Guidelines for Centrifugal Blast Cleaning

by

A. W. Mallory

SSPC STEEL STRUCTURES PAINTING COUNCIL

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I. INTRODUCTION

For many years, it has been acknowledged that the quality of surface preparation vitally influences the performance of coating systems applied on structural steel to protect the steel from corrosion. Similarly, abrasive blast cleaning is accepted as the method by which essential degrees of cleanliness and surface texture (or anchor pattern) can best and simultaneously be achieved.

Prior to the 1930's, abrasive blast cleaning could be accomplished only with compressed air, nozzle blast systems. Air blasting, even now, is the only means by which blast cleaning can be performed in certain cases, particularly for maintenance and repair of existing structures. Blast cleaning as an automated, in-house, production-line operation became possible with the introduction of the centrifugal blast wheel in the early 1930's. Centrifugal blast cleaning systems are far more productive and cost-efficient than air blast systems.[1,2] In addition, they can achieve a high degree and uniformity of quality. For these reasons, centrifugal blast cleaning machines have become virtually essential in the steel fabricators' shops.

Persons unfamiliar with the process can use the information in these guidelines to understand how centrifugal blast cleaning systems are used to prepare steel surfaces for coating. Basic criteria defining the desired finished conditions of the surface are reviewed, and guidelines for selecting equipment and abrasive blast media are presented. The Guidelines Table of Contents directs the reader to individual subjects and details of process control.

The Guidelines emphasize procedures of operations and maintenance that have the greatest impact on quality. The principal objective is to aid in assuring efficient, economical, and consistent production of high quality surface preparation with centrifugal (wheel) blast cleaning systems.

The Guidelines are, *by intent*, abbreviated in discussion of certain aspects of the total process. They are *not intended* to replace detailed accounts of systems operating and maintenance procedures furnished by equipment and abrasive suppliers, but rather to identify the most significant of such procedures, and to emphasize the importance of establishing and adhering to a required program of process controls. They incorporate, by direct reference and annotated bibliography, previously published technical data and general information pertinent to surface finish criteria and to the centrifugal blast cleaning process.

II. SURFACE PREPARATION SPECIFICATIONS

Specifications that define the requirements for surface preparation of steel prior to application of coatings will vary, depending on the end use of the steel, the type of coating system, and agreement between the contracting parties. Familiarity with the different surface preparation criteria and terminology is essential for selecting the blast cleaning system and the abrasive to be used, and for establishing operating procedures that will result in reliable conformance to those criteria.

Close attention is required to the condition of the steel surfaces prior to and following the blast cleaning operation; either or both of these conditions may require auxiliary cleaning procedures. The type of material (alloy and hardness), the condition of the surfaces to be cleaned, the size and configuration of the workpieces, and specific criteria that define the finished surfaces directly influence selection of the system, selection of abrasive, and establishment of operating procedures.

A. Pre-Cleaning (Prior to Blast Cleaning)

Surface contaminants should be removed from the steel prior to blast cleaning in order to avoid contamination of the abrasive and re-deposition of the contaminants on otherwise clean surfaces.

Heavy deposits of surface contaminants such as grease should be removed by scraping and dry wiping. Residual traces of contaminants such as oil or grease or other types of petroleum products, waxes or residues of marking devices should be removed. Acceptable methods of cleaning are described in SSPC-SP 1, "Solvent Cleaning".

Traces of moisture can be tolerated in the blasting process. However, snow, ice, and standing pools of water must be removed from the workpieces before blast cleaning. Depending on the environmental conditions under which the steel is stored prior to blast cleaning, it may be necessary to clean and warm-air dry the steel prior to blasting.

B. Surface Condition Prior to Cleaning

Typical conditions of the surfaces of steel are illustrated in SSPC publications[3] and in the Guide to SSPC

Vis 1.[4] The pictorial illustrations include four surface conditions, described as follows:

Rustgrade A — Adherent Mill Scale
Rustgrade B — Rusting Mill Scale
Rustgrade C — Rusted
Rustgrade D — Pitted and Rusted

C. Required Degree of Cleaning

Degree of cleaning may be stipulated by reference to or inclusion of the following cleanliness specifications:[3,4,5,6]

Degree of Cleaning	Steel Structures Painting Council (SSPC) Specifications	National Ass'n. of Corrosion Engineers (NACE) Test Method (TM-01-75)	Swedish Stds. Association SIS05-59-00
White Metal	SSPC-SP 5	NACE #1	Sa3
Near-White	SSPC-SP 10	#2	Sa2-1/2
Commercial	SSPC-SP 6	#3	Sa2
Brush-Off	SSPC-SP 7	#4	Sa1

D. Appearance of Blast Cleaned Surfaces

Appearance of the blast-cleaned surface for any one of the four degrees of cleaning will vary, depending on the type of abrasive used. Surfaces cleaned to White Metal with cast steel shot will differ in appearance from those cleaned to White Metal with cast steel grit. They will also differ from surfaces blast cleaned to White Metal with sand or other non-metallics.

Uniformity of color on a given workpiece, or from one workpiece to another, will be affected by the grade of steel, original surface condition, configuration of the material being cleaned, discolorations from mill or fabrication marks, and by the shadowing from blast cleaning patterns.

