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PHOTOGRAPHIC STANDARDS
FOR
ABRASIVE BLASTED STEEL

LAB. PROJECT 9400-34, TECHNICAL MEMORANDUM #2

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APPROVED:



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APPENDICES

- A - Guidebook of Abrasive Blasting Standards (with Figures 1 thru 14)
- B - NACE Definitions of Abrasive Blasted Standards

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1. As authorized by reference (a), the U.S. Naval Applied Science Laboratory has completed a set of photographic standards to depict various grades of abrasive blasted steel. These, together with descriptive material, are bound in loose-leaf form and forwarded herewith as Appendix A. Assistance of the Photographic Branch of this Laboratory in preparation of the photographic standards is acknowledged.

2. Color control was achieved by Kodak gray standards photographed together with each steel specimen plate and compared against the original gray standards during print development.

Photography flood lights were at an angle of 45° to the surface to create a three-dimensional effect. Film was Kodak Ektacolor. Specimen plates were masked with a metal template during abrasive blasting to depict different conditions of surface preparation.

3. The standard surface designations are those adopted by Task Group T-6G-2 of the National Association of Corrosion Engineers (NACE)⁽¹⁾ on 17 November 1962, but the actual conditions are modified principally as follows:

(1) NACE definitions are reproduced in Appendix B for informational purposes.

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a. The NACE "Commercial" finish specified "at least two thirds of the surface area shall be free of all visible residues and the remainder shall be limited to light discolorations, slight staining or light residues." The two-thirds requirement is considered too limiting and is changed herein to one-half. Figures 1 and 2 of Appendix A provide graphical representations of surfaces one-half and two-thirds, respectively, blasted to gray metal; the latter represented by lighter tones in the photographs.

b. The NACE "Near-White Metal" finish specified "at least 95 percent of the surface shall have the appearance of a surface blast cleaned to a white metal surface finish, and the remainder shall be limited to light discoloration." The 95 percent requirement is considered too low, as demonstrated by examination of Figure 3 of Appendix A, where the lighter gray areas amount to 95 percent of the total surface area. This photograph evidently cannot represent a "Near-White" surface. A minimum of 99 percent white-gray surface is more representative of "Near-White", as is seen in Figure 4 of Appendix A.

c. The NACE "White-Metal" specification requires a surface which "shall be free of all oil, grease, dirt, mill scale, corrosion products, paint, or any other foreign matter." Although this condition can be achieved, instances frequently occur where spots of rust, paint, and scale remain at the base of pits and cannot be eliminated without removing the metal virtually to the bottom of the pits. This process incurs excessive expenditure of grit, labor, and metal. A surface having a maximum area of 0.1 percent residue within the pits is as adequate for all practical purposes as an "All White" surface, and encompasses the usual persistent impurities. This condition is shown in Figure 5 of Appendix A.

d. Other modifications of the NACE descriptions include more definite and quantitative characterization of contaminants, as well as the original condition prior to blasting. The modified standard descriptions are listed in the introduction of Appendix A.

4. The first draft of the guidebook has been completed under Appendix A. It is requested that the Bureau authorize this Laboratory to forward Appendix A to all Naval Shipyards and to Supervisors of Shipbuilding, for comments and aid in its expansion.

5. Future work will include improvement of photographic techniques and expansion of the guidebook to include additional surfaces, different types of abrasive, and other special conditions. Completion of the expanded

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guidebook with respect to abrasive blasting is expected in Fiscal Year 1965.

Principal Investigator



I. GELD

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APPENDIX A

GUIDEBOOK OF ABRASIVE BLASTING STANDARDS

FIRST DRAFT

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INTRODUCTION

It is axiomatic that performance of a coating is dependent on the quality of the surface preparation. A coating system inherently resistant to a particular exposure will not perform well with an inadequately prepared surface.

One method, commonly used by the Navy, of achieving a suitable surface is by abrasive blasting, which removes rust, mill scale, old paint, dirt, grease, etc. The degree of blasting should be correlated with anticipated exposure conditions. For example, although marginal surface preparation will cause rapid coating failure in sea water, it may be adequate for touch-up coating in non-critical exposures such as in dry compartments below deck.

