Technical Bulletin

ERVIN INDUSTRIES, INC.

3893 Research Park Drive
P.O. Box 1168
Ann Arbor, Michigan 48106
(734) 769-4600
(800) 748-0055
(734) 663-0136

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BLAST-CLEANING WITH STEEL SHOT AND GRIT FOR SURFACE PREPARATION FOR PROTECTIVE COATINGS

It has long been recognized that the life-performance of various protective coatings is directly influenced by the quality and degree of pre-coating surface preparation. Two basic factors have to be considered in evaluating the quality of surface preparation:

Degree of cleanliness
Profile, or anchor pattern

Degree of Cleanliness:

The fundamental requirement is removal from the steel surface of any contaminants that would be conducive to premature paint failure. Three principal degrees of blast-cleaning cleanliness are specified and described by both the Steel Structures Painting Council (SSPC), and the National Association of Corrosion Engineers (NACE):

Degree of Cleanliness	Specification Numbers
White Metal	SSPC-5; NACE 1
Near White	SSPC-10; NACE 2
Commercial	SSPC-6; NACE 3

Definitions in these specifications relate precisely to surface appearance and the degree of freedom from certain listed contaminants. The following comment relative to SSPC's Specification SP6 6-1-91, Commercial Blast-cleaning is significant:

> "This method of surface preparation will result in a high degree of cleaning that will lead to long-life of practically any paint system. It is believed that Commercial Blast-cleaning will suffice for the majority of cases where blast-cleaning is believed to be necessary."

SSPC SP6 6-1-91 defines the Commercial surface finish 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 tight residues of paint or coating 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 each square inch of surface area shall be free of all visible residues and the remainder shall be limited to the light discoloration, slight staining or tight residues mentioned above."

White metal and near white specifications are much more stringent in their cleanliness requirements than commercial blast-cleaning, and are used in situations where the applied coating is subjected to extremely corrosive atmospheres. Where the commercial finish stipulates that "at least two-thirds of each square inch shall be free, etc.: ". . . . the near white specification stipulates "at least 95% shall be free, etc;" . . . . and white metal stipulates that the surface "shall be free of all . . . . etc." White metal means just that: All. In ordinary atmospheres its use and the attendant high costs are seldom warranted as paint primer have appreciable tolerance for slight amounts of tightly adhered rust or rust stains.

Provision is made in each of the above specifications for use of photographic or other visual standards that modify or give further definition to the cleanliness, if permitted by the specific contract involved. SSPC VIS 1-89 and NACE TM-01-70 and TM-01-75 provide such pictorial standards.

Profile . . . . Anchor Pattern:

All three specifications state that the height of profile (measurement of top of peaks to the bottom of valleys) shall be limited to a maximum height that will not be detrimental to the life of the paint film.

Studies have shown that shot or grit larger than U.S. 16 mesh (.0469" opening) can produce a maximum profile that is too high. Thus, SAE S-330 shot (which allows 5% max or .0469") tends to be the largest size used for structural steel or plate profiles.

There may be instances, however, where mill scale is so heavy that the greater impact value of larger material (S-390 Shot or G-18 Grit) is required to achieve the required cleanliness. In such cases, it is most important that additions of new abrasive be made in the smallest feasible amounts, as often as required to keep the abrasive hopper two-thirds full. This is necessary in order to maintain a stabilized and balanced size-consist in the work-mix, without excess amounts of original size abrasive.

With the advent of more exotic coating systems designed for the most difficult environments, it has been considered desirable to specify more narrow ranges of profile height than a specification that deals with maximum height only. Comprehensive R & D programs have been conducted by both SSPC and NACE covering multiple profile measurements: Peak Height; Peak Count (number of peaks per inch); Surface Roughness (Micro-inch Average).

Some key conclusions resulting from these R & D programs, and from field experiences of Ervin's structural steel customers, are listed below. These conclusions relate to the effect on cleanliness and profile when using steel shot vs. grit . . . . shot/grit-mixes . . . . different sizes . . . . different hardnesses.

From the standpoint of cleanliness, no clear-cut superiority was shown comparing grit-blasted surfaces vs. shot-blasted or shot/grit-mix blasted surfaces. It is noteworthy that all three specifications provide for the use of either shot or grit . . . . i.e., they do not stipulate use of grit only, or use of shot only.

Speed of cleaning varies greatly depending on the cleanliness specification. White metal blast-cleaning is the slowest and by far the most costly finish to attain. Near white finish can be achieved twice as fast. Commercial finish can be achieved about five times faster than white metal finish.

The color of the cleaned surface may be affected by the type of abrasive used. Grit-blasted surfaces may appear brighter than shot-blasted surfaces, due to greater reflectivity of the more

angular anchor pattern produced. Brightness should not be confused with cleanliness . . . . both the grit and the shot produced equal degrees of cleanliness.

