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MICHIGAN
STATE HIGHWAY DEPARTMENT
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State Highway Commissioner

PERFORMANCE TESTS ON EXPERIMENTAL BLACK TRAFFIC PAINTS

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A Cooperative Project with Maintenance Division

Highway Research Project 47 G-36 (8a)
Progress Report 1

Research Laboratory
Testing and Research Division
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SYNOPSIS

This report covers a current phase of performance testing of MSHD No. 26A Black Pavement Marking Paint (tar type). This paint was investigated in comparison with several pigment-containing modifications of the No. 26A paint, plus four bituminous traffic paints and one enamel type black paint.

The performance testing of the black traffic paints was initiated because the No. 26A paint generally dried more slowly than white and yellow traffic paints deposited at the same time, and because it exhibited erratic durability. Performance testing demonstrated that No. 26A paint dries faster and is more durable when pigment extenders are incorporated. The tests also showed that this paint, when applied in the specified initial coating thickness, equals the durability of any other test paint, and when pigmented is superior to the others.

It is believed that the durability and drying time deficiencies of No. 26A paint can best be remedied by hot spraying a specially designed formulation at a high dry-film thickness.

PERFORMANCE TESTS
ON EXPERIMENTAL BLACK TRAFFIC PAINTS

In the summer of 1955, Mr. W. W. McLaughlin requested that the Research Laboratory investigate the performance of MSHD No. 26A Black Pavement Marking Paint (tar type), currently used with white traffic marking paint in black-white skip centerline stripes, and also as a separating stripe between the two yellow center stripes on undivided multi-lane highways.

No. 26A black has been the specified black traffic marking paint since January 14, 1954, superseding MSHD specification No. 26 Black Pavement Marking Paint. Adopted as a faster drying modification of MSHD No. 26 black, the No. 26A paint has the same formula as was then specified for pavement marking use by the Illinois Division of Highways.

Investigation of the current No. 26A black paint, including consultation with the Maintenance Division, revealed certain deficiencies:

1. The unbeaded black paint applied at the recommended rate of 10 to 12 gallons per mile, generally fails to dry to non-tracking as fast as beaded white or yellow paints applied at the specified rate of 16.5 gallons per mile.

2. Settlement of extensive, hard, tarry components from the paint occurs occasionally under storage conditions.

3. Erratic, but often poor durability occurs when this paint is applied at thicknesses which dry at a rate comparable to current, improved white and yellow traffic paints. Poor durability may also be expected if supernatant liquid from a drum of paint exhibiting settling, is sprayed out as a traffic stripe.

The durability and drying qualities could be improved by the simple corrective measure of applying a faster drying black tar paint at a greater stripe thickness. However, a faster drying tar paint may be difficult to formulate without inclusion of pigment type extenders.

Observation of the drying process of the 26A tar paint and other unpigmented bituminous type traffic paints shows that after deposition, a surface skin quickly forms, which then functions as a retarding medium for the escape of the remaining solvent from the liquid sub-layer. At any time before sufficient drying occurs, this surface skin can be broken by a passing automobile tire, which then tracks the liquid sub-layer. Pigments, if added to

