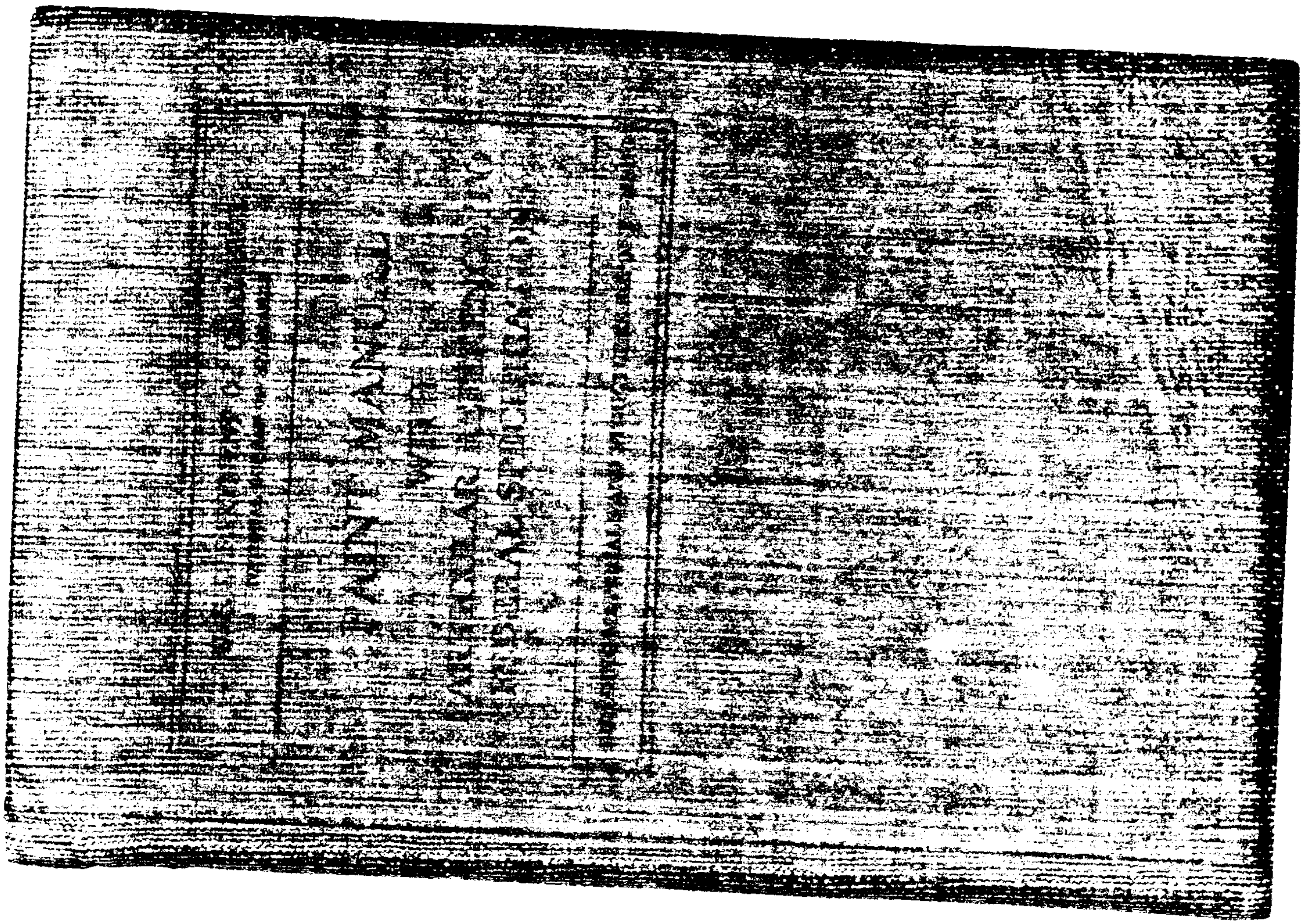


Paint Manu

WITH PARTICULAR REFERENC
FEDERAL SPECIFICATION

By Percy H. Walker *and* Eugene F. H

BUILDING MATERIALS AND STRU
REPORT BMS105

Issued October 11, 1945

U. S. DEPARTMENT OF COMMERCE
Henry A. Wallace, Secretary
NATIONAL BUREAU OF STANDARDS, Lyman

For sale by the Superintendent of Documents, Washi
Price $1.00.

Foreword

The need for information on protective coating materials in addition to that given in National Bureau of Standards Technologic Paper T274, published in 1925, has been expressed from time to time by various governmental agencies. Many changes in such materials have occurred since that publication, now out of print, was issued. Thus, this manual has been compiled to aid in the procurement of materials that would be suitable and adequate for most kinds of painting and that would assure successful application. The manual is based in large part on Federal Specifications and supplements but does not replace them.

Methods are described for the preparation of surfaces and the application of coatings that are known from experience to give satisfactory results. The information contained herein cannot supplant the skill of the experienced painter, but should assist the procurement officer in specifying and obtaining the proper paint materials. It should also assist the planner and technical supervisor of work in obtaining and maintaining durable finishes at reasonable cost.

LYMAN J. BRIGGS, *Director.*

CONTENTS

Contents

Contents

PAINT MANUAL

WITH PARTICULAR REFERE
FEDERAL SPECIFICATI

By Percy H. Walker and Eugene F

ABSTRACT

This manual presents recommendations by the
Standards and cooperating organizations for the
of painting materials meeting Federal Specificat
technical in nature, the manual provides practic
the application of protective coatings. It also expla
ments in the field of painting and includes pe
Descriptions of approximately 60 paints and
included to enable the painter to choose the most
for the surface to be covered. Emphasis is pla
applying coatings and preparing surfaces for o
protection with the materials used. Where pain
curred, the causes are traced and remedies sugg

I. INTRODUCTION

It is the purpose of this manual to help
eral Government agencies in the proper s
of paint (see glossary) and painting mat
under Federal Specifications.

Specifications for paint define for the
quality of materials to be procured. To t
they provide a fair basis on which to bi
Adequate specifications for paint contain tw
visions: requirements for composition and
results, or performance, although one type
may receive more emphasis than the other.

Federal Specifications are approved and
the Director of Procurement, Treasury Dep
use of all Government agencies in the purch
and equipment. They should not be confu
cations issued by the various Federal d
agencies for materials and construction to
special requirements. Federal Specificatio
chased from the Superintendent of Docume
ernment Printing Office, Washington 25,

send without charge a price list of Federal Specifications, on request.

A Federal Specification sets a standard that is considered adequate and economical for the service expected. If the purchase order requires that material conform to a particular Federal Specification, the seller may commit a fraudulent act if he knows that the material being furnished does not conform. Most manufacturers know how Federal Specifications apply to their products.

A specification sets forth in detail the minimum requirements and makes no allowance for material of superior grade. The purpose of the specification is to procure material that will give good performance. However, the difference in cost between material meeting the specification and that for material giving somewhat better performance may not be justified.

Federal Specifications for paint are set at a sufficiently high level of quality to give good service. They define materials fully adequate for the purpose intended at a reasonable price without expensive and unnecessary frills and cover paints obtainable from the widest practicable sources of supply.

It is the buyer's responsibility to see that deliveries of paints actually do conform to specifications, and that material purporting to meet a particular Federal Specification for paint is not accepted without test. Otherwise, material inferior to that called for in the specification will be accepted and used. The inevitable result will be unsatisfactory service and complaint that the specification is inadequate, whereas, the fault would lie with the purchaser who has not taken the necessary steps to be certain that the quality purchased and paid for was actually delivered.

The fact that a Federal Specification paint is less expensive than a proprietary brand of paint of the same type is not an indication that its quality is inferior to that of the higher-priced paint, which may include promotion and selling costs, but that it meets the prescribed quality requirements for this type of paint. The technical committee charged with preparing Federal Specifications for paints is constantly on the alert to revise or amend specifications to improve quality. Therefore, Government purchasing agents can be assured that paints they buy under Federal Specifications are of good and adequate quality.

II. GENERAL COMM

Federal Specifications are prepared
prised of representatives from the Gover
ing use for the materials or articles,
National Bureau of Standards who d
in research or in acceptance tests, an
manufacturers producing paint materia
gation, they are circulated to manufac
Federal Specifications are not prepare
mercial products of a type but only th
services of the Government agencies
establish minimum requirements for t
Some agencies buy materials and artic
quiring conformance to a designated F
Other agencies, which contract for t
buildings or the manufacture of articl
tractor to use designated materials co
propriate Federal Specification. Inspe
of material may be done at the place
point of use, or both. Frequently, an a
ments to the specification in order to me
dition or for some other reason.

After the specification has been in
slight changes based on experience with
improvements in the material covered
amendment to the original specification,
previous amendments. More compreh
covered by a complete revision, which i
dition of the lower-case letters a, b, c, e
the original issue. Thus Federal Specif
Putty indicates the first revision of t
putty.

Government and other large organiza
of equipment that is surface finished
special conditions for rapid and carefu
coating material not covered by Federal
general, the specifications for the comp
contain directions for inspecting and tes
it is completed rather than detailed sp
materials used in the various coats. W
finishes is more important than the ma
cases. Several of the Government agenc
time or another, specifications for coate

such specifications are those covering the finish on steel bedsteads (Panama Canal), laboratory furniture (Department of Agriculture), school desks and tables (Office of Indian Affairs), and school furniture (District of Columbia).

Federal Specifications usually follow the same outline of form and are arranged in nine sections:

Section A—Applicable Specifications.
Section B—Types, Grades, etc. (as applicable).
Section C—Material and Workmanship, etc. (as applicable).
Section D—General Requirements.
Section E—Detail Requirements.
Section F—Methods of Sampling, Inspection, and Tests.
Section G—Packaging, Packing, and Marking for Shipment.
Section H—Requirements Applicable to Individual Departments.
Section I—Notes.

Details of this arrangement and explanation of each section may be found in "Outline of Form for Federal Specifications," for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D. C., price 5 cents.

Emergency Alternate Federal Specifications were set up during the war emergency to conserve supplies of strategic or critical materials or to provide substitutes for materials not available. Symbols for these specifications are the same as for the basic Federal Specifications except for the letter "E–" that precedes the symbol, as E–TT–P–115 for TT–P–115. However, for paint and paint materials, these "E–" specifications have been canceled, superseded by revised Federal Specifications, or incorporated in conservation amendments, indicated by asterisk (*). These conservation amendments will be considered for revision as required.

"Willing-to-Certify" lists are compiled by the National Bureau of Standards and distributed to governmental purchasing agencies and to others upon request. They include the names of firms that have stated to the National Bureau of Standards they are willing to certify to purchasers that they can supply commodities guaranteed to conform to Federal Specifications.

Simplified Practice Recommendations are proposed by manufacturers, dealers, or users, and may be defined as lists of sizes, varieties, and types of products th
proved for regular stock purposes. The
of Standards cooperates with these groups
the recommended lists of items after the
proved by producers, distributors, and us
covered by a Simplified Practice Recom
establishes standards for the number of col
sizes.

A price list for all effective Simplified
mendations may be obtained free of charg
tional Bureau of Standards.

Commercial Standards promulgated b
Bureau of Standards are voluntary record
proved by producers, distributors, and con
terminology, types, classifications, grades
characteristics of manufactured products
better understanding between buyer and
clude standards, methods of test, rating,
labeling, and provide a uniform basis for
They are made effective by means of volu
on invoices and labels or by grade mar
themselves.

A price list for all effective Commercia
be obtained free of charge from the Nat
Standards.

III. COMMENTS ON INDIVIDUAL

1. GENERAL CONSIDERATIO

As a matter of convenience, the composit
paint-making materials is sometimes state
by weight, sometimes in proportions by vo
times in terms of the weight of one cons
the volume of another. For example,
analyzed in the laboratory, the various
usually weighed as they are separated, an
method of indicating the result is in percer
but when paint is mixed on the job, facilit
may not be available, and it is usually no
proportion the liquids in quarts and ga
(see glossary) are usually purchased and
pound. For example, it is frequently conv
term "100 lb of white lead to 3 gal of linseed

The density of paint is usually stated in pounds per gallon. It may be stated as specific gravity, which is the ratio of the weight of paint to that of an equal volume of water. Pounds per gallon times 0.12 equals specific gravity. The reciprocal of pounds per gallon is a fraction of a gallon per pound and is given the special name "bulking value" (see glossary). It may also be said that the material bulks 0.1 gal/lb, meaning that it has a bulking value of that amount or that it weighs 10 lb/gal. The bulking value of a pigment refers to the volume of liquid displaced by 1 lb when wet with the liquid and not to the apparent volume of the material when dry, which includes a large percentage of air-filled voids. The "pigment volume," abbreviated PV, (see glossary) is the ratio of the percentage by volume of the pigment in a paint to the percentage by volume of pigment plus nonvolatile vehicle (see glossary).

(a) COMPOSITION BY WEIGHT AND BY VOLUME

To describe a method of converting weight to volume or volume to weight assume:

A = percentage by weight of volatile vehicle
a = bulking value of volatile vehicle
B = percentage by weight of nonvolatile vehicle
b = bulking value of nonvolatile vehicle
C = percentage by weight of pigment
c = bulking value of pigment
D = weight in pounds of 1 gal of total mixture
$1/D$ = bulking value of total mixture.

One hundred pounds of the mixture has a total volume of $Aa + Bb + Cc$ gallons; the bulking value of the mixture is $(Aa + Bb + Cc)/100 = 1/D$ and the percentages by volume of the constituents are

$$\frac{100\,Aa}{D} \text{ or } \frac{100\,Aa}{Aa + Bb + Cc} = E \text{ percent by volume of volatile vehicle}$$

$$\frac{100\,Bb}{Aa + Bb + Cc} \text{ or } \frac{100\,Bb}{D} = F \text{ percent by volume of nonvolatile vehicle}$$

$$\frac{100\,Cc}{Aa + Bb + Cc} \text{ or } \frac{100\,Cc}{D} = G \text{ percent by volume of pigment.}$$

If the percentage by weight or by volume of any two of the three components is known, the percentage of the third is the sum of the two known percentages subtra 100. Thus:

$100 - (A + B) = C$ $\quad$ $100 - (E + F) =$
$100 - (B + C) = A$ $\quad$ $100 - (F + G) =$
$100 - (A + C) = B$ $\quad$ $100 - (E + G) =$

(b) BASIC SPECIFICATIONS

Basic specifications are prepared for use where t supply of raw materials is available. It will be some basic specifications stress detailed require chemical composition (exterior house paints, for whereas others emphasize requirements based o and performance tests (interior paints and var example).

(c) AMENDMENTS TO BASIC SPECIFICATIONS

Amendments to basic specifications are for th of incorporating slight changes due to experien provements in material covered by the specifica emergency amendments, indicated by an asterisk first page of the specification, were intended t strategic or critical war materials and replace were not available because of the war emergency of an asterisk for the same purpose is also in this manual.

2. LIQUIDS NOT GENERALLY USED ALO

Liquids form the vehicle (see glossary) portion In general, liquids should be purchased by volum being 1 U. S. gal, 231 cu in. at 60° F. For large it is suggested that the weight in pounds per gallo and the net weight of the delivery be determi volume can then be obtained by dividing the net the weight per gallon.

(a) Oil; Linseed, Raw
JJJ–O–336, Apr. 28, 1931
Amendment 2, May 28, 1943

Oil; Linseed, Boiled
JJJ–O–331, May 26, 1931
Amendment 2, May 28, 1943

Linseed oil is the most important of the drying glossary); a drying oil being one that changes to a

hard, tough, elastic substance when exposed in a thin film to the air.

Raw linseed oil is the material from which boiled and refined linseed oils are made and is the most important of the liquids used for mixing paint on the job. The quality of raw linseed oil is probably more influenced by the presence of "foots" (the mucilaginous matter that settles to the bottom of a container) than by other deviations from the specifications. Paint made with oil containing considerable foots, but otherwise of high quality, is liable to dry very slowly and may easily be washed off long after it appears to be dry. As foots gradually settle, clear oil from the upper portion of the container may be drawn off.

It is necessary to use a drier with raw linseed oil; the amount varies, but usually for white or very light-tinted paint, 1 part of drier to 19 parts of oil is satisfactory. Dark-colored or black paint may require more drier than lighter colors.

Raw linseed oil dries too slowly for most purposes. Thus, as has just been stated, driers are added to the oil to accelerate the rate of drying. Instead of adding driers to raw linseed oil at room temperature, another method is to heat the oil in combination with compounds of lead, manganese, and cobalt. By using heat, these compounds dissolve in the hot oil, and the oil thickens slightly and becomes somewhat darker in color. This results in a product known as boiled linseed oil. The term "boiled" is a misnomer, as, in heating the oil, it is not actually boiled. Boiled linseed oil is frequently recommended for priming coats of paint intended for use on plaster, cement, and brick. A mixture of raw and boiled oils is often used in priming paints for structural steel. A blend of good raw oil and drier may be substituted for boiled oil.

(b) Soybean Oil; Refined
JJJ–O–348, June 25, 1942

Soybean oil is used largely in edible products rather than in paint. It is slower drying than linseed oil and generally is used in combination with faster drying oils, such as tung, perilla, or linseed oils. Its main uses are in varnish vehicles for interior paints and enamels, because paints made with soybean oil do not yellow as much as many other oils. Likewise, it is used in some of the best interior, architectural, white enamels (see glossary) based on sy glossary) of the alkyd type. The type o trade as "mechanically refined nonbreak with Federal Specification JJJ–O–348.

(c) Tung, China Wood Oil; Ra
JJJ–O–353, Dec. 10, 1943

Tung oil is one of the chief oils used i of fast-drying, waterproof oil varnishes (s most important characteristics for iden oil are its high specific gravity and high Raw tung oil dries rapidly but not to a s not used as such in exterior house paints is almost universally used. Some tung oil treating the raw oil so as to overcome i in house paints. However, the great use manufacture of oil varnishes used as such and liquids for the manufacture of interio deck enamels, water-resisting enamels, an ized finishes.

(d) Turpentine; Gum Spirits and Wo
(Steam-Distilled and Sulfate),
(for) Paint
LLL–T–791b, July 12, 1941

Turpentine; Wood (Destructively
(for) Paint
LLL–T–792a, July 12, 1941

The basis of purchase of turpentine (s Federal Specifications) provides for p volume, 231 cu in. to the gallon at 70° 7.12 to 7.25 lb/gal. When purchases are quotations should be by the pound or pounds, and the request for bids should st tions are by the gallon, pound, or hundre I–3 in the specifications states that nothin in should be construed to exempt the selle with the Federal Naval Stores Act or a plicable to the selling of turpentine.

Turpentine is one of the oldest and volatile thinners for oil paints and for nishes. However, in prepared paints, vo rived from petroleum and having the gen

of turpentine are used to a considerable extent. Destructively distilled wood turpentine, used in the manufacture of paint and varnish, is a good solvent, and, in general, can be used in place of gum spirits or wood turpentine with good results. A sample for odor should be specified before making purchases under Federal Specification LLL–T–792a. At present, the amount of turpentine available is inadequate to meet the demands of the paint and varnish industry. It is preferred by the painter because it is not likely to cause varnishes or paints to thicken or gel when diluted with it. The characteristic odor makes turpentine easily identified.

(e) Thinner; Paint, Volatile Mineral Spirits TT–T–291a, July 26, 1945

Volatile mineral spirits should be purchased by volume, 231 cu in. to the gallon. The basis of purchase for mineral spirits is given in detail in paragraph F–4a of the Federal Specification.

Federal Specification TT–T–291 covers a petroleum distillate known as mineral spirits or petroleum spirits; it evaporates at about the same rate as turpentine and is frequently used in its stead for thinning oil paints. It distills between kerosine and V.M. & P. (Varnish Makers and Painters) naphtha. Chemically, it is a mixture of aliphatic, naphthenic, and aromatic (see glossary) hydrocarbons. It should evaporate completely from the film during the drying period; otherwise, heavy ends, which do not evaporate, may hinder drying or prevent drying of the paint to a satisfactory film. Its weight per gallon varies considerably, but an average figure is about 6½ lb. Some varnishes may not be entirely miscible with mineral spirits. Because of the present limited production of turpentine, it is advisable to use other thinners whenever possible; in many cases, mineral spirits are entirely satisfactory as a substitute for turpentine, and in almost all cases can replace at least a part of the turpentine.

(f) Drier; Paint, Liquid TT–D–651a, Aug 28, 1942

Two types of liquid drier are covered in Federal Specification TT–D–651a. Driers consist of metallic soaps or salts of organic acids dispersed in suitable media thinned to a liquid with petroleum spirits, turpentine, or a mixture thereof, and are for use in paints or simil
rials. Resinates, linoleates, and naphthena
Type I driers call for both lead and ma
also contain cobalt or any other drying me
are intended for general use, the minimu
lead and manganese representing the no
quired for use with raw linseed oil in the
of liquid drier (see glossary) to 19 volume
driers should be free from lead, contain
percent of cobalt, and be used where le
necessary. Both driers are much like sh
ishes, except for their larger content of dr
specification limits the total nonvolatile m
than 30 percent by weight. The additi
drier to a paint results in the paint dryin
addition of too much drier may also caus
too slowly or may produce other undesirab
wrinkling of the film. A good rule is to
amount of drier consistent with the dryi
of the paint.

(g) Thinner; Lacquer TT–T–266, Apr. 20, 1942

Federal Specification TT–T–266 covers
intended for use in connection with spra
forming to Federal Specification TT–L–58
ing this specification will weigh from 6.8
15.5° C (60° F) and should be purchase
cu in. to the gallon. A typical formula for
is as follows:

	W
Butyl acetate	
Butyl alcohol	
Ethyl acetate	
Petroleum naphtha	
Toluene	
Total	

(h) Oil; Flatting and Mixing (for Thinning White-Lead and Similar Paste Paints) TT–O–356a, Aug. 30, 1943

Class 1, Flatting Oil.—This is a co
thinning white-lead paste and similar pa

composed of processed drying oils and drier, thinned with turpentine, mineral spirits, or a mixture thereof; when added to white-lead paste and similar paste paints, it produces flat, washable, interior finishes for use on plaster, wood, wallboard, and fabric surfaces. A flat finish may be obtained by adding 2 or 3 gal of flatting oil to 100 lb of white-lead paste. New plaster and wood should be primed in the usual manner before applying the flat-finished coat. Flatting oil is also used as a vehicle for glaze colors on plaster by mixing some of the oil with colors-in-oil, such as umber, sienna, and Van Dyke brown.

Flatting oils weigh about 7 lb/gal at 60° F.

CLASS 2, MIXING OIL.—This is also a complete vehicle for thinning white-lead paste and similar paste paints, and is composed of processed drying oils with or without resins, driers, turpentine, and mineral spirits. It is used for finish-coat paint for exterior surfaces where low-gloss or eggshell finishes are desired and for interior decoration where finishes having a gloss higher than those obtainable with class 1, flatting oil, are desired. Mixing oil may be used in the proportion of 3 gal of mixing oil to each 100 lb of white-lead paste.

The average weight of mixing oil is 7 lb/gal.

(i) Oil; Linseed-Replacement (for Thinning Paints and Pastes-in-Oil) TT–O–371, May 1, 1943 Amendment 2, March 17, 1944

Linseed-replacement oil should be purchased by volume, 231 cu in. to the gallon. The weight of 1 U. S. gal of this material at 60° F varies slightly, but generally it will fall within the range of 7.3 to 7.5 lb/gal.

Linseed-replacement oil is a mixing or thinning oil blended before packaging and is used widely in thinning paste white lead on the job and ready-prepared paints. The material is a replacement for either raw linseed oil, thinner, and drier or for boiled linseed oil and thinner. Although linseed-replacement oil was prepared during the war period and was designed to aid in the conservation of linseed oil, it should not be considered as a mere substitute for linseed oil. The replacement oil contains heat-bodied linseed oil, and some paint experts consider tha of this oil makes the replacement oil actual ordinary raw or boiled linseed oil, both in water resistance.

In many war emergency amendments to Fed tions for oil paints, the vehicle specified is in serve linseed oil. For example, the amendm Specification TT–P–40 provides a vehicle spe eral Specification TT–O–371 for Linseed-Re except that the requirements for appearan viscosity (see glossary) are waived. This plished by using a vehicle that may consist by weight of thinner and drier and 65 percen oil composed of 3 parts of raw or alkali-ref sary) linseed oil and 2 parts of Z-2 pale heat oil. The amendment requires that some hea present but does not limit the amount or kind oil used in replacement oil should be bodied a tures and should have an acid number (se not more than 8, based on total solids. In all except black and graphite, the pounds of oil p be not more than 3.75 (to meet War Pro Order M–332* as amended April 12, 1944, which is to conserve the supply of domest Normally these paints contain about 5 lb of o

Amendment 2 of Federal Specification T vides for two types of linseed-replacement o driers added, and type II, without driers.

Type I is for thinning paints or pastes, job, which require a drying type of thinni II is for thinning ready-mixed paints or past contain sufficient drier. Neither type is inter flat paints.

The attention of paint users is directe Bureau of Standards Letter Circular LC71 of Linseed Oil in Paint, a copy of which m free of charge from the National Bureau Washington 25, D. C.

The formulas given in table 1 involve the white lead with linseed-replacement oil [1].

* This order was revoked on Aug. 31, 1945.

† Figures in brackets indicate the literature references paper.

TABLE 1.—*Linseed-replacement oil formulas for reducing paste white lead to paint*

Type of work	Coat	Soft-paste white lead	Linseed-replacement oil	Pure turpentine	Flatting oil	Yield	Coverage (spreading rate) per gallon
		lb	*gal*	*gal*	*gal*	*gal*	*ft²*
New exterior wood (three coats)	Priming coat	100	4	2	.....	9¼	600
	Second coat	100	1½	1½	.....	6¼	700
	Gloss finish	100	3¼	.....	.....	6½	700
New exterior wood (two coats)	Priming coat[1]	100	2¾	.....	.....	6	500
	Gloss finish	100	3¼	.....	.....	6⅓	700
Repainting wood exterior	First coat	100	2	2	.....	7¼	700
	Gloss finish	100	3¼	.....	.....	6½	700
Exterior concrete, stucco, and asbestos cement shingles	Priming coat	100	5	.....	.....	8¼	200
	Second coat	100	2	1	.....	6¼	400
	Gloss finish	100	3¼	.....	.....	6½	500
	Semigloss finish	100	1	.....	2	6¼	500
Exterior brick common	Priming coat	100	5	¾	.....	9	200
	Second coat	100	3	1	.....	7¼	400
	Gloss finish	100	3¼	.....	.....	6½	500
	Semigloss finish	100	1	.....	2	6¼	500
Repainting brick, stucco, concrete and asbestos shingles	First coat	100	2	1	.....	6¼	400
	Gloss finish	100	3¼	.....	.....	6½	500
	Semigloss finish	100	1	.....	2	6¼	500
Unpainted interior, plaster and wallboard	Priming coat	100	5	.....	.....	8¼	600
	Second coat	100	2	.....	1	6¼	800
	Flat finish	100	.....	.....	2	5¼	800
Unpainted interior, plaster and wallboard (2 coats)	Priming coat						
	Flat finish	100	4	.....	.....	7¼	600
		100	.....	.....	2	5¼	800
Repainting interior, plaster and wallboard	First coat	100	2	.....	1	6¼	800
	Flat finish	100	.....	.....	2	5¼	800

[1] Add 1/8 pint of raw umber in oil to this formula.

3. PIGMENTS

Pigments form the solid portion of paint
cally insoluble in the vehicle or liquid portio
ing section describes the various pigments, i
black, colored, and metallic aluminum, cove
Specifications:

(a) White Lead; Basic-Carbonate, I
Paste-in-Oil, and Semipaste
containing Volatile Thinner
TT-W-251b, May 30, 1945

White Lead; Basic-Sulfate, Dry
and Paste-in-Oil
TT-W-261a, Oct. 25, 1937
Amendment 2, Sept. 6, 1943

White lead, a component of almost all w
colored paints, is one of the most importa
pigments. Both kinds, basic-carbonate and b
frequently used in ready-mixed paints. For
the job, paste-in-oil is used, whereas the
used by the paint manufacturer. The ter
paste is used to designate the usual paste w
posed of about 91 percent of basic-carbonate
9 percent of linseed oil, or 89 percent of
white lead, 2 percent of turpentine, and 9 pe
oil. When referring to white lead in ready-n
term may mean either basic-carbonate whit
sulfate white lead; this latter material is
extent in commercially prepared, exterio
paints.

There are two types of commercial whi
heavy paste and soft paste. Type B, paste-in
paste white lead. Type C is a soft, or semi
development and is similar to the heavy pa
the addition of a small amount (about 2 p
pentine. It is more easily removed from th
mixed with vehicle than type B and thus
type B by most users.

One hundred pounds of either type of past
3¼ gal. One gallon weighs about 30 lb. As
some tendency in the past to add too muc
white-lead paste, it is suggested that tables
consulted for the correct proportions. Nati

Standards Letter Circular LC717, mentioned in connection with linseed-replacement oil, gives additional details on this point.

Instead of mixing white-lead paint on the job with a combination of several materials such as liquid drier, turpentine, and linseed oil, it may be easier to use a single liquid, such as: Oil: Linseed-Replacement (Fed. Spec. TT–O–371), or Oil: Flatting and Mixing, (Fed. Spec. TT–O–356a). This is illustrated in tables 1 and 5.

TABLE 2.—*Painting exterior new wood (3 coats), using ordinary linseed oil and white-lead paste*

[Mixed-on-the-job formulas]

Materials	Formulas		
	Priming coat	Body coat	Finish coat
White lead, semipaste (TT–W–251b, type C) ..... *lb*	100	100	100[1]
Raw linseed oil (JJJ–O–336) ..... *gal*	4	1 1/2	3 1/4[2]
Turpentine (LLL–T–791b)[3] or mineral spirits (TT–T–291a) ..... *gal*	2	1 1/2	.....
Liquid drier (TT–D–651a) ..... *pt*	1	1	1
Quantity of paint produced ..... *gal*	9 1/8	6 3/8	6 3/8

[1] For the finish coat, some users may want a lead-zinc paint. In this case, use 75 lb of the white-lead paste and 25 lb of zinc-oxide paste (TT–Z–301).

[2] For a harder film, the linseed oil may be reduced to as low as 2 1/4 gal. In this case, 2 to 3 pt of turpentine should be added.

[3] For priming wood, turpentine is preferred by some painters.

TABLE 3.—*Painting exterior new wood (2 coats), using ordinary linseed oil and white-lead paste*

[Mixed-on-the-job formulas]

Materials	Formulas		
	Priming coat	Finish coat (1)	Finish coat (2)[1]
White lead semipaste (TT–W–251b, type C) ..... *lb*	100	100	100
Raw linseed oil (JJJ–O–336) ..... *gal*	1 1/2	3 1/4	2 1/8
Turpentine (LLL–T–791b)[2] or mineral spirits (TT–T–291a) ..... *gal*	1/2	.....	1/8
Liquid drier (TT–D–651a) ..... *pt*	1	1	1
Raw umber-in-oil (TT–P–381) ..... *pt*	1/4	.....	.....
Spar varnish (TT–V–121b) ..... *gal*	3/4	.....	.....
Quantity of paint produced ..... *gal*	6 3/8	6 3/8	6 3/8

[1] Alternate finish-coat formula (2) meets Federal Housing Authority requirements and gives a harder film than formula (1).

[2] For priming wood, turpentine is preferred by some painters.