Desired appearance of the surface may be depicted by reference to SSPC Pictorial or NACE Visual Standards.[3,5]

E. Surface Profile

Surface profile is generally defined as the quantitative value of average peak-to-valley depth on the abraded surface, measured in mils (1.0 mil = 25 microns [0.001 inch]). Specifications may also include a description of profile as being of undulating appearance (as generally produced by steel shot) or angular and irregular (as produced by steel grit). Other specifications, in lieu of quantitative values, may define the required profile height as "fine", "medium", and "coarse", accompanied by description of peak shape.[6,7]

Contractual documents (specifications, etc.) that include surface profile to be achieved should also define the procedure by which the profile is to be evaluated for acceptance.

Because of controversy about methods, equipment, and techniques for evaluating surface profile, specifications may require the use of a specific instrument or procedure or both, or alternatively, the use of a profile reference coupon representing the roughness necessary for the end product.

Equipment most commonly used for evaluating profile height include visual comparators, depth micrometers, and replica tape.[8 [Chapt. 6], 9] However, there may not be exact correlation in the results obtained from different equipment and techniques and from sophisticated laboratory techniques.[6] Therefore, it becomes extremely important that *all parties concerned agree* on the instrument (or procedure) to be used *and adhere* to that agreement.

F. Post Cleaning (After Blast Cleaning)

After blast cleaning, and prior to application of coatings, the following procedures may be required:

1. Remove rusting that may have reoccurred, if visible on surfaces viewed without magnification; removal may require secondary blast cleaning.
2. Remove visible deposits of oil, grease, or other contaminants; use acceptable methods as noted above for pre-cleaning.
3. Remove dust and loose residues on the blast-cleaned surfaces prior to the application of coatings. Acceptable methods include brushing; blow-off with clean, dry air; or vacuum cleaning. (When compressed air is used for blow-off, use and maintain moisture and oil separators and traps to provide a clean and dry air supply.)

G. General Requirements

Specifications or visual standards, or both, of industry associations other than SSPC, NACE, and SIS and of industry end-users may also be stipulated in the job contracts.

The fabricator who is to perform the surface preparation must be entirely familiar with all aspects of the requirements, particularly as related to degrees of cleanliness, appearance of blast-cleaned surfaces, and surface profile. In addition, all parties entering into the job contracts must acknowledge and agree to the methods to be used during final inspection and acceptance of the product for determining cleanliness and profile. In some instances it may be desirable, or required, to produce (and preserve) pre-production specimens of an agreed-upon type, size, and quality for use as acceptance standards for the duration of the contract.

III. CENTRIFUGAL BLAST SYSTEMS

Centrifugal blast cleaning systems are available for the surface preparation of steel either prior to or after fabrication. The basic and most typical machines are described briefly below.

A. Horizontal Workpiece Machines

For pre-fabrication cleaning, the 4-wheel machine (Figs. 1 and 2) uses a powered roll conveyor to move workpieces through the machine. Two wheel units above the conveyor are located so that the abrasive will clean the top and sides of workpieces moving through the machine. Two additional wheel units, located below the conveyor, clean the bottom and sides of the workpieces.

This type of machine is generally used to clean plate and rolled shapes such as angles, channels, and I-Beams. Plate is conveyed through the machine in a horizontal position. Multiple lengths of smaller angles and channels arranged side-by-side on the conveyor are cleaned simultaneously. Randomly shaped smaller pieces, such as gusset and toe plates, are frequently placed in baskets carried through the machine on the rolls.

B. Vertical Workpiece Machines

For cleaning after fabrication, the 8-wheel machine (Figs. 3 and 4) uses work cars, a shop crane, or monorail to convey workpieces through the machine. Eight wheel units — four located on each side of the conveyor — insure thorough exposure of the workpieces to the abrasive blasts (Fig. 5).

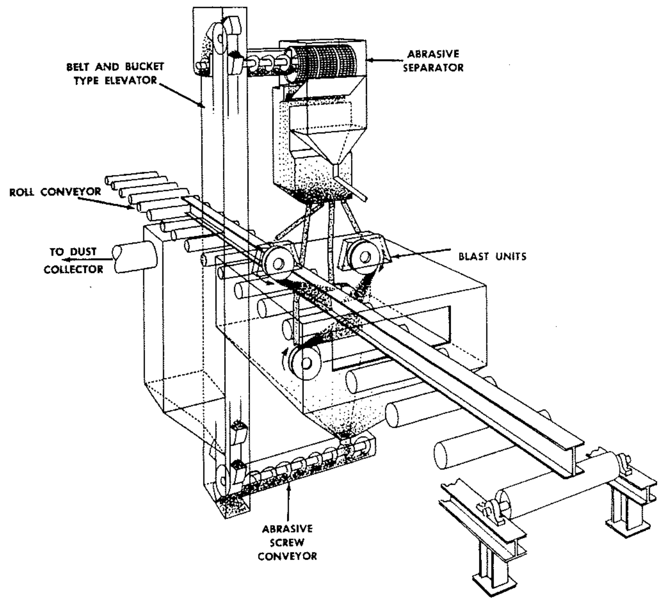


FIGURE 1
Schematic Illustration of Typical Four-Wheel Blasting Machine.
Courtesy of Wheelabrator-Frye, Inc.