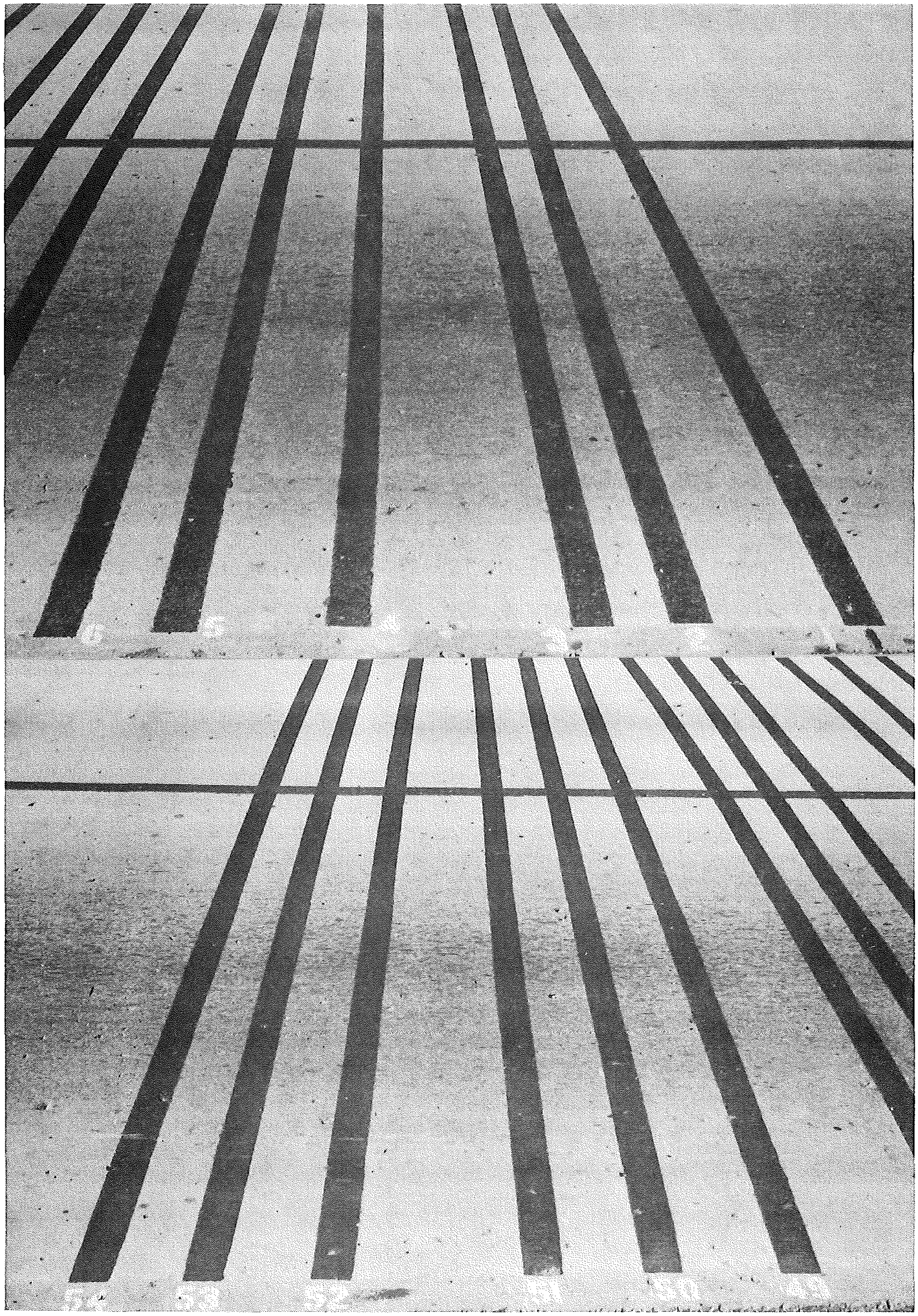

FIGURE I. INITIAL APPEARANCE OF TYPICAL TEST STRIPES.

tar paint, should prevent tracking by acting as supports for a passing tire, thus preventing breaks in the surface skin, and in effect, producing a faster drying time.

Few fast-evaporating solvents are available for the tar pitch base. In paint produced to the 26A specification, the tar pitch base is cut-back with what is essentially a benzol distillate, the fastest-evaporating member of the tar group of solvents. Possibly a faster drying tar paint could be obtained by substituting fast-evaporating chlorinated solvents, such as methylene chloride or carbon tetrachloride, for a portion of the present solvent. The chlorinated solvents are more expensive, but since they tend to non-flammability, they should help raise the extremely low flash point of the 26A black paint (Tagliabue Open Cup of about 15° F.).

Field Testing

Durability of a variety of types of black paints was investigated by means of road performance testing to obtain information of value in planning future research and development efforts. Unmodified and modified 26A tar paint formulations, and a number of other black paints were deposited on concrete pavement in one of the Research Laboratory's four test areas (US-27, M-78) on October 11, 1955.

The performance test paints included:

1. MSHD specification 26A tar paint, unmodified.

2. 26A paints modified to contain a number of different pigment extenders. Inclusion of these pigment extenders in a paint vehicle generally reduces drying time and increases paint service life.

3. Asphaltic paints, included because MOA asphalt cement has been used in the past by the Department for pavement marking purposes.

4. Proprietary black paints, including one non-bituminous paint.

5. Paints with sand or glass-bead overlays, since this is an expeditious method of incorporating extenders into a paint.

Eighteen paint combinations were employed in the test section. Each paint was applied in four-inch stripes at the rate of twelve gallons per mile. The paint characteristics including the drying times are listed in Tables 1 and 2. The initial appearance and location of the test section are shown in Figures 1 and 4 respectively.