TABLE 4.—*Repainting exterior wood (2 coats) linseed oil and white-lead paste*

[Mixed-on-the-job formulas]

Materials	
White-lead, semipaste (TT–W–251b, type C) ..... *lb*	
Raw linseed oil (JJJ–O–336) ..... *gal*	
Turpentine (LLL–T–791b) or mineral spirits (TT–T–291a) ..... *gal*	
Liquid drier (TT–D–651a) ..... *pt*	
Quantity of paint produced ..... *gal*	

TABLE 5.—*Painting interior plaster, wallboard, and using white-lead paste*

[Mixed-on-the-job formulas]

Materials	Priming coat	Body coat
FORMULAS		
White lead, semipaste (TT–W–251b, type C) *lb*	100	100
Mixing oil (TT–O–356a, class 2) ..... *gal*	4 to 5	3 to 4
Wall primer (TT–P–56) ..... *gal*		
Quantity of paint produced ..... *gal*	7 1/4 to 8 1/4	6 1/4 to 7 1/4
ALTERNATE FORMULAS		
White-lead, semipaste (TT–W–251b, type C) *lb*	100	100
Raw linseed oil (JJJ–O–336) ..... *gal*	3	...
Turpentine (LLL–T–791b) or mineral spirits (TT–T–291a) ..... *gal*	1 1/4	1 1/2
Varnish (TT–V–71a) ..... *gal*	2	4
Liquid drier (TT–D–651a) ..... *pt*	1	1/2
Quantity of paint produced ..... *gal*	9 3/8	5 1/2

An easy way to mix white-lead paint, w
weights are not available, is to measure th
volume. This plan is illustrated in figure 1

(b) Zinc-Oxide; Dry and Paste-in-Oil TT–Z–301, Mar 31, 1931
Zinc-Oxide; Leaded, Dry and Paste- TT–Z–321, June 23, 1931

Zinc oxide (see glossary) with varying pr
from ore (American process) or from s

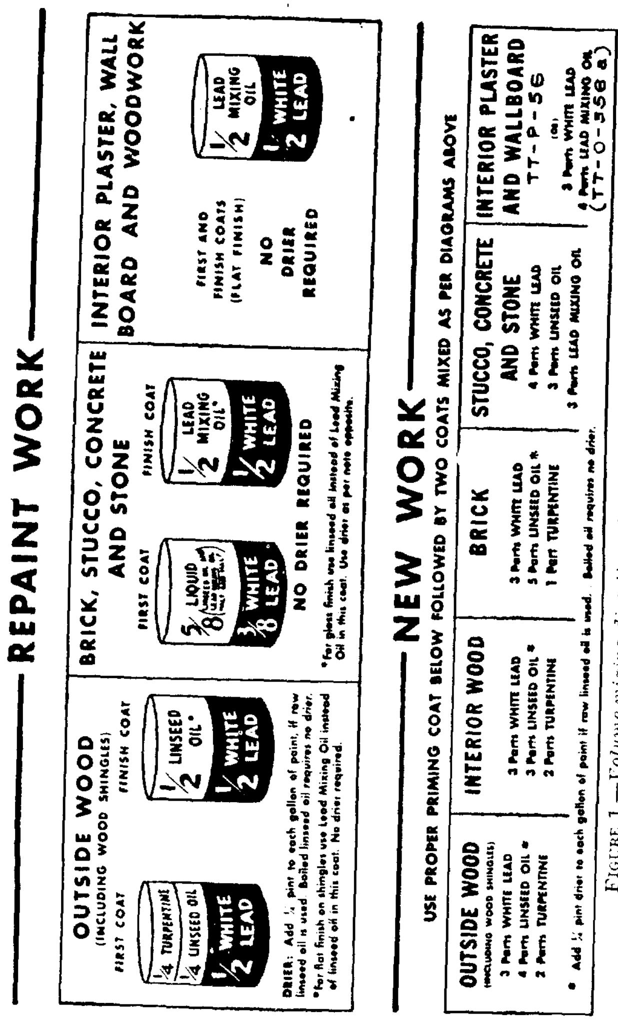


FIGURE 1.—*Volume-mixing directions for soft-paste white lead TT-W-251b.*

process). Made by either process, it may differ in color and oil absorption. Hence, a purchaser should have an agreed-upon sample for color, color strength, and oil absorption. Zinc oxide alone with linseed oil gives a paint that chalks less readily than most other linseed-oil paints (see glossary) but dries to a hard film that tends to check and crack. It is added to the chalking type of pigments to harden the film, to help retain the color of light tints, and to retard the formation of mildew. Paints mixed-on-the-job may contain either zinc-oxide or low-leaded zinc-oxide (see glossary) pastes-in-oil. In general, not more than 1 lb of either type of zinc-oxide paste-in-oil should be used with 3 lb of white-lead paste or semipaste.

By weight, an average zinc-oxide paste-in-oil meeting the specification contains 83 percent of pigment and 17 percent of oil; by volume, 44 percent of pigment and 56 percent of oil; and 1 gal weighs about 25 lb.

(c) Red Lead; Dry and Paste-in-Oil
TT-R-191a, July 5, 1938
Amendment 2, May 28, 1943

Red lead is used in paint for priming iron and steel surfaces. Federal Specification TT-R-191a covers two types and three grades as follows:

TYPE I, DRY	TYPE II, PASTE-IN-OIL
Grade A......85 percent.	Grade B......95 percent.
Grade B......95 percent.	Grade C......97 percent.
Grade C......97 percent.	

Type I, dry red lead, may vary somewhat in specific gravity, becoming slightly lighter as the true red lead increases. Grades A, B, and C have a specific gravity of about 8.9, and 1 gal of dry red lead weighs about 74 lb with a bulking value of about 0.0135 gal/lb.

Type II, paste-in-oil, has an average specific gravity of 5.37 and shows an average weight per gallon of about 45 lb. Formulas for mixing red-lead paints on the job are given in tables 6 and 8. The priming paint in table 6 weighs 25 lb/gal and has a PV of 30. The formulas given in table 8 produce paints that have a PV of 36 and dry somewhat harder and with less gloss, and allow recoating earlier than paints whose vehicle is high in oil (as in table 6).

TABLE 6.—*Painting iron and steel (exposed to the weather), using red lead and ordinary linseed oil* [1]

Materials	Formulas (mixed-on-the-job)		For the finish coat, any of the following Federal Specification ready-mixed paints may be used—
	Priming coat	Body coat	
Red lead paste (TT-R 191, types B or C) ..... lb.	100	100	TT-P-31a (red or brown). TT-P-40 (white, gray, etc.). TT-P-61a (black). TT-P-71a (green).
Raw linseed oil (JJJ-O-356) ..... gal.	1 1/8	1 1/8	
Turpentine (LLL-T-791b) or mineral spirits (TT-T-291a) ..... pt.	1 1/2	1 1/2	
Liquid drier (TT-D-651a) ..... pt.	1 1/2	1 1/2	
Lampblack-in-oil (TT-P-381) ..... pt.	.....	3/4	
Quantity of paint produced ..... gal.	4 1/2	4 3/8	

[1] If boiled linseed oil (JJJ-O-331) is used, omit drier, and the oil may be increased to 2 gal.

TABLE 7.—*Painting iron and steel (exposed to the weather), using blue lead and ordinary linseed oil*

Materials	Formulas (mixed-on-the-job)		For the finish coat, any of the following Federal Specification ready-mixed paints may be used—
	Priming coat	Body coat	
Blue-lead paste (TT-B-486, type B). lb.	100	100	TT-P-31a (red or brown). TT-P-40 (white, gray, etc.). TT-P-61a (black). TT-P-71a (green).
Boiled linseed oil[1] (JJJ-O-331) ..... gal.	2 3/4	2 3/4	
Turpentine (LLL-T-791b) or mineral spirits (TT-T-291a) ..... pt.	2	2	
Liquid drier (TT-D-651a) ..... pt.	1	1	
Lampblack-in-oil (TT-P-381) ..... pt.	.....	3/4	
Quantity of paint produced ..... gal.	6 1/4	6 3/8	

[1] If raw linseed oil is employed, use 1 qt of drier.

(d) Blue-Lead; Basic Sulfate, Dry and Paste-in-Oil
TT-B-486, Oct. 2, 1934
Amendment 1, May 28, 1943

Blue lead is a slate-gray sublimed pigment that contains approximately 75 percent of basic-lead sulfate and generally more than 20 percent of other lead compounds. Blue-lead oil paints brush easily and are durable for priming structural steel. Blue lead is also used in special vehicles designed for marine use.

Type A, dry pigment, is a blue basic-lead sulfate useful in the manufacture of type B, paste-in-oil, or ready-mixed paint, as described in Federal Specification T gallon of dry blue lead weighs about 57 lb.

Type B, paste-in-oil, is used for blue-lea mixed on the job. One gallon of the paste about 30 lb. Formulas for mixing blue-lead job are given in tables 7 and 8. The formula coats in table 7 produce paint weighing about having a PV of 29. The formula for primin 8 produces a paint weighing about 19 lb/gal PV of 34. This formula gives a paint that dr with less gloss and allows recoating earlier whose vehicle is high in oil (as in table 7).

TABLE 8.—*Painting iron or steel (exposed to the red or blue lead and linseed-replacem*

Materials	Formulas (mixed-on-the-job)		For t the Speci pai
	Priming coat	Body coat	
RED LEAD			
Red lead paste (TT-R-191a, types B or C) ..... lb.	100	100	TT-P
Turpentine (LLL-T-791b) or mineral spirits (TT-T-291a) ..... gal	1/2	1/2	TT-P-
Linseed-replacement oil (TT-O-371). gal	2	2	T
Lampblack paste (TT-P-381) ..... pt.	-	3/4	T
Quantity of paint produced ..... gal.	4 3/4	4 3/8	
BLUE LEAD			
Blue-lead paste (TT-B-486, type B). lb.	100	100	TT-P
Turpentine (LLL-T-791b) or mineral spirits (TT-T-291a) ..... gal	1/2	1/2	TT-P-
Linseed-replacement oil (TT-O-371). gal	2 3/4	2 3/4	T
Lampblack paste (TT-P-381) ..... pt.	-	3/4	T
Quantity of paint produced ..... gal.	6 1/8	6 1/2	

(e) Aluminum Pigment Powder and P (for) Paint
TT-A-468, Mar. 6, 1942

Aluminum pigment is largely pure metallic contains appreciable amounts of "polishing mixture of stearic and other fatty acids. Th

of the combined and uncombined fatty matter varies from less than 1 percent by weight to not more than 4 percent. This specification covers two types and two classes of aluminum pigment:

Type I.—Aluminum-pigment powder.
Class A.—For general paint use.
Class B.—For special finishes.

Type II.—Aluminum-pigment paste.
Class A.—For general paint use.
Class B.—For special finishes.

Aluminum-pigment paste weighs about 12.4 lb/gal.

Class A aluminum-pigment powder is known commercially as Standard Varnish Grade. Class B aluminum-pigment powder is finer than class A and is known in the trade as Extra Fine Lining Grade.

Formulas for mixing aluminum paint on the job are given in table 9.

TABLE 9.—*Aluminum paint*
[Mixed-on-the-job formulas]

Purpose	Mixing formulas			
	Aluminum		Varnish	
		lb		gal
Priming coat on exterior wood.	TT-A-468, class A, paste	2	TT-V-81a, type I, class B	1
Do	TT-A-468, class A, powder	1½	TT-V-81a, type I, class A	1
Body coat on exterior steel	TT-A-468, class A, paste	3[1][2]	TT-V-81a, type II, class B	1
Finish coat on exterior steel	TT-A-468, class A, paste	2	TT-V-81a, type II, class B	1
Do	TT-A-468, class A, powder	2	TT-V-81a, type II, class A	1
Finish coat on interior steel	TT-A-468, class A, paste	2	TT-V-71a	1
Do	TT-A-468, class A, powder	2	TT-V-71a	1
Special finishes having maximum smoothness.	TT-A-468, class B, paste	1¼	TT-V-81a, class B	1
Do	TT-A-468, class B, powder	¾	TT-V-81a, class A	1
Sealing coat to prevent bleeding of stains.	TT-A-468, class A, paste	2½	TT-V-71a[3]	1

[1] Aluminum is not recommended as a priming coat for steel.
[2] The addition of ¼ lb of iron-blue paste (TT-P-381) is recommended.
[3] The addition of ½ pt of mineral spirits (TT-T-291a) is recommended.

In purchasing aluminum paste or powder, it is advisable that the material should match a mutually-agreed-upon sample for smoothness, luster, and appearance. Both powder and paste mix easily with long-oil sary) varnish, such as described in Federal S TT-V-81a. In general, the amount of aluminu in the completed paints is less than 20 percent by 8¾ percent by volume. The PV is less than 18. mixing formula is 2 lb of class A aluminum paste to 1 gal of mixing varnish.

(f) Pigments; Colors-in-Oil (for) Paint TT-P-381, July 27, 1944

The colors-in-oil listed in Federal Specificatio are pigments ground in a vehicle of about 80 pe oil and 20 percent volatile solvent, with a sma wetting or dispersing agent to form paste of a that will flow from the containers.

TABLE 10.—*Characteristics of colors-in-oil fo*

Colors	Federal specification for pigment content	I
Blacks:		
Color 1A—bone black	TT-B-600	
Color 1B—carbon black, high-color	TT-C-120, class A	
Color 1C—carbon black, standard all-purpose	TT-C-120, class B	
Color 1D—lampblack	TT-L-70	
Blues:		
Color 2A—iron-blue	TT-I-677	
Color 2B—ultramarine-blue	TT-U-450	
Browns:		
Color 3A—metallic brown	TT-M-251	
Color 3B—sienna, burnt	TT-S-346	
Color 3C—umber, burnt	TT-U-481	
Color 3D—umber, raw	TT-U-481	
Greens:		
Color 4A—chrome green	TT-C-235	
Color 4B—chromium-oxide-green	TT-C-306	
Oranges:		
Color 5A—chrome orange, dark	TT-C-290, type V	
Color 5B—chrome orange, light	TT-C-290, type IV	
Reds:		
Color 6A—iron-oxide, bright-red	TT-I-511, type II	
Color 6B—indian-red	TT-I-511, type I	
Color 6C—mineral red	TT-M-381	
Color 6D—toluidine	TT-T-562	
Color 6E—venetian	TT-V-220	
Yellows:		
Color 7A—chrome-yellow, lemon	TT-C-290, type II	
Color 7B—chrome-yellow, medium	TT-C-290, type III	
Color 7C—chrome-yellow, primrose	TT-C-290, type I	
Color 7D—ocher	TT-O-121	
Color 7E—sienna, raw	TT-S-346	
Color 7F—yellow-iron-oxide	TT-Y-210	

Table 10, column 1, gives the names of these colors. Column 2 refers to Federal Specifications for content of dry pigment. Column 3 gives approximate weight in pounds per United States gallon of the soft paste conforming to the specification, and column 4 gives the minimum percentage by weight of pigment in the soft paste.

Following are the intended uses of the various pigments-in-oil described in table 10:

BLACKS.—This group covers four black pigments used for tinting and solid colors:—boneblack; high-color carbon black, all-purpose carbon black, and lampblack. Carbon black and lampblack are stronger than boneblack in tinting strength, and lampblack is most frequently used. Boneblack and carbon black are blacker than lampblack. All these color pastes produce paints suitable for "trim colors" (see glossary) by thinning the paste to brushing consistency with a vehicle composed of 3 parts of linseed oil, 1 part of spar varnish (see glossary), and ½ part of liquid drier, by volume.

Synthetic black iron oxide (not included as a color-in-oil in the above list) is a black pigment covered by Federal Specification TT–I–698. This pigment consists of oxides of iron, and has a specific gravity of about 4.7. It is used in black metal protective paints, and for tinting and blending purposes.

BLUES.—This group covers two blue pigments—iron blue (also called Prussian blue) and ultramarine blue. Iron blue has a relatively low specific gravity and high bulk and is stronger than ultramarine blue. For tints, iron blue is very susceptible to the action of alkalies, however weak, whereas ultramarine blue is not affected by alkalies but is affected even by weak acids. Although both colors, in either tints or solid colors, have fair permanency when exposed to the weather, a newer blue pigment known as copper-phthalocyanine blue is more durable, in light or "shutter blue" tints. Federal Specification TT–C–610 covers this newer pigment.

BROWNS.—This group covers four brown pigments: metallic brown, burnt sienna, burnt umber, and raw umber. Metallic brown is adaptable as a trim color, but is used more as a solid paint and is durable for painting barns, tin roofs, and freight cars. The other brown pigments are suitable for tinting purposes and for stains. They are among the most durable when exposed to the weather.

Another brown pigment (not included
the above list) is synthetic brown iron
Federal Specification TT–I–702. This p
oxides of iron and has a specific gravity
used in various types of paints and enam

GREENS.—This group covers two green p
green and chromium-oxide green. Chrom
a mixture of two pigments, chrome yello
covers a variety of light, medium, and d
used both for tinting purposes and for
Chrome greens are brighter and stronge
oxide greens, but they are not as permanen
to alkalies. Chromium-oxide green consis
ment, chromium oxide, and is used with
purposes to give soft, gray-green tints; fo
a durable, solid color; and for tinted bri
somewhat weaker in tinting strength an
power than chrome green, but is more p
withstand high temperatures and is unaf
and acids.

ORANGES.—This group covers two shades
that may be used for tinting and for sol
They are relatively permanent when expos
The pigment is a basic lead chromate ob
designated as light and dark, the latter
International Orange.

REDS.—This group covers five red pigm
iron oxide, Indian red, mineral red, toluidi
tian red. With the exception of toluidi
ments may be used for tinting purposes.
oxide and Indian red are used in all types o
and stains, and are quite permanent; miner
tian red are widely used for exterior barn
toluidine red, a bright, organic red, is per
posed to the weather but is not permanen
such as pink, when used outdoors.

YELLOWS.—This group includes a variet
ments:—lemon chrome yellow, medium
primrose chrome yellow, yellow ocher,
yellow iron oxide. For tinting purposes, th
are suitable for outside use. One pound o
yellow added to 50 lb of white-lead paste
ivory" shade. This color may also be used
color paint, following the thinning suggest

I-4a, Federal Specification TT–P–381. For tinting purposes, yellow ocher is a durable outdoor shade; one pound of the paste added to 50 lb of white-lead paste gives a "chamois" tint. Raw sienna is used more widely for tinting and staining purposes than for solid or trim color. When mixed with whites, it gives tints classed as ivory and light buff. These tints prove durable when exposed to the weather. Yellow iron oxides are used for both tinting and solid colors, particularly in floor enamels. They cover a variety of shades and on reduction with whites give cream, ivory, and buff tints. They are much stronger than the yellow ochers. Another yellow pigment, zinc yellow, is used to some extent as a color pigment, but its main use is a rust-

TABLE 11.—*Identification of widely used tints made by tinting 100 pounds of paste white lead with Federal Specification TT-P-381, Pigments-in-Oil; Paint Colors*

[This information is merely as a guide.]

Color	Pigment	Maerz and Paul number[1]	Munsell number[2]	Name ISCC–NBS[3]	Formula (based on 100 pounds of white lead)
Blacks	Lampblack	37-A-2	9.0Y5.6/0.2	Medium gray	¼ pt.
	Iron blue	37-K-5	1.6B3.8/4.2	Moderate greenish blue.	½ pt.
Blues	Ultramarine blue	35-G-2	9.5BG6.7/2.0	Pale blue	1 pt.
	Sienna, burnt	5-B-11	3.0YR4.4/5.2	Moderate brown	1 pt.
	Umber, burnt	14-D-6	0.5Y4.8/3.0	Pale brown to medium yellowish brown.	1 pt.
Browns	Umber, raw	12-C-2	5.8Y6.6/2.8	Weak yellow	1 pt.
	Chrome green (medium)	20-A-8	2.5G5.0/3.9	Weak yellowish green to medium green.	1 pt.
Greens	Chromium oxide	21-A-4	7.0GY5.6/1.6	Weak yellow-green.	¾ pt.
Oranges	Chrome orange (dark)	9-C-6	6.2YR7.8/6.2	Pale orange	¼ pt.
	Indian red	6-J-9	8.2R3.9/3.6	Weak red	1 pt.
Reds	Toluidine red	3-J-8	4.0R5.3/6.0	Moderate red	¾ pt.
	Venetian red	5-E-11	1.8YR4.1/5.2	Moderate brown	1 pt.
	Chrome yellow (medium)	9-K-5	1.8Y7.7/8.2	Moderate yellowish orange.	¾ pt.
Yellows	Ocher	11-C-4	0.8Y6.6/4.0	Weak yellowish orange.	1 pt.
	Sienna (raw)	11-G-5	0.5Y6.6/4.9	Weak yellowish orange.	1 qt.
	Yellow iron oxide	10-I-6	9.2YR7.4/7.0	Weak to moderate yellowish-orange	1 pt.

[1] A Dictionary of Color, by Maerz and Paul, McGraw-Hill Book Co., Inc., New York, N. Y.

[2] Munsell Book of Color (1929). Munsell Color Co., Baltimore, Md.

[3] Inter-Society Color Council Proposed Color Nomenclature for Drugs. Developed and recommended by the National Bureau of Standards.

inhibitive pigment in metal primers (see
pigment is covered by Federal Specificati

As indicated, several of the colors just
mixed with white-lead paste or other whit
to form light tints. For example, 100 pou
paste mixed with a definite volume of the
oil of a particular brand produces the col
11 and referred to by number in "Diction
Maerz and Paul [3], and the "Munsell
Munsell [4]. However, this information is
only as an approximate guide.

4. READY-MIXED OIL AND VARNISH VE

All ready-mixed paints should be purc
The purchaser should specify the type,
case of tints or body colors, the exact c
whether it should match a sample agreed u
seller (preferably a wet sample of paint).

(a) Paint; Oil, Exterior, Ready-M
Light Tints, and White
TT–P–40, May 19, 1943
Amendment 1, June 26, 1943*

Federal Specification TT–P–40 covers
terior oil-gloss paint intended as finish co
are for use over a primer as second or thi
side wood, metal, and concrete. The prim
able for the particular material on which
Type I is a multiple-pigment paint ava
white, general-purpose paint; class B, a sp
free paint to be used where sulfide fumes
and class C, a tint base. If a particular ti
ing material may be added to the class C w
A white should not be tinted. Type II is a
obtainable in both white and tints.

The type of titanium dioxide used in
should be used only for white as it chalks

Class C contains the proper type of tit
be mixed with colors because it chalks rela

Both types brush freely, have exception
power, and dry to an oil gloss. Before th
unpainted wood, the wood should be treat
that seals the surface and insures uniform

in the succeeding coats. Such a prepared primer conforms to Federal Specification TT–P–25. A self-primer can be made by adding 1 pt of linseed oil to 1 gal of either type I or type II paint. For two-coat work the primer should be spread at the rate of 450 ft²/gal and the topcoat or finish coat, should be spread at the rate of 550 ft²/gal. For three-coat work the primer should be spread at the rate of 500 to 600 ft²/gal and the second and third coats at from 600 to 700 ft²/gal. If necessary, the paint can be slightly thinned by the addition of not more than 1 pt of turpentine or mineral spirits to 1 gal of paint.

Type I class A white paint (titanium-lead-zinc) weighs 16 lb/gal and has a PV of 30; one gallon of paint contains 0.27 gal of pigment and 0.90 gal of film-forming solids. The pigment is composed of 57 percent by volume of white lead plus zinc oxide in the ratio of 1.2 to 1. Type I class B (titanium-zinc) weighs 13 lb and has a PV of 29; one gallon of paint contains 0.26 gal of pigment and 0.88 gal of solids. Figures for type I class C tint-base paint are practically the same as for type I class A.

Type II white lead paint weighs 20 lb/gal and has a PV of 28; one gallon of paint contains 0.25 gal of pigment and 0.89 gal of solids. This is a heavy-bodied paint that can be thinned for finish-coat painting by the addition of not more than 1 pt of turpentine or mineral spirits to 1 gal of paint.

Under amendment 1 to TT–P–40, the amount of linseed oil in the paints just described is reduced from a range of 86 to 88 percent by weight of vehicle to not less than 65 percent, and the PV is increased from about 29 in the basic specification to about 36 in the amendment. Where reactive pigments such as zinc oxide (see glossary) are present, it is particularly important for the manufacturer to use the most nonreactive, heat-bodied oil available in order to avoid thickening of the paint and lowered durability.

As a result of this amendment, type I classes A and C paint weigh 16 lb/gal and contain 0.26 gal of pigment, 0.71 gal of film-forming solids, and not over 3.75 lb of linseed oil. The PV is 37, an increase from 29 in the basic paint.

Type II paint weighs 20 lb/gal and contains 0.25 gal of pigment and 0.71 gal of solids. The PV is 36, an increase from 28 in the basic paint.

(b) Paint; Exterior-Primer, Ready White (Undercoat for Wood TT–P–25, Dec. 9, 1942 Amendment 1, June 5, 1943

This is a specialized paint intended pri
dercoat, or primer, on outside unprimed w
exterior painting. Its purpose is to ov
uniform absorption by the wood of the
paint. It should be applied without thinn
turpentine or mineral spirits may be adde
of paint) at a spreading rate of approxin
and should be allowed to dry at least 48 hr
is hard, before the topcoat is applied. B
tests at this Bureau and elsewhere, this ex
wood has given very good results.

When properly formulated and applie
systems offer equal durability and subst
labor over the usual three-coat paint syste
that the total thickness of the paint coat
cases. Two-coat systems are not intended
materials. The final film thickness should
three-coat jobs of conventional paint (abo

This paint (Fed. Spec. TT–P–25) may
priming exterior wood in three-coat pain
first coat for repainting weathered exterio
It should not be used as a topcoat or finis

Although the exact composition of this p
fied, the preferred formula is 66 percent of
percent of vehicle by weight as follows:

Pigment:	50 percent of white lead (one-h one-half sulfate).
	35 percent of titanium-barium pi TiO_2).
	15 percent of magnesium silicate.
	100 percent.
Vehicle:	28 percent of Z-4 bodied linseed oil
	28 percent of raw linseed oil
	4 percent of coumarone resin or ester gum (cooked in the Z
	40 percent of mineral spirits and
	100 percent.

This paint weighs 16 lb/gal, and has a PV
lon of paint contains 0.26 gal of pigment

film-forming solids. The above formula is the preferred one to use in making paint to meet Federal Specification TT-P-25, and it is recommended that the formula be incorporated in purchase orders for this priming paint.

(c) Paint; Exterior, Ready-Mixed, and Semipaste, Black
TT-P-61a, Oct. 28, 1944

Federal Specification TT-P-61a covers an exterior black gloss paint (slow drying) for use on wood and structural steel. This paint is one of the most durable when exposed to the weather. When applied to structural steel primed with two coats of a rust-inhibitive paint (for example, red-lead paint), it gives very good service as a topcoat, or cover coat and retains its color well. The paint has good working properties and excellent hiding power. It can be made from a variety of inexpensive pigments, such as the various mineral blacks in which the amount of carbon varies from 20 to more than 70 percent.

An average paint weighs 10 lb/gal and has a PV of 18; one gallon contains 0.14 gal of pigment and 0.80 gal of film-forming solids.

(d) Paint; Graphite, Outside, Ready-Mixed, Black
TT-P-27, July 23, 1938
Amendment 2, Jan. 23, 1945

Black graphite paint covered by this specification is used for structural steel such as bridges and tanks. It is furnished in two types.

Type I, natural flake graphite pigment, is dark steel gray with a metallic luster; blackness is obtained by the addition of lampblack or carbon black. This graphite has, to a certain extent, the property of "leafing," a characteristic that probably accounts for its durability.

Type II, which is generally darker in color than type I, may include all four forms of graphite:—natural crystalline vein or lump, natural crystalline flake, artificial graphite, and natural "amorphous."

A good method of painting structural steel is to apply a coat of a rust-inhibitive primer, such as red lead or blue lead paints, and to follow with one coat of natural (untinted) dark-gray graphite paint and a finish co
paint meeting this Federal Specification

Paint meeting Federal Specification
lb/gal and has a PV of 21; one gallon
pigment and 0.87 gal of film-forming so
this paint contains about 5 lb of linseed

(e) Paint, Red-Lead Base; Linseed O
TT-P-86, Sept. 9, 1939
Amendment 1, Sept. 1, 1943*

The basic unamended specification co
glossary), gloss (see glossary) paint u
body coats on steel and iron. One or
applied but two are preferable. If thinn
pentine or mineral spirits should be use
oil. This ready-mixed paint keeps well i
respect is superior to paints mixed on th

Paint meeting Federal Specification
least 25 lb/gal and has a PV of 28; one
gal of red lead and 0.95 gal of film-form

The amendment reduces the amount of
percent by weight to not less than 65 no
cent. A conservation paint is thus prod
a good surface for repainting in a sho
original, although it has a lower consist
To keep the red-lead pigment in loose s
tion of aluminum stearate by the manuf
percent by weight of the pigment is reco

It is estimated that 1 gal of paint meet
weighs 24 lb and contains 0.25 gal of p
solids, and not over 3.75 lb of linseed oil
increase from 28 in the basic paint.

(f) Paint; Blue-Lead-Base; Basi
Linseed-Oil, Ready-Mixed
TT-P-20, Jan. 12, 1940
Amendment 1, Sept. 1, 1943*

Blue-lead paint is a dark slate-gray
priming and body (see glossary) coats or
is characterized by very good working
erties, and is durable. One or two coats
two are preferable. This paint weighs 2

PV of 29; one gallon contains 0.27 gal of blue lead and 0.92 gal of film-forming solids.

The amended specification reduces the amount of linseed oil from not less than 90 percent by weight to not less than 65 per cent and not more than 70 percent by weight. Although the emergency paint does not have as high gloss as the basic paint, it is durable. Successive coats can safely by applied sooner than when the basic paint is used. It is estimated that 1 gal of paint meeting this amendment weighs 19 lb and contains 0.26 gal of pigment, 0.71 gal of solids, and not over 3.75 lb of linseed oil. The PV is 36, an increase from 29 in the basic paint.

(g) Paint; Iron-Oxide, Ready-Mixed, and Semipaste, Red and Brown
TT–P–31a, Sept. 12, 1941
Amendment 1, July 20, 1943*

Iron oxide paint is a durable and economical paint; it is used widely on exterior wood and metal (particularly on tin roofs) and is frequently referred to as roof and barn paint, red metallic paint, metallic brown paint, mineral red and brown paint, or freight-car red. It may be used both as a priming and a finish, or cover, coat on structural steel.

Because of the iron oxide, the color of the paint is red or brown, of which many different hues and shades can be furnished under this specification. The only practical method of getting the desired color is to have a color chip or preferably a wet sample of paint meeting the specification. The sample is used for color only.

The ready-mixed paint contains a small amount of spar varnish and zinc oxide, thus increasing color retention and decreasing the susceptibility of the paint to mildew.

Ready-mixed paint meeting the basic specification weighs 14 lb/gal and has a PV of 28; one gallon contains 0.24 gal of pigment and 0.84 gal of film-forming solids.

The amendment, which applies only to the ready-mixed paint, reduces the amount of linseed oil from 82 percent by weight to not less than 65 nor more than 70 percent, thereby producing a paint that dries with less gloss than the original. Actual use will determine whether or not the paint with less oil is as satisfactory as paint meeting the basic specification.

One gallon of the conservation paint weighs 14 lb and contains 0.24 gal of pigment, 0.69 gal of solids, and not over

3.75 lb of linseed oil. The PV is 31, an
the basic paint.

(h) Paint; Outside, Ready-M
Medium-Chrome-Yello
TT–P–53 Feb. 12, 1937
Amendment 1, Sept. 1, 19

This is a durable bright-yellow pain
tended for application to exterior woo
used with black paint on radio towers
tional signs. If a close match is desired
be designated. Tinted paints on a white
or buff, for example) should be purch
Specification TT–P–10.

Under the basic specification the pai
and has a PV of 28; one gallon contains
and 0.88 gal of film-forming solids.

The amendment reduces the amount of
percent by weight to not less than 65 no
cent, and broadens the color range of th
to include light to medium chrome yello
way Marking Yellow, formerly calle
Army-Navy Aircraft Yellow, and War
No. 120).

One gallon of the conservation paint
contains 0.24 gal of pigment, 0.69 gal of
3.75 lb of linseed oil. The PV is 34, an i
the basic paint.

(i) Paint; Ready-Mixed, Internation
TT–P–59, June 17, 1937
Amendment 1, Sept. 1, 1943*

Specification TT–P–59 covers the re
high-grade exterior paint of a color know
Orange (approximately the color of a ri
types of paint are included in the basic s

The most durable of the three, type A
mented, linseed-oil house paint recomm
for large-scale painting. It forms a soft
requires several days for drying between c
in Federal Specification TT–P–59, the wet
and white checkerboard at the rate of n

Although a small amount of spar varnish is added to the vehicle to improve color retention, the paint has a tendency to fade or dull somewhat on exposure. The pigment is a blend of 79 percent of opaque pigment by volume and 21 percent of transparent pigment. Type A paint weighs 18 lb/gal and has a PV of 28; one gallon contains 0.25 gal of pigment and 0.87 gal of film-forming solids.