A perfectly uniform white-gray grit blasted finish, although relatively more expensive and time consuming, is often necessary as preparation for specialized coatings in severe exposures. Between these extremes are different degrees of blasting for intermediate exposure conditions.

This guidebook is intended to minimize confusion in judging degrees of abrasive blasting by serving as a visual aid for supervisors and inspectors, and as a basis for contractual specifications. The descriptions given below will serve as reference standards for degrees of blasting, and are illustrated by black and white, and color photographs (actual size). The black and white photographs were taken of pencil drawings, purposely blurred, and exactly representing different degrees of blasting. The color photographs are divided into horizontal strips, illustrating in a general way three or more of the specified conditions. In most cases, the blasted areas shown are part of larger plates, suitably masked. Standard descriptions are as follows:

1. Original Condition. Original plate appearance is important to help determine the amount of work required, and interpret roughness of surfaces obtained as well as nature of residues (e.g. rust, paint, mill scale) remaining.

2. Brush Blast. This is defined as a surface from which all oil, grease, dirt, loose mill scale, loose rust, loose paint or coatings, are removed, but which may retain light mill scale, rust, paint, and coatings, provided it has been exposed to the abrasive blast pattern sufficiently to expose numerous flecks of the underlying metal fairly uniformly distributed over the entire surface.

3. Commercial. This is a surface from which all oil, grease, dirt, mill scale, rust, paint, and other foreign matter not embedded in pits have been completely removed except for slight streaks or discolorations. The

latter conditions are defined as surface contaminations with the following limitations:

- a. Maximum thickness of 0.2 mil (this is the approximate limit of sensory detection by drawing a fingernail over the film-metal boundary).
- b. Resistance of less than 0.5 ohm when tested with blunt prongs of an ohmmeter, as described in the Bureau of Ships Technical Manual, Chapter 19, page 6, revised 15 July 1962. The resistance method cannot be used to indicate presence of embedded metallic abrasives; these are detected either visually or by the fingernail test.

If the surface is pitted, slight residues of paint, rust, or scale is permitted in the bottom of the pits. At least one-half of each square foot of surface shall appear a uniform white-gray free of all visible residues, and the remainder shall be limited to the light discolorations and staining defined above. Lighter gray areas of Figure 1, illustrate 50 percent clean, gray metal. Figure 2, representing two-thirds base metal exposure, is included for comparison.

NOTE: If any portion of the surface meets all the "Commercial" requirements except those of a or b, in paragraph 3 above, the condition is considered as a "Brush Blast" regardless of amount of gray metal exposed. This also applies to the "Near-White" and "White" conditions below. Only a small additional effort will be required to remove such residues and meet the specified conditions.

4. Near-White Metal - This is a surface from which all oil, grease, dirt, mill scale, rust, paint, embedded abrasive, and other foreign matter have been completely removed except for slight streaks or discolorations. The latter are defined in the requirements for a "Commercial" finish. If the surface is pitted, slight residue of paint, rust, or scale may be found in the bottom of the pits. At least 99 percent of each square foot of surface shall be slightly roughened, with a uniform white-gray appearance free of all visible residues, and the remainder shall be limited to the light discoloration defined above. Figure 4 illustrates a surface blasted to the specified minimum condition. Figure 3, representing a 95 percent base metal exposure, is included for comparison.

