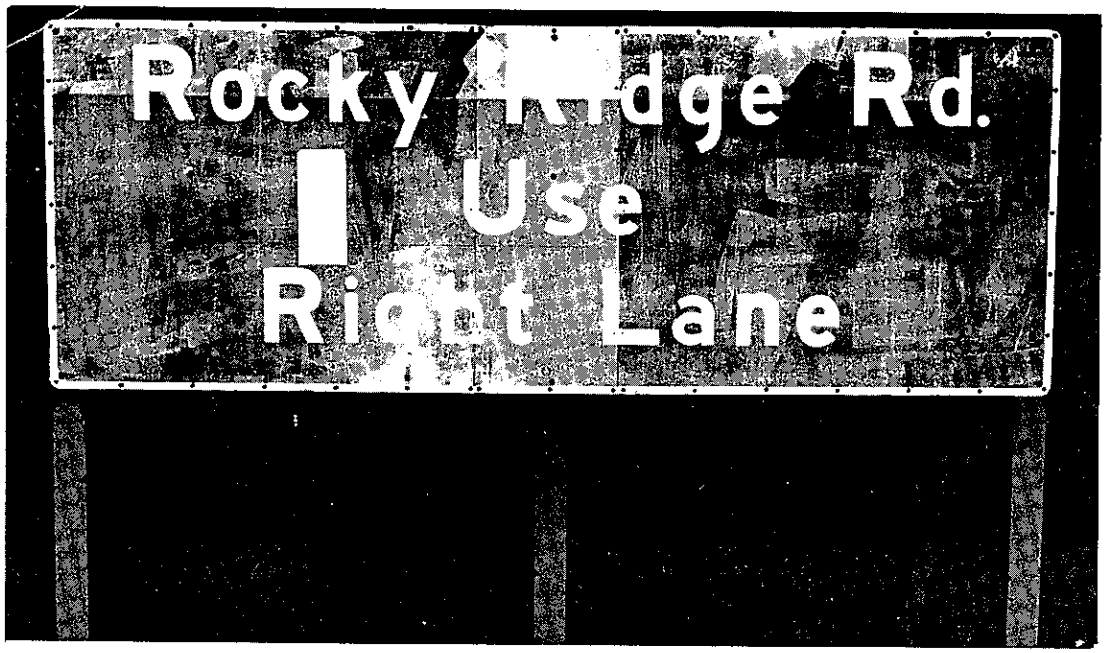

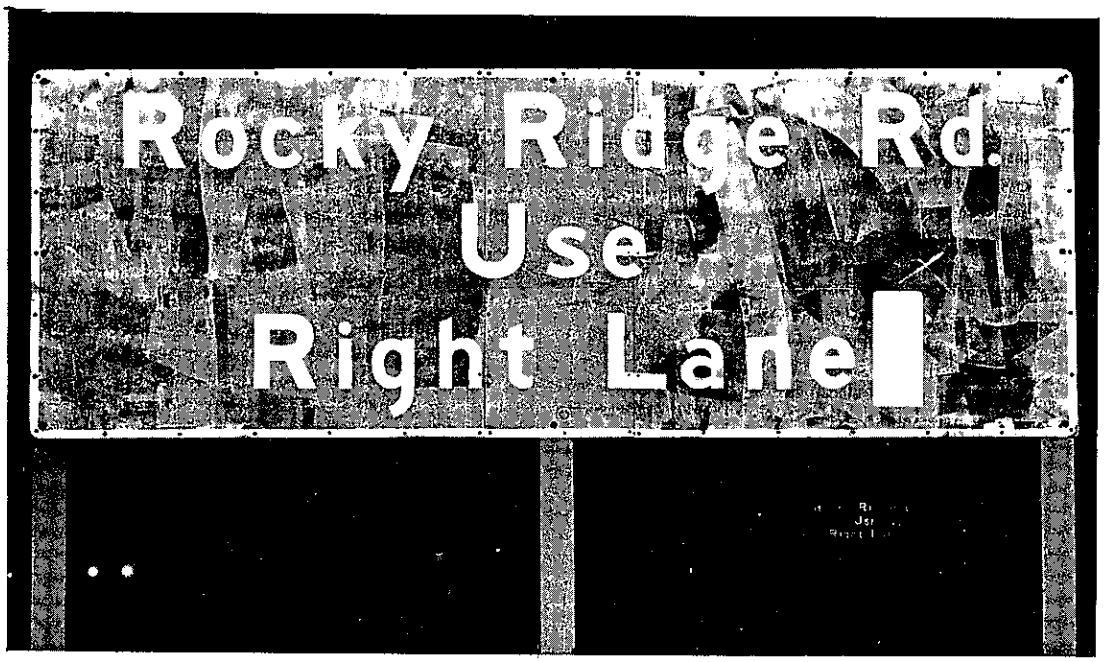

Shoulder-mounted, South exposed Scotchlite signs, showing difference in nighttime appearance between center panels and outside panels. Note difference in weathering of the two productions of Scotchlite above and below top splice joint seam on top picture. The "n" and "e" in "Lane" of both pictures are laboratory control letters .

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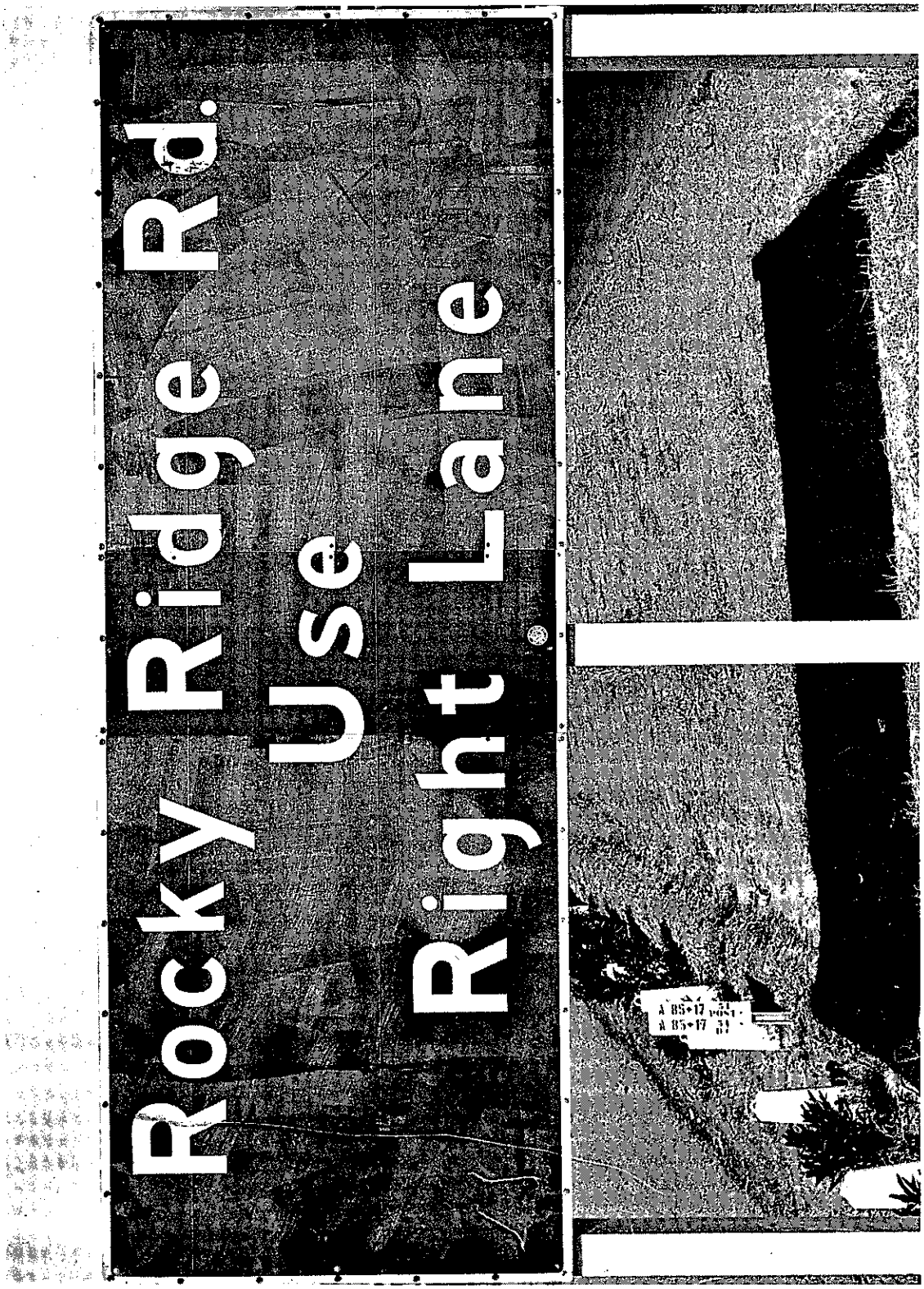

Shoulder-mounted, South exposed Scotchlite sign. Daytime appearance of sign in Exhibit 11, bottom. Note difference in weathering of outside panels and of center panel.