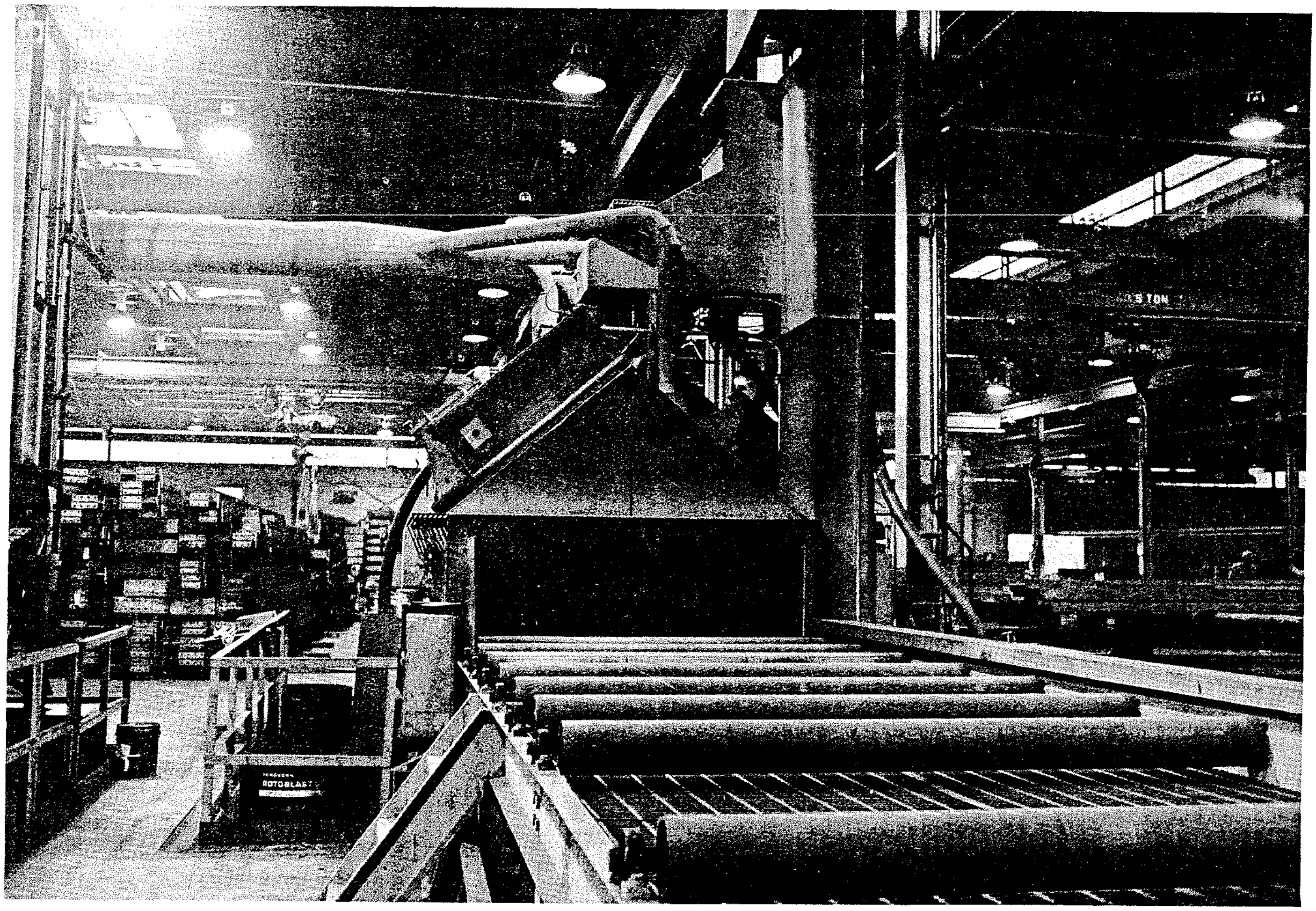


FIGURE 2
Four-Wheel Centrifugal Blasting Machine.
Courtesy of Pangborn

The 8-wheel vertical machine is used for cleaning girders and other fabrications with surfaces in every plane, and for heavy plate. Plate is conveyed in a vertical position; smaller pieces can be arranged on a rack, in multiples, for conveyance through the machine.

Variations of these two basic types of structural cleaning systems are also available, some of which may utilize more than the four or eight wheels, respectively, for the two types of applications. The design selected depends on the particular requirements of the fabricator or contractor operating the machine.

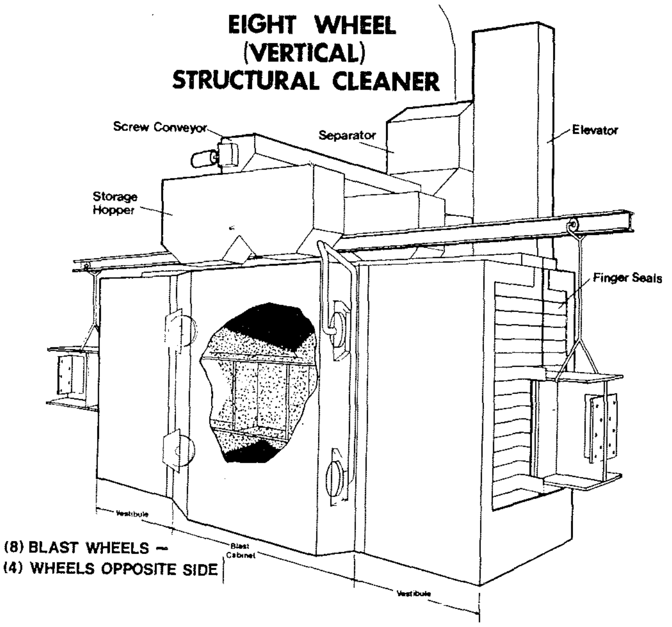


FIGURE 3
Schematic Drawing of Eight-Wheel Machine.
Courtesy of Wheelabrator-Frye, Inc.