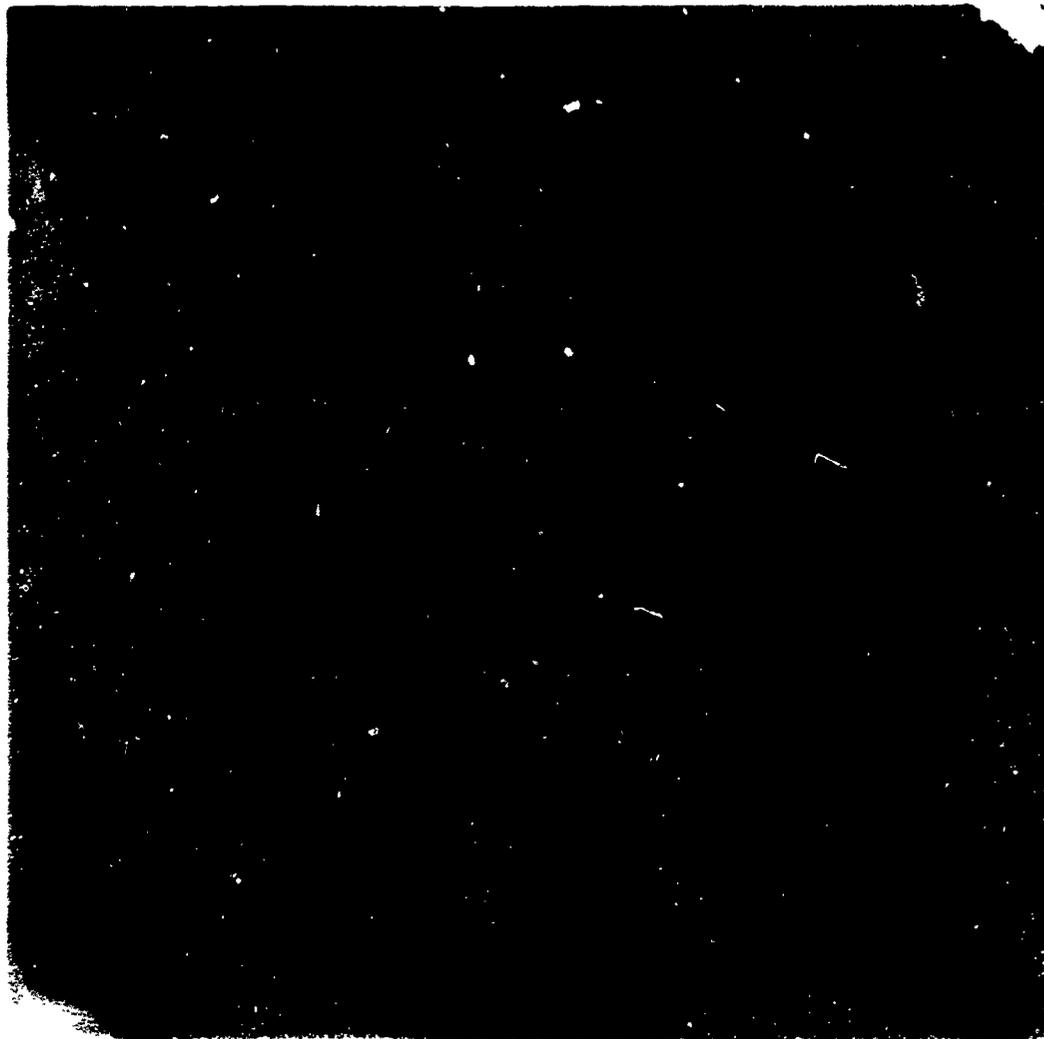
5. White Metal - This is a slightly roughened, uniform white-gray surface, free of all oil, grease, dirt, mill scale, paint, embedded abrasive, and other foreign matter. If the surface is pitted, slight residues of paint, rust, or scale may be found in the bottom of the pits. These residues shall occupy no more than 0.1 percent of each square foot of surface, as illustrated in Figure 5.

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Appendix A

In conditions 3,4, and 5 the white-gray surfaces may be faintly tinted with the color or shade of the abrasive medium used.

NOTE: To prevent fading and changes in hue, the guidebook should not be exposed for prolonged periods to sunlight or excessive heat or humidity.

This guidebook is preliminary. It requires the aid and cooperation of Naval Shipyards, Supervisors of Shipbuilding, and other interested organizations and agencies. These can help in expansion of the guidebook by forwarding the following to the U.S. Naval Applied Science Laboratory: (a) comments on the present guidebook and suggestions for improvement, (b) additional specimens (for inclusion in the guidebook) blasted in similar horizontal strips, to further illustrate the above-described standard conditions. Specimens can be taken from new and weathered plate, ships' hulls, submarine fuel oil ballast tanks, tanker gasoline cargo tanks, etc. Specimens may illustrate the effects of different types of abrasive procured locally and used in normal production, riveted and welded construction, unusual base metal corrosion patterns, and coatings and films not illustrated herein. Specimens should be shipped with sufficient desiccant included to prevent rerusting and be accompanied with appropriate descriptive information.