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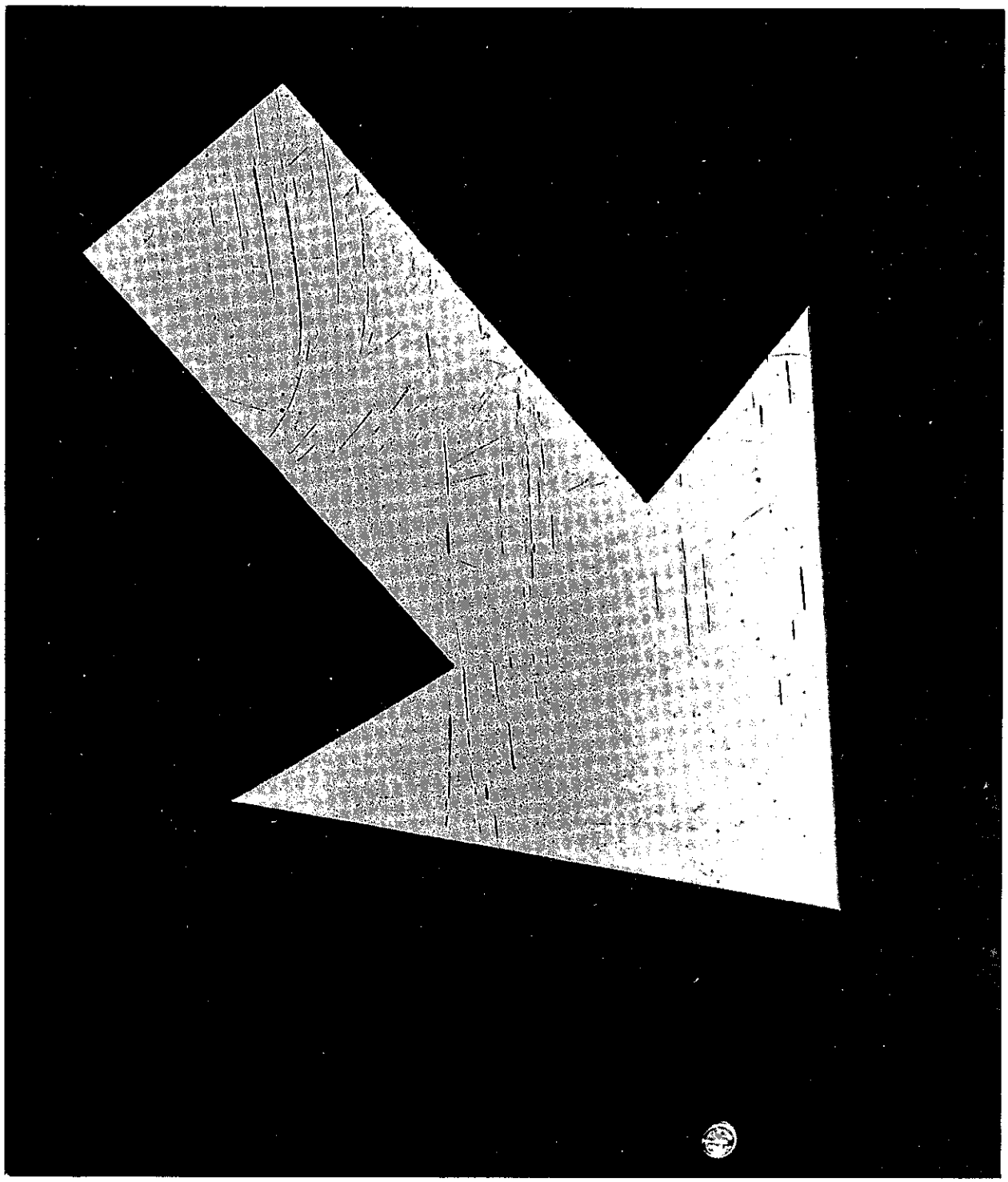

Shoulder-mounted, South facing Silver Scotchlite legend on black porcelain enamel. Deterioration after 3 1/2 years service.