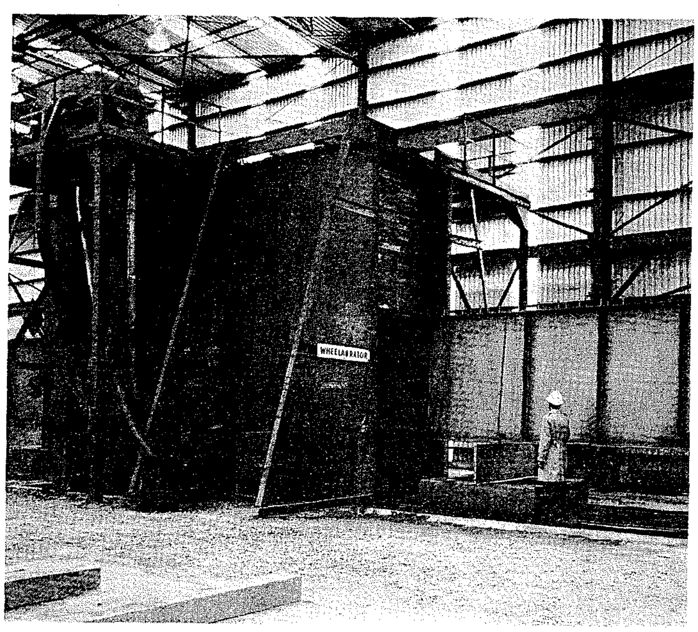


FIGURE 4
Eight-Wheel Centrifugal Blasting Machine.
Courtesy of Wheelabrator-Frye, Inc.

IV. SYSTEMS COMPONENTS

Centrifugal blast cleaning systems incorporate five basic sub-systems (Fig. 6).

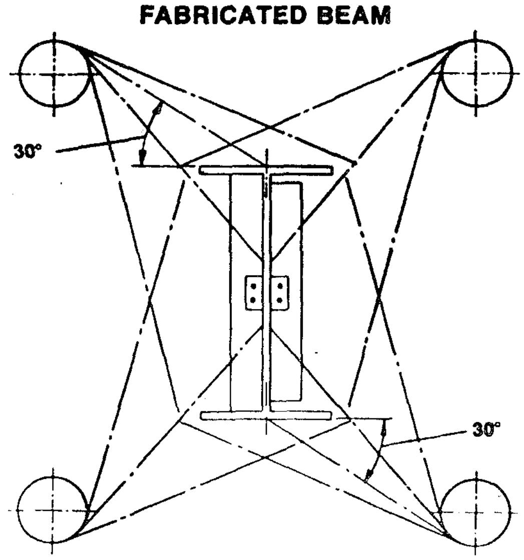
A. Wheel Units

Motor-driven bladed wheels hurl abrasive media by centrifugal force in a controlled direction and pattern, and at controlled velocity and quantity. For surface preparation of steel, the blast machines typically use multiple wheel units, positioned so that the abrasive will reach every surface of the workpieces to be cleaned. The number of wheels mounted on a machine is determined by the size and complexity of the work to be cleaned. Enough wheel units are usually installed so that workpieces can be cleaned in one pass through the machine, at a reasonable line speed (production rate).

The abrasive from each wheel is thrown in a fan-like pattern (Fig. 7) of about three to four inches in width and up to 30 to 36 inches in length, depending on the distance from the wheel to the surface of the workpiece. The velocity of the thrown abrasive is a function of the diameter of the wheel (at the tips of the blades), the length and profile of the blade face, and the speed at which the blast wheel is rotated. The quantity of abrasive thrown at a given wheel speed is regulated by the power of the wheel motor.

Depending on the blast cleaning job to be performed, the equipment manufacturer can select from almost innumerable combinations of wheel horsepower, abrasive quantity, and abrasive velocity. However, for the typical steel cleaning system, the use of 19½ in. diameter wheels driven at 2250 RPM by 30 HP motors will provide abrasive velocity of approximately 14,400 feet per minute (240 fps) with a cor-

RECOMMENDED BLAST PATTERN FOR TYPICAL FABRICATED BEAM



30° — MINIMUM EFFECTIVE ANGLE OF IMPINGEMENT

FIGURE 5
Blast Pattern that Provides Thorough Exposure of Workpiece.
Courtesy of Pangborn

responding flow rate of about 800 pounds per minute of steel abrasive per wheel.

B. Abrasive Cleaning and Recycling

After striking the workpiece, the abrasive drops into a collection hopper under the machine, and is then fed by gravity or screw conveyor to a belt and bucket elevator. The elevator conveys the abrasive, mill scale, rust, and other contaminants to an airwash separator above the machine (Fig. 8). A combination of screens and baffle plates in the separator, and air movement through the separator,

FIGURE 6
Parts of a Centrifugal Blast Cleaning System.
Courtesy of Wheelabrator-Frye, Inc.

removes the contaminant particles, the dust, and abrasive particles that have become too small to be effective. Clean, reusable abrasive drops to a storage hopper and is again fed to the wheels. A typical 8-wheel machine system has the capability of recycling more than three tons of abrasive per minute.

C. Dust Collector

Dust created by the blast process is withdrawn from the recirculating abrasive and from the machine enclosure into a dust collector. Typically a fabric, filter-type collector, this component creates constant air flow through the separator as well as through the cleaning machine so that areas adjacent to the equipment remain clean and dust-free.