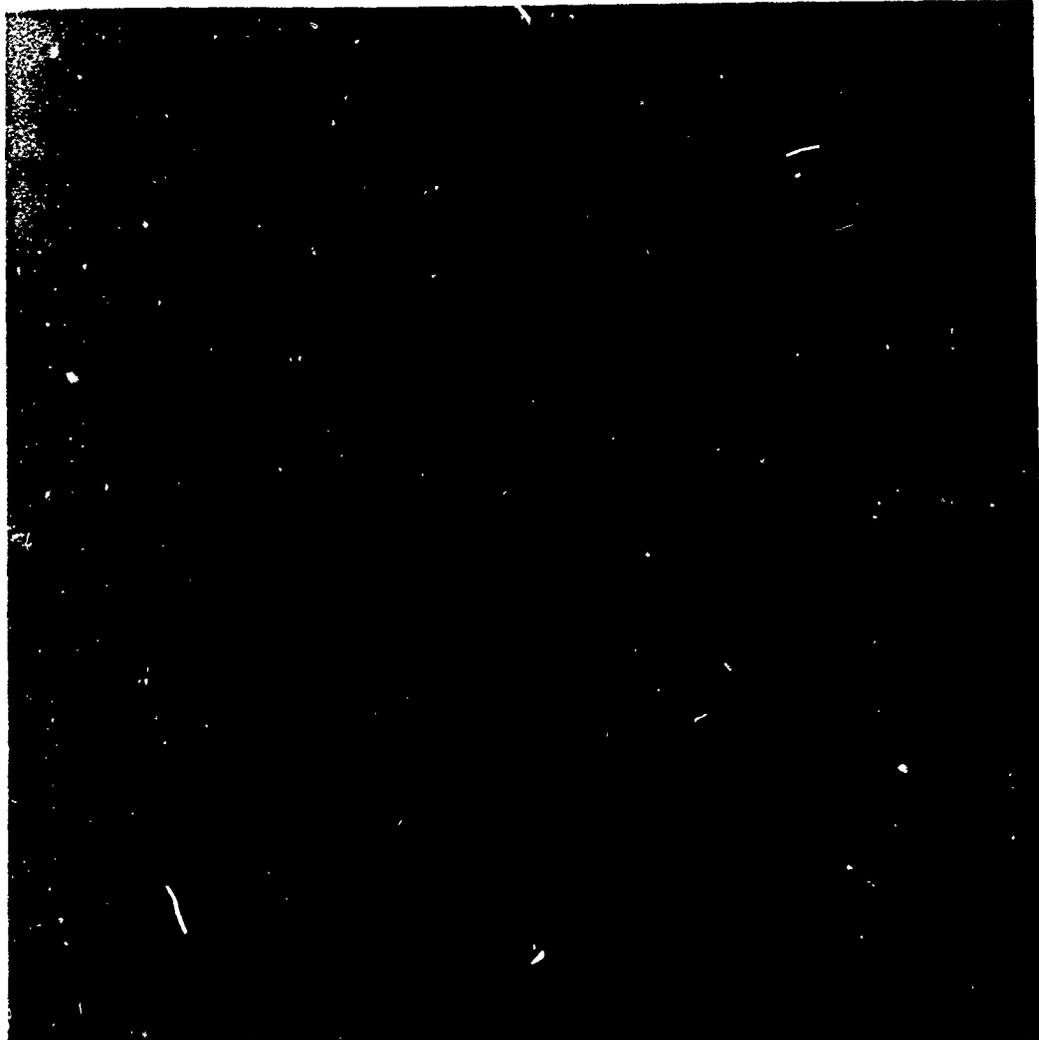


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Figure 1 - Representation of a Blasted Surface, 50% Descaled