In centrifugal blast-cleaning, the rapidity with which abrasive is recycled results in a tremendous number of impacts in a relatively short time. In the case of steel grit, these repeated impacts tend to forge the originally sharp, angular particles into almost-round spheres, thus developing a work-mix that is quite similar in appearance to a shot work-mix. The lower the hardness of the grit, the more rapidly it rounds up. Harder grit, such as LG Grit, will retain its angularity longer before rounding up. Thus, LG Grit can produce a brighter finish (reflectivity) than either shot or a low hardness grit.

The cost, in time and abrasive consumption, to achieve the required cleanliness will depend greatly upon the initial surface condition of the work. The initial condition can range from new steel, where the surface is completely covered with tight mill scale and minimal evidence of rust . . . . to old, used and weathered steel with most of the surface being rusted and pitted, and having poorly adhering paint.

Cleaning old steel with considerable rust-pitting requires the presence of abrasive particles small enough to get into the rust pits or crevices. Using smaller shot and grit sizes may help with respect to the rust pits, but sufficient impact is still needed to break loose heavy mill scale, etc. Whatever size is used, it is imperative that additions of new abrasives be made frequently, in small amounts, and that the separator operation be geared to retaining the smallest effective abrasive particles in the work-mix . . . . they are the particles that will attack the rust-pits.

Profile Height:

. . . . increases as the abrasive size is increased.
. . . . decreases as the abrasive size is decreased.
. . . . increases, but only slightly, with the longer blast-time cycles required for the more stringent grades of cleaning.
. . . . varies, but only slightly, with blast angles between 45° and 90°.

The effects on profile of degree of cleanliness or blast angle are definitely minor as compared to the effect of changes in size.)

If a large size of shot or grit is needed to remove stubborn mill scale, and too great a profile height results, re-blasting with a smaller size will decrease the overall profile height.

Peak Count:

. . . . decreases as the abrasive size increases.
. . . . increases as the abrasive size decreases.
. . . . is not affected significantly by the blast angle.
. . . . is generally the same, regardless of whether cleaned to white metal, near white, or Commercial.

Differences in peak height or peak count result from differences in average particle size, rather than from differences in shape (grit vs. shot). Any given profile height or peak count achieved with grit can also be attained by using shot . . . . if the size-consist of the respective work mixes is similar.

Profile measurements achieved by either shot or by grit can usually be attained by a shot/grit-mix, if the shot and grit components of the mix are of the same hardness as the shot or grit previously used.

Mixing a 40-50 HRC shot with harder grit (MG or LG) will reduce abrasive consumption and reduce the wear/tear on equipment compared to the use of 100% of MG or LG grit. The harder grit will provide the benefits of faster cleaning and greater angularity of surface finish.

By mixing MG or LG grit with shot that is equal in hardness to the MG or LG grit, greater cleaning effectiveness and faster cleaning will result compared to use of regular SAE shot and grit with hardness levels of 40-50 HRC. In addition, with the shot and grit in the mix being the same hardness, the resulting work-mix will maintain a constant shot/grit proportion, as both will break down at the same approximate rate.

Increasing the hardness of steel shot or grit has these effects:

. . . . consumption rate is increased.
. . . . wear/tear on equipment is increased.
. . . . average work-mix size developed is smaller in size (resulting in lower average impact value, but with increased coverage).
. . . . cleaning speed can be increased on certain types/conditions of work being cleaned.
. . . . greater angularity of surface finish can give better paint adherence for those special white metal or near white applications.

When substituting shot for grit, or when changing to a shot/grit-mix in place of grit, consideration must be given to the phenomenon of grit round up, and the effect this has on work-mix size. When grit rounds up each particle becomes smaller in size than it originally was as an angular grit particle . . . . about one size smaller. This should be borne in mind when mixing grit and shot.

In addition to the quoted SSPC and NACE specification, there are others that deal with blast-cleaning surface preparation, including:

American Association of Highway Officials
(Standard Specifications for Highway Bridges)

U.S. Military Specification TT-C-490
(Cleaning and Preparation of Ferrous Metals
for Organic Protective Coatings)

American Welding Society . . . C2-2-52T
(Recommended Practices for Metallizing)
(Blast-cleaning is required as a surface
preparation for subsequent metallizing.)

American Railway Engineering Association
(Utilizes SSPC Specifications)

SSPC has a comprehensive list of publications dealing with surface preparation that can be purchased directly from SSPC headquarters. If a copy of the listings and price list is desired, please advise us.

ERVIN INDUSTRIES, INC.
ANN ARBOR, MICHIGAN
1-800-748-0055