Type B is a chrome orange, synthetic enamel (see glossary) paint. The paint hides about 300 ft^2/gal. It has more pull under the brush than type A paint and dries faster, an overnight drying period between coats being sufficient. On weathering, type B holds its color better and picks up less dirt than type A but is generally not as durable. The pigment is the same as that in type A paint, but the vehicle is a synthetic resin varnish of the glyceryl phthalate (see glossary) type. Type B paint weighs 13 lb/gal and has a PV of 24; one gallon contains 0.12 gal of pigment and 0.5 gal of solids.

Type C is a synthetic enamel of the glyceryl phthalate type, similar to type B, except that the pigment is a vivid, light-fast, orange red, organic pigment dye of the dinitroaniline type. A typical enamel, hiding 220 ft^2/gal, it should be applied as a finish over flat ground coats of the same color. This enamel is outstanding in color retention on exposure to the weather. As it has the pull under the brush typical of enamel paints, type C paint is recommended for small-scale painting, particularly on metal that has been built-up with ground coats of the same color. The properties of this enamel are similar to those of toluidine red enamel in Federal Specification TT–E–531a, and give a color of greater brilliance than types A and B. Under normal conditions, an overnight drying period between coats is sufficient.

Type C paint weighs 7.8 lb/gal and has a PV of 20; one gallon contains 0.1 gal of pigment and 0.47 gal of solids.

Amendment 1 to TT–P–59 applies only to type A paint; it reduces the amount of linseed oil from approximately 85 percent by weight to not less than 65 nor more than 70 percent. One gallon of paint meeting this amendment weighs 18 lb and contains 0.27 gal of pigment, 0.74 gal of solids, and not over 3.75 lb of linseed oil. The PV is 36, an increase from 29 in the basic paint.

(j) Paint; Ready-Mixed, Olive
TT–P–81a, Dec. 10, 1943*

This revision of Federal Specificatio
tended to conserve linseed oil.

The paint is suitable for use on wood
to the weather. It dries to a semigloss fini
color retention. Unless otherwise specifi
tended to match War Department Olive

Although weight per gallon varies acc
ments chosen, those suggested in paragra
eral Specification produce a paint weighi
having a PV of 34. One gallon contain
ment and 0.68 gal of film-forming solids.

(k) Paint; Ready-Mixed and Semi
Exterior, Chrome Green
TT–P–71a, April 9, 1941
Amendment 1, Sept. 28, 1943*

This specification covers an exterior,
seed-oil paint for application to wood an
tinted white-lead undercoats. Type A, s
used. Type B, ready-mixed paint, is a pa
This paint weighs 12.7 lb and has a PV
contains 0.21 gal of pigment and 0.81 ga
solids.

The purposes of amendment 1 to Fed
TT–P–71a are to improve the basic specifi
serve linseed oil. The amendment covers
known in the trade as a "trim enamel."
prepared, it shows enamel-like flowing a
erties, excellent hiding power, and mor
brush than ordinary house paint. The
smooth finish with a high initial gloss, wh

A successful formula for 1 gallon of
paint is 2 lb of chemically pure chrome
easy dispersing type) and 1 lb of fine-pa
sium silicate or aluminum silicate, with
of litharge (5 lb to 100 gal of paint).
percent TT–V–121b spar varnish and 15
(see glossary) linseed oil, with a small
manganese-cobalt drier.

One gallon of medium chrome-green t
made under this specification weighs 9.6 lb

0.10 gal of pigment, 0.63 gal of solids, and not over 3.75 lb of linseed oil. The PV is 16, a decrease from 25 in the basic paint.

(l) Primer, Paint; Zinc Dust-Zinc Oxide for Galvanized (Zinc-Coated) or Zinc Surfaces
TT–P–641, Apr. 20, 1939
Amendment 1, Sept. 1, 1943*

The above specification covers three types of zinc-dust-zinc-oxide paint used principally for priming exterior, new or old galvanzed iron and zinc surfaces. They are also satisfactory as finish coats, except under conditions requiring special finishes. Type I is a linseed oil, air-drying paint. Types II and III contain a synthetic resin vehicle; glyceryl phthalate in type II and phenolic resin in type III; both dry faster than type I paint and may be either air-dried or baked at temperatures up to 380° F. For normal service, the adherence of type II appears to be best, although type I is nearly as good and has the advantage of easy brushing; however, if unusually severe moisture conditions prevail, type III is preferable (for example, on the interior of steel water tanks).

This paint can be furnished in class A, semiprepared, and class B, ready-prepared. The zinc oxide in class A is mill-ground in the entire vehicle. The zinc dust comes in a separate container. To blend the ingredients, the zinc dust and a small portion of the paint are stirred to a smooth paste, then the balance of the paint is added and thoroughly mixed. Class A is preferable to class B, as the ready-prepared paint may not keep well in the package.

One coat hides completely and is adequate for many service conditions on new galvanized iron; two coats are ample for rusty (weathered) galvanized-iron surfaces, except where special finish coats are necessary for added protection. The paint retains its gray color on prolonged exposure to the weather. For finish coats the paint may be tinted, although lampblack appears to reduce durability. Chromium oxide green gives a soft, pleasing green that is durable and shows good color retention.

Prior to priming, the new surface should be cleaned with turpentine or mineral spirits and wiped dry. Although not usually necessary, standard chemical treatments for cleaning may be used. Galvanized roofs that have weathered

until the iron-zinc alloy is exposed make a
for this paint.

Paints covered by the specification are suit
ing but may be sprayed if thinned with not
of turpentine or mineral spirits to 1 gal of

Type I paint weigh 23 lb/gal and has a
gallon contains 0.31 gal of pigment and 0.
forming solids.

Type II paint weighs 16 lb/gal and has a
gallon contains 0.17 gal of pigment and 0.4
Type III paint weighs 23 lb/gal and has a
gallon contains 0.32 gal of pigment and 0.62

The amendment, which applies to type I
the amount of linseed oil from 89 percent by
less than 65 nor more than 70 percent. One
paint weighs 19 lb and contains 0.23 gal of pi
of solids, and not over 3.75 lb of linseed oil.
a decrease from 37 in the basic paint.

(m) Paint; Concrete and Masonry Exterior, Eggshell-Finish Ready-Mixed, White and Tin
TT–P–24, Feb. 25, 1943

This oil-base exterior paint is a finishing co
primed concrete, brick, and stucco surfaces,
The paint dries to an eggshell finish. Where
is desired, exterior paints for wood and metal
(Fed. Spec. TT–P–40).

Type I paint is made in white only. Ty
bought in tints or in white, to be tinted by
who should specify the color and whether it s
selected sample.

As moisture back of the paint film serious
life of oil-paint coatings, new masonry should
until the walls are dry. This may require
months and will depend upon weather condit
the thickness and porosity of the walls. It
portant to prevent water from entering the wa
ing.

Because paint adheres poorly to highly gl
it is suggested that preparatory to painting,
be either acid washed, lightly sandblasted, or
coarse grit abrasive stones. This treatment

necessary for concrete cast against plywood, Presdwood, or steel forms.

Old coatings of organic or cement-base water paint in good condition need not be removed. Peeling, scaling, or flaking paint and whitewash should be completely removed.

A suggested formula (by weight) for paint meeting the specification contains 60 percent of pigment and 40 percent of vehicle as follows:

	Pigment *Percent*
White lead	35
Zinc oxide	30
Titanium dioxide	10
Magnesium silicate	25
	100

	Vehicle *Percent*
Nonvolatile vehicle	45
Thinner	55
	100

An average paint of either type meeting the specification weighs about 14 lb/gal and has a PV of 42; one gallon contains 0.22 gal of pigment and 0.53 gal of film-forming solids.

For surfaces that have not previously been painted, the following Federal Specification priming paint is suggested:

	gal
Paint; TT-P-24	1
Varnish, spar (nonreactive); TT-V-121b	½
Thinner, paint; TT-T-291a	¼

The priming paint weighs 11 lb/gal.

(n) Paint; Traffic, Exterior, White and Yellow
TT-P-115, Apr. 29, 1942
Amendment 1, May 30, 1945

This specification covers a ready-mixed traffic paint known as center line, zone-marking, and road-marking paint. It is obtainable in white and yellow colors, the yellow being called Highway Marking Yellow, formerly called Federal Yellow.

Both paints are intended for applicat
of temperatures, to bituminous and conc
ing heavy traffic. The paints may be ap
machine. Certain types of spray machi
thinned in the proportions of 1 pt of u
1 gal of paint. In not more than ½ hr
to touch and within an hour (at 70° to
to an eggshell hard gloss finish. The
toxic thinners may make these paints u
unless proper precautions, such as adeq
taken.

As some traffic paints have a tenden
container during prolonged storage, it
purchase this paint too far in advance
though soft settling is expected, hard
ment is undesirable. A properly form
should keep in good condition for at lea

Although the specification is based mai
requirements, a satisfactory white traff
lb/gal and has a PV of 49; one gallon
pigment and 0.56 gal of film-forming so
is 55 percent by weight of titanium-bari
percent of zinc oxide, and 25 percent of
the vehicle is a quick-drying, 15-gal, oleo

The yellow paint weighs 14 lb/gal an
one gallon contains 0.24 gal of pigme
solids. The pigment is 45 percent by
yellow, 20 percent of zinc oxide, and 3
and silicates; the vehicle is the same as
paint.

(o) Enamel; Heat-Resisting (400°
TT-E-496, June 6, 1941
Amendment 1, Sept. 14, 1943*

Federal Specification TT-E-496 covers
enamel, type I, bituminous-base (unpigm
resin-base (pigmented). Both types ar
on surfaces exposed to temperatures up t
steam pipes and boiler fronts. Where
water and gasoline is also necessary, the
advisable. Neither type should be applied
are hotter than 140° F, and 48 hr of dr
temperature should elapse before the coa
the maximum temperature, 400° F. Bec

of the volatile thinners, these enamels should be applied in well-ventilated areas free from open lights or flames.

Type II enamel generally contains 2 percent by weight of high-grade carbon black and 98 percent of a synthetic resin (alkyd) vehicle. It weighs 7 lb/gal and has a PV of 3; one gallon contains 0.01 gal of pigment and 0.35 gal of film-forming solids.

Amendment 1 is necessary because of the critical shortage of alkyd resins and applies only to type I enamel.

(p) Enamel; Pigmented (Air-Drying and Baking) Black
TT–E–521, July 22, 1930
Amendment 3, Sept. 14, 1943

Material covered by this specification is a high-grade black enamel containing no bituminous materials. It produces an opaque, glossy, durable black coating for exterior and general use. The composition is generally about 2 percent of high-grade carbon black and 98 percent of long-oil, water-resisting varnish.

This enamel weighs 8 lb/gal and has a PV of 2; one gallon contains 0.01 gal of pigment and 0.45 gal of solids.

(q) Enamel; Lusterless, Olive-Drab
TT–E–514, Jan. 28, 1943

The lusterless olive-drab enamel covered by this specification is intended for camouflage. It serves as a *flat* finishing coat on *primed* metal and wood surfaces. The color should match Olive-Drab No. 319[5].

The materials are noncritical but do not produce as durable an enamel as those containing synthetic resins of the alkyd type, such as the finish on Army motor vehicles [6].

Although this is a performance specification and a variety of pigments can be chosen, the following formula is frequently used:

	Weight *Percent*
Yellow iron oxide	18.0
Medium chrome yellow	6.3
Lampblack	3.2
Zinc oxide	0.8
Magnesium silicate	33.2
Diatomaceous silica	26.5
Barytes	12.0
	100.0

These pigments produce an enamel we
lb/gal and having a PV of about 45; one
0.17 gal of pigment and 0.38 gal of solids.

(r) Enamel; Water-resisting, R
TT–E–531a, June 4, 1935
Amendment 3, Sept. 14, 19

This specification covers a bright-red
grade intended for general exterior use. T
is used widely on fire-alarm boxes. It is wa
a high gloss, and is durable.

The toluidine pigment used in the enamel
of different lots less variable than the color
red paints that do not contain toluidine.
are needed only where a very close match o
eries is required. Recently a dark shade
has been produced containing pigment dy
metanitro-paratoluidine-azo-betanaphthol
tests described in the specification. When t
dicates red enamel containing this dark sh
red, the limits on "color", as required in pa
the specification, do not apply. Unless spec
by the purchaser, it is understood that the s
red enamel strictly meeting the color, as s
graph E-1.

To meet the requirement for hiding pow
12 percent by weight of toluidine toner
This enamel weighs 7 lb/gal and has a PV o
contains 0.08 gal of pigment and 0.19 gal
solids.

Amendment 3 provides for an enamel con
3.25 lb of linseed oil per gallon of enamel.

(s) Enamel; Interior, Gloss, Light Tints
TT–E–506a, Dec. 1, 1938
Amendment 1, Sept. 14, 1943*

Enamel paints meeting this specification
use on interior wood, metal, and plaster over
coats. After being properly applied and
thoroughly, they can be washed with mild
water.

Although white enamel paints may be p
the specification without reference to a col

variation in white surfaces from blue-white to yellow-white makes it advisable for the purchaser who desires a close match to specify color (preferably by having a wet sample of acceptable enamel). Because of the wide range of tints, this method of color matching is the practical one to use.

For white enamel paints, mixtures of strong white opaque pigments, such as titanium dioxide, zinc sulfide, and zinc oxide, can be used; for the tinted paints, pure tinting colors should be chosen. A typical pigment mixture for white enamel is 80 percent by weight of titanium dioxide and 20 percent by weight of zinc oxide.

When the enamel contains 30 percent by weight of this pigment and 70 percent vehicle, it weighs 10 lb/gal and has a PV of 9; one gallon contains 0.08 gal of pigment and 0.49 gal of film forming solids.

Amendment 1 contemplates an enamel containing not more than 2.5 lb of linseed oil per gal.

(t) Paint; Oil, Interior, One-Coat-Flat, Heavy-Bodied (for thinning), Light Tints and White (Combined Sealer, Primer, and Finish)
TT–P–47, Feb. 25, 1943

This specification covers an interior one-coat, "nonpenetrating," flat, heavy-bodied, oil-base paint to be applied directly to porous, absorptive surfaces, such as wallboard, wallpaper, plaster, and wood. It is designed to give a uniform finish without the use of a special primer or sealer, and to conserve shipping space and containers as a war emergency measure. It should find wide use after the war.

Although high dry hiding power is desirable, it should not be obtained at the expense of washability and good sealing properties. The paint should dry to a relatively low gloss with a slight angular sheen, even though a relatively high ratio of binder (see glossary) to pigment is desirable. Where adjoining areas of the surface to be painted show marked differences in porosity, as in the case of patched plaster, the patched areas should be painted and allowed to dry before the entire surface is painted.

The vehicle in this paint is usually a long-oil varnish, containing at least 100 gal of oil per 100 lb of resin, consist-

ing mainly of processed drying oils, ester
plus the required amounts of volatile
One such vehicle of a 200-gallon varnish
13 poises (see glossary), a nonvolatile co
and passed a 350-percent kauri reducti
Pigments should be opaque white titan
sulfide base and suitable extending p
colors should be limeproof.

The paint is furnished in a heavy-bodi
glossary), so that it can be thinned wit
spirits or turpentine to 1 gal of the thick
ing a paint of normal properties. If the
to buy this paint ready for use (instead o
bodied consistency), it should then meet
specification for the reduced paint.

It is estimated that an average paste
specification weighs about 12.5 lb/gal an
one gallon contains 0.33 gal of pigment a
forming solids.

The paint thinned for use weighs abo
has a PV of 60; one gallon contains 0.23 g
0.38 gal of solids.

(u) Paint; (for) Priming Plaster
(Plaster Primer and Sealer)
TT–P–56, Oct. 5, 1935
Amendment 1, March 1936

This specification covers a pigmented
(see glossary) in white or tints, to be use
sizing coat on interior walls and ceilings
and cement wallboard. It may also be
interior woodwork. It should not be app
faces.

Many formulas may be used to produ
plaster primer and sealer, since the requi
are mainly physical. The only limitation
that the vehicles shall contain not less th
nonvolatile matter. Usually the pigmen
paint contains some titanium dioxide and/
extending pigments. The pigment of a t
percent by weight of titanium dioxide, 24 p

sulfate, and 20 percent of magnesium silicate. The composition of the paint is as follows:

	Weight *Percent*	Volume *Percent*
Pigment	44	18.2
Nonvolatile vehicle	34	45.2
Volatile vehicle	22	36.2
	100	100.0

The weight per gallon is 11 lb and the PV is 29.

(v) Paints; Oil, Interior, Eggshell-Flat-Finish, Ready-Mixed and Semipaste, Light Tints and White
TT–P–51a, Jan. 16, 1937
Amendment 1, Sept. 14, 1943*

This specification covers an interior eggshell to flat wall paint, available in ready-mixed or in semipaste form. The ready-mixed paint produces a washable body and finish coat but is not generally suitable for stipple finish. Although 1 gal may be diluted to make a priming paint by adding from 1 qt to 1 gal of boiled linseed oil, the use of priming paint conforming to Federal Specification TT–P–56 is preferable. The semipaste is seldom used.

Some paints and enamels dry hard quickly, whereas others, the vehicle of which contains more oil and less resin, are more flexible and develop hard films slowly. Gloss paint or enamel (Fed. Spec. TT–E–506a) is more washable than a flat paint, but no paint should be scrubbed within 30 days after application. When a washable paint is desired, as in a kitchen or bathroom, yet the glare of full gloss enamel is objectionable, a semilustrous finish can be produced by mixing TT–P–51a flat wall paint (or TT–P–47 one-coat flat) and TT–E–506a enamel, in varying proportions. Some recent laboratory work at the Bureau indicates that TT–P–47 paint is superior to TT–P–51a paint for this purpose. A Federal Specification for semigloss enamel (TT–E–508) is in preparation.

The specification for TT–P–51a paint is based on performance requirements rather than on composition. The paint is characterized by high hiding power, eggshell to flat finish, easy brushing, and good resistance to scrubbing with mild soap and water.

The purpose of amendment 1 is to conserve linseed oil. It is contemplated that the paint under the amendment will

contain no more than 1.2 lb of linseed oi
(to conform to linseed oil conservation
War Production Board).

Federal Specification TT–P–51a do
specific formula, but the following is
suggestion:

	Weigl *Perce*
Titanium dioxide	15.9
Calcium sulfate	19.1
Nonvolatile vehicle	14.0
Volatile vehicle	21.0
	100.0

On gallon of this paint weighs 11 lb

(w) Paint; Varnish-Base (for) Concrete and Woo
TT–P–146, June 5, 1942

This paint is intended for interior
wood and concrete floors and other floor
dampness. It is known to the trade
paint." Concrete basement floors shou
before painting. The floor should be d
to paint it is during the winter or earl
that the basement can be heated), wh
the basement is very low. The paint s
a thin layer and be brushed out well, a
lowed for drying between coats. Two
generally sufficient. A thin film of wax
newed, serves to protect the paint. A
the organic solvent type (Fed. Spec.
gested.

On wood floors it is suggested that f
paint 1 qt of thinner, composed of 2 pa
oil and 1 part of turpentine, be added
paint; for the second coat 1 pt of boi
gallon of paint may be added. On c
suggested that for the first coat 1 qt of li
tion of 2 parts of spar varnish and 1 pa
added to each gallon of paint; the seco
plied as furnished.

Floor paints meeting this specificatio
within 12 hr as determined by the ne

Time Recorder, an instrument for measuring the drying time of paint and varnishes. The vehicle in this paint should be a tough, flexible, high-grade floor varnish able to withstand wear on wood and concrete floors as well as outdoor weather. It should be at least 25 or 30 gal long, passing a 40-percent kauri reduction (see glossary).

Although a great variety of pigments may be used in making paints meeting this specification, the following is one example of a durable lightweight gray paint:

	Weight *Percent*	Volume *Percent*
Pigment:		
Titanium dioxide	10.0	3.0
Calcium sulfate	24.0	11.8
Carbon black	1.0	0.6
Vehicle:		
Interior varnish (TT-V-71a)	65.0	84.6
	100.0	100.0

One gallon of this paint weighs 10 lb and has a PV of 29. These values apply only to the formula just given for a lightweight gray paint. The specification covers a variety of colors including grays, browns, reds, buffs, and greens.

(x) Paint; Rubberbase (for) Cement Floors
TT-P-91, May 23, 1939

This is a ready-mixed paint for use on interior concrete flooring subjected to dampness and not exposed to sunlight. It is suitable for concrete basement floors. The paint for the first coat should be diluted with 1 qt of thinner, consisting of equal volumes of mineral spirits and toluol free from water, to each gallon of paint. The surface to be painted should be clean and dry and the room sufficiently ventilated. Smooth, densely troweled concrete floors should be etched with a 10-percent solution of hydrochloric acid, washed with water, and thoroughly dried before paint is applied. New concrete floors should age at least 2 months before being painted; three coats are generally recommended, but two coats are frequently used. In repainting work, this type of paint should be used only when the same type has been used previously on the same surface.

The variety of colors available makes it advisable to designate a sample for color (preferably a wet sample of the paint).

A typical gray paint passing the sp

Pigment:	
Titanium dioxide	
Zinc oxide	
Carbon black	
Nonvolatile vehicle:	
Rubber base[a]	
Plasticizer (see glossary)	
Volatile vehicle	

[a] Generally either chlorinated rubber or n

One gallon of the above paint weigh
of 28. At the present writing, this
because of the critical situation on rul

(y) Fume- and Heat-Resisting
National Bureau of Standar
Letter Circular LC489, Jan

Enamel paint that does not become
ous heat or chemical fumes is not
Specification. An enamel having th
scribed in National Bureau of Stand
LC489 should prove desirable for us
tories, commercial kitchens, tobacco
refrigerator rooms, dairies, and sev
Paint that will not discolor in such
composition. The pigment must be fr
and may consist of lightproof lithopon
various titanium pigments, zinc oxide,
The vehicle must also be free fro
driers, and preferably from linseed,
drying oils. A vehicle frequently us
grade damar resin dissolved in turpent
and plasticized with a softener, such
more modern vehicles are synthetic a
and acrylic resins, and the newer type
rinated rubber resins dissolved in solv

For color-retention tests, glass pan
white enamel and with this same ena
and pale buff, using lampblack and
tively. The coated panels were plac
saturated with water and ammonium

the buff became discolored because of the formation of black iron sulfide. The others retained their original color.

To obtain resistance to discoloration, it may be necessary to subordinate other properties. Fume-resisting enamel paint may be less flexible than the usual architectural white enamel and less water resistant than the "4-hour" type of white enamel (Fed. Spec. TT–E–506a, type A).

The reader is referred to NBS Letter Circular LC489 for additional details on the subject.

(z) Enamel; Drum-Coating, Exterior, Rust-Inhibiting, Solvent-Resistant
TT–E–485 March 15, 1944

This is an olive-drab, semigloss enamel prepared to conserve zinc during the war emergency. It is used as a one-coat painting system on the exterior of steel storage drums for the armed forces. Because of the shortage of certain materials required for its manufacture, such as glyceryl phthalate resin, this enamel is temporarily not available for civilian use.

5. VARNISHES AND ANALOGOUS PRODUCTS

Oil varnishes are blends of drying oil and resins, natural or synthetic, driers, and volatile thinners (see glossary). Spirit varnishes do not contain drying oils. This section deals first with oil varnishes, then with spirit varnishes.

(a) Varnish; Asphalt
TT–V–51a, Feb. 2, 1944

This is a general utility asphalt varnish for interior and exterior surfaces and is particularly suitable for painting indoor water and gas pipes. It dries with a smooth, black, lustrous finish similar to black enamel. Its composition is hard native asphalt or asphaltite fluxed and blended with drying oils, then thinned with solvents and driers.

Although the specification is based mainly on performance requirements, a linseed oil-Gilsonite varnish that met the specification was composed of 7 gal of heat-bodied linseed oil to 100 lb of Gilsonite selects, fluxed and blended, then thinned with a mixture of turpentine, petroleum naphtha, and lead-manganese driers.

A typical varnish shows:

	Weight *Percent*	Volume *Percent*	*lb/gal*
Varnish	..	..	7.40
Nonvolatile	45	40	...
Volatile	55	60	...
	100	100	

(b) Varnish; Interior
TT–V–71a, Sept. 9, 1939
Amendment 2, Sept. 14,

Material covered by this specification
a 20- to 25-gal varnish (see glossary) in
interior use, including floors, except wh
erties are necessary. (For cabinet rubbin
Spec. TT–V–86). Although the unamen
a very good general purpose interior va
specification has lowered the requiremen
and water resistance, because of the scar
materials.

Varnish meeting both the basic spe
amendment shows the following characte

	Weight *Percent*	Volume *Percent*	*lb/gal*
Varnish	..	..	7.40
Nonvolatile	45	40	...
Volatile	55	60	...
	100	100	

(c) Varnish; Mixing (for) Alumin
TT–V–81a, Oct. 5, 1939
Amendment 2, Sept. 14, 1943*

Mixing varnish covered by this specifi
for use as the vehicle in aluminum pai
varnish. Type I varnish is a very long-
100 gal) and should be used in preparing
exterior wood subjected to severe we
Type II varnish should be used in paint in
use (particularly for metal). For sprayi
be thinned with 1 pt of turpentine to 1
though it is recommended that aluminum
at the same consistency as for hand brush

Because aluminum paste contains abo
weight of volatile thinner, varnish wit

[class A, 0.65 to 1.00 poise (see glossary)] is suitable for use with aluminum powder, and varnish with the higher viscosity (class B, 0.85 to 1.25 poises) for use with aluminum paste.

Varnishes meeting this specification have the following characteristics:

	Weight *Percent*	Volume *Percent*	*lb/gal*	*gal/lb*	sp gr
Type I varnish	..	..	7.49	0.1335	0.899
Nonvolatile	55	49			
Volatile	45	51			
	100	100			
Type II varnish	..	..	7.40	.1350	.888
Nonvolatile	50	44			
Volatile	50	56			
	100	100			

(d) Varnish; Rubbing, Cabinet
TT–V–86, June 29, 1939
Amendment 1, Oct. 8, 1941

Cabinet-rubbing varnish is intended for interior wood surfaces where a rubbed finish is desired. It does not cover the requirements of a baking varnish for use on metal and is not recommended for floors. However, it may be used on wood or metal, particularly chairs, tables, and desks. (Varnish for general interior use is covered by Federal Specification TT–V–71a.)

A typical rubbing varnish is about 10 gal in length and has the following characteristics:

	Weight *Percent*	Volume *Percent*	*lb/gal*	*gal/lb*	sp gr
Varnish	..	..	7.326	0.1365	0.879
Nonvolatile	45	39.6			
Volatile	55	60.4			
	100	100			

(e) Varnish; Spar, Water-resisting
TT–V–121b, Dec. 10, 1943
Amendment 1, Jan. 24, 1944*

Water-resisting spar varnish is a durable general utility varnish, suitable for both interior and exterior use where

high gloss or initial hardness of film
cause certain materials were critical,
tain varnish meeting the unamended
the war emergency. Tung oil and phe
widely in this type of spar varnish.

The amended specification produces
nish than the original and provides les
for water resistance.

Varnish meeting this specification is
gal in length and shows approximately

	Weight *Percent*	Volume *Percent*	*lb/ga*
Varnish	..	..	7.4
Nonvolatile	55	49.4	
Volatile	45	50.6	
	100	100.0	

The nonvolatile portion of this var
generally consists of linseed oil and a
as congo, terpene resins, ester gum, and

(f) Sealer, Floor; Varnish-Type (for
TT–S–176a, Sept. 20, 1941
Amendment 1, Jan. 7, 1944*

This floor sealer is intended for use in
wood or cork floors and floor coverings
factory foundation for varnish, for liq
emulsion wax. The sealer is furnishe
two classes: class 1 is suitable for use o
ing a rapid and high absorption rate, an
of denser structure. When the floors
wood or cork tile, they should be trea
(Fed. Spec. TT–F–336a) before the sea
sealer is similar to spar varnish but co
matter and correspondingly less nonvol

Class 1 sealer may be thinned with t
spirits; class 2 sealer should require
sealer meeting the amended specificati
and less water-resistant than one meet
specification.

Sealers conforming to either the basic or the amended specification contain approximately the following:

	Weight *Percent*	Volume *Percent*	*lb, gal*	*gal, lb*	sp gr
Class 1 sealer	..	..	7.246	0.138	0.88
Nonvolatile	40	34.8			
Volatile	60	65.2			
	100	100.0			
Class 2 sealer	..	..	7.02	.1425	.842
Nonvolatile	25	21			
Volatile	75	79			
	100	100			

Spar varnish TT–V–121b may be used as a sealer that will be somewhat similar to class 1 if thinned with one-half its volume of mineral spirits or turpentine and somewhat similar to class 2 if mixed with an equal volume of mineral spirits or turpentine.

(g) Varnish; Damar
TT–V–61, Apr. 20, 1939
Amendment 1, Jan. 7, 1944*

Damar varnish specified in TT–V–61 is a spirit varnish to be applied to indoor surfaces, both as a transparent finish and as a vehicle for white or light-colored enamels exposed to high temperatures (radiators, for example). It is not intended for use under conditions that require an abrasion-resistant, moisture-resistant, or indentation-resistant varnish. Suitable Federal specifications cover varnishes for these purposes.

Damar resin has the lowest acid and saponification numbers (see glossary) of all the important natural resins, commercial samples having acid numbers from approximately 25 in the best grades to 35 in the poorest and saponification numbers from 27 to 50. The resin is light in color and on exposure to sunlight, bleaches to water-white. As a contrast to damar resin, manila resins have high acid numbers, 125 to 143, and high saponification numbers, 158 to 169. Damar resin is soluble in petroleum spirits, turpentine, coal-tar naphtha, chlorinated solvents, and hot drying oil [7]. It adheres tenaciously to surfaces.

Damar varnish meeting this specification shows approximately the following characteristics:

	Weight *Percent*	Volume *Percent*	*lb, gal*	*gal, lb*	sp gr
Damar varnish	..	..	7.466	0.1339	0.896
Nonvolatile	45	38.4			
Volatile	55	61.6			
	100	100.0			

As amendment 1 is a temporary measure to conserve critical materials during the emergency, the following finishes are suggested as substitutes for damar varnish:

Varnish; Interior, TT–V–71a.
Varnish; Spirit (Shellac Varnish Replacement), TT–V–130.
Paints; Oil, Interior, Eggshell-Flat-Finish, TT–P–51a (painting radiators).

(h) Shellac; Orange
TT–S–271, April 29, 1930
Amendment 1, May 27, 1944*

All shellac (see glossary) is a manufactured product of stick lac, the secretion of the *Laccifer Lacca Kerr*. Four types of orange shellac are covered by Federal Specification TT–S–271. Type A includes the grades of shellac known to the trade as Double Triangle G, Diamond I, Superfine, the highest grades, D.C. and V.S.O., and the so-called machine-made shellacs, CV and CVTN.

Type B includes Fine, Good, and Heart, the grades considered in the trade as lower than Superfine but higher than Pure T.N.

Type C represents the grade known in the trade as Pure T.N. This shellac is rosin free (see glossary), but is darker and contains more insoluble material than types A or B.

Type D represents the grade known in the trade as U.S.S. A.T.N. and usually contains rosin up to a maximum of 3 percent. It is lighter in color than type C but is darker and contains more insoluble material than type A or B.

The color of orange shellac (see glossary) used in orange shellac varnish is immaterial as it results in only a slight difference in the color of the varnish films. However, if the buyer desires to consider color, he should furnish a selected sample and should state which of the two methods given in section E-3g of the specification should be used in determining the color. It should be noted that, when tested

by method 1, shellacs containing appreciable amounts of wax and orpiment are lighter in color than those containing small amounts of these substances. A shellac may be darker than the selected standard when tested by method 1 but lighter when tested by method 2.

(i) Varnish; Shellac
TT–V–91a, Feb. 26, 1940
Amendment 2, Jan. 7, 1944*

Federal Specification TT–V–91a is expected to meet all Government needs for shellac varnish (see glossary). It comes in type I, bleached (white), and type II, orange. Each type covers two grades, A and B, and each grade three kinds of body—light, medium, and heavy. The desired type, grade, and body should be stated in the invitation for bids.

Ordinarily, grade A of type I fulfills all the needs for a white shellac varnish and grade B should be used only in cases requiring a clear, bleached varnish almost entirely free from wax or other suspended matter.