PHOTO L-19369-14

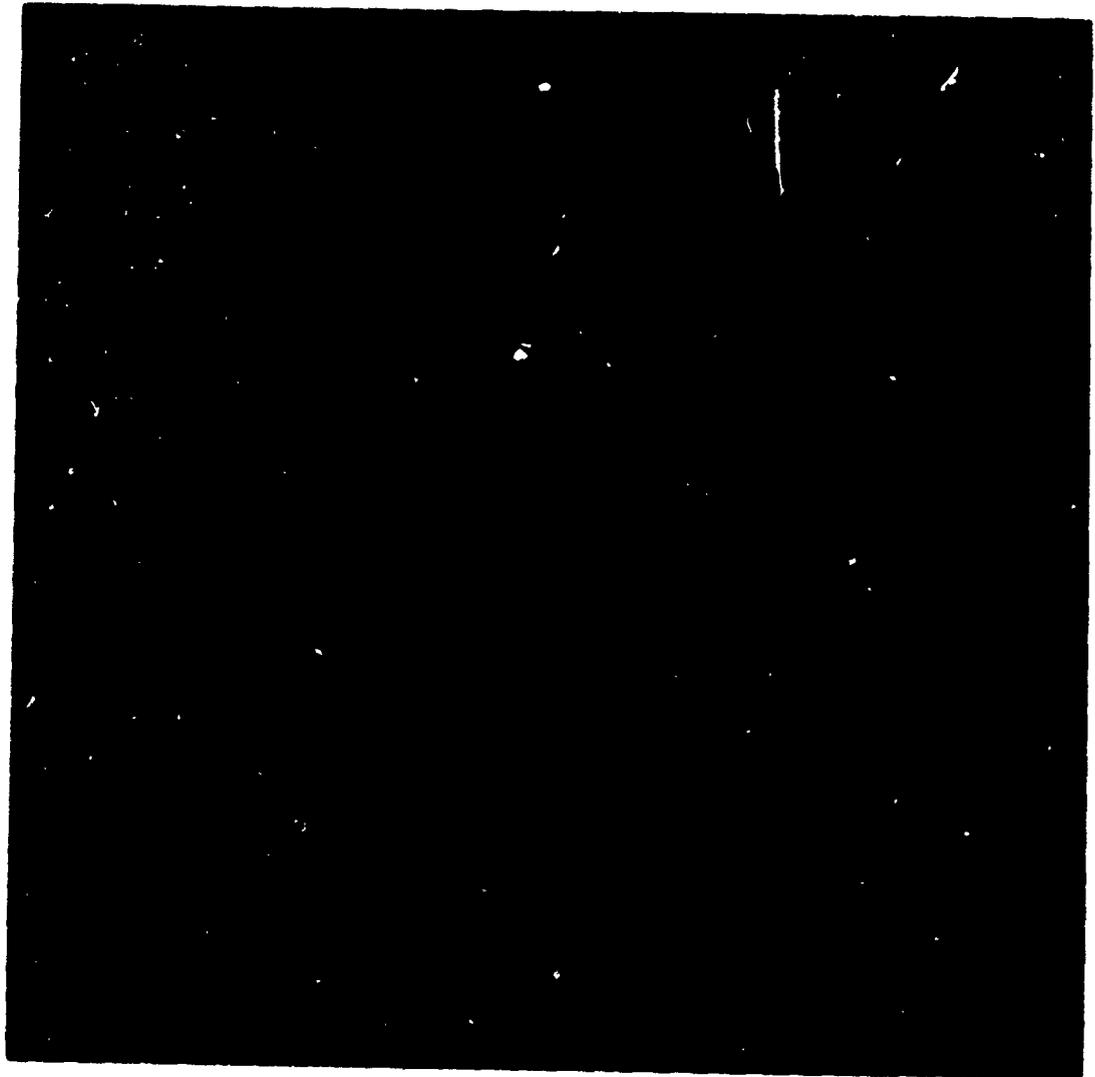


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Figure 2 - Representation of a Blasted Surface, 67% Descaled

PHOTO L-19369-15



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Figure 3 - Representation of a Blasted Surface, 95% Descaled