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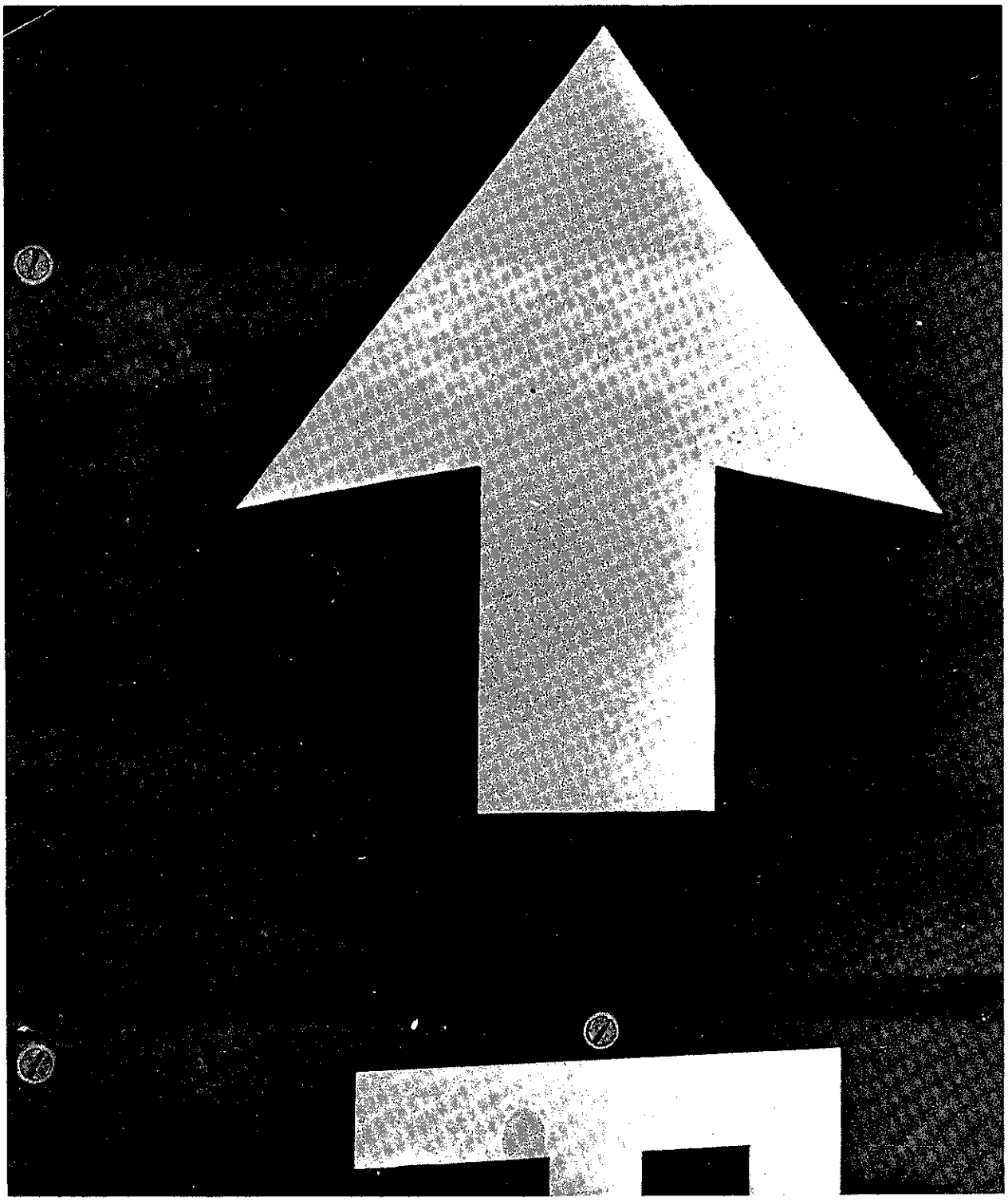

Shoulder-mounted, North exposed Silver Scotchlite legend on black porcelain enamel. No evidence of checking or peeling after 3 1/2 years service.

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Shoulder-mounted, West exposed Silver Scotchlite. Legend on black porcelain enamel showing failure of Scotchlite legend after 4 years Desert exposure.

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