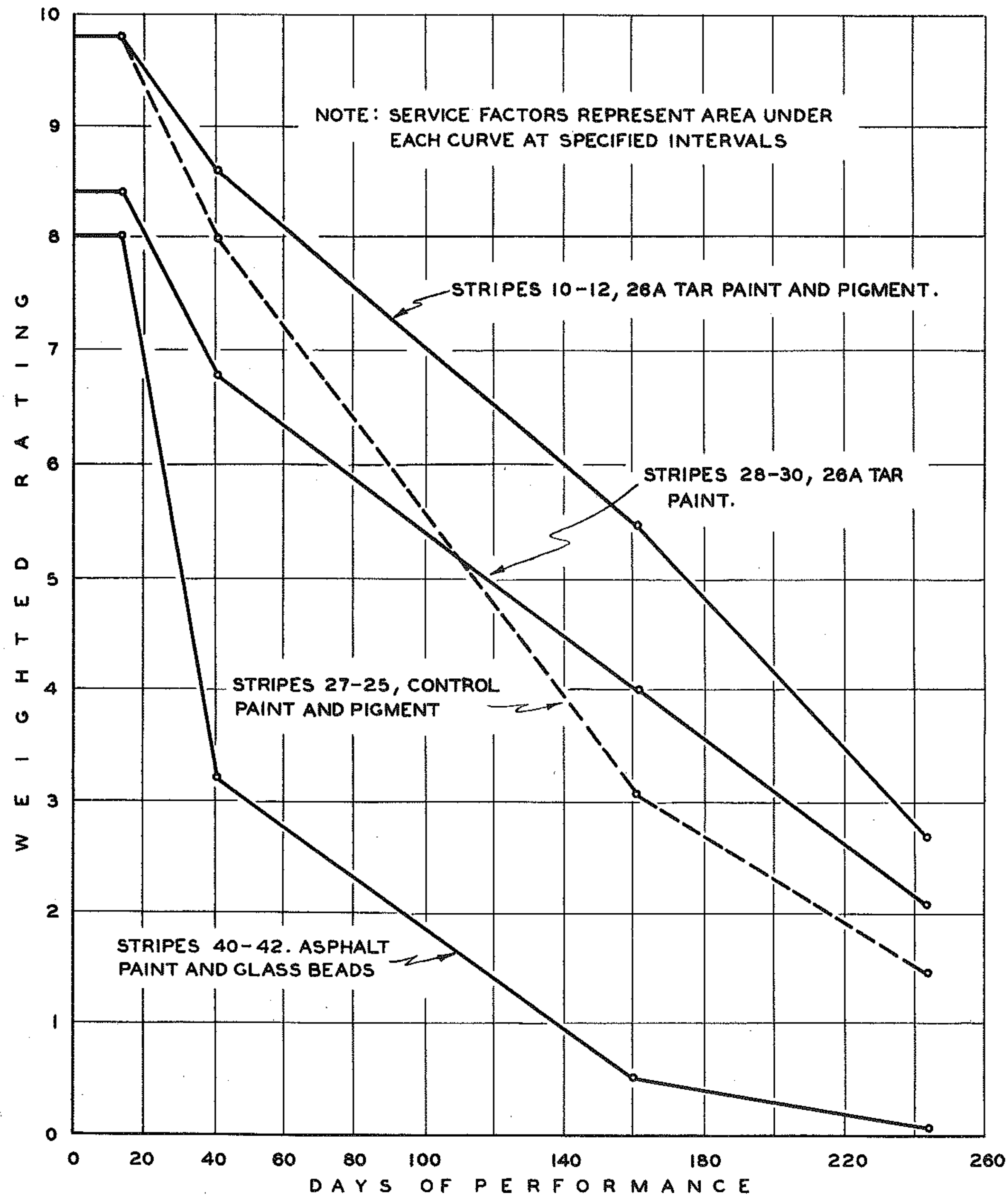

FIGURE 2. PLOT OF WEIGHTED RATINGS VS. DAYS OF PERFORMANCE
(SOME TEST SYSTEMS)

Discussion of Results

The experimental black test stripes were rated periodically for eight months. These ratings were based on appearance and durability, but did not include a rating on night visibility, which is poor for all black paints. Accordingly, the weighted rating value indicating the merits of these paints is a modification of the rating system used for white and yellow traffic paints. This rating value is defined as:

$$\text{Weighted rating} = 0.20A + 0.80D$$

where

A = appearance rating including color retention
D = durability rating.

A service factor was calculated for the black test paints using the same equation as is employed for white and yellow traffic paints.

The first evaluation of these stripes, made fourteen days after application, produced the durability and appearance ratings listed in Table 3. This evaluation showed that some of the test stripes had eroded noticeably after two weeks of service. Table 3 also includes service factor values, which are a measure of area under curve as shown in Figure 2, for all evaluations, as well as the Percent of Best Value covering the total period of observation. The condition of all test stripes on the last day of observation is shown in Figures 3A, 3B, and 3C.

Conclusions

From the ratings of the experimental test paints in the performance section, the following facts are indicated:

1. MSHD No. 26A tar paint (unmodified) stripes 28-30, gave equal or better performance than any of the other non-tar test paints (see Table 3, last column).