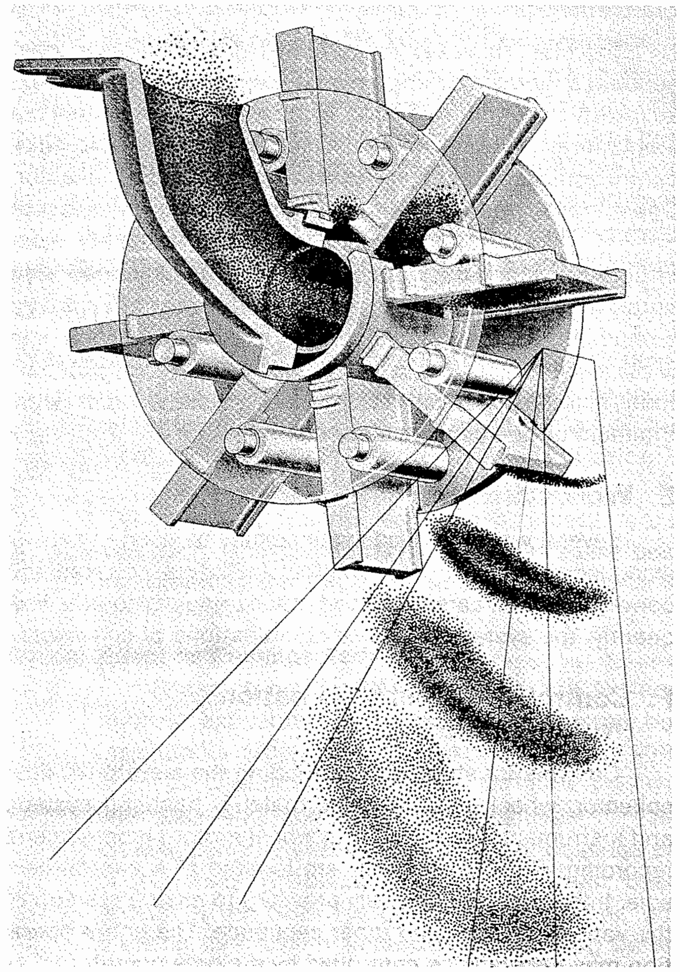


FIGURE 7
Centrifugal Blast Wheel; Development of Blast Pattern.
Courtesy of Wheelabrator-Frye, Inc.

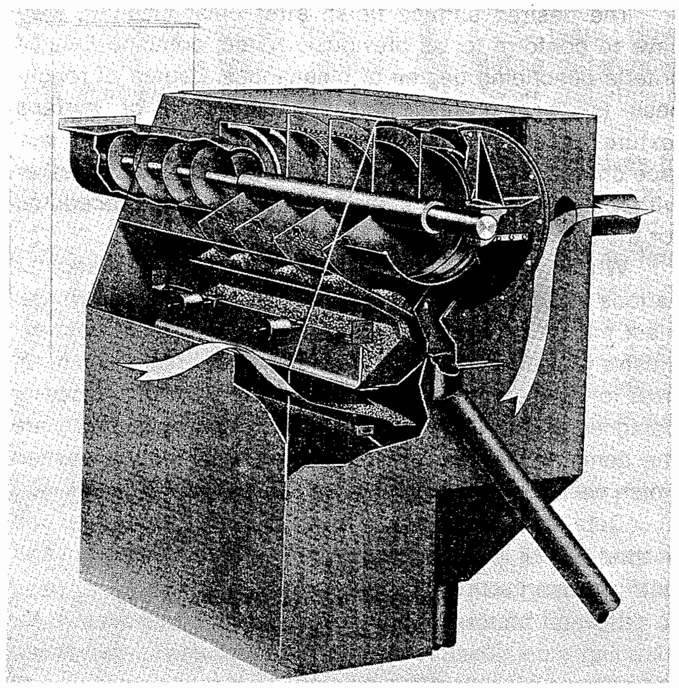


FIGURE 8
Airwash Separator System.
Courtesy of Wheelabrator-Frye, Inc.

D. Cabinet

The blast chamber contains flying abrasive and dust generated by the cleaning process. Ventilation assures that air pressure within the blast enclosure is lower than the ambient air pressure, so that dust cannot escape to adjacent work areas but instead is drawn into the dust collector. Openings for work entry and exit are equipped with seals to prevent flying abrasive from escaping. Cabinets constructed of low carbon steel sheet are usually lined with abrasive-resistant materials made from rubber or synthetic compounds, or special alloy plates, or both, in areas in line with the direct blast from the wheels. Cabinets may also be constructed of special alloy, wear-resistant steel with minimum or no supplementary liners.

E. Work Conveyor

Several work handling systems may be used to convey workpieces through the machine, including powered roll conveyors, work cars, overhead cranes and monorails. Frequently, the systems may use combinations of conveyors.

F. Controls and Instrumentation (Not Illustrated)

Controls for starting and stopping the elevator(s), dust collector, wheel units, and the material handling system, and instruments for monitoring wheel motor amperage and recording wheel blast hours are located at a central console. Interlocks are generally provided to assure start-up of the various systems in proper sequence. The entire operation may generally be controlled by a single operator.

V. BLAST CLEANING ABRASIVES

The desired surface finish after blast cleaning may have to conform to, as previously noted, combinations of criteria describing degree of cleanliness, degree of roughness (surface profile), and characteristics of surface texture. Essential to the achievement of the specified surface characteristics is the choice of the abrasive, together with the establishment of appropriate operating procedures for the blast machine.