Grade A of type II usually includes rosin-free shellac. It is lighter in color than grade B, which is intended for use where small percentages (not over 3 percent) of rosin are not objectionable and where lightness of color of shellac varnish is not essential.

The thinner, or solvent, used in shellac varnish may be either one of two formulas. It may consist of specially denatured alcohol made of 100 gal of 95-percent ethyl alcohol (190 proof) and 5 gal of methyl alcohol. It may consist of a proprietary solvent composed of materials authorized by the U. S. Bureau of Internal Revenue as follows: 100 gal of the above-described specially denatured alcohol, 5 gal of denatured ethyl acetate, and 1 gal of aviation gasoline. Isopropyl alcohol (99 percent) is permitted by the U. S. Army Air Corps as an alternative for the above-described formulas, and the Navy Department requires that unless otherwise specified, the solvent must be denatured alcohol made from U. S. P. grade ethyl alcohol denatured by the addition of 0.05 percent of croton oil U. S. P. and dyed by the addition of fuchsin, 1 part in 500,000 [8].

Light-, medium-, and heavy-bodied varnishes correspond respectively to 4-, 4.5-, and 5-lb "cuts" (see glossary) of shellac. The minimum allowable percentages of nonvolatile matter for each body of varnish given in section E of this

specification have been corrected for
moisture, including volatile matter, a
soluble matter in flake orange shellac;
moisture and volatile matter in bleache
varnishes made by cutting 4, 4.5, and 5
bleached shellac in 1 gal of specified sol
nonvolatile requirements of the specifica
ner has prepared directions for making
varnishes of various bodies [9].

An average light-bodied shellac va
specification has the following charact

	Weight *Percent*	Volume *Percent*	*lb/ga*
Light-bodied shellac varnish	..	..	7.170
Nonvolatile	35.5	30.6	
Volatile	64.5	69.4	
	100.0	100.0	

An average heavy-bodied shellac var
ing characteristics:

	Weight *Percent*	Volume *Percent*	*lb/ga*
Heavy-bodied shellac varnish	..	..	7.262
Nonvolatile	41.0	35.7	
Volatile	59.0	64.3	
	100.0	100.0	

(j) Varnish; Spirit (Shellac Varnish
TT–V–130, Sept. 28, 1943

This specification covers the improv
and is intended (as a conservation me
replace shellac varnish, which it resem
It can be applied to wood, metal, pape
may also be used in place of oil-resin va
drying is more important than length
Shellac varnish replacement (a var
forming to the specification may be pro
ber of available domestic materials wit
ing oils and metal driers. However, di
tion produces a variation in properties
varnish replacement may consist of abou

weight of an alcohol-soluble, polymerized (see glossary) rosin blended with about 25 to 50 percent by weight of zein (protein derived from corn) and dissolved in alcohol; a plasticizer (for example, low-titre fatty acids) may also be present. Blends of polymerized rosin and ethyl cellulose have also been used. The method of blending these materials appears to affect the quality of the product. The ordinary spirit varnishes composed of simple solutions of copals (see glossary) and rosin dissolved in alcohol do not meet this specification.

Performance tests show that the good grades of shellac varnish replacement appear to be equivalent to shellac varnish in color, gloss, drying time, film clarity, coverage, ease of sanding, water resistance, and abrasion resistance. On the other hand, the film is less resistant to the action of various solvents, such as alcohol, than films of shellac varnish dried the same length of time.

The varnish should not be mixed with ordinary paint, varnish, or lacquer, or be thinned with turpentine or mineral spirits.

The material should be applied in thin coats by either spray gun or brush.

Some of the earlier shellac replacement varnishes tended to thicken or gel in the package. On the other hand, certain brands have always exhibited good stability in the package. This would indicate that, when the ingredients are correctly formulated and combined, there should be no gelling.

As an aid in keeping the material in satisfactory condition, it is suggested that the buyer request that shellac replacement varnish be packed in glass containers. These should be kept in a relatively cool place not exposed to direct sunlight. The material should not be stored in an excessively hot or cool place.

Although the material is a wartime product, it served a very useful purpose at a time when shellac varnish was unobtainable.

(k) Lacquer; Spraying, Clear and Pigmented (General Use) TT–L–58, April 29, 1942

Spraying lacquer (see glossary) purchased under this specification should contain cellulosic derivatives. This lacquer is intended for indoor or outdoor use, and is to be applied by a spray gun. It is not inte
lacquer. Metal surfaces should be pr
primer, and wood surfaces should be s
seal before applying this lacquer.

For application by spraying, the lac
factory for use without a thinner, un
However, should thinning be necessary
Federal Specification TT–T–266 is sug

The nonvolatile base for type I cle
sist of:

| | Wei
Per |
|---|---|
| Cellulose nitrate | |
| Alkyd resin | |
| Dibutyl phthalate | |
| Fish oil | |
| The above nonvolatile vehicle | |
| Lacquer thinner TT–T–266 | |

Type II (pigmented lacquer) can b
(or 13.4 gal) of the above type I lacq
of a suitable pigment. The weight per
does not vary much from 7½ lb; type
lb. and type II with a medium chr
about 7.8 lb.

**(l) Sealer; Floor; Lacque
(for Oiled Wood Fl
TT–S–171, April 8, 1**

This floor sealer is intended for seal
ing and oiled wood floors that have bee
Sealing the oil within the flooring pre
ring of the finished surface. This lac
smooths and integrates the surface to
thus producing a finished appearance a
for wax and varnish. Open-grained
treated with wood filler, Federal Spec
before the application of sealer.

Precautions should be taken adequa
room while applying the sealer.

6. WATER PAINTS

Water paints were probably the first paints used by man and are still widely used. The following four Federal Specifications have been prepared for water-reducible paints.

(a) Calcimine; (Cold- and Hot-Water Types) TT–C–96, May 4, 1940

Calcimine, or kalsomine, is an inexpensive powdered mixture of pigments, such a whiting, china clay, and glue made ready for application by the addition of water. It is intended for temporary interior use and is easily removed by sponging the surface with warm water.

The specification covers two types of calcimine: type I, cold water, and type II, hot water. Type I is more convenient for mixing, as water at ordinary temperatures can be used. Type II calcimine, considered a smoother brushing calcimine than type I, requires boiling water for mixing.

Unpainted plaster walls should be sized with either a glue-water size or, if the plaster is dry, a varnish size; the latter can be bought ready-prepared or made by thinning 1 gal of interior varnish (Fed. Spec. TT–V–71a) with 1 qt of turpentine. For the best results, a foundation can be made for the calcimine by applying one coat of flat wall paint (TT–P–51a) over either the varnish size or over one coat of primer (TT–P–56).

One thick coat of calcimine is usually sufficient. If a second coat is necessary, it must be brushed on skillfully to avoid lifting the first coat. After the calcimine has been applied, the room should be aired thoroughly to dry the calcimine quickly.

In repainting with calcimine, the old calcimine should first be sponged off with warm water, thus removing all the old calcimine (and the dirt) before applying the fresh coat.

A typical white calcimine powder has about the following composition:

Ingredients	Weight *Percent*	Volume *Percent*
Pigment:		
Whiting	75	70.8
China clay	21	20.6
Binder:		
Glue	3	6.0
Phenol (carbolic acid)	1	2.6
	100	100.0

One gallon of this white calcimine powder
voids weighs 21 lb and has a specific gravity
actual shipping weight of the calcimine wil
this theoretical weight.

(b) Paint; Cement-Water, Powder, White (for Interior and Exterior Use) TT–P–21, June 30, 1941

Portland-cement–water paint covered by th
is intended for use on porous surfaces of mas
stucco, common brick, masonry block, and
(except gypsum plaster). It does not bon
some brands are used satisfactorily on galva
is furnished in two types and two classes, in w

Type I powder contains not less than 65 p
land cement and not more than 25 percent of
type II powder contains not less than 80 perc
cement and not more than 10 percent of hydra
types include from 3 to 5 percent of titaniu
sulfide, or a mixture of these, and from ½ to
water repellents, calcium or aluminum stearat
should give satisfactory service, but where th
moisture, as in swimming pools and water
paint should be used.

Class A powder has no siliceous aggregat
contains from 20 to 40 percent. Class A is
surfaces except open-textured masonry. C
gested for open-joint walls and materials
block, lightweight aggregate block, and si
where a heavy coating is necessary to fill voi
The aggregate in class B tends to lessen ma
crazing. If the texture resulting from the us
taining class B powder is too rough, a coat of
ing class A powder may be used.

Cement-water paint should bond with th
with succeeding coats of paint of either t
finish of high durability. Durability of the c
mined more by the paint surface, the method
and the curing of the paint film than by the
cement-water powder used in the paint.

Most cement-water paint films have ad
when dry, but during rainy weather they fre
nearly transparent. Inclusion of from 3 to 5

696245 46 5

opaque pigments titanium dioxide or zinc sulfide tends to improve the opacity of the wet film.

The surface to which the paint is applied must be clean, damp, and free from dirt, dust, oil, "form-lacquer", or any other substance that would prevent the paint from striking in or bonding to the wall. If the surface to be painted has been previously treated with an organic waterproofing compound or a sealing type of paint, the coating must be removed (preferably by sandblasting). The surface must be sufficiently porous to afford "tooth" for the paint. If there is doubt, as in the case of monolithic concrete, the surface should be lightly sandblasted, etched by washing with "builder's acid" (see glossary), and rinsing thoroughly with water, or dry rubbed with an abrasive stone.

Although cement-water paint can be applied by whitewash brushes or spray guns, the best results are obtained by scrubbing the paint into the surface with a stiff-fiber brush. Thus, a good bond is produced between the paint coating and the wall surface and between coats of the paint itself. This method is particularly recommended for application of type II paint and where waterproofing is desired. Soft brushes are not recommended.

Tints and white may be intermixed to produce a variety of colors; however, the addition of dry tinting colors should be avoided as they should be milled-in by the manufacturer to avoid color streaking.

(c) Paint; Cold-Water, Exterior, Powder (with mixing liquid) TT–P–22, August 30, 1943

This specification covers a low-cost powder paint and a mixing liquid to produce a dry porous film. This "breathing" type of paint is intended for surfaces permeable to moisture and where durability and protection from weather are not required. It is applied chiefly to exterior surfaces of cement, cinder block, and brick, and may be used for weather-beaten wood and for firm interior surfaces such as concrete, brick, and cement.

The paint is obtainable in white and light tints. However, a note in the specification indicates that it may be obtained in dark solid colors, such as camouflage colors. For tints and solid colors, the purchaser should specify the color required and whether the tint should match a designated sample.

To meet the requirements for wet and
white and light tints it is necessary to us
dioxide, or some of the types of zinc sulfide
factory white material passing this specific
to contain 13 percent of milk casein and
percent of hydrated lime. Camouflage colo
Drab, No. 303, Earth Yellow, No. 305, an
should match the appropriate standard sh
card [5]. Paint mixed as in section F-3b
tion, when brushed on the type of hiding-
glossary) described in section F-3g (1),
following minimum wet and dry capaciti

> No more than 7.5 ml of paint spread
> of 1 sq ft shall be required to attain co
> dry hiding.[2]

In addition to matching the color standa
flage colors should show the following min

> No more than 6 ml of paint spread
> of 1 sq ft shall be required to attain co
> dry hiding.

The opacity requirements for colors of
flage colors should approximate those of
colors that they most nearly match.

The use of linseed oil, raw or boiled, a
in addition to water, as mixing liquids f
paint has long been a common practice. I
impart weather resistance and flexibility,
an oil-in-water emulsion in casein powder p
available are specially processed drying o
emulsifier and stabilizer to disperse the o
water. Such "water-dispersible" oils co
percent by weight of solids. Either type
duce satisfactory paints, but when the in
specifies emulsified oils, the testing labo
notified because the emulsified oil will no
Federal Specification for boiled linseed oil.

The surface to which the paint is applie
and uniformly damp. Loose paint, dirt,

[2] Lighting and viewing conditions [10].

removed by scraping and by brushing with a wire brush; calcimine and glue-bound water paint can be removed by washing. Metal should be primed with a suitable oil paint (such as red lead paint, Fed. Spec. TT–P–86) before water paint is applied.

Powder paint should be purchased by net weight. In the case of tints, the purchaser should specify the color required and whether it shall match a selected sample.

Although this is a performance specification, a typical paint made from 100 lb of white powder, 10 gal of water, and 1 gal of oil contains the following ingredients:

	Weight *Percent*
Titanium dioxide	7.9
Calcium carbonate	18.3
Hydrated lime	2.1
Clay	16.7
Casein	6.8
Preservative	0.5
Linseed oil	4.1
Water	43.6
	100.0

Such a paint weighs about 11.1 lb/gal and has a PV of about 59. This is merely an example, as other formulations may be used under the specification.

(d) Paint; Cold-Water, Interior Light Tints and White TT–P–23a, Mar. 22, 1940

The cold-water paint covered by this specification is furnished in powder and in paste form. It is intended chiefly for decorating plaster and other dry interior masonry surfaces but is sometimes used for temporary exterior work. It is not recommended for use on basement walls if dampness is present because of its tendency to mildew.

The binder in this paint is milk casein, soya bean protein, or other forms of protein. However, the specification is based on physical tests, not on composition.

Dry opacity tests made according to the specification have shown that the same hiding power is obtained from 3.5 qt of one paste and 4.25 qt of another paste with the same content

of zinc sulfide and total solids. The degree
a paste is also affected by the inerts chosen.

Some users are interested in the washabili
paints. In practice, the time required for t
age before it can be washed varies from 5 to
that develop washability slowly may be cle
than those that develop it quickly. Mild
tepid water are recommended for washing t

Before cold-water paint is applied, the su
ered should be free from powdery materia
plaster and calcimine, and should present a
face for painting. Iron and steel should be
paint to prevent rust stains.

The possible variation in porosity of adja
faces may frequently make advisable the a
initial priming or sealing coat to overcom
effects. Such sealers are obtainable in bo
water-base types. An oil-base primer n
Specification TT–P–56 is satisfactory if suc
trates and fills the surface, drying to a
within 18 hr.

Although Federal Specification TT–P
mainly on performance requirements, a typ
der may contain (percentage by weight) abo
22 whiting, 12 hydrated lime, 1 trisodium p
servative, and 10 casein. This mixture has a
of about 2.74, and 1 gal of the powder wei
Type II paste may contain (percentage by
66.7 of the above pigments and casein (to
and 33.3 water. This paste weighs about 1
a PV of about 72. These are merely exa
formulations may be used under the specifi

Directions for mixing with water are us
each package of powder and paste. In the a
tions, the material should be thinned to a
tency for brushing. Although paints shou
mixing requirements stated in sections E–1b,
of the specification, it is better practice to us
day they are mixed.

Samples are not usually necessary. If
should be called for in the invitation for bid
of the bid sample should be stated, the specif
in all other respects.

(e) Paint; Resin-Emulsion, Interior, Paste Light Tints and White TT–P–88a, May 26, 1945

This specification covers a water thinned paste paint of the resin-emulsion type that may be applied as a decorative coating on interior walls and ceilings of plaster. In addition to plaster, it may be used on concrete, brick, masonry, wallboard, and fabric. Paint meeting this specification is not intended for wood and metal but may be used on such surfaces if they are suitably primed.

This cold-water paint dries in 1 to 3 hr and may be recoated in 6 to 8 hr. The film becomes hard after drying overnight.

Before this paint is applied, the surface should be free from powdery material, such as dust, calcimine, or loose plaster, and should present a sound, firm surface for painting.

Attention is called to suggestions regarding porous surfaces and washing, given in section III–4–(d) of this manual, which also apply to this and similar paints.

The paint can be applied either by brush or spray, but not in freezing weather. The brushes should be washed with soap and water before the paint dries on the brush. Although emulsion paint is usually applied by brush, it can be applied by spraying and by "roller" coating. The latter procedure has become very popular as a quick and easy method for applying emulsion paint to the surfaces of walls and ceilings.

Directions for mixing the paste with water are usually printed on each package. Nothing but water should be added to the material unless otherwise recommended by the manufacturer. For application to plaster, 2 parts by volume of paste are usually thinned with 1 part by volume of water so that 1 gallon of paste makes 1½ gal of paint. For porous surfaces, 3 parts of paste can be thinned with 2 parts of water. For spraying, 5 parts of paste are thinned with 2 parts of water. These proportions are approximate. When given, the manufacturer's directions should be followed.

Federal Specification TT–P–88a is based mainly on performance requirements, and considerable latitude is allowed the manufacturer regarding composition. The product is an oil-in-water emulsion in which the vehicle is an emulsion of film-forming oils, resins, etc., in an aqueous phase. The water or outer phase contains a number
cluding water; an emulsifying agent (see
casein; a bodying agent, such as alginate
a preservative, such as phenol and its d
foaming agent, such as pine oil or butyl a
alkalies, such as ammonia. The oil phase
resins, and driers. A type used before t
an oil-modified alkyd resin (see glossa
resins became critical because of the war
sisted of materials such as ester gum an
formulation of such a product requires
and experience on the part of the manu

The pigments used are the same as in hi
consisting of titanium-base and zinc sul
together with extenders such as clay, mi
silicate for white colors.

A typical paste paint contains (perc
about 50 percent vehicle (25 to 30 perce
50 percent pigment. An average past
lb/gal and the PV is about 54.

(f) Whitewash

Whitewash is one of the oldest paint
for both exterior and interior surfaces;
telephone poles, roadside obstructions,
and brickwork.

The principal ingredient in whitewas
satisfactory paste can be made with hydr
results are obtained by using quicklime t
with enough water to make a moderately
been kept in a loosely covered container
preferably months. Eight gallons of s
produced by slaking 25 lb of quicklime
or by soaking 50 lb of hydrated lime in 6
paste should then be strained through a fi
lumps or foreign matter.

Whitewash can be made from variou
lime paste and other ingredients. Two
whitewash are

FORMULA NO. 1

Casein	
Trisodium phosphate	
Lime paste	

The casein should be soaked in 2 gal of hot water until thoroughly softened (approximately 2 hr). The trisodium phosphate dissolved in 1 gal of water is added to the casein mixture and the casein allowed to dissolve. This solution should be mixed with the lime paste and 3 gal of water. Such a whitewash shows the following characteristics:

Ingredients	Weight *Percent*	Volume *Percent*
Hydrated lime	29.0	15.0
Casein	2.6	3.1
Trisodium phosphate	2.6	1.9
Water	65.8	80.0
	100.0	100.0

The whitewash weighs 10 lb/gal and has a specific gravity of 1.21; one pound bulks 0.099 gal. The PV is about 75.

FORMULA NO. 2

Common salt	12 lb
Powdered alum	6 oz
Molasses	1 qt
Lime paste	8 gal

The salt and alum are dissolved in 4 gal of hot water, after which the molasses is added to the mixture. The resulting clear solution is then added to the lime paste, stirred vigorously, and thinned with water to the desired consistency. This whitewash has a yellow tinge when first applied, but the color disappears in a few days, leaving a white film. Material made according to this formula is used by highway departments for marking trees, poles, and other objects on highways.

If skim milk is available, a satisfactory whitewash or cold-water paint can be made by diluting a moderately heavy, cold, lime paste (about 33 lb of hydrated lime and 8 gal of water) with 5 gal of skim milk.

For additional information on whitewash the purchaser is advised to consult the bulletin of the National Lime Association mentioned in reference [11].

7. MISCELLANEOUS MATERIALS USED BY PAINTERS

This group covers materials that cannot be classified, such as fillers, putty (see glossary), paint and varnish removers, waxes, bituminous plastic cement, and asphalt roof-coating.

(a) Filler; Wood, Paste
TT–F–336a, Sept. 20,

Wood filler is a mixture of silex or
quick-drying varnish used to fill the p
wood, such as oak, before varnish is ap
before painting. The paste filler is
consistency with turpentine or mineral
filler covered by this specification is
open-grained floors and flooring. Whe
substituted for a pigmented liquid woo

In applying the filler, a thick coati
into the wood with a stiff brush. Aft
paste can be wiped off across the grain
should then be rubbed well with excels

Paste wood filler should be purcha
Samples are not usually necessary. If
be called for in the invitation for bids.
bid sample should be stated, the spec
all other respects. (For colored filler s
specification).

The lightest and heaviest uncolored
this specification show the following ch

	Weight *Percent*	Volume *Percent*	*lb/gal*
Light filler	..	..	15.82
Pigment	78	56	....
Nonvolatile	17	32	....
Volatile	5	12	....
	100	100	

	Weight *Percent*	Volume *Percent*	*lb/gal*
Heavy filler	..	..	17.24
Pigment	85	66	....
Nonvolatile	10	21	....
Volatile	5	13	....
	100	100	

When 10 lb of the lightest paste is
(1 gal) of mineral spirits, a lightweig
the following characteristics is produce

	Weight *Percent*	Volume *Percent*	*lb/gal*	*gal/lb*	sp gr	PV
Thinned light filler	..	..	10.22	0.097	1.226	64
Pigment	47	22	....	....	....	..
Nonvolatile	10	12	....	....	....	..
Volatile	43	66	....	....	....	..
	100	100				

(b) Putty and Elastic Compound; (for) Metal-sash Glazing TT–P–781a, July 12, 1941 Amendment 1, July 20, 1943

(c) Putty; Pure-Linseed Oil; (for) Wood-Sash Glazing TT–P–791a, June 25, 1938 Amendment 1, July 20, 1943

Before glazing, both old and new surfaces should be free from dampness, ice, dirt, and loose paint. Such substances can be removed by drying the surfaces, then wiping them clean with a cloth saturated with turpentine, mineral spirits, or similar solvent. Suitable priming coats should be applied to the bare clean wood or metal before applying the putty. These priming coats on wood should be allowed to dry and should prevent excessive loss of oil or other vehicle from the putty or glazing-compound. Many glazing technologists do not recommend a primer, such as shellac, that dries to a hard glazed surface. Suitable materials for priming wood are thin white-lead–linseed-oil paint, Federal Specification TT–P–40, amendment 1, type II; exterior primer paint, TT–P–25, amendment 1, or spar varnish, TT–V–121b, thinned with one-fourth its volume of mineral spirits or turpentine. These coatings should be allowed to dry hard before putty or elastic glazing compound is applied.

All steel sash should be primed with a rust-inhibitive paint, for example, red-lead paint conforming to Federal Specification TT–P–86, amendment 1.

Putty and elastic glazing compound should be painted within 2 months after application. However, the paint should not be applied until the putty is hard and thoroughly set, as the formation of an airtight film retards drying and may later cause the surface of the paint to check. Certain special quicksetting putties must be painted within a week of exposure to the weather to avoid deterioration of the

putty. Paint should be applied carefully
paint coat to extend slightly beyond the
on the glass to form a seal.

Glazing materials covered by Federal S
P-781a are intended for general use for the
sash and are analogous to (but not alway
the best plastic calking compound conform
Insofar as it is practicable, glazing mat
formulated to afford maximum ease of ap
detracting from durability.

Type I covers elastic glazing compounds
mainly for glazing either interior or exteri
also properly primed wood sash. It shou
surface but should remain slightly soft a
neath for a reasonable period of time. Th
condition is desirable where windows, glaz
ing transoms, and elevator housings are su
able vibration, and on skylights, where ma
is necessary. Consequently, type I materia
fied where low annual maintenance cost i
portance. If available, it should always
manent structures.

Type II covers a metal sash putty of lo
type I, but is probably satisfactory for tem
Both types of glazing material should be a
to the manufacturer's directions.

Glazing materials should be used while t
and as they come from the container, wit
any thinner. Therefore, the materials sho
in relatively small amounts for immediate

Type I elastic glazing compound meet
tions may contain whiting, a small amount
a mixture of bodied drying and semidry
fish and soybean, drier, and thinner. It h
the following characteristics:

	Weight *Percent*	Volume *Percent*	*lb/gal*
Elastic glazing compound	..	..	17.42
Pigment	85	65.9	....
Nonvolatile	13	28.9	....
Volatile	2	5.2	....
	100	100.0	

Federal Specification TT–P–791a covers the requirements for high-grade linseed-oil putty for general use on woodsash glazing. It is furnished in types I and II. Although the two types may be used interchangeably, type II is recommended where a hard material is desirable, such as for filling holes and cracks. Some users consider it more durable than type I putty.

Type I whiting putty with the maximum pigment has the following characteristics:

	Weight *Percent*	Volume *Percent*	*lb/gal*	*gal/lb*	sp gr	PV
Putty, type I	..	..	18.18	0.055	2.18	74
Pigment (whiting)	88.0	71.2	....	....	....	..
Nonvolatile vehicle	10.8	25.5	....	....	....	..
Volatile vehicle	1.2	3.3	....	....	....	..
	100.0	100.0				

Type II white-lead–whiting putty with maximum pigment shows the following characteristics:

	Weight *Percent*	Volume *Percent*	*lb/gal*	*gal/lb*	sp gr	PV
Putty, type II	..	..	19.43	0.051	2.33	74
Pigment (white lead)	10.0	3.44	....	....	....	..
Pigment (whiting)	79.0	68.33	....	....	....	..
Nonvolatile	9.9	25.62	....	....	....	..
Volatile	1.1	3.21	....	....	....	..
	100.0	100.00				

Often putty contains less pigment than the maximum specified, usually not less than 85 percent in type I. A typical putty shows:

	Weight *Percent*	Volume *Percent*	*lb/gal*	*gal/lb*	sp gr	PV
Putty, type I	..	..	17.37	0.057	2.08	68
Pigment	85.0	65.6	....	....	....	..
Nonvolatile	13.5	30.5	....	....	....	..
Volatile	1.5	3.9	....	....	....	..
	100.0	100.0				

(d) Remover; Paint and V
(Organic-Solvent Ty
TT–R–251a, Aug. 28, 1
Amendment 2, Oct. 28,

Paint and varnish removers are inte
application to interior surfaces but ma
terior work if this can be done efficie
nished in two types.

Type I paint and varnish removers
in places that are relatively free from
II removers are intended for use wh
against fire hazard is desired. Althou
type may be considered nonflammable i
dition, some discretion must be employe
nonflammable solvents that commonly
of the active ingredients tend to evapo
flammable portion. Thus it is importa
of this type from damaged or leakin
prevent evaporation, as far as practical
of the material.

NBS Letter Circular LC749, Paint a
ers, contains detailed information on
various kinds of paint and varnish rem

(e) Wax, General Purpose; Solvent
Paste (for Floors, Furniture, e
P–W–158, Sept. 17, 1942
Amendment 1, March 11, 1943

This general purpose wax, as the titl
indicates, is intended for use as a polishi
faces as floors (except asphalt or rubbe
is available in one grade and in type
II (paste). The latter may be used
finish on automobiles.

(f) Wax, Floor; Solvent Type, Liqui
P–W–134, Oct. 29, 1942

The floor wax specified herein is int
flooring except composition containing

(g) Wax, Floor; Water-Em
P–W–151a, April 8, 19

This liquid wax is intended for use o
rubber flooring, and linoleum. It is t

does not have to be polished after application. It is a water-wax emulsion, and should be kept in clean containers. Severe or prolonged freezing may break the emulsion, and thus it is suggested that it be not subjected to severe or prolonged freezing temperatures.

(h) Cement; Bituminous, Plastic SS–C–153, Aug. 1, 1933

Bituminous plastic cement is black in color, and composed of a bituminous binder (asphaltic-base in type I and coal-tar base in type II), inorganic filler, such as asbestos fiber, and a solvent. The material is a soft, pliable paste that holds its shape within 2 or 3 days after application and gradually hardens to a tough rubber-like coating that is waterproof and durable. One hundred pounds of the cement spread ⅛ in. thick will cover approximately 150 ft².

Bituminous plastic cement is used on coal-tar pitch, for repairing leaks and cracks in all types of roofs—concrete, tin, composition, or shingle—for repairing chimneys, flues, gutters, spouting, eaves, and cornices, or as expansion-joint material for concrete and masonry. It adheres to brick and mortar and remains elastic, expanding and contracting with the surface. Type I, asphaltic-base cement, is similar to roof coating meeting Federal Specification SS–R–451, except in consistency; it should be used with Federal Specification HH–F–191a flashing felt.

(i) Roof-Coating; Asphalt, Brushing-Consistency SS–R–451, Aug. 1, 1933

Material meeting this specification is known in the trade as asphalt-asbestos roof coating. It is an inexpensive black paint, usually composed of asphalt base (with or without fatty oils), a volatile solvent, and a mineral filler such as asbestos fiber. Because the durability of the coating is dependent upon its thickness, the paint is of heavy brushing consistency and can be spread at the rate of 52 ft²/gal for a film 1/32 in. thick and at 26 ft²/gal for a film 1/16 in. thick. Unlike ordinary paint, this coating should not be brushed out thin.

Asphalt roof-coating is recommended for use on corroded tin roofs that leak. Ordinary linseed-oil paints would be

too thin for this purpose. However, for met condition, linseed-oil paints (Fed. Spec. T preferable.

IV. PREPARATION OF SURFACE APPLICATION OF PAINTING MAT

The success of a painting job depends prim factors: (1) the condition of the surface (2) the condition of the preceding paint coat job, (3) the prevailing atmospheric conditio of the paint and its suitability for the servic is probable that the disregard of these facto cause of paint failures with all materials.

1. WOODWORK

(a) EXTERIOR SURFACES

(1) *New Work.*—Painting should be don dry weather. The surface should be free fr and should not be painted until it feels dr Painting should not be done when the tempe 50° F or in urgent cases below 40° F, and in n temperature is expected to drop 20 degrees 50° F. Precaution should be taken not to pa den drop in temperature. This is accomplish the work early enough in the afternoon to all set before a sudden drop in temperature should not be applied while rain, snow, or sl the surface. As a rule, dry woodwork can mediately after erection. If the lumber or when placed or has been made very wet reason, it is suggested that at least 1 week weather precede the painting.

Oil paint applied over knots and sappy w alligator and peel and with pine woods to c is apt to be more alligatoring of paint over kn exposure, because of more sunshine, and m coloration of the paint over knots on the no sunshine is weakest. The knots may be spo Orange Shellac Varnish (Fed. Spec. TT–V Varnish Replacement (Fed. Spec. TT–V–1 grade aluminum paint applied a day or two l the priming-coat paint. The Western New

the Federation of Paint and Varnish Production Clubs found that an effective sealer for knots consists of pure shellac varnish plasticized with 6 liquid ounces of blown castor oil to the gallon of shellac varnish. This formula originated at the Forest Products Laboratory, Madison, Wis. However, experience in painting army cantonment buildings constructed of No. 2 common southern yellow pine containing many knots indicates that ordinary shellac varnish or aluminum paint is of little value in sealing knots (see section VIII). When shellac varnish is applied too liberally over the knots, the paint on weathering tends to peel off. When the shellac varnish is applied thin, the paint may not peel, but yellow discoloration may show through from the pitch. All pitch should be scraped or burned from knots and other places; it is suggested that these areas then be scrubbed with turpentine prior to painting.

Excessive moisture back of the paint film is responsible for many failures of paint on exterior wood surfaces. The interior plaster in a frame dwelling house contains a great deal of moisture that dries slowly and is drawn through walls into the exterior wood by the heat of the sun. A properly formulated priming coat will permit this moisture to pass through the film. If paint is applied to the exterior wood siding before the new plaster is dry, it may blister (see glossary) and peel.

The usual system of painting houses in white and light tints includes raw-linseed-oil paints like the unamended Federal Specification TT–P–40 and white-lead paints mixed on the job according to the formulas in table 2 for mixing white-lead paint. These paints have the advantage of easy brushing properties and can be spread over large areas, 600 to 700 ft^2/gal. Three coats are usually required on new wood. The cost of labor and the length of time required to complete the job has resulted in the introduction of the two-coat system. These paints may contain heat-treated oils (or varnish) in the vehicle, like that covered by amendment 1 of TT–P–40 and the formulas in table 3 for white-lead paint mixed on the job. A typical primer for a two-coat paint system is exemplified in Federal Specification TT–P–25.

The first coat should always be carefully brushed and crossbrushed, if practicable, over all parts of surfaces so that cracks and nail holes receive enough paint to wet the

surfaces. The older, unbodied, linseed-
be brushed out to cover about 600
type priming paints like those in F
TT–P–25, amendment 1, June 5, 1943,
mixed-on-the-job paints used on a tw
applied at about 450 ft^2/ gal. In good
ing, all coats should be allowed to dry

Nail holes and cracks should be
putty (Fed. Spec. TT–P–791a, amen
1943) as soon as the priming coat is
week of clear, warm weather, the pu
enough to receive the second coat.