2. The control paint, stripes 25-27, a modified good grade black enamel gave performance equal to 26A black paint. This paint has some merit; it produced an intense black stripe. However the black enamel is more expensive than the tar paint.

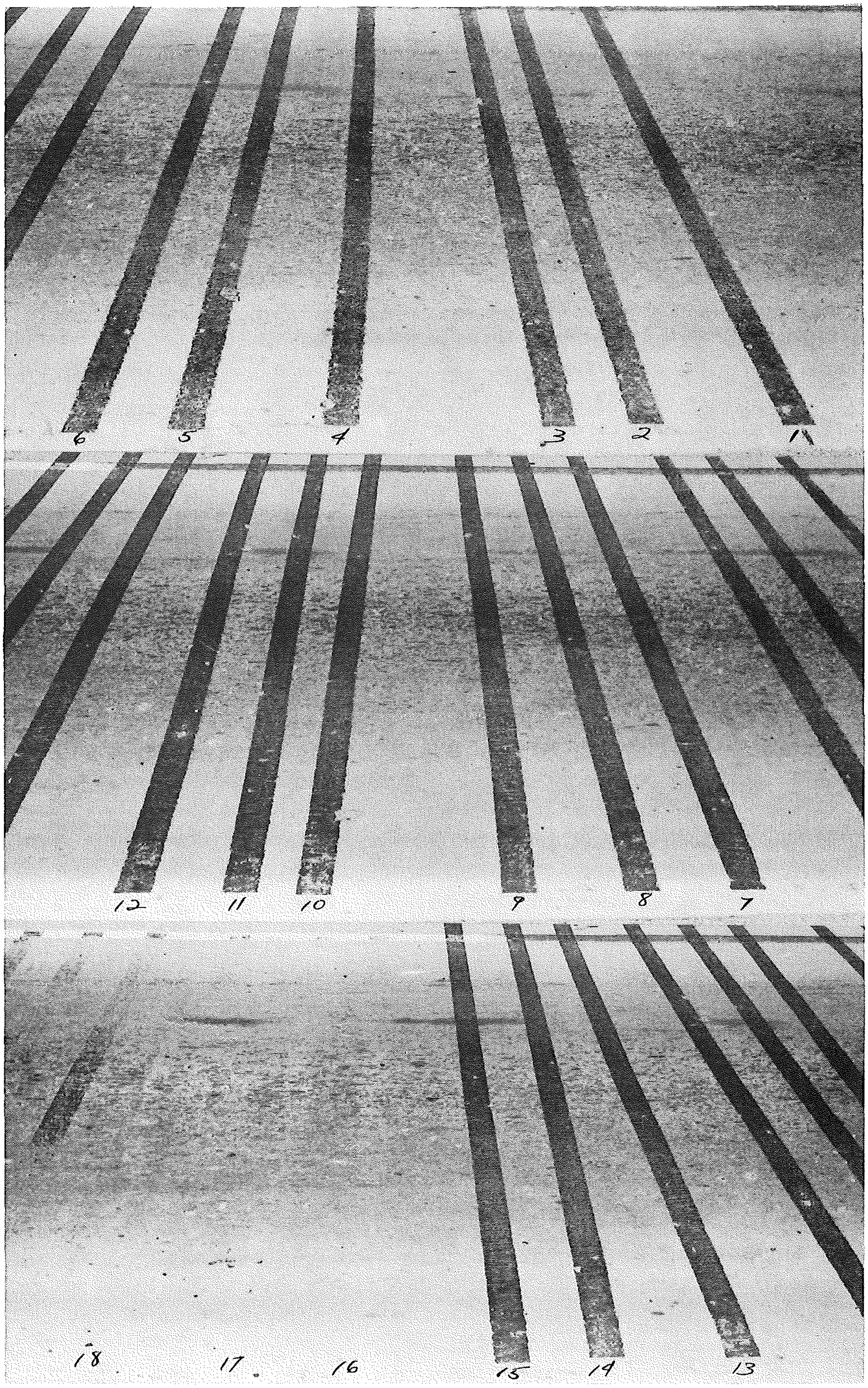

FIGURE 3A. APPEARANCE OF TEST STRIPES 1 - 18
AFTER 245 DAYS OF PERFORMANCE

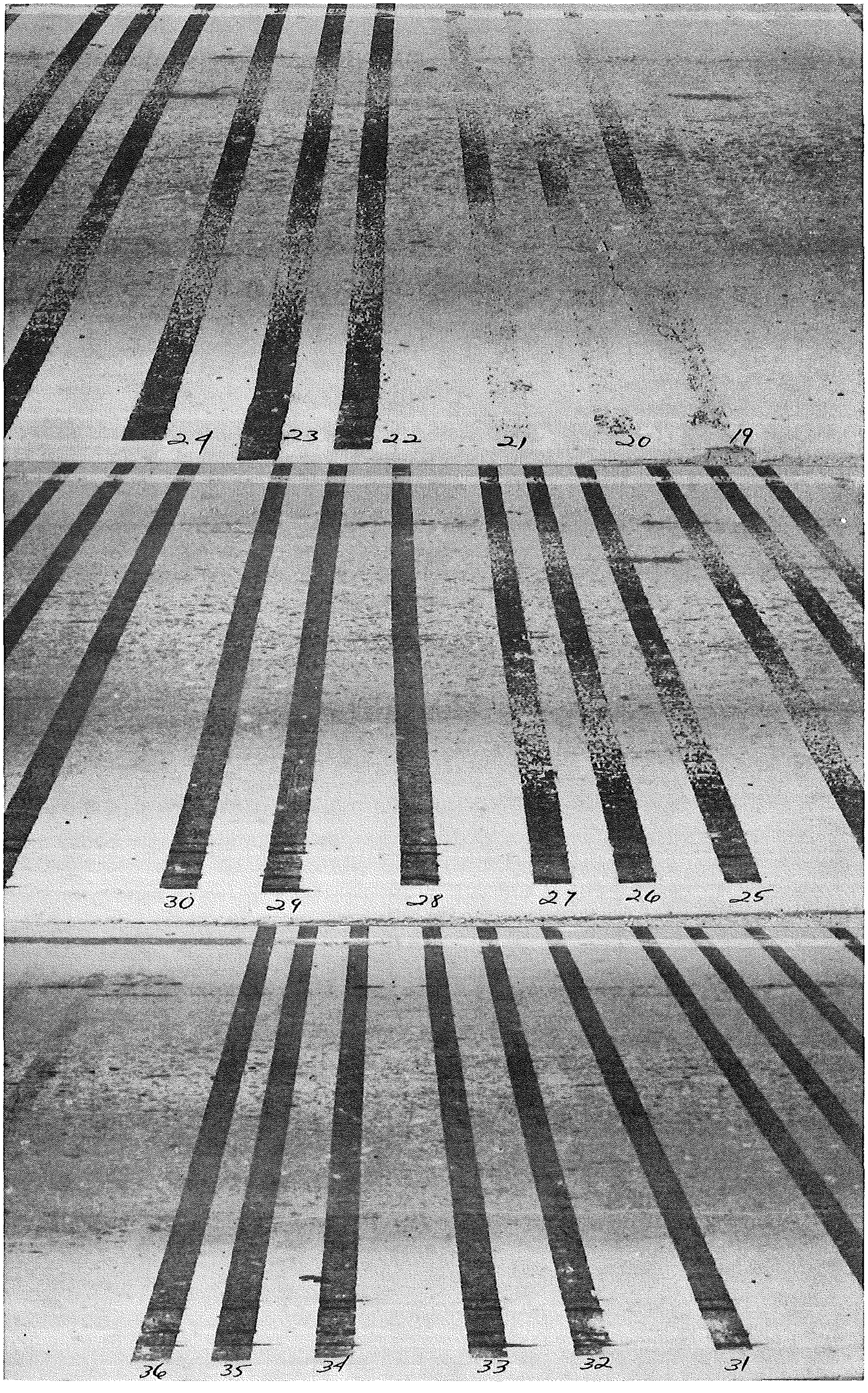

FIGURE 3B. APPEARANCE OF TEST STRIPES 19-36
AFTER 245 DAYS OF PERFORMANCE

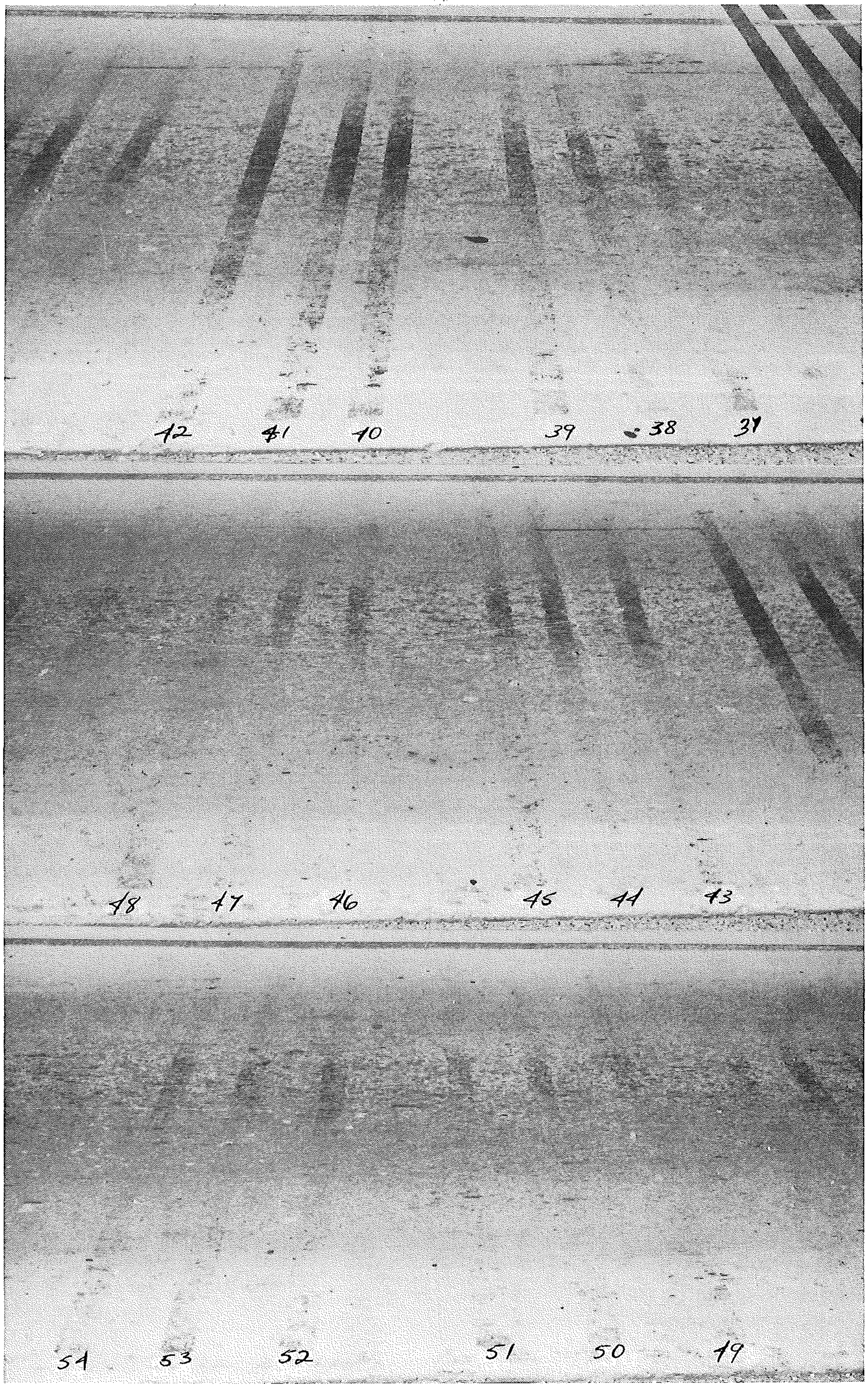

FIGURE 3C. APPEARANCE OF TEST STRIPES 37-54
AFTER 245 DAYS OF PERFORMANCE

3. Test pigment extenders, pre-mixed into the 26A tar paint, stripes 1-15, decreased drying time and improved performance of this paint.

4. Overlays of glass beads or Ottawa sand in stripes 31-36, unexplainably failed to improve performance of 26A tar paint, but did decrease drying time.

5. The good black color of 26A tar paint can be further enhanced with graphitic pigments (see Table 3, 'appearance' column).

Recommendations

Durability of 26A black tar paint can be increased and field drying time decreased by one of the following measures:

1. Incorporate low cost pigments, preferably of the graphitic type, into the paint.

2. Deposit a heavier dry film thickness of the paint. This may be accomplished by utilizing the hot spray technique, by equipping the black paint discharge line on the spray truck with a preheater. The California Division of Highways used this method. A higher viscosity and lower solvent content modification of No. 26A tar paint should be hot sprayed; and as a safety measure, the flash point of a hot spray formulation should be raised.

The second of these two alternatives seems preferable. For the test stripes, the extender pigments were incorporated into the tar paint by premixing by means of a laboratory paint shaker. However, to meet service requirements, the extender pigments would have to be incorporated into the tar paint during manufacture, thus increasing purchase cost. A pigment-containing tar paint would also be subject to settling in field storage and would very likely require shipment in open-head drums. On the other hand, a hot spray tar paint formulation is unlikely to exceed present cost for an equal volume of film forming solids.