While many kinds of blast media may be used for various surface preparation applications in the centrifugal blast machines, cast steel shot or grit is used almost exclusively for cleaning structural steel. Size, shape, and hardness of the abrasive particles, together with a properly balanced and controlled mix of abrasive particle sizes*, are the dominant factors in determining whether the desired finish will be attained.

Detailed discussions of blast cleaning abrasives, and of the effect of various abrasives on surface cleanliness and profile, are presented in other texts.(6,7,8)

Several factors influence selection of the abrasive for cleaning steel. The discussion that follows is intended to aid in selecting the abrasive best suited to the surface preparation requirements. For a given job the abrasive may be specified, selected by the contractor, or selected jointly by the contracting parties.

A. Type, Shape, and Hardness

1. ***Effect on Cleaning***

a. Tight and slightly rusted millscale (SSPC Rust Grades A and B) is most effectively removed with operating mixes of steel shot, 40-50 Rc hardness.

b. Steel grit of the same hardness as steel shot (40-50 Rc) may also be used for cleaning surfaces of Rust Grades A and B. Grit particles of this hardness, under repeated impact, will tend to ball up and become less angular in shape. However, with the regular addition of new abrasive, operating mixes of grit of this hardness contain a greater percentage of angular particles. The grit is therefore slightly more effective than shot in removing light rust deposits and flaking mill scale from Rust Grade B surfaces, and in removing weld slag and torch-burned scale from fabricated components.

c. Steel grit of 40-50 Rc hardness is also more effective than steel shot for cleaning steel of Rust Grades C and D. A slightly greater scrubbing action is achieved with the grit because, as in *b* above, the operating mix contains a greater percentage of angular particles than the steel shot operating mix.

d. For the more heavily rusted and pitted surfaces, particularly Rust Grades C and D, steel grit of 50-60 Rc hardness is more effective than steel shot or grit of the lower hardness. The operating mix of the harder grit effectively penetrates into and scrubs contaminant particles from the surface pits. The mix contains a greater percentage of new abrasive particles; and the particles themselves, in breaking down to the smaller sizes, retain a more predominantly angular and somewhat sharp-edged shape than do the grit particles of lower hardness.

e. A mixture of steel shot (40-50 Rc) and steel grit (50-60 Rc) may be used; the greater impact of the round shot fractures and removes mill scale while the harder, angular grit particles scrub the surface.

In a carefully controlled machine operation, such an operating mix is effective for all Rust Grades, particularly for Rust Grades C and D.

The importance of maintaining an operating mix is emphasized for all centrifugal wheel blast operations, but is *particularly significant* in this instance. Generally, the proportions selected for the mix will range from ratios of 1:1 shot to grit to 3:2 shot to grit. *Such mixes are difficult to maintain* in the desired proportions because the harder grit will break down at a faster rate than the shot.

Because of the difference in the rate of breakdown (particle size reduction), it is very probable that the

*Note: "Properly balanced and controlled mix" will be referred to as "operating mix" in this text.

newly added abrasive must contain a higher percentage of grit than the percentage of grit to be maintained in the operating mix. The grit and shot should be of comparable particle sizes and should be mixed when added to the system.

Generally speaking, the respective proportions will be about as follows:

FOR OPERATING MIX PROPORTIONS	ADD NEW ABRASIVE PROPORTIONS
1:1 (50% Shot/50% Grit)	1:2 (33% Shot/67% Grit)
3:2 (60% Shot/40% Grit)	1:1 (50% Shot/50% Grit)
7:3 (70% Shot/30% Grit)	3:2 (60% Shot/40% Grit)

Actual operating experience with a given centrifugal wheel blast cleaning system, and the information gained by routinely monitoring the abrasive operating mix may dictate adjustment of the proportions of shot and grit for addition of new abrasive.

Maintaining the desired balance (or ratio) in the operating mix demands careful attention to

- controlling abrasive losses from the system,
- efficient operation of the separator, and
- close control of additions of new abrasive to the system.

Screen analyses of the recirculating abrasive should be conducted systematically. This will greatly aid in establishing the proportions of shot and grit in the mixture of new abrasive to be added and in maintaining the desired operating mix in the machine.

2. ***Effect on Surface Profile (Operating Mix)***

a. Steel shot (40-50 Rc) produces relatively smooth-bottomed craters or pits and generally an undulating surface of well-defined craters.

b. Steel grit (40-50 Rc) produces a slight angularity of the profile shape.

c. Steel grit (50-60 Rc) produces greater sharpness of peaks and valleys and generally a slightly higher profile than softer grit of the same size.

d. A combination mix of steel shot (40-50 Rc) with steel grit (50-60 Rc) produces a surface typical of the harder grit but with a slightly reduced profile height because of the effect of the steel shot.

e. Surface profile height is dependent upon the size, type, and hardness of the abrasive, and hardness of the workpiece being processed.

f. Typical profile heights produced by operating mixes of various abrasives are shown in SSPC-SP COM(4) and other reports.(6,7)

3. ***Effect on Surface Appearance***

Different abrasives produce different "color" on blast-cleaned surfaces. To those who have become accustomed to the use of sand abrasive, there is a natural tendency to question the cleanliness of surfaces cleaned with cast steel shot or grit. In general, and as an example, a White Metal (SSPC-SP 5) surface obtained by sand-blasting will have a brighter, whiter appearance than a steel grit-blasted surface. In turn, the grit-blasted surface will look brighter and whiter than a shot-blasted surface. The color varies because changes in the angularity of the surface profile produced by the various abrasives also change the reflectivity of the surface. The greater scrubbing and scouring action produced by the angular particles of steel grit and sand (or other non-metallic abrasives) as compared with the more uniform impact and slight peening action of the steel shot also contributes to variations in color.