PHOTO L-19369-16

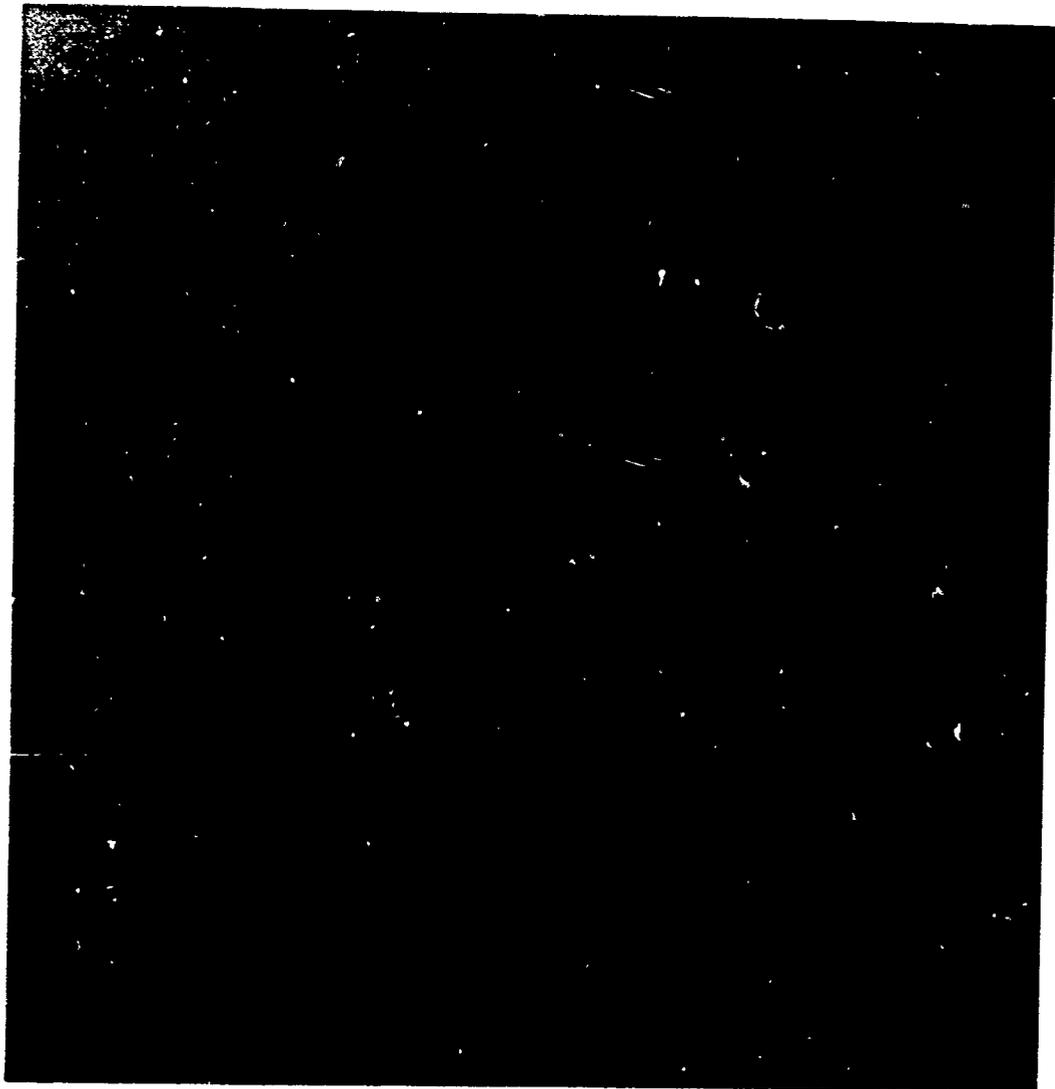


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Figure 4 - Representation of a Blasted Surface, 99% Descaled

PHOTO L-19369-17



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Figure 5 - Representation of a Blasted Surface, 99.9% Descaled

PHOTO L-19369-18

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Metal - Mild Steel

Abrasive - Black slag, 40 mesh, dry

Pressure - 90 to 100 pounds

Blast angle - 90°

Degrees of Blasting

- A. Original Condition - Moderately rusted
- B. Brush Blast - Most red rust removed. Adherent underlying rust remaining. Some bare metal exposed.
- C. Commercial - About 1/2 to 2/3 gray metal exposed. Remainder is light discoloration.
- D. White Metal - Residues (in pits) amount to about 0.1% of surface.