Window sills and outside doors
nished. For this work no wood filler
wood is close-grained), but several co
TT–V–121b should be applied. While
rior woodwork properly painted with
of high-grade oil paint approximate
wood should last at least 4 years befor
exposed woodwork finished with goo
nish will probably need to be revarni

(2) *Refinishing.*—Unlike applicatio
limited to good weather conditions, th
surface can proceed under any weathe
is feasible for men to work. The succes
depends on how well any scaling paint
attached paint is removed from the wo
that all insecurely attached paint be
from the surface, otherwise, no matter
failure is apt to occur over any loose pai
prepared surface.

(a) Loose Paint.—All loose paint
by wire brushing or scraping. A comb
methods, depending upon the condition
nature of the surface, has been found
effective. Following wire brushing an
face should be sanded with No. 1½ or N
further insure the removal of loosely
to better prepare the surface for a sm
job. It is recommended that all old pa
flaking be removed, preferably by burni
or by the use of paint and varnish re

686245 46 6

(b) KNOTS.—All pitch should be scraped or burned from knots. In general, no further preparation, such as spot painting of knots with shellac varnish or aluminum paint, is necessary, although customary practices may be followed.

(c) ADDITIONAL MEASURES FOR SMOOTHING SURFACES.—Decayed or split boards that cannot be suitably prepared for repainting should be removed and replaced. All loose boards should be securely fastened, using large-headed nails, preferably galvanized. Protruding nails should be removed or driven into the wood. Open nail holes, and countersunk nails, should be filled with putty. Gaps between ends of siding and corner boards, or window and door casings should be filled with calking compound (Fed. Spec. TT–C–598). Surfaces soiled with foreign matter, such as roofing pitch and tar, should be scraped free from this foreign matter and the surface thoroughly washed with mineral spirits.

(d) MILDEW.—To combat mildew, it is extremely important that mildew-infected surfaces be thoroughly scrubbed with water containing some trisodium phosphate (phosphate cleaner, Fed. Spec. O–T–671a). It is a white powder that can be purchased in small lots as "Technical Trisodium Phosphate," or in grocery stores under brand names. The infected surfaces should be scrubbed with a solution of about three tablespoons of trisodium phosphate dissolved in a gallon of water, using floor scrubbing brushes. The surface should then be rinsed with clean water and allowed to dry before applying the paint.

The most efficient method of combatting badly mildewed areas is to wash the areas with a solution of 1 part of bichloride of mercury dissolved in 300 parts of water. However, this is a dangerous poison, and consequently the use of trisodium phosphate solution is recommended.

When mildew is particularly severe, the priming and finishing paint should contain a fungicide. The bid should specify that, in addition to meeting the Federal Specification, the paint should contain 1 part by weight of mercuric chloride to every 600 parts by weight of paint. The bichloride should be properly ground and evenly dispersed in the paint liquid. The content of mercuric chloride should be stated on the paint container label with the necessary precautions for use. Commercial brands of fungicides other than mercuric chloride have also been developed especially

for use in paint. They are available i
be dispersed easily in the paint by th
application.

(e) APPLICATION OF PAINT.—After
pared for repainting, all bare spots sh
with TT–P–25 exterior primer, followe
coat (or any other color desired). If
been removed, the entire surface shou
TT–P–25 exterior primer.

(3) *Staining of Shingles and W*
are thin, fluid paints in which the shing
being laid. Suitable stains properly a
rough siding give a durable finish on

With the exception of some dark-bro
refined coal tar or creosote and vola
stains are usually made from very fin
drying oils, and volatile thinners. Ma
stains contain some creosote oil. Howe
servation of wood, creosote must be fo
a hot-pressure treatment. As oil paint
is likely to be ruined by the creosote
glossary), pigment-oil shingle stains
preferable if repainting is contemplate
making shingle stains from suitable
as TT–P–381, is a mixture of 3
(TT–O–356a, class 2) and 1 part of eit
seed oil. Federal Specification numbe
are given in table 10 and color designa

The following is a list of the mos
Some of these colors may not be obta
war emergency:

Brown:	Metallic brown.	Red:	
	Sienna, burnt.		
	Umber, burnt.		
Green:	Chromium oxide.	Yellow:	

Other stains are made by dissolving
solvents or other liquids, including wa
made stains are used oftener than th
The manufacturer's directions for a
followed. Some of these stains will bl
over them. Usually it is difficult to lig
viously stained wood; it can readily b

and interior wood stains are covered in Federal Specifications TT–S–706 and TT–S–711.

(4) *Porch Floors.*—Wood porch floors should be as carefully prepared for painting as other exterior surfaces. A priming coat of paint mixed on the job can be made according to the formulas in tables 1 or 2. The paint should be well brushed out, not flowed on in a thick film. If ready-mixed paint is used, it should comply with Federal Specification TT–P–146. Each gallon of paint should be diluted with 1 qt of thinner containing 2 parts of boiled linseed oil and 1 part of turpentine for the priming coat. After the first coat is dry, joints, cracks, and other defects should be filled with putty firmly pressed in and smoothed over with a putty knife. When the putty is dry, the surface should be lightly sandpapered.

The second coat may be mixed according to the formulas in tables 1 or 2, tinted to a shade of gray darker than the first coat but lighter than the finish coat. If ready-mixed paint (Fed. Spec. TT–P–146) is used, 1 pt of the mixture used to thin the priming coat should be added to each gallon of the paint. A third coat (if desired) can be made by adding 1 pt of high-grade spar varnish to each gallon of a desired gray finish-coat prepared according to the finish-coat formula in tables 1 or 2. Ready-mixed paint (Fed. Spec. TT–P–146) can also be used for the third coat; if too thick to be spread easily, the paint can be thinned slightly with turpentine or mineral spirits.

(b) INTERIOR SURFACES

The same directions for preparing the surfaces of new exterior wood for painting apply to interior woodwork. In addition to having the surface clean and dry, it is advisable to roughen very smooth wood slightly with fine sandpaper.

(1) *New Work.*—Durable and attractive finishes on interior woodwork and wood furniture are obtained from varnish and analogous materials. Linseed-oil paints used on exterior wood may not be suitable for interior work because of slow drying and tendency to turn yellow.

There are some hardwoods with strongly colored heartwood that tend to become lighter in color in strong light, but most of our important native woods darken in sunlight, even under a good coating of white paint, and remain relatively unchanged in darkness. Wood when kept dry will last for centuries indoors.

Varnishes applied to interior surface
age. Consequently, wood coated with i
kept indoors may darken if not exposed
but otherwise remain in good condition f
the contrary, wood kept indoors and exp
light may result in the failure of the v
in a few years.

Wood stains are widely used to either
the color of interior wood without obs
grain. Wood stains can be purchased u
fication TT–S–711 or may be made in
first method, colors-in-oil (Fed. Spec.
mixed with flatting oil (Fed. Spec. T
By the second method, wood stains can
½ pt of color-in-oil with 1 gal of thi
liquid is composed of 1 part raw linseed
tine, and ½ part drier (Fed. Spec. TT–I
is usually obtained from raw sienna. Da
obtained by mixing a small quantity o
the light-oak mixture. Mahogany and
obtained by using burnt sienna.

The usual system of staining and varn
trim is to apply the coats in the follow

1. Stain coat (Fed. Spec. TT–S–711

2. Filler coat for open-grain woods o
F–336a).

3. Sealer coat, bleached shellac va
TT–V–91a). This coat is needed only
aniline dye, for example, mahogany sta

4. First coat, varnish (Fed. Spec.
with ½ pt of turpentine per gallon.
should be sanded lightly when dry with

5. Second-coat, varnish (Fed. Spec.
without thinning. Should be sanded sa

6. Third coat, varnish (Fed. Spec.
a dull rubbed finish is wanted, let the
dry hard for 72 hours; then rub with p
water to a uniform dull finish.

The best results will be obtained if va
ing to the following instructions:

1. Smooth, thin coats should be app
temperature between 70° and 80° F, and
room.

2. Varnish should be brushed on with the grain of the wood, crossbrushed, then brushed again with the grain of the wood.

3. The minimum number of coats necessary to attain the desired finish should be applied.

4. Ample time should be allowed for the coats to dry.

5. Freshly varnished work should be kept clean and dust free.

6. Each coat should be rubbed lightly with fine (No. 4/0) sandpaper to a dull finish before the next coat is applied.

7. Brushes and varnish cans should be kept free from dust.

A durable and attractive finish on interior furniture (particularly on a mahogany table top) is an oil-rubbed finish. The unfinished wood should be frequently rubbed with boiled linseed oil thinned with turpentine or mineral spirits, the excess oil being wiped off. Raw linseed oil alone is also used. This process is repeated four or five times, after which the oil need only be applied at occasional intervals. After the pores of the wood have been filled with linseed oil by the first series of applications, any animal or vegetable oil or fat may be used. The more the finish is rubbed, the better it will be. After long years of use, a beautiful patina is developed. Hot dishes placed on a table top do not turn this finish white. Because the process of oil polishing is tedious and slow, it is not used much today. Modern production schedules in finishing wood furniture at the factory call for either nitrocellulose lacquers, or low-bake (140° F), thermosetting, synthetic-resin finishes.

PAINTING AND ENAMELING.—In painting interior woodwork for flat finish, the first coat may be primer and sealer covered by Federal Specification TT–P–56, followed by one or two coats of TT–P–51a eggshell flat paint. The TT–P–56 primer does not dry hard enough to sand, and thus should not be considered as an "enamel undercoater." This material can be made by adding ¼ gal of TT–P–56 primer to a gallon of TT–P–51a paint. This could be used directly on the wood, omitting the TT–P–56 primer, or as an enamel undercoat over the TT–P–56 primer.

A semigloss finish on interior wood may be produced by using two coats of paint composed of equal parts by volume of TT–P–51a paint and TT–E–506a enamel. The first coat should be thinned with 1 pt of turpentine to 1 gal of paint.

A full-gloss finish on interior wood can be obtained by

the application of two coats of TT–E–5
first coat should be thinned with 1 pt of t
gallon of enamel. For better hiding powe
gloss finish, two coats of enamel underco
(equal volumes of TT–P–51a and TT–E–5
a single coat of TT–E–506a enamel.

(2) *Refinishing.*—Surfaces that have
finished should be properly prepared for r
can be removed by sanding the surface li
sandpaper. Holes or cracks should be f
wood (see glossary) that has been stained
face, sanded, and spot-varnished. After
treatment, the woodwork is ready for t
varnish.

Cherry and mahogany stained wood ma
dyes that "bleed" through paint or enam
enamel is to be applied to such surface
should first be sealed with a thin coat of
with a freshly mixed aluminum paint in t
2 lb of aluminum powder to 1 gal of Inter
eral Specification TT–V–71a (see also for

If the surface is to be refinished by pa
intended for interior use should be appl
primer for interior wood is Plaster Pr
TT–P–56. This can be followed by Egg
Ready-mixed Paint, TT–P–51a, the finis
quently applied to interior surfaces. If
is desired, Gloss Enamel, TT–E–506a, can
tain finishes with intermediate degrees
paints can be mixed in various proportion
equal parts of these two paints, TT–P–51a
may be used as a finish coat for bathroom

2. MASONRY, CONCRETE, AND

(a) EXTERIOR SURFACES

(1) *Oil Paints.*—Exterior surfaces tha
with oil paints require careful preparati
back of the paint film will seriously imp
or varnish-base paints, when applied to c
masonry, walls made of these materials
oughly dry before being painted. The dr
from 3 to 12 months and will depend upo
tions and upon the thickness and porosity

is equally important to prevent water from entering the wall after painting.

To seal open-textured walls, cinder block for example, it is advantageous to apply a cement-sand grout as the base coat. The grout can be used on new masonry that has not been coated previously with a sealing type of paint or with an organic waterproofing compound. The grout is composed of approximately equal parts by volume of portland cement, fine sand passing a No. 18 sieve, and water.

Before the grout coating is applied to the walls, water should be forced into them by means of a garden hose. They should then be allowed to drain until no free water remains on the surface. The grout coating should be scrubbed in with a stiff-fiber brush, thereby forcing the grout into the openings and producing a surface of uniform porosity. It is advisable to avoid hot, sunny days in applying the grout coating.

To insure proper hydration of the portland cement used in grout, damp-curing is necessary. The grout should be wet with the fine spray of a garden hose. This operation can be started after the grout has set sufficiently that it will not be damaged by the spray (usually about 6 hours) and should be repeated about twice a day over a period of 48 hours, depending upon weather conditions.

Faulty mortar joints and map cracks in stucco or concrete may be filled with grout. Large cracks in masonry walls should be cut V-shape and filled with mortar composed of 2 or 3 parts of sand with 1 part of portland cement, and enough water to give a putty-like consistency. After the mortar has set, it should be damp-cured by the same method suggested for the grout. A minimum of 90 days of good drying weather should elapse before oil paint is applied over the grout- or mortar-filled joints and cracks.

Adequate preparation and cleaning of the surface to be painted improves the durability and appearance of the paint coating. Dirt and dust can be removed with brushes of stiff fiber or wire. Efflorescence can be removed by wetting the surface with water, applying a solution of muriatic acid at least 20 percent in strength and, after 5 minutes, scouring off the salt deposits with a stiff brush. After each acid treatment the surface must be promptly and thoroughly washed with an abundance of water. Traces of oil can be removed with steel brushes, abrasive stones, or a lye solution. However, if the surface is generally contaminated

with oil, it is more effective to lightly sand
be painted or to postpone painting until
removed by action of the weather.

Because paint does not adhere well to
glazed surfaces, it is suggested that, prepa
ting, they be either acid-washed, lightly
rubbed with coarse-grit abrasive stones. T
frequently necessary for concrete cast a
Presdwood, or steel forms. Brick that is
glazed should also be roughened with abra

Old coatings of organic waterproofing
cement-water paint still in good condition n
However, whitewash and peeling, scaling,
should be completely removed.

Oil gloss paints, which are suitable for
wood or metal, may also be used on proper
dry masonry. Paints meeting Federal Spe
40 are suggested for white and light tints
creams, light buffs, and ivory; TT–P–31a
for dark reds and browns. For a dull-finis
and light tints TT–P–24 should be used.
can be made by thinning each gallon of
finish coat paint with 1 qt of spar varnish
faces and 2 qt for rough porous surfaces a
½ pt of mineral spirits or turpentine. Th
be applied without thinning.

Oil paints should not be applied during
weather or when the temperature is below
1 week of clear, dry weather should preced
of the first coat. As masonry surfaces ten
collect condensed moisture, painting early
and late afternoon should be avoided excep

(2) *Water Paints.*—Exterior masonry ca
coated with water paints if the surface is p
and directions for applying the paint are ca

Cement-water paint should bond with
with superimposed succeeding coats of eit
to form a cementitious finish of high durab
bility of the coating is influenced more by t
the method of application, and the curing
than by the composition of the cement-wat

For additional information on paintin
water paint, the reader is referred to sectio
this manual.

(b) INTERIOR SURFACES

Interior surfaces of masonry concrete and plaster should be prepared for painting in the same way as similar new exterior surfaces. Finish coats may be either oil paints or water paints.

(1) *Flat Finish.*

OIL-TYPE PAINT.—In painting new walls of plaster or concrete, the first coat should be primer and sealer (Fed. Spec. TT–P–56). This should be applied without thinning. The second coat should be TT–P–51a eggshell flat paint, applied without thinning. In place of this system, the wall may be painted with 2 coats of TT–P–47 paint. For repainting, the surface should be primed and sealed with TT–P–56 primer, followed by a coat of TT–P–51a eggshell flat. As an alternate, the surface may be painted with a single coat of TT–P–47 paint.

WATER-THINNED PAINT.—The plaster or concrete should be free from grease, wax, dirt, or calcimine. Cracks and holes should be filled with patching plaster. These areas should be spot-primed with the water paint. On old painted walls that are glossy, the surface should be washed with water in which is dissolved some trisodium phosphate (about 2 oz per gallon) before applying water paint. On porous surfaces, particularly when the porosity varies, a special primer may be necessary before applying casein paint, Federal Specification TT–P–23a. Resin-oil emulsion paint, TT–P–88a, can generally be applied directly to the plaster or wallboard. One gallon of paste is thinned with 4 pints of water. One or two coats of this paint is sufficient.

(2) *Semigloss Finish.*—For both new and repainted work, the first coat should be Federal Specification TT–P–56 primer and sealer. If suction spots appear after this paint is dry, they should be spot-primed with the primer. The second coat should be semigloss wall paint. This may be prepared by mixing 1 gallon of either TT–P–51a flat or TT–P–47 flat and 1 gallon of TT–E–506a enamel.

(3) *Full-Gloss Finish.*—First coat should be TT–P–56 primer and sealer, allowed to dry 24 hours. Second coat should be enamel undercoater (equal parts by volume of either TT–P–51a flat or TT–P–47 flat and TT–E–506a gloss), allowed to dry 24 hours. Third coat should be TT–E–506a enamel.

For a discussion of paint failures on plaster the reader is referred to NBS Letter Circular LC301, Painting Plaster.

(c) CEMENT FLOORS

(1) *General Suggestions for Preparin*
—The surface of interior and exterior co
painted should be clean, dry, and in a su
receive the paint. It is suggested that
floors age for 1 year prior to painting. T
be applied when the humidity is very low
results, the application of two coats is re
type of floor coating to be used should
prevailing conditions and by the limitati
floor paints.

(2) *Floor Paints and Enamels.*—One
lar finishes for cement floors is a paint or
to a solid, opaque film. This type of fi
using as a paint base, natural resins, sy
example phenol formaldehyde and coum
chlorinated and crepe rubber. Tung oil i
these materials to give water- and alkali-r
bility.

(3) *Varnish-Type Paints.*—Where a c
above grade and not on the ground, and
not encountered, the varnish type of fl
give good service. A satisfactory varn
concrete and wood floors is Federal Speci
P–146. If this material is used, a prim
made by thinning 4 parts of the paint wi
ture consisting of 2 parts of spar varnish
pentine. The finish coat can be applied

(4) *Rubber-Base Paints.*—Where a c
below grade directly on the ground, as i
and where dampness due to condensation
ber resin-base paint, Federal Specificatio
gested. This type of paint is not a "cur
resistant and does not soften when the fl

Surfaces to be coated with rubber-base
cial preparation in that cement floors are
hard and smooth. Because this type
adhere well to smooth surfaces, the floor sh
by etching with a solution containing fr
muriatic acid to each gallon of water.
tails the reader is referred to section I
manual.

When the floor is clean and dry, at
rubber-base paint should be applied.

each gallon should be thinned with either 1 qt of mineral spirits or the thinner recommended by the manufacturer and should be spread at the rate of 300 ft²/gal. The second coat should be applied directly at the rate of 600 ft²/gal. It should not be used over other types of floor paint.

(5) *Maintenance.*—A thin film of wax protects any of the finishes described. The wax can be renewed at frequent intervals where the floor is particularly worn. A liquid floor wax of the organic solvent type is generally more serviceable than a water-emulsion wax. For a detailed explanation of the use and preparation of waxes, see NBS Letter Circular LC764, Care of Floors. The reader is also referred to NBS Letter Circular LC758, Finishes for Concrete Floors.

(6) *Refinishing.*—The method of preparing floors for refinishing depends upon the condition of the surface. If the paint has been waxed and is in good condition, except for worn areas, the wax should be removed by applying turpentine or petroleum spirits and scouring with steel wool while still wet. Paint applied over wax does not dry satisfactorily. Paint that is peeling can be removed in several ways. One method is to soak the surface for about 30 minutes with a solution of 2 lb of caustic soda (household lye) dissolved in 1 gal of hot water. Another method is to cover the floor with a thin layer of sawdust that has been soaked in the lye solution, allowing it to remain overnight. In either case, the old paint can then be removed with a wide steel scraper and the surface rinsed thoroughly with clean water. CAUTION: The operator should be protected by rubber gloves and goggles. If the solution is spilled on the skin, the spot immediately should be flushed with water and brushed over with vinegar to prevent severe burning.

3. FERROUS METAL: STRUCTURAL IRON AND STEEL

Nonmetallic structural materials are painted primarily for decoration. However, the chief purpose of painting structural iron and steel is for protection, the decorative value being secondary. In painting structural steel, such as bridges, water towers, and any other similar type of structure that must stand for many years exposed to the weather, the price of the paint alone is not an accurate "yardstick" with which to measure the cost of maintenance painting. As the cost of the paint seldom represents more than 25 percent of the total cost of painting such structures, it is good prac-

ice to apply a durable paint and a suf
to insure long service. New work sho
coats and two covercoats, or topcoats.
price of the paint may be relatively h
lon should not be the yardstick by whi
ing job is judged. It costs at least as
of poor or fair quality as it does one
Thus, over a period of years, the mos
cheapest, the real yardstick being the
paint applied per year of service.

To illustrate: A water tower wit
is to be repainted with one coat of p
of paint; paint A costs $3.00 per gall
per gallon; the labor cost is three time
Paint A gives 5 years of service and p
the cost per square foot per year of
is as follows:

Paint A	*Pa*
$ 30.00 for paint	$ 25.0
90.00 for labor	75.0
$120.00	$100.0
6000)120.00(.20	6000
5).20(.04	3).

In the above example, A and B p
have the same spreading rate (600
paint that costs less per gallon does
higher-priced paint.

The inference to be drawn from th
the highest-priced paint is necessarily
that over a period of years, the most
on a cost per square foot basis, is the
of the price per gallon of the paint.

(a) CLEANING

Proper cleaning of steel surfaces is
the most important operations to be
painting. Because the life of any p
pendent upon surface preparation, th
considerable attention by technolog
(American Institute of Steel Constru
(Iron and Steel Institute). To att
paint must make intimate contact wit

it is applied. Any foreign substance present on the steel (such as dirt, grease, oily scum, moisture, acids, alkalies, rust, or loose scale), even though the substance may be invisible, separates the paint from the steel.

There are a variety of methods of cleaning and preparing steel for painting, including mechanical cleaning processes (sand, shot, or grit blasting, scraping, wire-brushing, chipping, and simple hand wiping); flame cleaning; and various chemical cleaning processes (hot alkaline solutions, organic solvents, including solvent vapor degreasing, alcoholic phosphoric acid cleaners, hot acid phosphate cleaners containing detergents, and emulsion cleaners).

For example, oily substances can be removed by using organic solvents (by dipping, wiping, but preferably by solvent vapor degreasing), hot alkaline solutions followed by thorough rinsing, or self-emulsifying cleaners.

FLAME-CLEANING.—A relatively new process for the preparation of steel surfaces for painting is "flame-cleaning." This consists of a special torch through which an oxyacetylene flame is applied to the steel surface. This process removes loosely adherent scale and rust. In addition, the process drives moisture from the surface ("dehydrates" it). Thus, if the paint is applied while the steel is still warm, a good bond between the priming coat and the steel should result.

The most widely used but least-efficient method is hand cleaning with a scraper, hand-or power-driven wire brushes, and chipping hammers. This method is used to remove rust and loose scale.

Loose rust and scale can be removed by partial sandblasting, but closely adhering millscale will remain. If the remaining millscale is tightly bonded to the steel and if the surface is properly painted, good service may be expected.

All rust, scale, and other coatings can be removed by pickling, or by complete sandblasting with fine, sharp sand to leave a uniform surface resembling frosted silver. With the former method, the article is pickled in a 5-percent solution of hot (160° to 180° F) sulfuric acid, rinsed with water, dipped in a 5-percent solution of phosphoric acid, and rinsed again with water. Sandblasting and pickling are the best methods of preparing steel for painting. If the steel is not painted soon after these operations, it is advisable to flame-clean the surface immediately before the first coat of paint is applied.

(b) RUST-INHIBITIVE WASH

Rust-inhibitive washes are solutions
rectly formulated, etch the metal and for
ing of uniformly fine texture, thus produ
tive surface receptive to the priming pa
tion of these washes to iron and steel arti
ing is practiced extensively in factories.
on steel work after erection of the struc
recently. There are several such processe
are, for the most part, patented.

Tests on clean, sandblasted steel have
U. S. Engineer Office, Rock Island, Ill
relative value of various inhibitive wash
for steel. The results indicate that co
wash-coat inhibitors, when properly use
with all types of paint coatings used o
particularly effective with coatings of th
taining zinc chromate and iron oxide.
Rock Island indicate that the most sati
centration is approximately 8 percent (s
hibitive wash). The washes should be
scale-free steel, following the manufactu

Tests at the National Bureau of Stand
the rust-inhibitive treatment should be al
the steel and become dry. It should t
washed with water to remove excess inh
to dry before applying paint. Further i
use of anticorrosive treatments for steel
Methods of Investigation of Surface Tre
sion Protection of Steel, BMS44, Surf
Steel Prior to Painting, and BMS102, P

A satisfactory inhibitive wash origin
Engineer Office has the following compo

Orthophosphoric acid (commercially pure, H
Sodium dichromate ($Na_2Cr_2O_7.2H_2O$) .....
Caramel solution .....
Wetting agent (such as "Cellosolve" (ethy
monoethyl ether) ($C_2H_5OCH_2CH_2OH$) ..
Water .....

Some of the patented washes contain
heavy metals, such as zinc, manganese, an

The following description illustrates the use of the wash on structural steel in the field [12]:

"02. *General Painting Provision.—(a) Surface Cleaning and Preparation.*

"*(1) Unpainted Ferrous Surfaces* of parts to be fabricated or erected at the site where the structure is completed shall be shipped from shops or places of manufacture without paint. After erection or complete permanent installation in place, they shall be entirely cleaned of all millscale and other foreign substances to base metal, by sandblasting. As soon after cleaning as practicable and prior to formation of any form of corrosion from atmospheric moisture or other causes, all metal surfaces to be painted shall be thoroughly treated with the chemical rust-inhibitor, applied by brush and permitted to dry. This chemical inhibitor, however, shall be applied only under conditions such that the temperature of the surfaces to which applied and the air in contact therewith, are between 50° F and 110° F. in order to insure proper chemical reaction with the metal. After drying, any unneutralized reactive residue (characterized by a sticky, black, or dark-green appearance) on the surfaces shall be removed by thorough wiping with wet cloths and the surfaces redried. The inhibited surfaces shall then be given a priming coat of paint, as soon thereafter as practicable, but in any event prior to deterioration or destruction of the inhibited surface. Should the inhibited surface be damaged or destroyed at any point by any *means whatsoever, the surfaces shall be cleaned* and reinhibited in an approved manner prior to application of the paint.

"*(2) Alternate pre-erection cleaning and inhibiting.*—Upon specific written request by the contractor, the contracting officer may authorize alternate mill or shop pickling, or sandblasting and inhibiting, prior to fabrication or erection, in lieu of the field sandblasting and inhibiting after erection as specified in subparagraph (1) above. Where this is desired, however, the contractor shall provide at his expense an original additional coat of zinc chromate-aluminum primer-metal which shall be applied immediately following the application and drying of the chemical rust-inhibitor, in order to protect the surfaces against corrosion during the period of fabrication and erection or until the specified painting is begun, provided that this period shall not exceed 9 months for one coat. This pre-erection or construction period coating shall be maintained in good condition by re-inhibiting and repainting any areas damaged during the construction period, and after 9 months of service the coating shall be completely renewed. Prior to the application of the specified permanent field paints, the surfaces of the construction coating shall be thoroughly cleaned with mineral spirits and all welds or other unpainted areas shall be properly cleaned and inhibited."

(c) PRIMING PAINTS

Both inhibitive washes and paints are usually applied to structural steel by brushing, but they may also be applied by spraying. The paints used for spraying are mostly of the oil type, which require considerable time for drying. A widely used priming paint for structural steel exposed to

the weather is red lead meeting either
TT–P–86, or amendment 1 to that s
can also be used for other intermedia
darkening each coat with the additi
lampblack-in-oil, but it is unsuited f
lead paint (Fed. Spec. TT–P–20) is
priming and body coats. Iron oxide
all coats. An aluminum paint may
coat (but not the priming coat) on
subjected to rural exposure; black pa
61a) may also be used for the finis
exposures, flake graphite paint (Fe
iron-oxide paint (Fed. Spec. TT–P–
coats. A durable system of painting
of two coats of a rust-inhibitive primi
red-lead, TT–P–86, or blue-lead pain
by two coats of a topcoat, or finish-co
carbon black paint, TT–P–61a; flak
P–27; iron oxide paint, TT–P–31a;

The National Bureau of Standard
Circular LC422, The Painting of St
contains additional information on t

4. NONFERROUS M

(a) METALLIC ZINC COA

The best coatings to protect iron a
nated atmospheres are galvanized, sh
plated zincs. It has been estimat
coating of 2 oz/ft² will last approx
certain dry tropical locations, 25 ye
5 years in urban industrial Englan
English railway tunnel.

Most paints do not adhere well to
Exposing the metal to the weather
improves this condition, but a bette
good proprietary phosphate chroma
painting. A more effective method
grease by washing the surface with
spirits. After drying the surface, a
oxide primer paint, TT–P–641, types
be applied, followed by succeeding c
on the rest of the structure.

(b) TREATMENT OF ALUMINUM AND MAGNESIUM

Aluminum and aluminum-magnesium alloys should be anodized before being given one or more coats of a suitable high-grade paint. Zinc-chromate primers are widely used are are known to give good results. Trim paint, aluminum paint, iron oxide paint, graphite paint, or the usual outside house paints can be used over the primer with good results.

(c) COATINGS FOR CERTAIN OTHER METALS

Metals such as tin, terne plate, copper, and bronze are easily painted. Oil and grease should be removed from these metals with mineral spirits or turpentine, then dried. After the metal has been cleaned, copper flashings, downspouts, and similar parts should be slightly roughened with very fine sandpaper, then coated with the paint used on adjacent surfaces. Iron oxide, Fed. Spec. TT–P–31a, is a good paint for tin plate and terne plate. Copper and bronze fly screens can be kept in good condition by washing with a solvent, such as mineral spirits, to remove grease, followed by an application of Air-drying Black Enamel, Fed. Spec. TT–E–521, type A, thinned with one-eighth its volume of turpentine. Zinc-dust paints (Fed. Spec. TT–P–641, types I or II) are also recommended for galvanized screens.

5. STEEL SUBMERGED IN WATER

Extensive studies have been made in recent years on the problem of paints suitable for use on steel submerged in water. Among groups doing research on this subject are various companies, including pigment producers, the U. S. Navy Yards, the U. S. Engineer District of the War Department, the U. S. Maritime Commission, and the Tennessee Valley Authority. All the studies have shown the importance of proper preparation of the surface to be painted and have revealed that *priming paints that give excellent service under ordinary atmospheric exposure may be unsatisfactory when used on steel submerged in water.* Likewise, paints that give good results in fresh water may not give good results in salt water and vice versa. Paints show a greater tendency to blister in fresh water than in salt water. Surfaces covered with a priming paint only may appear satisfactory in immersion tests but when topcoated may prove unsatisfactory. Thus, an attempt to evaluate primers independently of topcoats is of question-

able value. Some paints may
when used both for priming and
cial paint is used for priming. T
intercoat compatibility and a
physical properties of primer an
is essential to test paint *system*
paints.

(a) COAL-TAR-BASE

(1) *Hot Application.*—Coal-tar
steel submerged in water. The
processed coal tar usually combin
filler. The ability of these enam
pheric temperature changes and t
varies widely and depends upon
which the enamel was formulated
nated by trade name, such as "w
enamels, or according to their s
mined by the ring and ball metho
or 180° F enamels.

Waterworks enamels are capabl
atures ranging from —20° to +
any tendency to flow, sag, flake,
faces. Enamels of this type confo
American Water Works Associa
Department [14].

Pipe-line enamels are an unpla
base enamel *intended primarily*
coating for the exterior of underg
ing oil or gas. They are usually
and temperature changes than the

Enamels having physical cha
between the pipe-line and waterwe
and can usually be obtained fr
either of these types.

Before the hot, molten enamel
should be coated with a primer t
between the metal and the ename
an air-drying liquid coating that
brushing or spraying. This neces
flowing and leveling properties, t
to foam during application, and t
to a matt finish. Its spreading ra
to the application of the subseq

should conform to the requirements established by the manufacturer. Surfaces to be primed should be free from rust, mill scale, oil, and moisture. A shot or sandblasted surface is the most satisfactory. In no case should the primer be applied to surfaces coated with an oil-base paint.