These differences in appearance must be recognized but cannot be given adequate verbal definition. The variations in appearance are best illustrated by the NACE Visual Standards TM-01-70 and TM-01-75.

4. ***Effect on Coatings Performance***

Research conducted by SSPC in salt fog and outdoor exposure tests indicates that small but measurable differences may exist in the performance of coatings applied over surfaces cleaned with steel shot and steel grit, respectively.(10,11) No clear superiority in the performance of coatings on shot- versus grit-blasted surfaces has yet been shown in the SSPC research data. However, grit blasting has shown evidence of producing better coating performance in the vicinity of scribed areas on the test panels.

Outdoor exposure tests conducted by NACE Task Group T-6H-15 have produced results that closely parallel those of the SSPC tests. However, the results indicate the relative differences to be so slight as to be considered statistically insignificant.(12)

Note: Test panels cleaned with steel abrasives for the SSPC research programs (PACE Phase I and II) and the NACE T-6H-15 program were processed in centrifugal wheel blast machines, except as later noted. Panels were cleaned with abrasive operating mixes of S-280 steel shot (40-50 Rc hardness) and G-40 steel grit (56-60 Rc hardness). The SSPC PACE Phase I and II programs also include panels cleaned by nozzle blast with G-14 steel grit of unidentified hardness.

B. Operating Mix

Two very basic recommendations about the abrasive used in a blast cleaning system should be heeded. First, when determining the type, nominal size, and hardness of the abrasive required to produce the desired surface finish, *use an operating mix of abrasive,* preferably pre-conditioned by prior cycling through the blast system. Second, for the most economical, efficient, and high-quality operations, *maintain the operating mix* during production. The importance of this process control function cannot be emphasized too strongly.

1. ***Abrasive Selection***

   Pre-production trials should be conducted to establish operating conditions and to select an abrasive mix.

   a. Abrasive already in an existing machine must have been recycled for a sufficient length of time to have generated an operating mix as evidenced by screen analyses.

   b. If a substantial change in abrasive type, size, or hardness is necessary, consult the machine supplier or abrasive supplier or both.

   c. A specially formulated (screened and sized) operating mix may be obtained from abrasive suppliers for starting up a new machine.

   d. Once a desired surface finish is achieved, abrasive screen analyses can be made and recorded for reference during later production operations.

2. ***New (Purchased) Abrasive***

   a. There are two accepted specifications for cast steel shot and grit:

   Society of Automotive Engineers — SAE J-827
   Steel Founders' Society of America — SFSA 20-66

   It should be noted, however, that abrasives of both lesser and greater hardnesses than defined by these specifications (namely 40-50 Rockwell C) are commercially available. And, as previously noted, cast steel grit of greater hardness may sometimes be selected for some structural steel cleaning applications. Thus, *all pertinent documents (contractual, process, purchase, etc.) that specify the abrasives to be used must clearly designate the* ***abrasive by size and by hardness.***

   b. Newly purchased abrasive is sized according to SAE Specification J444 (Table 1). For shot, the size designation corresponds with the aperture size of the nominal screen; for grit the size designation corresponds to the number of the nominal screen with the prefix "G" added. The new abrasive consists of a relatively small proportion of particles smaller than the nominal (designated) size, with most particles being of a size corresponding to and slightly greater than the screen size by which the abrasive size is designated. (Example — new S-*280* shot will contain a minimum of 85 percent particles retained on a 0.0*280* in. mesh opening screen; new G-*40* grit will include at least 70 percent particles retained on a #*40* NBS Screen).

   New abrasive should not be procured on the basis of price alone. Cast steel abrasives, for instance, may have a defective microstructure even though they are of the proper chemical composition and hardness. Such abrasive will fail prematurely, resulting in excessive fines in the operating mix and high costs of abrasive consumption; excessive abrasive fines may also overload the recycling and ventilation systems, cause erratic abrasive flow, reduce cleaning effectiveness, and necessitate reduction of cleaning speeds.

   The process of evaluating abrasives is time consuming; thorough comparisons of quality can be obtained only through carefully controlled field tests in the actual blast machine. However, approximate comparisons of quality can be conducted by the average user with conventional laboratory facilities, using procedures for analysis of the microstructure and hardness of the abrasive particles. Information and assistance regarding such laboratory techniques can be provided by the abrasive manufacturers.

   The important point is that the lowest priced new abrasive can frequently become the most expensive to use.

3. ***Abrasive Breakdown***

   As the abrasive is repeatedly impacted against the workpiece, the particles eventually fracture and flake off so that an operating mix of varying amounts of the larger (new) and smaller recycled particles develops. Large particles provide sufficient mass to break tenacious scale; the medium and smaller sized particles scour and remove the cracked and fragmented scale from the surface, reduce the surface profile height, and increase the number of profile peaks (Fig. 9).