Figure 7 (Photo L-19369-20)

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Metal - Mild Steel

Abrasive - Black slag, 40 mesh, dry

Pressure - 90 to 100 pounds

Blast angle - 90°

Degrees of Blasting

- A. Original Condition - Coated with mill scale containing rust patches.
- B. Brush Blast - Inner mill scale remaining, together with some rust.
Uniformly distributed spots of bare metal exposed.
- C. Brush Blast - About 2/3 gray metal exposed. Would be considered a
"Commercial" finish, except that a few spots are present
with resistance of 20 to 50 ohms.
- D. White Metal - Less than 0.1% residue remaining.

Figure 8 (Photo L-19369-21)

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Metal - Mild Steel

Abrasive - Black slag, 40 mesh, dry

Pressure - 90 to 100 pounds

Blast angle - 90°

Degrees of Blasting

- A. Original Condition - Painted surface with extensive failure and severe corrosion.
- B. Brush Blast - Tight paint spots remaining. Tight rust in pits and discoloration of original corroded areas. About 90% bare metal exposed.
- C. White Metal - About 0.1% residue left in pits. No paint or surface rust remaining.

Figure 9 (Photo L-19369-22)

Metal - Mild Steel

Abrasive - Black slag, 40 mesh, dry

Pressure - 90 to 100 pounds

Blast Angle - 90°

Degrees of Blasting

- A. Original Condition - Severe corrosion and paint failure.
- B. Brush Blast - Tight, yellow undercoat and inner adherent rust remaining. Some bare metal exposed.
- C. Commercial - About 60% gray metal exposed, remainder tight rust stain. Spots of yellow undercoat remaining in pits.
- D. Near-White Metal - About 99% gray metal exposed. Remaining residue within pits.
- E. White Metal - Less than 0.1% residue remaining.

Figure 10 (Photo L-19369-23)

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Metal - Mild Steel

Abrasive - Black slag, 40 mesh, dry

Pressure - 90 to 100 pounds

Blast angle - 90°

Degrees of Blasting

- A. Original Condition - Paint failure with light rusting.
- B. Brush Blast - Tight paint and rust remaining. About 40% gray metal exposed.
- C. Commercial - About 80% gray metal exposed. Remainder consists of gray discoloration and tight rust within pits.
- D. Near-White Metal - About 99.5% gray metal exposed. Remaining residue is within pits.
- E. White - Less than 0.1% residue remaining.

Note: Disregard residue at boundaries between strips.

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Metal - Mild Steel

Abrasive - Black slag, 40 mesh, dry

Pressure - 90 to 100 pounds

Blast Angle - 90°

Degrees of Blasting

- A. Original Condition - Severely corroded and pitted. Surface covered with red rust and weathered mill scale.
- B. Brush Blast - Tight mill scale and rust stains remaining. About 35% gray metal exposed.
- C. Brush Blast - About 75% gray metal exposed. Would be considered a "Commercial" finish, except that residues were not stains or discolorations, but adherent scale with resistances of 3,000 to 5,000 ohms.
- D. Brush Blast - About 99% gray metal exposed. Would be considered a "Near-White Metal" finish except that residues were not stains or discolorations, but adherent scale with resistance of 500 to 2500 ohms.
- E. White Metal - No residue remaining.

Note: This is an example of a surface which can be blasted only to a "Brush Blast" or "White Metal" finish. No intermediate stages can be attained. It is also an example of where photographic standards are supplemented by electrical tests.