In heating the enamel for application, great care should be taken to prevent coking, caused by local overheating, or loss of volatile components, caused by general overheating. The maximum temperature to which the enamel can be heated and the length of time that it may be kept in the working kettles at this temperature are obtainable from the manufacturer. The rather narrow limits set by producers usually fall within the range of 325° to 450° F. The method of applying coal-tar-base enamels is determined by the character of the surface to be coated. They can be applied either by pouring or by daubing with a palmetto bristle brush. Although the temperature of the material to be applied depends chiefly upon the type of enamel used, it is determined also by the nature and temperature of the surface to be coated. The variation in these surface characteristics often necessitates different temperature of application for the same enamel.

The enamel should be applied only to clean, dry surfaces that have been primed with a bituminous primer recommended by the manufacturer of the enamel. Traces of moisture, frost, or oil will prevent good bonding between the primer and the enamel. If properly bonded to the primer and metal, the enamel fractures within itself when an attempt is made to chip it off with a screwdriver or chisel.

Coal-tar-base enamels are applied hot in a uniform coating approximately 1/16 in. thick. Steel surfaces coated by daubing should be reasonably free from brush marks and should show no tendency to honeycomb or pinhole. Pipe linings or coatings applied centrifugally should present a smooth surface, free from objectionable ridges, corrugations, projections, and depressions.

(2) *Cold Application.*—Coal-tar-base enamels for cold application are composed of a processed coal-tar vehicle and an inert inorganic filler thinned with a solvent. Although heavy-bodied, these enamels possess thixotropic (see glossary) properties and can be applied easily by hand brushing at normal working temperatures. Because of its consistency, this type of enamel when applied to vertical metal surfaces

in one coat up to a thickness of
shows no appreciable flow or sag
applied at a spreading rate of ap
under normal drying conditions,
24 hr to permit recoating. This ty
for application directly to dry clea
coat is used, it should be one reco
facturer.

The second coat should be brush
strokes of the undercoat. A film bu
of several thin coats will offer bett
of equal thickness applied as a sing
coating is capable of withstandin
between —10° and +140° F with
flowing, sagging, or otherwise losi
The amount of volatile thinner use
usually makes forced ventilation ne
is applied in closed places, and bec
fire and explosion, the enamel shou
fire or open flames.

A coating material of this typ
Na 1–05 of reference [14].

(b) VARNISH-TYPE P

Linseed-oil paints that give goo
steel exposed to the weather are usu
are not sufficiently water resistant
faces subject to intermittent or
water. The vehicle for underwate
pure phenolic resin-tung oil varnis
length, with or without linseed o
vehicle is used in both the primer
coats.

Aluminum paint has been widely
Engineers, Upper Mississippi River
Department, as the topcoat on ste
water. This paint consists of a mixt
paste to 1 gal of varnish (a 25-ga
tung oil varnish). One primer con
weight of aluminum paste and zinc
type of varnish. Other priming pa
various localities. For example, g
obtained with primers of blue lead-

dust–zinc oxide (with or without iron oxide) in suitable phenolic resin varnishes. The zinc dust–zinc oxide paint has given very good results in the Ohio River tests (steel parts of the Montgomery Island Dam) near Pittsburgh conducted by the Ohio River Division, Corps of Engineers, War Department. A pure blue-lead paint in a phenolic-tung oil varnish likewise has given good results as a priming coat in the Montgomery Dam tests.

Another formula for a primer that has shown good results in fresh water is zinc dust 25.0 lb, zinc oxide 4.4 lb, red iron oxide (84 percent) 0.6 lb, vehicle, 1.0 gal of a 33-gal length, 100-percent tung oil, pure phenolic resin varnish. Another is red iron oxide (84 percent) 4.0 lb, zinc chromate yellow 2.0 lb, diatomaceous silica 1.0 lb, magnesium silicate 1.0 lb, to either 1 gal of a 25-gal length, 100-percent tung oil, pure phenolic resin varnish or 1 gal of a 25-gal length, 50-percent tung oil–50-percent linseed oil, pure phenolic resin varnish.

Aluminum paint (2 lb of aluminum paste to 1 gal of a 25-gal length, 100-percent tung oil, pure phenolic resin varnish) has given good results as a topcoat on steel submerged in fresh water, but the steel should be primed with a special rust-inhibitive primer, such as blue lead, red lead, or zinc chromate before applying the aluminum paint.

In connection with the subject of painting steel submerged in fresh water, experiments on painting the interior of steel tanks holding drinking water were carried out by the Federation of Paint and Varnish Production Clubs and the Engineer Board of the War Department. The most satisfactory finish tested at Fort Belvoir, Va., was a baked thermosetting phenolic resin. Where baking is not possible (as in the field) two paints have given good results. One is a zinc dust–zinc oxide pigment in a 25-gal, pure phenolic-resin–linseed-oil varnish. The other is an iron oxide pigment in a pure phenolic-resin–tung-oil varnish. Prior to painting, the steel is cleaned and then given a phosphate pretreatment with the following solution:

Orthophosphoric acid (75 percent of H_3PO_4)	12 gal.
Chromium sulfate (water soluble)	25 lb.
Monobutyl phenyl phenol sodium sulfonate (Areskap)	1½ gal.
Ethylene glycol monoethyl (Cellosolve)	6 gal.
Water (enough to make)	160 gal.

Two coats of either the zinc-dust–z
iron-oxide paint are applied after t
Paints applied over steel which has be
phate show marked improvement i
applied to steel not phosphate-treate
be especially noted wherever exposu
involved.

The Bureau of Ships, Navy Depar
able work at the Philadelphia Navy
adopted a zinc-dust coating for fresh

The composition of the zinc dust p

Pigment	
Vehicle	
Pigment:	
Zinc dust	
Zinc oxide	

Vehicle: Unmodified para-phenyl
resin varnish, suitable for grinding wi
an oil-resin ratio of 2 to 1; that is, i
The uncooked oil and resin are heate
perature of 560° F in 1 hour and held
for 1½ hours to body. The varnish
temperature of 450° F in 45 minutes

The vehicle contains no rosin or ro
thinner is turpentine, mineral spir
naphtha. The driers must contain no

The paint weighs not less than 20 l
in 6 to 10 hours.

Letter Circular LC744, Painting
Tanks, may be obtained free of charg
Bureau of Standards.

V. CARE AND PREPARATION
MATERIALS

The durability and smoothness of
surface depends to a large extent upon
painting materials at the time of ap
paints in proper condition, suitable sto
be provided. Careful mixing and the
will aid in obtaining a satisfactory fini

1. STORAGE OF PAINTING MATERIALS

Paints, varnishes, lacquers, thinners, and other painting material should be stored in well-ventilated places where they will not be exposed to excessive heat, smoke, sparks, flame, or direct rays of the sun. The packages should be kept tightly closed when not in use. Powder paints should be stored in moisture-proof containers.

Ready-prepared paints and pastes stored in suitable cans or drums should be inverted every month to retard settling of the solid matter. However, unpigmented liquid materials (linseed oil, for example) should be left undisturbed.

2. PREPARATION OF READY-MIXED PAINTS

Ready-mixed paints should be prepared for application in places that are well ventilated and free from flame or direct sunshine.

Small lots of ready-mixed paints can be mixed most satisfactorily by "boxing," a procedure described and illustrated in figure 2 [9].

When preparing ready-mixed tinted paint, about one-third of the paint should be poured into a clean vessel. The remainder should be stirred to a uniform consistency before returning the portion that was removed. The entire quantity is then ready to be boxed and strained through fine wire screen or cheesecloth.

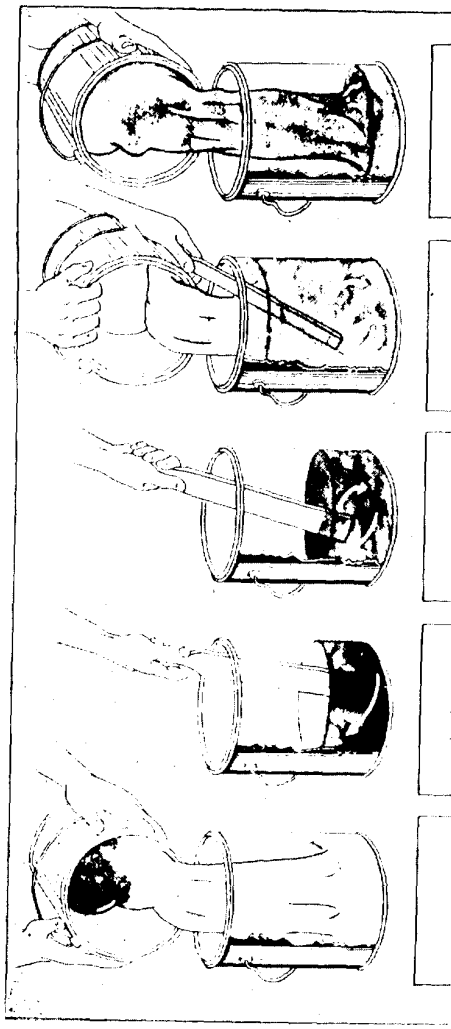
Another method of mixing paint is to insert the unopened can in a power-driven vibrator-type paint mixer for a period of 3 to 10 minutes. Because the violent agitation of this mixer tends to create many small bubbles in enamel paints, it is recommended that they be mixed by boxing.

3. MIXING OF PASTES AND POWDERS

It is important that powder and paste pigments be properly thinned if the desired effect is to be obtained. Some pigments furnished in paste form are to be mixed with oil by the purchaser; others, such as resin-emulsion paints, are to be blended with water.

(a) PASTES

(1) *Pastes-in-Oil.*—Most of the paste-in-oil pigments can be easily broken up by stirring with a strong wooden paddle



in the original container, taking care that no heavy sediment is left in the bottom. It may be necessary, even after careful stirring, to pour off some of the partly mixed paste into another clean can in order to thoroughly break up the bottom layer by more vigorous stirring. The part that has been poured off can then be returned to the can and the entire quantity again stirred until uniform.

The amount of paste necessary to make the desired amount of paint should be transferred to a container that has a greater capacity than the total volume of the completed paint. The required amount of oil should be measured and slowly stirred into the paste. When about half of the oil has been added, the mixture can be stirred readily and the lumps broken up easily. The remaining oil should then be mixed with the drier and thinner and stirred slowly into the paste. If two or more white-pigment pastes are used to make the paint, they can be mixed in the proper proportions before the oil is added. After the paste and oil have been combined, the paint is ready to be boxed, by the method shown in figure 2, and strained through fine wire screen or cheesecloth.

Various shades can be produced by tinting previously mixed white-base paint. The tinting paste should be thoroughly mixed with turpentine to a consistency similar to that of the completed white paint. This tinting liquid should be stirred slowly into the white-base paint until a uniform mixture is obtained. Care should be taken to use only the minimum amount of tinting liquid. When oil varnish is part of the vehicle, it is suggested that at least a part of the thinner be turpentine and that the varnish be stirred in after all other mixing operations have been completed.

(2) *Resin-Emulsion Paints.*—These paints are usually packaged in paste form to be thinned with water approximately in the proportion of 2 parts by volume of paste to 1 part of water. It is suggested that the paint be boxed after the ingredients have been thoroughly mixed. When manufacturer's directions are given they should be followed, as paste paints of different companies may vary in consistency. If the paint is applied by spray, additional water may be necessary. However, the paint should not be thinned to the point where more than two coats are needed to give adequate hiding power.

(b) POWDERS

Dry pigments are almost always
factory, but when necessary to mix p
on the job, the work room should be
the workmen should be protected by

(1) *Dry Red-Lead Paints.*—Pain
dry red lead by either of two methods
a quart of linseed oil may be poured
more than 1-gallon capacity and a p
stirring 25 lb of dry red lead into th
the paste to stand for at least 72 ho
wetting of the red-lead particles, an
oil can be added. A few hours before
of 2 parts of turpentine or mineral
drier may be stirred in.

The second method is to stir 25 lb
a quart of linseed-replacement oil
until a paste is formed. This shoul
then 3 pt of linseed-replacement oil
spirits should be added. The mixture
Pure red lead paint is available in re
Spec. TT–P–86).

(2) *Cement-Water Paints.*—Ceme
packaged in powder form and requir
water to prepare them for use. In
ommended procedure is to make a stiff
in small portions to the dry materia
After this, additional water may be
the paste to the desired consistency.
water varies with the fineness of the

The paint should be stirred vigorous
until it is of uniform consistency and
oughly wetted. Workability will be
the mixture to stand from 20 to 30 m
stirring. Most paints remain usable
being prepared, although in hot weat
cially those containing calcium chlo
within 3 hours.

Because cement-water paint tends
used, it is common practice to thin the
water when necessary to maintain th
There seems to be no serious objection
paint, provided it is done properly.

be stirred vigorously, as sometimes this operation restores its fluidity. Any additional water required should be added in small amounts and thoroughly mixed.

(3) *Casein-Powder Paints.*—Cold-water paints are also packaged in powder form. All types require the addition of water and one kind (Fed. Spec. TT–P–22) is furnished with a "mixing liquid" composed of raw or boiled linseed oil or spar varnish to be used in addition to the water.

EXTERIOR.—Powder for exterior paint should be mixed in the proportions of 90 to 100 lb of powder with 10 to 12 gal of water. The powder should be put into a metal or enamelware container. Porcelain and galvanized iron are very satisfactory, but wooden or unpainted iron mixing containers should never be used. The required amount of water at 70° F should be measured carefully in a separate vessel and gradually added to the powder in small portions, stirring constantly. The mixture should be stirred vigorously until it is of a smooth, thin, creamy consistency suitable for brushing, then allowed to stand 30 minutes before being used. It is good practice to strain the mixed paint through a No. 40 sieve but this is not essential. The paint should be used the same day it is mixed.

When mixing liquid in addition to water is used in preparing the paint, it should be used in the proportions of 1 gal to 90 to 100 lb of powder with 10 to 12 gal of water. Two-thirds of the required volume of water at approximately 70° F should be put into a metal or enamelware container. The powder should be added in small quantities, stirring thoroughly between each addition until a paste of uniform consistency is obtained. After the mixture has been allowed to stand for 30 minutes, the mixing liquid should be gradually stirred in, followed by the remaining portion of water.

INTERIOR.—Cold-water casein-powder paints intended for interior use should be mixed with water in the proportions of 8 to 10 lb of powder with 4 qt of water at approximately 70° F. The directions given for mixing powder and water for exterior paints should be followed.

4. CARE OF BRUSHES

Before a new brush is used with oil paint or oil varnish, it should be well shaken to remove loose hairs and dust, and then carefully combed straight. A steel comb is recom-

mended for the purpose. It may
pentine or mineral spirits. It
brush be soaked in linseed oil
being put into the paint. The su
out of the new brush before pai
be dipped into the paint to abo
bristles.

The best time to clean brushes
As much paint as possible shou
brush. Then it should be washe
paint brush cleaner until all pain
ing the brush, it should be laid fla
It may be necessary to follow thi
yellow laundry soap and water.

When brushes are to be used a
shop, it is considered good pract
2 or 3 in. above the bottom of a
mixture of raw linseed oil and a s
so that the bristles are completely
for oil paints, enamels, and varnis
water as the bristles become soft

After the brush has been washe
should be wrapped in paper and
advisable to place a few moth bal

A brush that has become hard
seldom be restored to first-class
the market several proprietary
brushes. One simple method is
organic-solvent-type paint and
hours. When the brush is remo
scraped out with a putty knife o
should then be washed free from
paint being removed by submergin
and working the liquid through t

Brushes used with shellac varni
placement should be kept either in a
alcohol or washed with denatured
and stored in a horizontal position

Brushes used with water paints
be washed with soap and water.
resin-oil emulsion paints, it is nece
with soap and water before the pa

An illustration of various brushes in well-equipped paint shops may be found in the Army Repairs and Utilities Manual [15].

VI. SAFETY MEASURES

The application of paint involves certain hazards for which adequate safety measures should be taken.

The National Bureau of Standards is not qualified to answer inquiries concerning the relative toxicity of various paints and pigments and detailed precautions to be used in spray painting. Questions of this nature should be directed to the U. S. Public Health Service, Federal Security Agency, Washington 25, D. C.

1. FALLS

Most of the injuries sustained by painters are the result of falls from scaffolds or ladders. Precautions that should be taken for the protection of painters are the same as for riggers, carpenters, and other workmen. For information on methods of protection for workmen, see "Safety Requirements for Excavation, Building, and Construction" [16].

2. FIRE

Oil paints, varnishes, and volatile liquids are flammable and should be kept away from fire. As a safety measure, they should be stored in closed containers. In a well-organized paint shop, paints, oils, and volatile liquids are stored preferably in a fireproof room. Many paint manufacturers print a statement on the label of the paint cans cautioning the user to keep the paint away from fire.

Rags used to wipe up linseed or other drying oils are also a frequent source of spontaneous combustion. They should be burned or drenched with water and put in an airtight metal-covered container.

3. POISON

The volatile liquids (turpentine, mineral spirits, and gasoline) used by painters are skin irritants. For this reason, the frequent use of such thinners to remove paint from the hands should be discouraged to avoid dermatitis. Prolonged inhalation of toxic fumes such as those emitted from benzol used in paint removers and carbon tetrachloride or

carbon disulfide used in removing
constitute a health hazard. Some
larly those containing lead and c
The inhalation of dust, such as that
and sandblasting, is a source of da
lead fumes while burning off old p

For precautionary reasons there
tilation in shops and rooms where
ventilation is insufficient, respirat
air should be used.

Food should not be kept or eate
other place where it is exposed to
or fumes from paint thinners. W
painting equipment, painters should
to thoroughly clean their hands a
Work clothes should be changed
workroom and should be laundered

VII. SAMPLING AND

The purpose of sampling is to obt
mens for record. The purpose of
compliance of the material with t
purchase-contract specification. Sa
the factory, while loading or unload
trucks, or after delivery of materia
specting a shipment of material is
whether it is in good condition and
according to good shipping proce
inspecting surfaces to be painted is t
aration is necessary before applyin
of inspecting finished work is to de
with the contract specification.

1. INSTRUCTIONS AND PRECAUT

Federal Specification TT-P-141a
ent of Documents, Washington 25, D
lowing directions for sampling:

"Official samples should be taken by, or
vision of, a person of judgment, skill, a
sampling.

"The portions taken for samples sho
characteristics and average condition of th

Precautions should be taken to assure that the sampling apparatus and the samples themselves are neither contaminated with nor altered by any extraneous matter not representative of the lot being sampled.

A single package from each lot of not more than 1,000 packages should be selected at random as representative of the whole. The seller has the option of being represented at the time of sampling, and when he so requests, is furnished with a duplicate sample.

Directions for sampling apply to liquid materials, dry pigments, pastes-in-oil, and mixed paints. The tests should be made according to the directions given in section F of the applicable Federal specification.

(a) LIQUIDS: THINNERS, OILS, AND VARNISHES

Whenever possible, liquids in original unopened containers should be sent to the laboratory. If this is not practicable, the contents of the container sampled should be thoroughly mixed, making certain the incorporation of any settlings. A clean, dry, glass bottle or tin can should be filled with not less than 1 qt of the sample, securely stoppered with a new clean cork or well-fitted cover or cap, sealed, and distinctly labeled. When requested, a duplicate sample may be taken from the same package for delivery to the seller. A third sample may be held for test in case of dispute.

(b) PIGMENTS, PASTES, AND READY-MIXED PAINTS

(1) *Dry Pigments.*—The package should be opened and a sample of not less than 1 lb taken at random from the contents. This should be placed in a clean, dry, metal or glass container, sealed, marked, and sent to the laboratory.

(2) *Pastes and Ready-Mixed Paints.*—Whenever possible, the original unopened containers of paste or ready-mixed paint should be sent to the laboratory.

When an original container of paint can not be sent to the laboratory for test and there are no facilities for mixing the material mechanically, a representative sample can be obtained by the procedure for boxing paint. Portable mechanical agitators are useful for mixing paint, and can be obtained in various sizes for mixing a gallon or a barrel of paint.

Caking of paint should be det
paint with a paddle or spatula.
tainer should then be thoroughly m
less than 1 qt placed in a clean, dry
marked, and sent to the laboratory
the report on caking. A good pai
container. A portion of the sampl
in-oil, or ready-mixed paint may be
in case of dispute.

(c) BITUMINOUS ENAMEL

(1) *Enamel.*—Samples should
below the surface and at least 3 i
container or from the center of the
lb of this solid material should be
parts of the unit or units sampled
A 50-lb sample of the mixture sho
laboratory for test.

(2) *Primer.*—The method of sa
same as that for sampling pigments,
paints. A statement from the manu
the following characteristics of pri
accompany the test samples.

1. Method of applying primer
feet per gallon.
2. Minimum and maximum dryi
application of enamel.
3. Temperature of coal-tar or
time of application.
4. Maximum allowable tempera
may be heated.
5. Maximum time enamel may be
at applicable temperature.

(d) COAL-TAR-BASE P

The method of sampling coal-tar
as that for pigments, pastes, and
shipment may be rejected without
laboratory if observations or tests
material does not meet the specifica
paint delivered is of a different co
or is of lighter weight per gallon tha
specified.

690245° 46 8

2. INSPECTION

Field inspection of new work is for the purpose of ascertaining whether the paint is being used at the required spreading rate, whether the work is being performed under proper weather conditions, and whether the surfaces to be painted are clean and dry. Moisture in wood and masonry can be detected by meters. Information regarding these devices can be obtained from the manufacturer, including William J. Delmhorst, 90 West St., New York, N. Y.; Raymond S. Hart, 7 Lincoln St., Jersey City, N. J.; L. A. Milbrock, 732 N. Lombard Ave., Chicago, Ill.; and C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.

New structural steel should be treated with two shop coats of inhibitive primer slightly different in color. If only one coat is used, the metal should be carefully inspected as soon as delivered at the site, and spot-coated with the primer wherever necessary. Within approximately 2 weeks a second coat should be applied over the whole surface.

Pinholes or cracks in bituminous coatings can be readily detected by means of an "electric holiday detector." The unit usually consists of a high-voltage transformer designed to operate on a 105- to 115-volt, 60-cycle power line, and an adjustable Tesla coil. A metal chain, band, or brush, whichever best conforms to the contour of the surface to be tested, is attached to the discharge terminal of the Tesla coil.

In inspecting the coating for defects, the metal chain, band, or brush is passed slowly over and in contact with the surface tested. The Tesla coil is so adjusted that at all times there is a uniform corona (violet in color) discharge between the metal chain, band, or brush, and the enamel coating. Breaks in the coating are indicated by sparking between the testing unit and the metal under the enamel. Such units are obtainable from electrical supply houses, especially those handling scientific instruments.

In connection with the subject of inspection, a leaflet issued by the National Paint, Varnish and Lacquer Association, "Paint Exposure or Complaint Report" [17], is useful in the inspection of new or previously painted metal and wood. From this leaflet there is reproduced the following field-inspection report sheet:

PAINT EXPOSURE OR COM

HISTORY

Location ..... Date
Lumber Used ..... Build
Age of Structure ..... Area
Applied on New or Previously Painted Su

Condition of Old Paint at Time of Paint

	South
Chalking	
Checking	
Cracking	
Blistering	
Peeling	
Flaking	
Scaling	

Type of Paint Previously Used.....
etc. .....
Method of Preparing Surface Before Ap
.....
Date of Painting .....
Kind of Primer .....
Reduction Made for Priming Coat .....
Kind of Paint.....
Reduction Made for Finishing Coats....
Number of Coats Applied on Body.....
Number of Coats Applied on Trim.....
Weather Conditions at Time of Painting.

INSPECTION

Date .....Inspector.....

	South	West	North	East
General Appearance.....	.....	.....	.....	.....
Discoloration	.....	.....	.....	.....
Gloss	.....	.....	.....	.....
Chalking	.....	.....	.....	.....
Checking	.....	.....	.....	.....
Cracking	.....	.....	.....	.....
Flaking	.....	.....	.....	.....
Scaling	.....	.....	.....	.....
Blistering	.....	.....	.....	.....
Peeling	.....	.....	.....	.....

Structural Defects Found Where Water Could Enter:

Window Frames .....Headers .....
Louvres .....Roof .....
Warped Siding or Trim Boards ..... Absence of Flashings or Defective Flashings .....
Poor Drainage of Surface Water .....Wet Basement .....
Lumber Siding Near Ground ..... Lack of Ventilation in Side Walls .....
Were Siding Butts Leaded? .....
Remarks: .....
.....

Moisture Test: Percentage of Moisture in Wood at Time of Inspection:
Where Failures are Evident.....
Where Failures are not Evident.....

Are Acid Factories, Smelters or Other Industries Near the Job?.....
Are Samples of Wood or Paint Films Available?.....
Location of Area from which Films were Obtained for Laboratory Examination .....
.....

Result of Film Examination:

Number of Old Coats.....
Adherence of Old Coats to Underlying Surface.....
What Photographs were Taken?.....

VIII. PAINT FAIL

Paint failures are inevitable, as n
last indefinitely. In addition, the in
many buildings during the war has
of paint failures. For these reasons,
section of the manual is significant.
structions or suggestions can not take
and experience of the master painter
in acquiring a practical knowledge of
properly.

Before discussing paint failures a
it may be helpful to point out that, i
is the least durable and black paint t
exposed to the weather; likewise, dar
more durable than light tints. For
paint is more durable than a white pa
is more durable than a light gray;
(Fed. Spec. TT–P–31a) is more dur
tan-colored paint. However, white a
reflect more light than dark-colored p
reflects about 80 percent of the light,
reflects only about 2 percent. The w
here indicates film integrity rather t
example, a medium-gray paint on th
may change to light gray after prolon
owner of the house may feel that t
(from the standpoint of appearance)
rity of the film may be unimpaired.

The cause of paint failures may be
able surface preparation prior to paint
application or unsuitable composition
be considered in avoiding failures are
correct proportioning of materials fo
of adequate drying time between co
rates, and suitable weather conditions

There are other causes of paint fa
those listed above, such as constructio
faulty maintenance, which includes
too infrequent painting and the com
paints in a coating. These faults a
common sources of paint failures.

Descriptions of some of the more c
failures and painting troubles with

remedies follow: Examples of paint failures in Army cantonments are shown in figures 3 to 22 and are used through the courtesy of the Office of the Chief of Engineers, War Department. Other illustrations of paint failures, figures 23 to 31, were furnished by the Forest Products Laboratory, Forest Service, United States Department of Agriculture, Madison, Wis. The photographs shown at the end of this chapter were made by F. L. Browne, of the Forest Products Laboratory. The reader is also referred to the photographs of paint failures shown in Federal Specification TT-P-141a.

1. ADHESION

The satisfactory adhesion of the first coat of paint to the underlying surface is extremely important. The success of the paint job depends to a very large extent on the bonding of the first coat to the foundation. Insufficient or unskilled preparation of the surface may result in defective adhesion. Having the surface clean and dry, sanding all glossy coats prior to applying subsequent coats, allowing sufficient time for each coat to dry hard (but no unnecessarily long) are all important factors in promoting good adhesion. In addition to suitable preparation of the surface, the priming paint should be formulated for the particular surface to which it is to be applied. To help obtain a satisfactory paint job, the following Federal specifications have been prepared:

TT-P-20—For priming structural steel
TT-P-86—For priming structural steel.
TT-P-25—For priming exterior wood.
TT-P-56—For priming interior plaster, concrete, brick.
TT-P-641—For priming galvanized iron.

A wide variation will be found in the paint-holding properties of woods in general use. The woods which hold paint longest and suffer least when repainting is neglected are cedar, redwood, and cypress; next in order are northern white pine, western white pine, and sugar pine; the third group in order is Ponderosa pine, spruce, and hemlock; the last group consists of woods which have the poorest paint-holding properties: Douglas fir, western larch, and southern yellow pine.

2. ALLIGATORING

Alligatoring consists of the development of interlacing lines over relatively large areas on a paint film, giving the

appearance of alligator's skin (see fig.
gatoring is the application of a hard
or varnish over a comparatively so
ample, a flat white paint applied ov
ing). The outer coat tends to oxidiz
drying, after which it contracts and s
the hard topcoat over the soft und
and consequent hardening of the und
is good practice to allow the primin
quent coats of paint or varnish to
long, before the next coat is applied.

Alligatoring may begin as checkin
break tends to grow wider at the bot
top. The top coating contracts, thus
the undercoat. In the typical extrem
the "islands" of coating between int
not only contracted in area but have
and, consequently, often have become
ing may be caused by the application
incompatible paints or by the appl
enamels over resin-impregnated surfa
24, 27, 30, and 31).

3. BLEEDING

Painting over knots (see figs. 6, 7,
resinous wood causes a dissolving ac
resin. As a result, white paint turns
over creosote, bitumen, or colors solub
stain, for example) likewise may cause
to dissolve into the paint coat. The r
surface with a sealer prior to applyi
made, quick-drying, aluminum paint
powder or paste to 1 gal. of interior
TT-V-71a) for interior work, or spar
TT-V-121b) for exterior work) is a
back creosote stains, bituminous ma
stains. Rosin-free orange shellac v
TT-V-91a) is used in thin coats over
ing. In this connection, the reader is
previously been said regarding the sub
knots.

Where resin has exuded from the wo
on the surface or has caused alligatori
area should be scraped and sandpaper

place when a paint has very little elasticity, particularly when a thick coat builds up (see Chalking) with continued repaintings. Certain paints are inclined to fail by cracking, curling, and scaling, whereas others fail by moderate chalking with or without checking. A surface on which the paint fails by moderate chalking is the least serious type of paint failure and the most economical for repainting.

Before repainting, the safest plan is to remove all scaling paint by burning and scraping off. If some of the old paint is not removed, it will eventually scale off, taking the new paint with it. The degree of scaling of paint depends on the kind of wood to which the paint is applied. For example, a paint that fails normally by cracking and scaling may exhibit this defect to a minimum extent on a wood that holds paint well, such as western red cedar and redwood. When applied to a wood that does not hold paint well, for example, southern yellow pine and Douglas fir, the paint may exhibit this defect to the maximum extent.

8. CRAWLING

Crawling is the tendency of a paint or varnish to form a discontinuous film by drawing up into drops or globules shortly after application and results from surface tension caused by either the surface or the paint. Oil paint applied at room temperature over a cold or greasy surface may also cause crawling. Others causes are the application of a glossy coat of paint over a fresh glossy coat, particularly when an outside house paint contains an excessive amount of linseed oil; the application of paint or varnish over previous coats that are not hard and dry; the presence of moist finger marks on a surface prior to varnishing; the mixing together of various brands of varnish; the use of varnish that has become thick and viscous; the presence of a thin film of wax on the surface left by the use of liquid paint removers; the application of paint in cold or foggy weather.

The remedies for many of the above causes are the elimination of these conditions. It is best not to apply paint or varnish in cold, foggy, or damp weather; undercoats should be thoroughly dry before applying subsequent coats; if the undercoats are glossy, they should be sandpapered. Rubbing the surface with turpentine and steel wool before applying the paint is helpful. If the paint seems to be subject to crawling, brushing it thoroughly into the surface

may correct the trouble. If such is the
of paint by spraying will aggravate th

9. "FADING" OF COL

Most paints change color on prolon
weather. This may be a true fading o
it is the result of either a chemical ch
on exposure to the weather or excess
paint. Some paints chalk unevenly,
blotchy effect on the color, particula
Other paints chalk evenly and self-clea
This is the preferred type of "fading"
or so-called fading of color occurs in sp
surface has not received sufficient coats
able primer. This is one of the reasons
fication TT–P–25 was made available
wood primer.

The so-called fading of color of pain
because of "hot spots" in the plaster
really due to the variable suction or po
Thus, unpainted plaster should be pri
primer (for example, Fed. Spec. TT–P–
subsequent coats of oil paint.

The change in color of outdoor pain
dirt. Some paints hold dirt, whereas
the dirt by chalking ("self-cleaning").
used in paint, it will hold dirt. For exa
are made of white lead, using 100 lb of
each paint with the addition of 3 gal of
No. 1, 4 gal of oil in paint No. 2, and
No. 3, on exposure to the weather, pai
the most dirt and paint No. 1 the least.
paint that remains unusually clean is o
Specification TT–P–10, type 1, Class B

Paints containing lead pigments will
hydrogen sulfide in the atmosphere. T
pears as a brownish or grayish film be
tion of lead sulfide. This discoloration
out" with hydrogen peroxide.