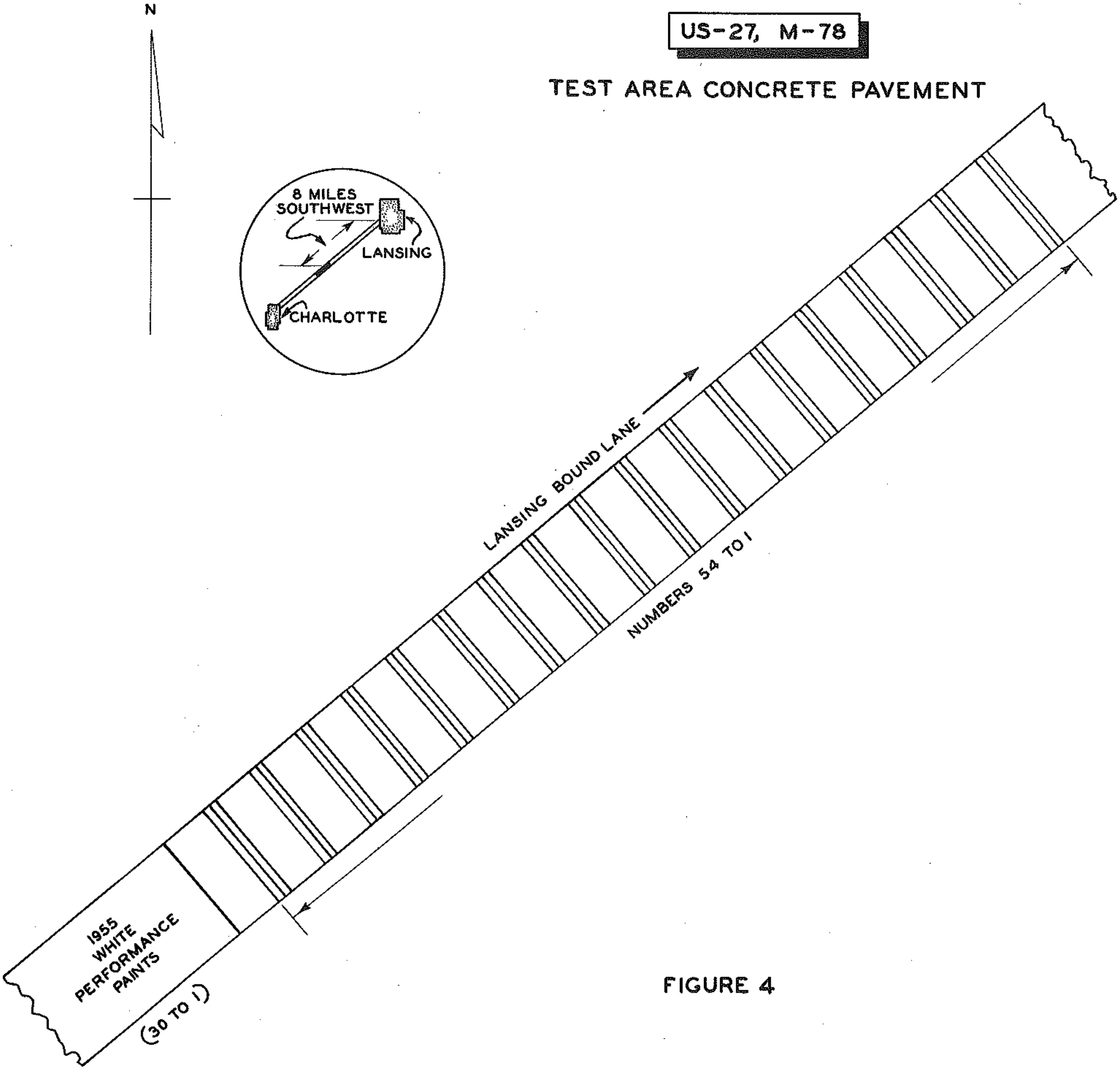

FIGURE 4

EXPERIMENTAL BLACK TRAFFIC PAINT TESTS
LOCATION DETAILS

RESEARCH PROJECT 47-G, 36 (8a)
APPLIED OCTOBER 11, 1955

TABLE 1

EXPERIMENTAL BLACK TRAFFIC PAINT TESTS
MATERIAL DETAILS
Research Project 47 G-36 (8a)

MSHD 26A Tar Paint:

55 PR 122. Laboratory identification number.
Western Tar Products batch No. 7, 1955 shipment.
Density - 1.09 or 9.08 pounds per gallon.
Viscosity - 56 KU: or 17.1 Engler viscosity at 25° C.

Chassis Black:

55 PR 105.
Truscon Paint No. 56-616 Air dry 46515 01.
Weight per gallon - 7.38 pounds.
Paint Volatile - 63.5%.
Paint Non-Vol. - 36.5%.
Viscosity - 52 KU:, or 36.7, Ford Cup No. 4, seconds.