Metal - Mild Steel

Abrasive - Black slag, 40 mesh, dry

Pressure - 90 to 100 pounds

Blast angle - 90°

Degrees of Blasting

- A. Original Condition - Surface coated with sound adherent paint. Blisters at edges caused by flame cutting.
- B. Brush Blast - About 50% gray metal exposed. Remainder is tight paint with spots of red undercoat evident. Paint was removed in flakes, during blasting, with no stains or discolorations produced. This is indicative of a good coating applied over a well prepared surface, with no corrosion present.
- D. White Metal - No residue remaining. The surface imperfections are gouges. These may appear as raised areas. This is a photographic optical illusion which can be corrected by rotating the photograph 90° counter clockwise.

Note: Degrees of blasting between "Brush Blast" and "White Metal" are usually not attainable with this type of surface.

Metal - HY-80 Steel

Abrasive - Black slag, 40 mesh, dry

Pressure - 90 to 100 pounds

Blast angle - 90°

Degrees of Blasting

- A. Original Condition - Surface coated with various thicknesses of heavy mill scale, in turn covered with a thin layer of red iron oxide.
- B. Brush Blast - Tight mill scale remaining with occasional flecks of gray metal exposed. Prior to reaching this stage, the surface appeared silver-gray with no scale apparently present. However, the ohmmeter check showed a resistance of greater than 5,000 ohms. Further blasting eliminated the burnished appearance and produced the B condition.
- C. Commercial - About 50% gray metal exposed. Remainder is dark stain with resistance of less than 0.5 ohm.
- D. Near White - About 99% gray metal exposed. Remainder is dark stain with resistance of less than 0.5 ohm.
- E. White Metal - Less than 0.1% surface contamination present.

Note: The ohmmeter test is advised when blasting HY-80 and similar steels to insure absence of mill scale.

Figure 14 (Photo L-19369-27)

Metal - High Tensile Steel

Abrasive - Black slag, 40 mesh, dry

Pressure - 90 to 100 pounds

Blast angle - 90°

Degrees of Blasting

- A. Original Condition - Surface coated with mill scale.
- B. Brush Blast - About 50% gray metal exposed. Remainder is tight scale and gray discoloration beneath.
- C. Brush Blast - About 95% of gray metal exposed. Would be considered a "Commercial" finish, but resistance of remaining scale (in some instances thicker than 0.2 mil) was 10 to 20 chms.
- D. Brush Blast - About 99% of gray metal exposed. Would be considered a "Near-White" finish, if the few raised spots of scale were absent.
- E. White Metal - All gray metal with no residue remaining.

APPENDIX B

NACE Definitions of Blast Cleaned Surfaces

White Metal Blast Cleaned Surface Finish is defined as a surface with a gray-white, uniform metallic color, slightly roughened to form a suitable anchor pattern for coatings. The surface, when viewed without magnification, shall be free of all oil, grease, dirt, visible mill scale, rust, corrosion products, oxides, paint, or any other foreign matter. The surface shall have a color characteristic of the abrasive media used. Photographic or other visual standards of surface preparation may be used to further define the surface.

Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks, or slight discolorations caused by rust stain, mill scale, oxides, or slight, tight residues of paint or coating that may remain. At least 95 percent of the surface shall have the appearance of a surface blast cleaned to a White Metal Surface Finish and the remainder shall be limited to the light discoloration mentioned above. Photographic or other visual standards of surface preparation may be used to modify or further define the surface.

Commercial Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, rust scale, and foreign matter have been completely removed from the surface and all rust, mill scale, and old paint have been completely removed except for slight shadows, streaks, or discolorations caused by rust stain, mill scale oxides or slight residues of paints or coatings that may remain; if the surface is pitted, slight residues of rust or paint may be found in the bottom of pits; at least two-thirds of the surface area shall be free of all visible residues and the remainder shall be limited to the light discoloration, slight staining or light residues mentioned above. Photographic or other visual standards may be used to further define the surface.

Brush-Off Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, rust-scale, loose mill scale, loose rust, and loose paint or coatings are removed completely, but tight mill scale and tightly adhered rust, paint, and coatings are permitted to remain provided they have been exposed to the abrasive blast pattern sufficiently to expose numerous flecks of the underlying metal fairly uniformly distributed over the entire surface. Photographic or other visual standards of surface preparation may be used to further define the surface.