Mildew generally forms in black splot
causing an unsightly change of color.
fairly common in the south. Commercia

prevention or retarding of mildew are now available in paste form to be added by the user.

Copper and bronze fly screens cause unsightly discoloration on white and light-tinted paints. The discoloration is a result of corrosion products from the copper or bronze and may be avoided by varnishing or painting the screens before corrosion takes place (see fig. 12).

10. LOSS OF GLOSS

On outdoor paints the first sign of weathering is loss of gloss, followed by chalking. Doubtless, both are different aspects of the same defect and are brought about by the same cause. Gloss is produced by an excess of oil or other binding material (linseed oil or varnish) and forms a smooth, glass-like film on the surface. Air, moisture, and sunlight cause these organic binding materials to deteriorate rapidly resulting in loss of gloss. Among other conditions causing loss of gloss are inadequate preparation of the surface; insufficient drying time between coats; painting in cold weather, particularly if there is a sudden drop (20 degrees F) in temperature during the fall or winter months before the paint has dried; incorrect use of paint removers and alkaline cleaners on paint; or exposure of the freshly painted surface to frost, fog, or moisture. When there is a possibility of dew or frost, the application of paint should be discontinued early in the afternoon.

11. RUNNING AND SAGGING

Running and sagging may ocur when the paint contains too much oil or is applied too freely. If an old paint surface is too glossy, the fresh paint may show sagging. A method of test for running and sagging of a red lead paint is given in Federal Specification TT–R–191a. A method of test for the sagging of red enamel is given in Federal Specification TT–E–531a.

12. TACKINESS AND SLOW DRYING

As pointed out under "alligatoring," each coat of paint or varnish should dry firm and hard before a subsequent coat is applied. Dirt and mildew may collect on paint that dries tacky or sticky. Slow drying may be caused by (1) insufficient drier in the paint or varnish, (2) the use of poor quality linseed oil, (3) too liberal application of paint, (4)

the application of paint or varnish o
is not dry, (5) the application of pa
damp, wet, or foggy weather, and (
paint during cold weather. Dark-c
black (Fed. Spec. TT–P–61a) and
TT–P–71a) dry more slowly than w
paints. If there is insufficient drying
the topcoat may lose its gloss, alligato
peel on prolonged exposure to the w
surface is a common cause of tackine

Certain kinds of paints and varnish
if stored too long in the original cont
more frequently to the "fast-drying"
varnishes than to the older types of
there is a possibility that paint is old
should be tested before use. If the d
lost, a little paint drier should be add

13. WASHING

Washing is the leaching out of the
ment in a paint during rain storms.
occurs when a paint contains a pigmen
soluble or is converted from a water-
soluble material through chemical ac
weathering.

14. WRINKLING

When a paint is applied too liberally
cold, damp weather, the top of the fil
leaving the paint beneath this skin sof
the finished surface has a wrinkled ap
and 22). To avoid this, each coat of
brushed out in a skilled manner, esp
weather. Also, it may be advisable to
of turpentine (about 1 pint to the gall
come this tendency. When painting i
to 50° F), the weather forecasts shoul
When a marked drop in temperature (
dicted for the evening of the day that p
painting should be discontinued early i
any event, paint should be applied b
10 a. m. and 3 p. m. during cold weathe

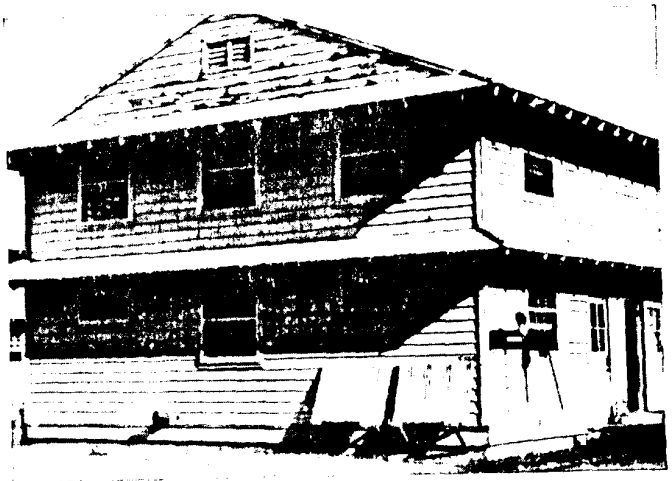


FIGURE 3.—*South and east sides of building show paint cracking and scaling at gable end of building.*

Paint is about 4 years old and is applied over southern yellow pine. Protection is given paint by overhanging eaves, which keep off direct sunlight and rain.

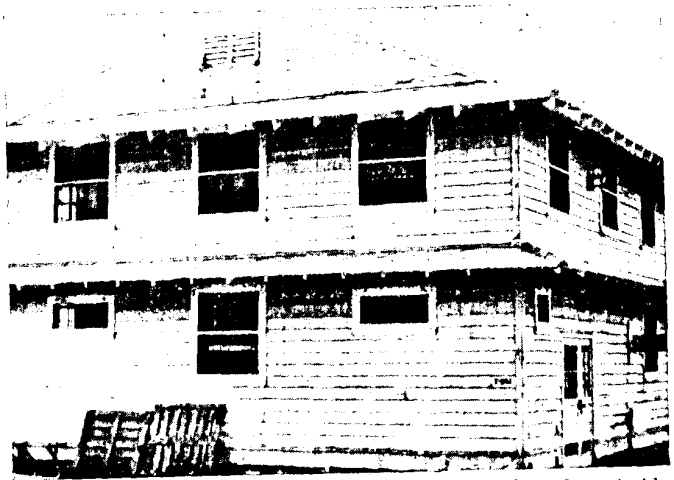


FIGURE 4.—*Same building as figure 3, showing north and west sides.*
Paint generally fails worse on south and east sides.

FIGURE 5.—*Wood siding on which paint*
Just before the photograph was taken, the area
The remaining paint was found to be insecure
slipped between the paint film and the wood.
paint be removed before repainting.

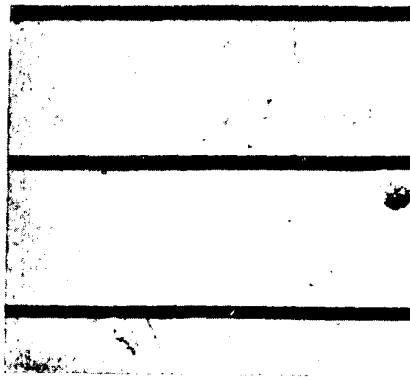


FIGURE 6.—*Failure of paint*

FIGURE 7.—*Close-up view of paint failure over knot shown in figure 6*

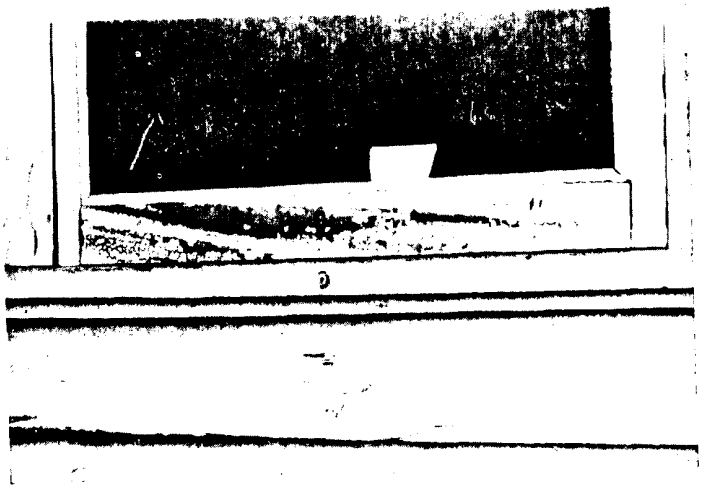


FIGURE 8.—*Alligatoring and crumbling of paint over resin streak in frame of fly screen.*

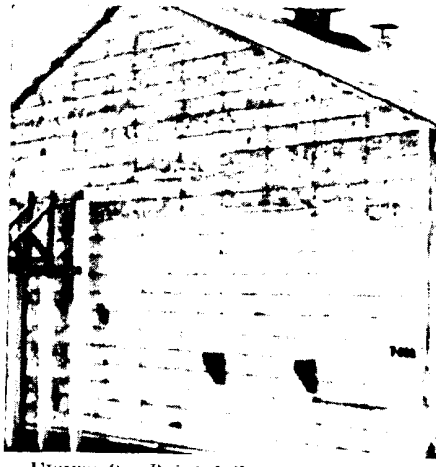


FIGURE 9.—*Paint failure on exterior wo condensation of moisture within*

Paint covering area shown on north side from w head height, and from northwest corner to first condition. The reason for this is that shower inside this area has metal wall covering, whic preventing condensation during cold weather. the rest of building developed after first winter

FIGURE 10.—*Typical discoloration of pai*

Before repainting, surface should be scrubbed wit alkaline cleaner, for example, trisodiu

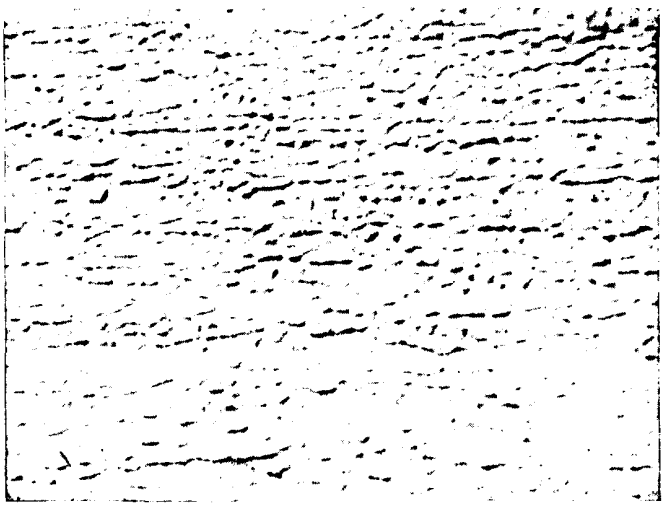


FIGURE 11.—*Typical checking pattern of paint on the outside of building after 5 years of service.*

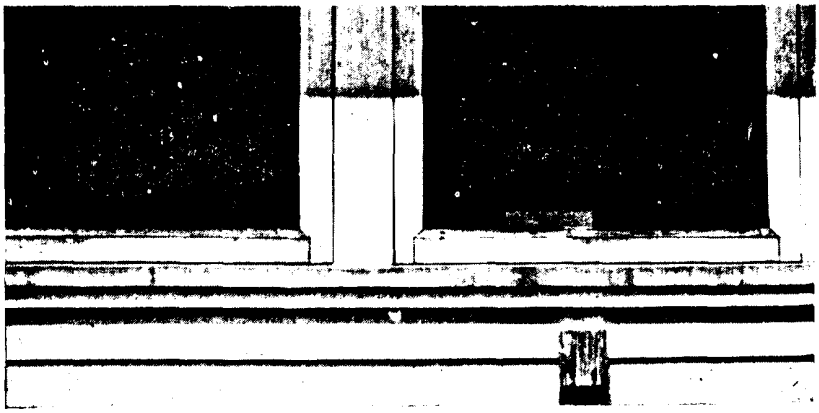


FIGURE 12.—*Discoloration of light-colored paint underneath fly screens, due to the corrosion of the screens.*

Screen wire should be painted to avoid this trouble.

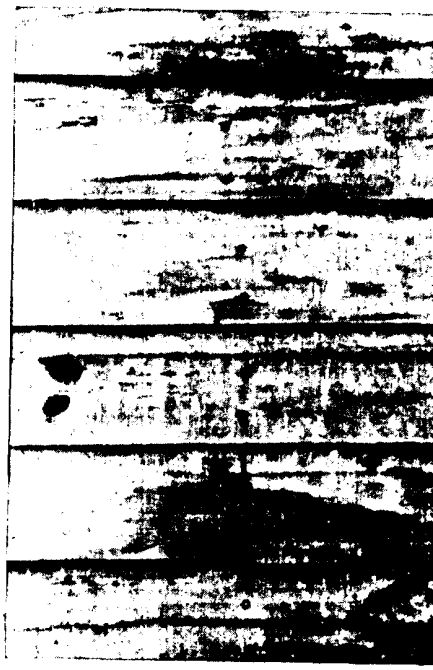


FIGURE 13.—*Rot on painted wood sid*

Surface should not be repainted until siding is
the basic structural fault causing the trouble
case it was due to inadequate flashing at juncti

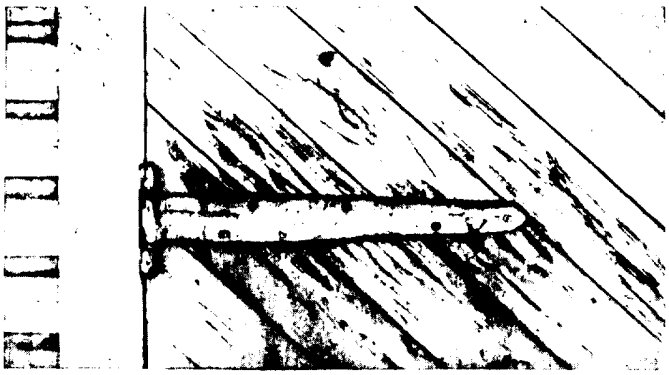


FIGURE 14.—*Illustration of how painted wood starts to decay around a hinge, which holds water.*

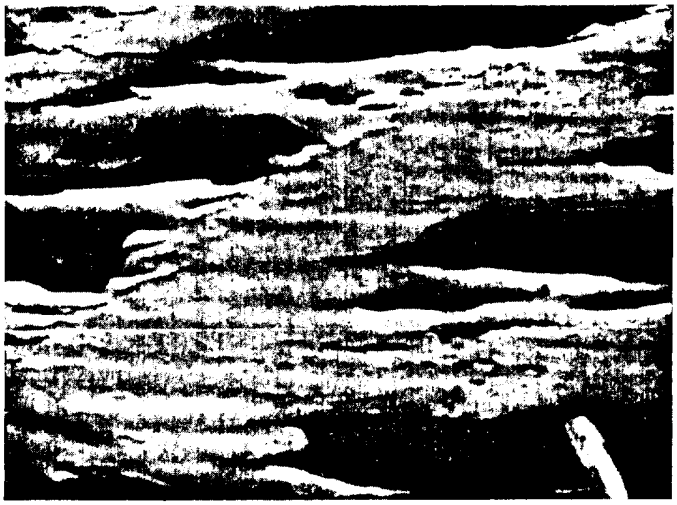


FIGURE 15.—*Close-up view of cracking, curling, and scaling of paint on southern yellow pine.*

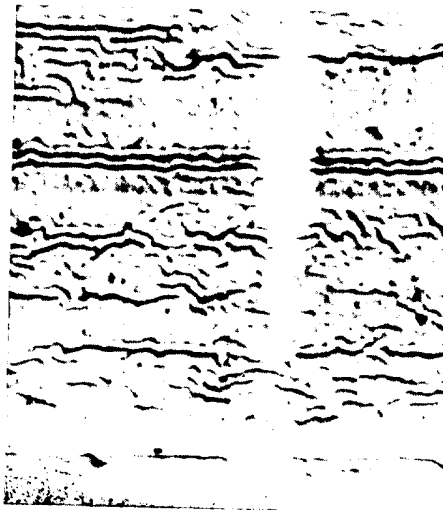


FIGURE 16.—*Wrinkling of*
Wrinkling occurred during application of paint
years of exposure.

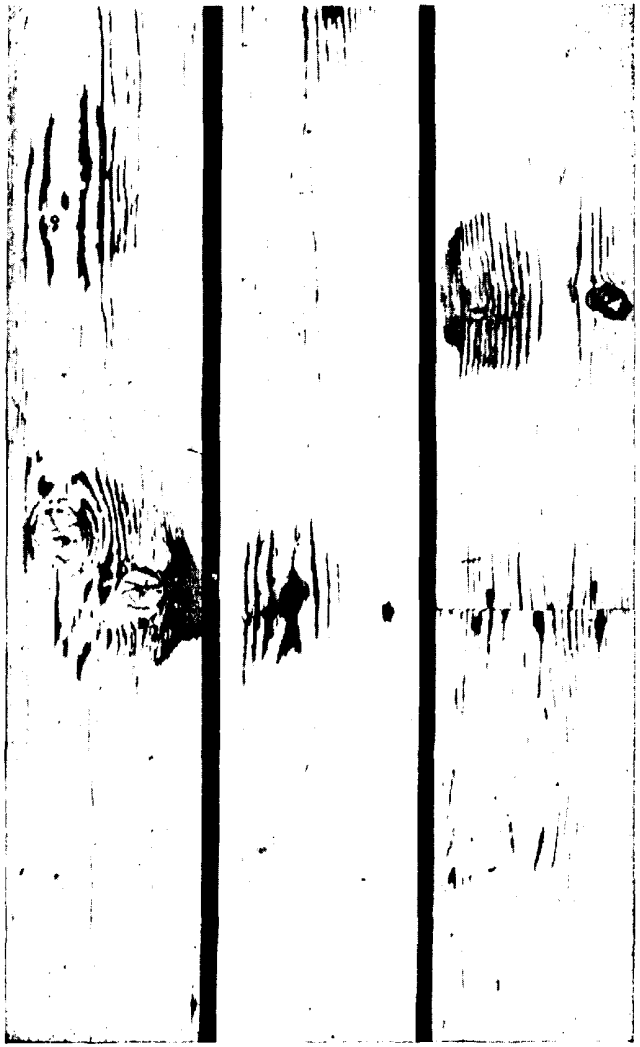


FIGURE 17.—*Typical paint failure over knots.*
Knots were shellacked generously prior to painting.

FIGURE 18.—*Serious peeling of paint.*

Peeling is particularly noticeable at corners. It was caused by collection of water behind certain parts of siding, probably the result of condensation in winter. At ground level the building is poorly ventilated.

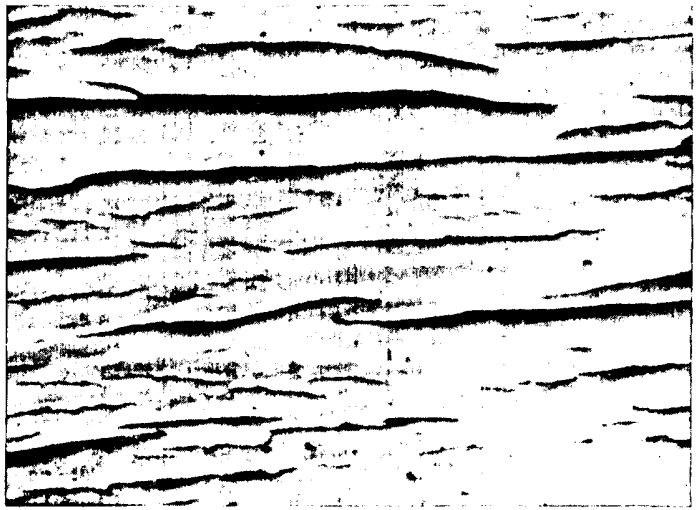


FIGURE 19.—*Details of paint cracking on exterior of wood building.*

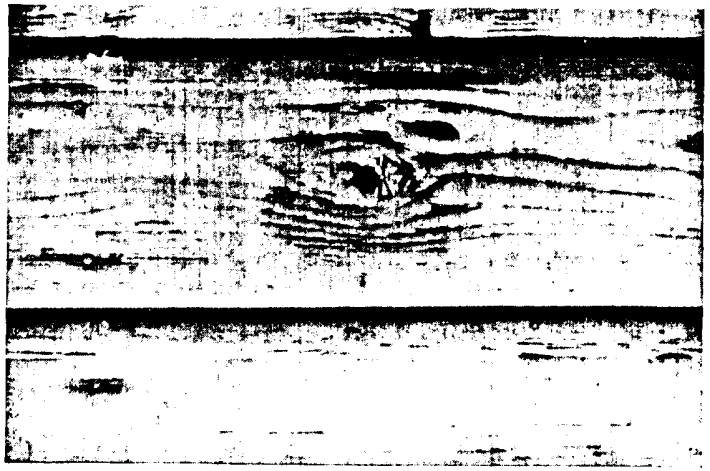


FIGURE 20.—*Failure of paint over a knot that had been shellacked prior to painting.*

FIGURE 21.—*Satisfactory appearance of paint on side of building, except over a few boards of summer wood.*

These boards will always give trouble and should be replaced.

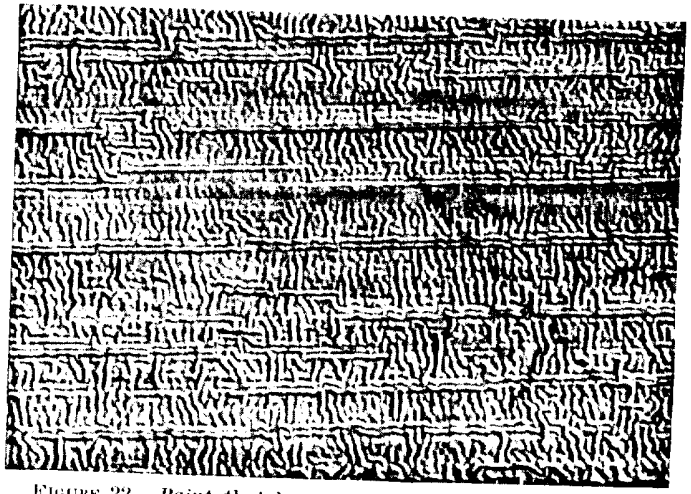


FIGURE 22.—*Paint that has wrinkled soon after application.*

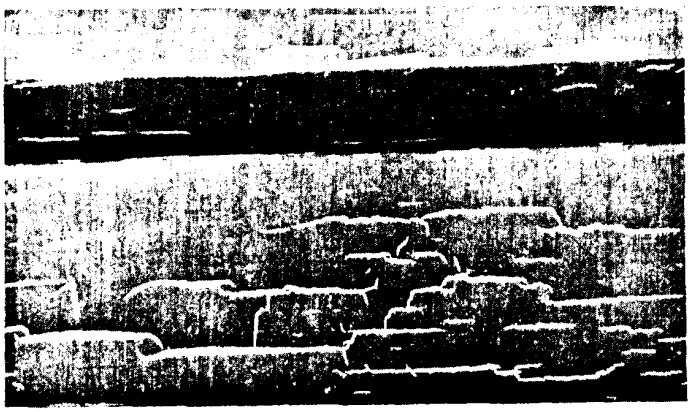


FIGURE 23.—*Typical alligatoring of finish coat of dark-brown paint (soft type) applied over white paint (hard type).*

Compare with figure 31.

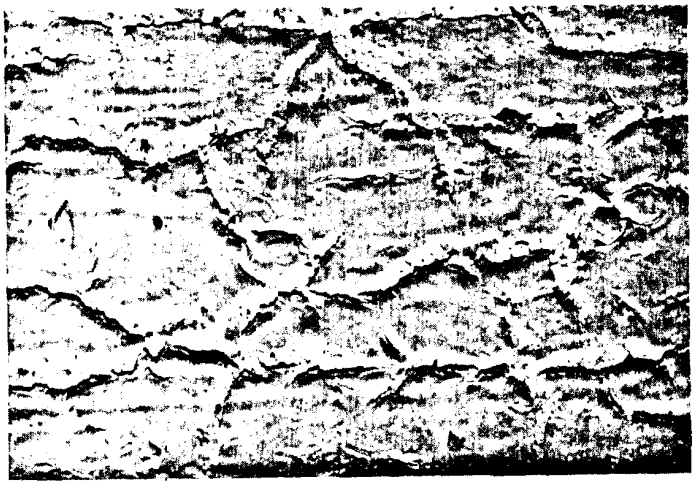


FIGURE 24.—*Additional example of alligatoring of paint.*

FIGURE 25.—*Typical example of "cur cracks.*

FIGURE 26.—*Checking and crumblin southern yellow*

FIGURE 27.—*Example of alligatoring.*
Satisfactory service may be obtained only by removing all old paint before repainting.

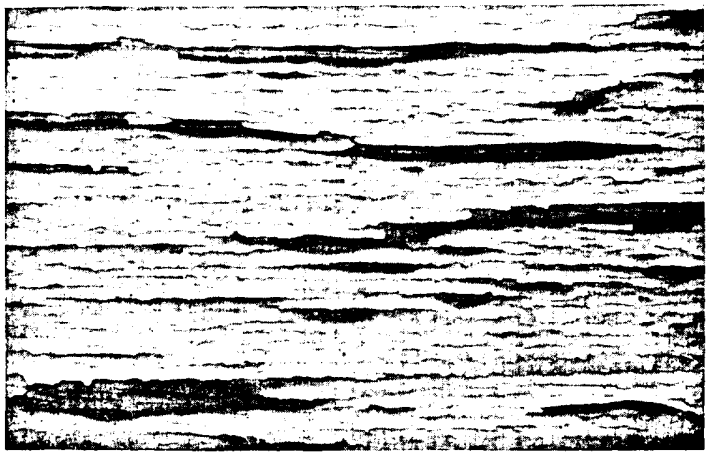


FIGURE 28.—*Checking, cracking, curling, and flaking of paint on southern yellow pine.*

FIGURE 29.—*Blistering of pa*
Siding on the left was covered with thre
that on the right, with two coats of
primer.

FIGURE 30.—*Alligatoring*

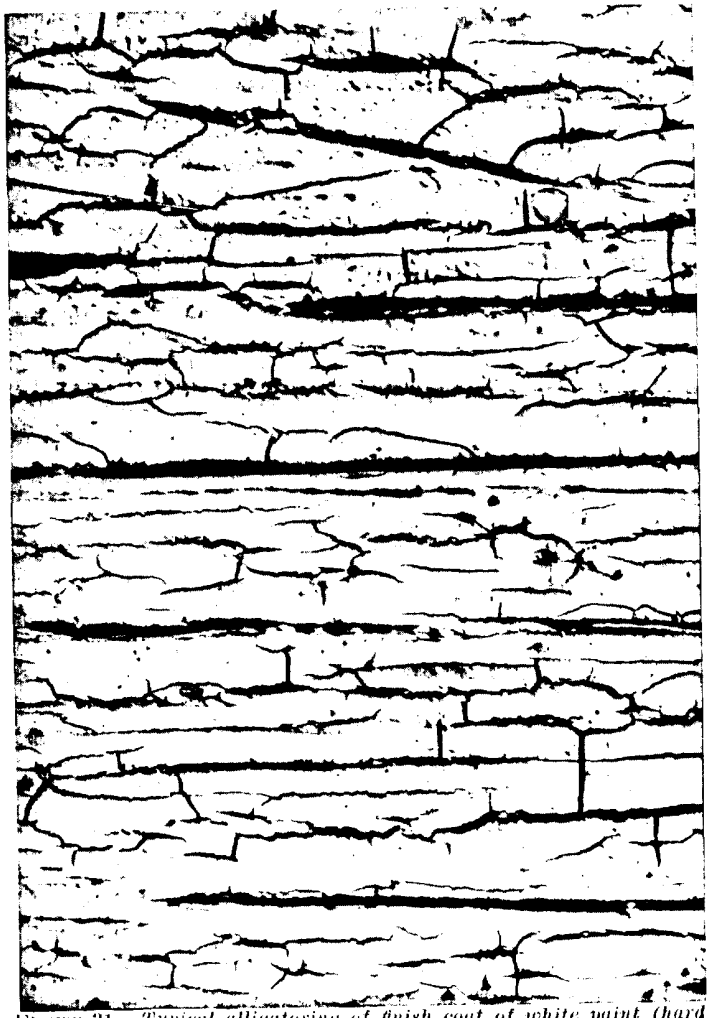


FIGURE 31.—*Typical alligatoring of finish coat of white paint (hard type) applied over dark-red paint (soft type).*

Compare with figure 23.

IX. BULKING VALUES OF PIG

The following tabulations, with
duced from Circular 667, Bulking
1943), issued by the Scientific Sect
nish & Lacquer Association [18].
ture for these tables is 15.5° C.

1. PIGMEN

The bulking values of such pigment
yellow and iron oxides vary rather wi
used in substantial percentages in a c
tints or solid colors, their actual valu
obtained from the producer.

Also, the large number of organic co
so widely in type and bulking value th
important ones have been included.

Pigment
Aluminum bronze, standard
Aluminum bronze, lining
Aluminum paste, 65% solids
Aluminum hydroxide
Aluminum silicate
Antimony oxide (Sb_2O_3)
Antimony sulfide
Barium carbonate
Barium sulfate (barite)
Barium sulfate (blanc fixe)
Basic lead carbonate
Basic lead sulfate
Black iron oxide
Blue lead
Cadmium red lithopone
Cadmium yellow
Calcium carbonate (chalk)
Calcium sulfate, anhydrous
Calcium sulfate, hydrated
Carbon black
Clay (kaolin)
Chrome green, light
Chrome green, medium
Chrome green, dark
Chrome oxide
Chrome oxide, hydrated
Chrome yellow
Chrome orange
Chrome orange, molybdate
Cobalt blue
Copper bronze powder

Pigment	Gallons per pound	Pounds per gallon	Specific gravity
Cuprous oxide	0.0207	48.23	5.79
Diatomaceous earth	.0520	19.24	2.31
Gold bronze powder	.0150	66.64	8.00
Graphite	.0541	18.49	2.22
Guignet's green	.0352	28.41	3.41
Hansa yellow	.0811	12.33	1.48
Indian red (98% Fe_2O_3)	.0235	42.57	5.11
Iron blue (prussian)	.0656	15.24	1.83
Iron oxide black	.0254	39.32	4.72
Iron oxide, red or brown, 97% Fe_2O_3	.0235	42.57	5 11
Iron oxide, red or brown, 70% Fe_2O_3	.0292	34.64	4 11
Iron oxide, red or brown, 40% Fe_2O_3	.0329	30.40	3 65
Iron yellow, natural	.0353	28.32	3.40
Iron yellow, synthetic	.0304	32.90	3.95
Kaolin (clay)	.0462	21.66	2.60
Lampblack	.0674	14.83	1.78
Lead, metallic (90:10 paste)	.0250	39.98	4.80
Lead, titanate	.0164	60.98	7.32
Litharge	.0127	78.64	9.44
Lithol red	.0765	13.08	1.57
Lithopone, regular	.0279	35.82	4.30
Lithopone, titanated	.0282	35.40	4.25
Magnesium carbonate	.0663	15.08	1.81
Magnesium silicate	.0421	23.74	2.85
Mercuric oxide	.0107	92.80	11.14
Metallic brown	.0304	32.90	3.95
Mica	.0424	23.57	2.83
Mineral black	.0480	20.83	2.50
Molybdate orange	.0207	48.31	5.80
Ochre	.0406	24.66	2.96
Orange mineral	.0136	73.53	8.82
Para red	.0811	12.33	1.48
Para red (15% on $CaCO_3$)	.0494	20.24	2.43
Para red, chlorinated	.0770	12.99	1.56
Paris green	.0371	26.99	3.24
Phthalocyanine blue	.0770	12.99	1.56
Phthalocyanine green	.0597	16.74	2.01
Prussian blue	.0656	15.24	1.83
Red lead	.0136	73.53	8.82
Sienna, burnt	.0326	30.65	3.68
Sienna, raw	.0365	27.41	3.29
Silica, quartz	.0453	22.07	2.65
Silica, diatomaceous	.0520	19.24	2.31
Slate flour	.0429	23.32	2.80
Talc (magnesium silicate)	.0421	23.74	2.85
Titanium-barium (25%) anatase	.0279	35.82	4.30
Titanium-barium (30%) anatase	.0283	35.31	4.24
Titanium-calcium anatase	.0384	26.07	3.13
Titanium-calcium, rutile	.0369	27.07	3.25
Titanium dioxide, anatase	.0309	32.32	3.88
Titanium dioxide, rutile	.0286	35.00	4.20
Titanium-magnesium	.0387	25.82	3.10

Pigment
Toluidine red
Tuscan red
Ultramarine blue
Umber, burnt
Umber, raw
Van dyke brown
Venetian red (40% Fe_2O_3)
Venetian red (20% Fe_2O_3)
White lead, carbonate
White lead, sulfate
Whiting
Zinc chromate (zinc yellow)
Zinc chromate (tetroxy)
Zinc dust
Zinc oxide
Zinc oxide (5% leaded)
Zinc oxide (35% leaded)
Zinc oxide (50% leaded)
Zinc sulfide
Zinc sulfide—barium
Zinc sulfide—calcium
Zinc sulfide—magnesium
Zirconium oxide

2. OILS

The scope of this table will suffice fo
Patented oils are not included as their types

Oils
Castor
Castor, dehydrated
Castor, dehydrated, Z 3
Cottonseed
Fish—(see also Menhaden, Pilchard, and Sardine)
Linseed, raw or boiled
Linseed, blown
Linseed, heat-bodied, E
Linseed, heat-bodied, Q
Linseed, heat-bodied, Z and higher
Menhaden
Oiticica, raw
Oiticica, liquefied
Perilla
Pilchard
Sardine
Soybean
Tall
Tung

696245° 46 - 10

3. SOLVENTS

In addition to the liquids in this list, a large number are not included. The solvents not included are specialties used in relatively small amounts and it is hoped that their omission will not detract from the usefulness of the table.