Control Paint (non-bituminous):

55 PR 106.
Truscon Paint No. 41403 04.
Weight per Gallon - 7.60 pounds.
Pigment - 4.1% Carbon black.
Veh. Non-Vol. 43.4%.
Viscosity - 61 KU.

Asphalt Paint A 134:

55 PR 102.
Leonard Refineries No. A 134.
Asphalt was vacuum distilled to SOA consistency then air blown to a 160° F. softening point; cut-back with (110-270°F.) petroleum thinner to about 55% solids, and about RC-0 viscosity.
Density - 0.874 or 7.29 pounds per gallon.
Viscosity - 66, F.C. No. 4, seconds at 25° C.

Asphalt Paint A 139:

55 PR 103.
Leonard Refineries No. A 139.
Same as A 134 (above) but blown to 190°F. softening point; cut-back to MC-1 viscosity.
Density - 0.876 or 7.30 pounds per gallon.
Viscosity - 93 KU: or 375, F.C. No. 4, seconds.

Asphalt Paint A 139b:

55 PR 104.
Leonard Refineries No. 139b.
Same as A 139 (above); cut-back to MC-0 viscosity.
Density - 0.858 or 7.14 pounds per gallon.
Viscosity - 140, F.C. No. 4, seconds at 25° C.

Pigment Extenders:

Celite	-	diatomaceous silica, Grade 349, Johns Manville Corporation, New York City.
Graphite	-	Grade 205, United States Graphite Corporation, Saginaw, Michigan.
Graphitic mica	-	paint grade sample from Truscon Corporation, Detroit, Michigan.

TABLE 2

EXPERIMENTAL BLACK TRAFFIC PAINT TESTS
APPLICATION DETAILS
Research Project 47 G-36 (8a)
Applied October 11, 1955[a]

Stripe No.	Coating in Test Section	Density	Viscosity	Dry Mins.
1 - 3	MSHD 26 A Tar + 10% Celite	1.20	71 KU	66[b]
4 - 6	26 A Tar + 20% Celite	1.30	82	36
7 - 9	26 A Tar + 10% Graphite	1.22	59	48
10 - 12	26 A Tar + 20% Graphite	1.34	60	36
13 - 15	26 A Tar + 15% Graphitic mica	1.30	57	42
16 - 18	Chassis black + 15% Celite	1.13	56	13
19 - 21	Chassis black + 15% Graphite	1.11	54	16
22 - 24	Control Paint + 10% Celite	1.04	70	37
25 - 27	Control Paint + 10% Celite and + 10% Graphite	1.18	80	42
28 - 30	MSHD 26 A Tar	1.09	56	77
31 - 33	26 A Tar + Type 3 bead overlay[c]			64
34 - 36	26 A Tar + Ottawa sand overlay[d]			53
37 - 39	Asphalt Paint A 134 + Ottawa sand overlay	0.87		35
40 - 42	A 134 + Type 3 bead overlay			50
43 - 45	A 139 + Type 3 bead overlay	0.88	93	40
46 - 48	A 139 + Ottawa sand overlay			30
49 - 51	A 139b + Ottawa sand overlay	0.86		24
52 - 54	A 139b + Type 3 bead overlay			25

[a]Weather was sunny, (65-80° F.) with moderate south wind.
[b]Drying time determined with weighted wheel, ASTM Method D 711-48.
[c]Type 3 bead overlays at rate of 6 pounds per gallon of paint.
[d]Applied at same machine setting as glass beads: Ottawa Sand is ASTM C 109.

TABLE 3

EXPERIMENTAL BLACK TRAFFIC PAINT TESTS
RATING VALUES

Stripe No.	14 day rating App.	Durability	Service Factor (after days) 16	41	141	245	% of best 245 days
1 - 3	8	8.5	84	78	65	55	89
4 - 6	7	10	94	87	71	58	94
7 - 9	9	10	98	93	76	61	98
10 - 12	9	10	98	94	78	62	100
13 - 15	9	10	98	91	73	60	97
16 - 18	7	10	94	83	45	26	42
19 - 21	8	10	96	89	60	40	65
22 - 24	10	10	100	90	62	45	73
25 - 27	9	10	98	93	67	48	77
28 - 30	8	8.5	84	79	61	48	77
31 - 33	7	8.5	82	77	60	48	77
34 - 36	7	9.5	90	81	59	47	76
37 - 39	6	8.5	80	64	28	16	26
40 - 42	6	8.5	80	71	34	21	34
43 - 45	6	8.0	76	60	25	14	23
46 - 48	6	7.5	72	57	24	14	23
49 - 51	6	8.5	80	62	26	15	24
52 - 54	6	8	76	60	25	14	23