Solvents	Gallons per pound	Pounds per gallon	Specific gravity
Acetone	0.1514	6.61	0.793
n-Amyl acetate	.1380	7.25	.870
n-Amyl alcohol	.1380	7.25	.870
Benzene, industrially pure	.1364	7.33	.880
n-Butanol	.1478	6.76	.812
n-Butyl acetate	.1370	7.30	.876
sec-Butyl acetate	.1393	7.18	.862
Butyl lactate	.1233	8.11	.974
Carbon tetrachloride	.0750	13.33	1.600
Cyclohexanone	.1270	7.87	.945
Diacetone alcohol	.1276	7.84	.941
Diethyl carbonate	.1232	8.12	.975
Diethylene glycol monoethyl ether	.1213	8.25	.990
Dipentene	.1396	7.16	.860
Ethanol, 95%	.1471	6.80	.816
Ethanol, S.D. 1	.1473	6.79	.815
Ethyl acetate	.1334	7.50	.900
Ethylene dichloride	.0952	10.50	1.26
Ethylene glycol monobutyl ether	.1331	7.51	.902
Ethylene glycol monoethyl ether	.1289	7.76	.931
Ethylene glycol monoethyl ether acetate	.1233	8.11	.974
Ethylene glycol monomethyl ether	.1243	8.05	.966
Ethylene glycol monomethyl ether acetate	.1189	8.41	1.01
Ethyl lactate	.1166	8.58	1.03
Hexahydrophenol	.1261	7.93	.952
Isopropanol	.1520	6.58	.790
Kerosene	.1510	6.62	.795
Methanol	.1514	6.61	.793
Methyl acetate	.1322	7.56	.908
Methyl acetone (48% acetone, 28% methyl acetate, 24% methyl alcohol)	.1444	6.92	.831
Methylene chloride	.0903	11.08	1.33
Methyl ethyl ketone	.1491	6.71	.805
Methyl isobutyl ketone	.1499	6.68	.802
Mineral spirits—			
Approx. distn. range, 155° to 200° C.	.1525	6.56	.787
Approx. distn. range, 180° to 250° C.	.1477	6.77	.813
Naphtha, aromatic petroleum—			
Approx. distn. range, 90° to 150° C.	.1501	6.66	.800
Approx. distn. range, 135° to 190° C.	.1421	7.04	.845
Approx. distn. range, 170° to 220° C.	.1380	7.25	.870
Naphtha, lacquer diluent	.1626	6.15	.738
Naphtha, solvent—			
Approx. distn. range, 130° to 155° C.	.1396	7.16	.860
Approx. distn. range, 150° to 200° C, Hi-flash	.1380	7.25	.870
Heavy, wire enamel solvent	.1291	7.75	.930

Solvents

Naphtha, V. M. & P.—
Approx. distn. range, 100° to 160° C.
Nitroethane
Nitromethane
1-Nitropropane
Petroleum spirits—
Approx. distn. range, 155° to 200° C.
Approx. distn. range, 180° to 250° C.
Pine oil
Toluene, industrially pure
Trichloroethylene
Turpentine
Xylene, 5°

4. RESINS AND OTHER F

Most of the synthetic resins and filmoge
tions) in use today vary so widely in thei
attempt to classify them would be mislea
have been entered have been assigned maxi
and the user of these tables should obtain
the producer.

In the few cases that have been investig
values of filmogens in solution differ fr
Assuming no change in the bulking value
filmogens occupy less volume in solution t
for the cellulosic filmogens given in the
to their solution in typical solvents or sol

Resins and other filmogens

Accroides
Alkyd
Asphalt, oxidized petroleum
Asphalt, steamblown petroleum
Beeswax
Candelilla wax
Carnauba wax
Casein
Cellulose acetate
Cellulose acetate-butyrate
Cellulose nitrate
Ceresin
Chlorinated diphenyl, 65% chlorine
Chlorinated rubber
Congo
Congo ester

Resins and other filmogens	Gallons per pound	Pounds per gallon	Specific gravity
Cumarone	0.1112	9.00	1.08
Damar	.1143	8.75	1.05
East India	.1155	8.66	1.04
Elaterite	.1166	8.58	1.03
Ester gum	.1062	9.41	1.13
Ethyl cellulose	.1035	9.66	1.16
Gilsonite	.1143	8.75	1.05
Kauri	.1155	8.66	1.04
Lac	.1000	10.00	1.20
Manila	.1122	8.91	1.07
Mastic	.1122	8.91	1.07
Melamine	.0984	10.16	1.22
Paraffin	.1349	7.41	.89
Phenol-formaldehyde	.1166 to .1000	8.58 to 10.00	1.03 to 1.20
Pontianak	.1122	8.91	1.07
Rosin	.1112	9.00	1.08
Rosin, limed, 4 to 6% Ca	.1091	9.16	1.10
Urea-formaldehyde	.0961	10.41	1.25
Vegetable oil pitch	.1177	8.50	1.02
Vinyl	.090	11.08	1.33
Zinc rosinate, 6% Zn	.1044	9.58	1.15

5. PLASTICIZERS

Plasticizers	Gallons per pound	Pounds per gallon	Specific gravity
Benzyl benzoate	0.1062	9.41	1.13
Blown castor oil, Z	.1200	8.33	1.00
Blown castor oil, Z6	.1166	8.58	1.03
Butyl acetyl ricinoleate	.1277	7.83	.94
Butyl phthalyl butyl glycollate	.1091	9.16	1.10
Butyl stearate	.1396	7.16	.86
Camphor	.1200	8.33	1.00
Diamyl phthalate	.1166	8.58	1.03
Dibutyl phthalate	.1143	8.75	1.05
Dibutyl sebacate	.1277	7.83	.94
Dibutyl tartrate	.1112	9.00	1.08
Dibutoxy ethyl phthalate	.1291	7.75	.93
Diethyl phthalate	.1072	9.33	1.12
Dihydromethyl abietate	.1166	8.58	1.03
Dimethyl phthalate	.1009	9.91	1.19
Ethyl phthalyl ethyl glycollate	.1016	9.84	1.18
Methyl abietate	.1177	8.50	1.02
Methyl phthalyl ethyl glycollate	.0980	10.20	1.22
Toluene ethyl sulfonamide	.1009	9.91	1.19
Tributyl citrate	.1143	8.75	1.05
Tributyl phosphate	.1225	8.16	.98
Tricresyl phosphate	.1017	9.83	1.18
Triethyl citrate	.1053	9.50	1.14
Triphenyl phosphate	.1009	9.91	1.19

Grateful acknowledgment is
ist, Forest Product Laborato
Scientific Section, National Pa
sociation; A. C. Goetz, con
Branch, War Production Bo
chairman, Federal Specifica
Procurement Division, Treas
Howes, Materials Unit, Techn
Housing Authority for their te
aration of this manual and to
R. Garner, of the Building Pr
tion of the National Bureau o
taking effort in reviewing the

X. LITERATUR

1. REFERENCES

[1] Dutch Boy Quarterly 22, No.
[2] National Lead Co., Handbook
111 Broadway, New York,
[3] A. Maerz and M. Rea Paul, A
Book Co., Inc., New York,
[4] A. H. Munsell, Munsell book
more, Md., 1929.)
[5] Color card supplement to U.
April 21, 1943. (Office, Chi
Washington 25, D. C.)
[6] Specification TAC-ES-680B.
tive coating materials, synth
Automotive Center, Specifi
Detroit, Mich.)
[7] C. L. Mantell, C. W. Kopf,
Technology of natural resi
Inc., 1942.)
[8] Federal specification TT-V-91
U. S. Government Printing
[9] Henry A. Gardner, Physica
paints, varnishes, lacquers,
(Institute of Paint Varni
Avenue, Washington 5, D.
[10] Deane B. Judd and Kenneth
colors, J. Research NBS 23
[11] G. J. Fink, Investigation of
paints, J. Ind. Eng. Chem.
basis for Bulletin 304D, W
(National Lime Association
D. C. Copies free on requ
[12] U. S. Engineer Dept., St. Lou
tures, standard specificatio
20, 1941. (Upper Mississip
Dept., St. Louis, Mo.)

[13] American Water Works Association standard specification (1A.5 1940, 7A.6 1940) for coal-tar enamel protective coatings for steel water pipe. (American Water Works Association, Inc., 500 Fifth Avenue, New York 18, N. Y., 1940.)

[14] Navy Department Bureau of Yards and Docks, specification for bituminous coating of steel surfaces No. 34Yb (1943). (Bureau of Yards and Docks, Washington 25, D. C.)

[15] Repairs and utilities manual, RU 0603.04. (Office of the Chief of Engineers, U. S. Army, Washington 25, D. C. This manual is on file at all U. S. Army posts.)

[16] Safety requirements for excavation, building, and construction, sections 8305.01 to 8306.08 (Construction Division, Office of the Chief of Engineers, War Department, Washington 25, D. C.).

[17] Paint exposure or complaint report (National Paint, Varnish & Lacquer Association, 1500 Rhode Island Avenue, N.W., Washington 5, D. C.).

[18] Circular 667, Bulking value tables, September 1943. (Scientific Section, National Paint, Varnish & Lacquer Association, 1500 Rhode Island Avenue, N.W., Washington 5, D. C.)

2. ADDITIONAL REFERENCES

The following list of references gives additional information on paint and painting materials. Federal Specifications are priced at 5 cents a copy unless otherwise indicated in the Federal Standard Stock Catalog. Request and remittance for them and for the following publications where a price is indicated should be made to the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Letter Circulars and TIBM Reports may be obtained free of charge from the National Bureau of Standards.

(a) BUILDING MATERIALS AND STRUCTURES REPORTS

Rolla E. Pollard and Wilbur C. Porter, Methods of investigation of surface treatment for corrosion protection of steel, NBS BMS8 (1938) 10¢.

Herman V. Cottony and Richard S. Dill, Solar heating of various surfaces, NBS BMS64 (1941) 10¢.

Rolla E. Pollard and Wilbur C. Porter, Surface treatment of steel prior to painting, NBS BMS44 (1940) 10¢.

Cyrus C. Fishburn and Douglas E. Parsons, Tests of cement-water paints and other waterproofings for unit-masonry walls, NBS BMS95 (1943) 15¢.

Wilbur C. Porter, Painting steel, NBS BMS102 (1944) 10¢.

(b) LETTER CIRCUL

Acid-proof coatings for concrete surfaces,
Bluing of iron and steel, NBS LC630 (194
Care of floors, NBS LC764 (1941).
Color charts: A descriptive list, NBS LC
Color harmony, NBS LC525 (1938).
Color and legibility, NBS LC730 (1943).
Conservation of linseed oil in paint, NBS
Control of humidity by saturated salt sol
Corrosion and protection of underground
NBS LC521 (1938).
Corrosion in soils, NBS LC689 (1942).
Dampness in masonry walls above grade,
Drainpipe cleaners or solvents, NBS LC75
Finishes for concrete floors, NBS LC758
Inside wall paint for chemical laboratories
enamel paint), NBS LC489 (1937).
Luminous and fluorescent paints, NBS LC
Outside house painting, NBS LC603 (1940
Paint, varnish, and bituminous materials
of the staff of the National Bureau o
Federal Specifications, NBS LC795 (19
Paint and varnish removers, NBS LC749
Painting exterior walls of porous masonry,
Painting Plaster, NBS LC304 (1938).
Painting of steam and hot-water radiators
Painting Steel Potable water tanks, NBS I
Painting of structural metal (steel, galva
copper), NBS LC422 (1934).
Paints and other protective coatings for tir
Paints for swimming pools, NBS LC746 (19
Polishes, NBS LC753 (1944).
Protection of track-scale parts from corrosi
Protective coatings for underground pip
(1938).
Refinishing wood furniture, NBS LC748 (19
Reflectance of paints and pigments, NBS
Salt-spray test (for metal corrosion), NBS
Sources of information on paint and rela
(1941).
Specifications for paint for use on railroa
(1922).
Spray painting, NBS LC773 (1944).
Sweeping compounds (also known as "floor
NBS LC754 (1944).
Tests for nonmetallic protective coatings fo
LC480 (1936).
Wood and shingle stains, NBS LC464 (1936

(c) SIMPLIFIED PRACTICE RECO

Paint and varnish brushes, R43-28, 5¢.
Color for school furniture, R111-30, 5¢.
Paints, varnishes, and related products, R1

Color code for marking steel bars, R166–37, 5¢.
Color marking for anesthetic gas cylinders, R176–41, 5¢.

(d) TECHNICAL INFORMATION ON BUILDING MATERIALS

Aluminum paints, NBS TIBM43 (1937).
Federal specification paint pigments and mixing formulas, NBS TIBM33 (1936).
Federal specification ready-mixed paints, semipaste paints, and mixing formulas, NBS TIBM34 (1946).
Miscellaneous paint drying oils and paint driers, NBS TIBM45 (1937).
Paint drying oils—linseed, NBS TIBM44 (1937).
Paint pigments—black, red, and lakes, NBS TIBM31 (1936).
Paint pigments—white, NBS TIBM30 (1936).
Paint pigments—yellow, brown, blue, green, and bronze, NBS TIBM32 (1936).
Paint for priming plaster surfaces, NBS TIBM11 (1936).
Painting of ferrous metals, NBS TIBM28 (1936).
Painting plaster, NBS TIBM18 (1936).
Preparation of paints from paste and dry pigments, NBS TIBM35 (1936).
Preparation of paints from semipaste paints, thinning ready-mixed paints, and preparation of water paints, NBS TIBM36 (1936).
Shellac, NBS TIBM48 (1937).
Varnish and lacquer, NBS TIBM47 (1937).
Volatile paint and varnish thinners, NBS TIBM46 (1937).
Wood and shingle stains, NBS TIBM49 (1937).

(e) COMMERCIAL STANDARDS

Colors for sanitary ware, CS30–31.
Colors for kitchen accessories, CS62–38, 5¢.
Colors for bathroom accessories, CS63–38, 5¢.
Artists' oil paints, CS98–42, 5¢.

XI. GLOSSARY OF SELECTED PAINT TERMS

The purpose of this glossary is to assist the reader in becoming better acquainted with the definitions and explanations of a limited number of terms currently used in the field of protective coatings. No attempt has been made to cover the entire field. For those interested in the definition of terms not included, the following references used in preparing this glossary are suggested:

Webster's New International Dictionary, Second Edition, unabridged.
Standard Chemical and Technical Dictionary by H. Bennett. Chemical Publishing Co., Inc., New York, N. Y.
The National Paint Dictionary, by J. R. Stewart. Stewart Research Laboratory, Franconia, Va.

Federal Specification TT-P-141a, Pai
lated Materials; General Specifica
Methods (20 cents, Superintendent
Definition of Terms Relating to Paint,
Products, A.S.T.M. Standards, 1942.
Testing Materials.

Acid number.—A value obtain
etc.; the number of milligrams
required to neutralize the free f
substance.

Alkali-refined oil.—Drying oil
duce its acid number.

Alkyd resin.—A group of synt
ing polyhydric alcohols, such as
with dibasic organic acids such as
and sebacic. A modifying age
impart certain properties. Some
semidrying, and nondrying oils;
ural resins such as rosin; synthe
stances. An average alkyd resi
about 50 percent of modifier such
30 percent of diabasic acid, and
alcohol (see glyceryl phthalate).

Aromatic.—Derived from or c
ence of the benzene ring—as appli
organic compounds—many of wh

Binder.—The nonvolatile porti

Bleeding.—When coloring mat
or an undercoat works up into su
to them a certain amount of colo

Blistering.—Formation of bubb
film, usually caused by moisture

Bloom.—Haze or clouded effect
face of dried enamel or varnish,
film.

Bodied linseed oil.—Bodied li
thickened by heat treating or blo
"body" or consistency. It may b
grees of body or viscosity, indicat
scale by letters of the alphabet.

Body coat.—Intermediate coat o
ing or first coat and the finishing,

Boiled linseed oil.—Raw linsee
in the presence of metallic dryin

method consisted in heating the oil by direct fire to a temperature of about 550° F, at which point oxides of metals, such as red lead, litharge, and manganese dioxide were added. More modern methods add soluble driers, such as resinates, linoleates, and naphthanates of lead, manganese, and cobalt, to the oil, which is heated to lower temperatures than in the older process.

Boot-topping paint.—A water- and weather-resistant marine paint used on the boot-topping area of vessels. The boot-topping area is that area on the exterior of the vessel extending from the light-load water line to 6 in. above the full-load water line.

Builders' acid.—An acid prepared on the job by adding 1 part by volume of muriatic (hydrochloric) acid to 4 parts by volume of water. The solution, which should be mixed in a wood pail and applied to the surface by means of fiber scrub brushes, will remove mortar stains from brick.

Bulking value.—Void-free volume of a unit weight of material expressed as decimal fraction of a gallon per pound.

Calcimine.—A wash consisting of a mixture of whiting, glue, china clay, and water (see Fed. Spec. TT-C-96).

Chalking.—A phenomenon of paint coatings manifest by loose powder coming from the film itself, at or just beneath the surface.

Consistency.—Relative firmness, limpidity, body, or resistance to agitation or deformation of a coating material in bulk.

Copals.—A group of resinous substances exuding from various tropical trees. Copal is collected from living trees or is dug from the ground as a fossil. The main sources are East India, New Zealand, and Africa. Some of the resins are amber, congo, kauri, manila, Pontianak, West India gum, and zanzibar.

Crazing.—A type of paint failure consisting of minute interlacing cracks on the surface of a finish caused by unequal contraction while drying.

Cut.—The dispersion of a certain number of pounds of shellac or resin per gallon of volatile liquid. For example, a 4-lb cut of shellac varnish contains 4 lb of dry shellac and 1 gal of alcohol.

Drier.—A composition that accelerates the drying of oil, paint, or varnish. Driers, usually compounds of metals, are available in solid, paste, and liquid form.

Drying oil.—An oil which posses
the property of readily taking up o
changing to a relatively hard, tough
exposed in a thin film to the air.

Efflorescence.—A white powdery
brick walls and similar masonry su
moved by builders' acid before surfa

Emulsifier or emulsifying agent.—
cal nature that intimately mix and
terials ordinarily immiscible, such a
duce a stable finished emulsion. Th
double task of promoting the emulsi
ing the finished product. Some ex
agents are alkali soaps (sodium
oleate); metallic soaps (aluminum
oleate); amino soaps (morpholine
(Turkey red oil); and casein (the na
and stabilizer in milk that keeps the
sified).

Enamel.—A paint that is charact
dry to an especially smooth, hard, glo

Film integrity.—The serviceabilit
may be described by (1) the appeara
coloration by dirt, loss of gloss, fad
hide, chalking, and checking visible
least 6 ft, and (2) film integrity: cra
and scaling of the film or discontinui
bare the underlying surface.

Filmogens.—General word for fi
such as linseed oil and varnish resin

Foots.—Slimy mucilaginous matte
some oils when they stand for a long

Form lacquer.—Thin varnish or la
crete forms to prevent the concrete
forms.

Garnet paper.—Similar to sandpa
sand used for making garnet paper i
as that used for jewelry but of more
ally dark claret in color.

Glazing.—Operation of setting win
Also, the process of obtaining Tiffan
tive effects on walls by the applicati
ment colors-in-oil such as sienna,
brown, thinned with flatting oil (Fe

Gloss (luster, sheen).—The property of a surface by which it reflects light specularly. Painters use the terms *high, enamel*, or *mirror* to indicate the highest gloss or luster; and *semigloss, eggshell*, and *flat* to indicate decreasing degrees of gloss in the order given.

Glyceryl phthalate resin (alkyd).—A synthetic resin of the alkyd group, used principally in paints, varnishes, and lacquers; sometimes called phthalic alkyd resin. It is made by reacting glycerin and phthalic anhydride. The alkyd resins as a group are made by reacting polyhydric alcohols, such as glycerin and the glycols, with dibasic organic acids, such as phthalic, maleic, succinic, and sebasic.

Gum.—Viscous vegetable secretion that hardens but, unlike a resin, is water-soluble; name often applied in the varnish industry to natural resins, as, for example, kauri "gum." A more appropriate term is "gum resin."

Hiding power.—The power of a paint or paint material to obscure the surface to which it is applied. In Federal specifications this property is expressed in terms of square feet per gallon.

Iodine number.—In the analysis of oils, fats, etc. the number of centigrams of iodine absorbed by 1 g of the substance.

Kauri reduction test.—A method of determining the relative flexibility of certain oleoresinous varnishes by using a solution of properly treated kauri resin in turpentine. (For details, see Fed. Spec. TT-P-141a, Method 415.)

Krebs units.—Arbitrary values representing viscosity or consistency of paints based on tests with the Krebs-Stormer viscometer.

Lacquer.—The term indicates a coating material that dries by evaporation. The many types include cellulosic lacquers, Chinese lacquers, sanitary or tin-plate lacquers, and spirit lacquers, for example, solutions of shellac in alcohol. Cellulosic lacquers (Fed. Spec. TT-L-58) are the most important and today, the term *lacquer* is applied almost exclusively to this type. Cellulosic lacquers, either transparent or pigmented, contain cellulose esters or ethers and plasticizers, with or without natural or synthetic resins as the basic film-forming ingredients. Lacquer dries rapidly by solvent evaporation.

Mil.—Unit of thickness; 1/1000 in. Used to measure the thickness of paint coats.

Nonvolatile vehicle.—Liquid portion of paint, with the exception of volatile thinner and water.

Oil length of varnish.—The number o
oil with which 100 lb of resin, or "gum,"
oil" varnish contains 25 gal of oil or o
gal or less; "medium-oil," from 10 to 2
of long-oil is spar varnish (TT-V-121b)
varnish (TT-V-86); medium-oil, inter
V-71a).

Oil varnish.—Varnish that contains re
as the basic film-forming ingredients an
solid film primarily by chemical reacti
nish).

Paint.—A mixture of pigment with v
be spread in thin coats for decoration, pr

Pigment.—Fine solid particles used in
paint and substantially insoluble in the

Pigment volume.—Percentage by volu
nonvolatile portion of a paint as calcul
value and composition data. The letters
used as an abbreviation.

Plasticizer.—An ingredient added to a
increase toughness, or otherwise modify

Plastic wood.—Mixture designed for t
work. Consists of wood flour, resins, vo
plastic binding material such as cellulose

Poise.—The cgs (centimeter-gram-seco
lute viscosity.

Polymerization.—A reaction in which
cules of the same substance combine to
higher molecular weight without chang
composition of the original material.
coating field, the term is applied to various
ing drying oils, such as linseed oil and t
such as rosin. In most varnishes the oil
careful heating. The presence of phenoli
the oil, during the varnish cooking, greatl
merization. Such varnishes dry largely
rather than by oxidation. Varnish films
by polymerization are characterized by
resistance and resistance to sunlight an
tung oil pure phenolic resin spar varnish

Primer.—The paint or analogous subst
to the surface of the material being pai
paint.

Putty.—A kind of cement used for fastening glass in sashes, stopping crevices, and similar purposes.

Resin.—A semisolid or solid, complex amorphous mixture of organic compound with no definite melting point, insoluble in water. Resins are usually either partly soluble in alcohols, ethers, and other organic solvents or can be made so by heating. On heating, resins soften, melt, and burn with a smoky flame.

Rosin.—The solid resin obtained as the residue from the preparation of turpentine from the crude resin of the pine tree.

Saponify.—To convert a fat or oil into soap by the action of an alkali. When esters are boiled with strong bases, soaps are formed. Linseed oil contains the glyceryl ester of linoleic acid. Thus, when a linseed-oil paint comes in contact with a surface that contains strong alkali and water, such as damp concrete basement floors, the oil is saponified and thus loses its bonding properties.

Sealer (size).—A liquid coating composition, usually transparent, such as varnish, that also contains pigment for sealing porous surfaces, especially plaster, preparatory to application of finish coats. A thin varnish of 1 gal TT-V-71a interior varnish plus 1 or 2 qt turpentine is frequently used as a "sealer" for plaster, prior to application of finish coats of paint. Federal Specification TT-P-56 is an example of pigmented sealer for plaster. Wood floor sealer (Fed. Spec. TT-S-176) is a thin varnish.

Shellac.—A resinous material commonly known as "flake shellac," secreted by the insect Laccifer Lacca Kerr. Shellac is obtainable in two forms, "orange" and "bleached." (Fed. Spec. TT-S-271).

Spar varnish.—A very durable, water-resistant varnish for severe service on exterior exposure. It consists of one or more drying oils: for example, linseed, tung, or dehydrated castor; one or more resins: for example, rosin, ester gum, 100 percent phenolic resin, or modified phenolic resin; one or more volatile thinners: for example, turpentine or petroleum spirits; and driers: for example, linoleates, resinates, or naphthanates of lead, manganese, and cobalt. It is classed as long-oil varnish (see "oil length of varnish"), and generally consists of 45 to 50 gal of oil to each 100 lb of resin.

Spirit varnish.—A varnish which is converted to a solid film by solvent evaporation. Damar Varnish (Fed. Spec.

TT-V-61) and Shellac Varnish (F
are spirit varnishes.

Spreading rate.—The amount of
which a given volume of paint can
spraying, etc. Usually expressed in
gallon.

Thixotropic paint.—The general
property or phenomenon, exhibited b
ing fluid when shaken. The change
tropic paint applies particularly to t
wall paints. Many paints of this typ
ity like the texture of whipped crea
but become highly fluid when the
remains so for an appreciable time.
mechanical disturbance, such as stir
putting the brush into the paint, ri
again. These are known as thixotro
logical property is of practical signi
age, application, and film properties

Trim enamel paint.—A subdivisio
known as house paints, differing fro
body colors by faster drying, by hav
showing fewer brush marks. Princi
on trim, screens, and shutters. (F
amendment 1).

Two-coat paint system.—A system
ing new exterior woodwork that con
and finish paint for application in
After two coats have been applied
dry, the thickness of the coating for
be about 0.0045 to 0.0055 in. (4½ to
such a thickness, the primer should
mately 450 ft²/gal and the finish coat

Varnish.—A homogeneous liquid
resin, drying oil, volatile thinner, and
in a thin layer and exposed to the a
verted to a transparent or translucen

Vehicle.—The liquid portion of a p

Viscosity.—Internal friction of a flu
opposite of fluidity. For example, lins
than turpentine; bodied linseed oil is
linseed oil. An important physical pr
and lacquer.

Volatile thinner.—The liquid portion of a paint, except water, which is volatile in a current of steam at atmospheric pressure.

Zinc oxide and leaded zinc oxide.—Zinc oxides covered by Federal Specification TT–Z–301 contain practically no lead. Leaded zinc oxides covered by Federal Specification TT–Z–321 are produced from ores containing lead and may contain from 7 to 40 percent of material other than zinc oxide, which is generally basic lead sulfate. The material is really a mixture of zinc oxide and basic sulfate white lead.

XII. LIST OF FEDERAL SPECIFICATIONS

As this publication goes to press, the following is the latest list of Federal Specifications pertaining to paint and related materials.

Federal specifications may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., for 5 cents each (no stamps), except TT–P–141a Methods of sampling and testing, 20 cents.

Federal Specifications Index, Part 1 of Federal Standard Stock Catalog Section IV may be obtained from the Superintendent of Documents, Washington 25, D. C. Price, 25 cents.

Acetone O–A–51a
Aluminum pigment (powder and paste) .TT–A–468
——, varnish for.....TT–V–81a
Asphalt primer SS–A–701
—— roof coating SS–R–451
—— varnish TT–V–51a
Benzol VV–B–231
Bituminous plastic cement SS–C–153
Black enamel TT–E–521
—— ——, heat resisting TT–E–496
Black paint, carbon...TT–P–61a
—— ——, graphite....TT–P–27
Blue lead, dry and in oil TT–B–486
—— ——, paint.....TT–P–20
Bone black, dry.....TT–B–600
—— ——, paste-in-oil.TT–P–381
Calcimine TT–C–96
Calking compound TT–C–598
Carbon black, dry.....TT–C–120
—— ——, paste-in-oil.TT–P–381
Casein paint, exterior..TT–P–22
—— ——, interior....TT–P–23a
Cement-water paint ...TT–P–21
Chrome green, dry ...TT–C–235
—— ——, paste-in-oil.TT–P–381
Chrome orange, dry ...TT–C–290
—— ——, paste-in-oil.TT–P–381
Chrome oxide, dry ...TT–C–306
—— ——, paste-in-oil.TT–P–381
Chrome yellow, dry ...TT–C–290
—— ——, paste-in-oil.TT–P–381
Cold-water paint, exterior TT–P–22
—— —— —— —— , interior TT–P–23a
Concrete and masonry paint TT–P–24
Copper phthalocyanine blue TT–C–610
Damar varnish TT–V–61
Drier, liquid paint ..TT–D–651a
Drum-coating enamel..TT–E–485
Eggshell interior paint TT–P–51a

Emulsion paint TT–P–88
Enamel, see under color or type
Exterior paint TT–P–40
—— primer for wood..TT–P–25
—— varnish (spar)..TT–V–121b
Filler, paste wood ..TT–F–336a
Flat interior paint ...TT–P–51a
Floor paint, rubber base TT–P–91
—— ——, varnish base TT–P–146
Galvanized iron primer TT–P–641
Gold-leaf QQ–G–566
Graphite paint TT–P–27
Green paint TT–P–71a
Heat-resisting enamel.TT–E–496
House paint, white and tints TT–P–40
—— ——, see under color or type
Indian red, dry TT–I–511a
—— ——, paste-in-oil.TT–P–381
Interior enamel TT–E–506a
Interior cold water paint TT–P–23a
—— emulsion paint...TT–P–88a
—— flat paint TT–P–51a
—— one-coat flat paint.TT–P–47
—— varnish TT–V–71a
International orange paint TT–P–59
Iron blue, dry TT–I–677
—— ——, paste-in-oil.TT–P–381
Iron oxide, black, dry..TT–I–698
—— ——, bright red, dry TT–I–511a
—— ——, —— ——, paste-in-oil TT–P–381
—— ——, brown, dry..TT–I–702
Iron oxide paint.....TT–P–31a
Lacquer, spraying TT–L–58
Lacquer, thinner TT–T–266
Lampblack, dry TT–I–70
——, paste-in-oil.....TT–P–381
Lead-zinc-titanium paint TT–P–40
Lithopone, dry TT–L–426
Lusterless olive drab enamel TT–E–514
Magnesium silicate TT–M–90
Masonry paint TT–P–24
Metallic brown, dry...TT–M–251

Metallic
paste-i
Methods
Mineral s
Mineral r
dry ..
Mineral r
paste-in
Mixing v
alumin
Olive-dra
lusterle
—— ——
paint .
Ocher, dr
——, pas
Oil, flatti
——, lins
—— , —
—— , —
ment .
—— , soy
—— , tu
Orange p
nationa
Paint, see
Pigments,
Plaster p
Primer, e
—— , gal
—— , pl
Protein b
paint .
—— ——
paint .
Prussian
—— ——
Putty, me
glazing
——, woo
glazing
Radioacti
compou
Red enam
Red lead,
paste .
Red lead
Remover
Rubbing
Sealer, fl
type ..
Shellac, o
Shellac v
Shellac V
Replace

The following Federal Specifications are in preparation but are not approved or printed as yet:

Ink; stencil (TT-I-558 and 559).
Paint; luminous, nonradioactive.
Paint; semigloss, wall, interior (TT-E-508).
Primer; paint, iron-oxide (for motor vehicles).
Shellac (revision of TT-S-271).

INDE