4. ***Maintaining the Operating Mix***

   Each abrasive type, size, and shape has its own impact life cycle, generally measured in pounds used per blasting hour. Preferably, new abrasive should be added continuously during blasting in amounts equal to the rate of withdrawal, or loss, from the system. Continuous, automatic systems of abrasive replenishment provide the most reliable method of maintaining a uniform abrasive operating mix in a production operation. In the absence of automatic systems, new abrasive is normally added once each shift, or after each eight hours of wheel blasting. It is recommended that additions not exceed fifty (50) pounds of new abrasive.

   Delay in adding new abrasive tends to decrease the percentage of coarser sizes in the operating mix; the result will likely be poorer quality cleaning and reduction in the depth of the anchor pattern. Conversely, adding a large quantity of new abrasive at one time increases the percentage of coarser sizes, resulting in a coarsening of surface profile, and for a given through-put speed, insufficient coverage and poorer cleaning. The net result in either case is reduction in operating efficiency or in product quality or both.

   Maintaining a uniform and stabilized operating mix also requires that the abrasive particles removed from the blast machine be of uniform size. To realize the greatest economic benefits from using metallic abrasive, the particle size removed should be the largest size that is ineffective in the cleaning operation. Control of the size to be removed requires careful attention to adjustment of the separator system and of the air flow through the separator. Care must also be taken to prevent (or minimize) losses of abrasive by carry-out on the workpieces, by loss through work entry and exit seals on the cabinet, or by leakage elsewhere on the machine (Fig. 10).

Generally, the operating mix should contain no more than 40% or no less than 20% particles of sizes equivalent to or larger than the newly purchased (nominal screen) size. For example, the screen analysis of a G-40 operating mix should show that the weight or volume of particles retained on a #40 (0.0165 mesh opening) screen is within the range of 20 to 40 percent of the entire analysis sample; the remainder of the sample should be of smaller particle sizes. The operating mix should typically contain particles of sizes ranging from one screen size larger to four or more screen sizes smaller than the nominal screen size of the new abrasive (Fig. 11). Recommended particle sizes at

CONTROLLING THE ABRASIVE OPERATING MIX

1 THRU PROPER ABRASIVE ADDITIONS
Additions=Consumption rate

2 PROPER REMOVAL SIZE SETTING

3 PROPER VENTILATION CONTROL
a. Separator
b. Dust collector

4 CONTROL OF CARRYOUT LOSSES
a. With work
b. Machine leaks

FIGURE 10
Maintaining the Operating Mix.
Courtesy of Wheelabrator-Frye, Inc.

IT'S THE ABRASIVE OPERATING MIX THAT DOES THE WORK

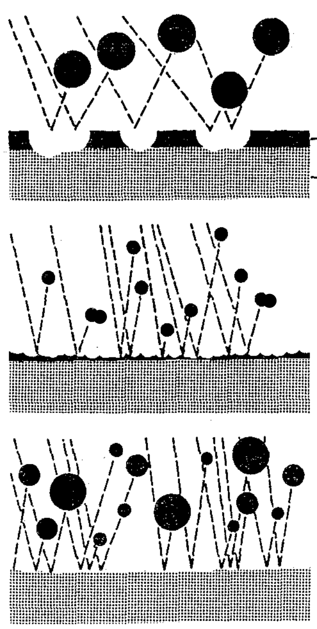


FIGURE 9
Rust and Scale Removal.
Courtesy of Wheelabrator-Frye, Inc.

which the abrasives should be withdrawn from the system are shown in Table 1 for each of the basic SAE sizes of shot and grit.

C. Production Rate and Cost Considerations

1. The smallest size of a given type and hardness of abrasive operating mix that will produce the desired cleaning results will, in general, provide the most highly productive and most economical cleaning operation.
2. Consumption of abrasive (aside from losses due to carryout on the workpieces) depends on, among other factors, the size of the abrasive particles removed through the separator. The separator adjustment and function must be monitored to prevent withdrawal of usable size abrasive particles (Fig. 12).
3. Steel grit breaks down slightly faster than steel shot of the same size and hardness. The smaller the grit, the greater the difference in breakdown compared to shot.
4. Increasing the hardness of steel grit or shot in a given operation may increase the breakdown and rate of consumption. Similarly, faster rates of wear may occur on the machine parts (wheel components, cabinet liners, and conveyor components). Increased costs incurred by selecting the harder abrasives become academic, however, if abrasive of lower hardness will not do the job. A combination of hardnesses of steel shot and grit will, of course,

TABLE 1

SAE SHOT & GRIT SIZE SPECIFICATIONS WITH SUGGESTED REMOVAL SIZES(1)

CAST SHOT SPECIFICATIONS FOR SHOT PEENING OR BLAST CLEANING

NBS Screen No.	Standard mm (3)	Screen Size (in)	Screen Opening Sizes and Screen Numbers with Maximum and Minimum Cumulative Percentages Allowed on Corresponding Screens SAE Shot Number													
			S1320	S1110	S930	S780	S660	S550	S460	S390 (4)	S330	S280	S230	S170	S110	S70
4	4.75	(0.187)	All Pass	—	—	—	—	—	—	—	—	—	—	—	—	—
5	4.00	(0.157)	—	All Pass	—	—	—	—	—	—	—	—	—	—	—	—
6	3.35	(0.132)	90% min	—	All Pass	—	—	—	—	—	—	—	—	—	—	—
7	2.80	(0.111)	97% min	90% min	—	All Pass	—	—	—	—	—	—	—	—	—	—
8	2.36	(0.0937)	—	97% min	90% min	—	All Pass	—	—	—	—	—	—	—	—	—
10	2.00	(0.0787)	—	—	97% min	85% min	—	All Pass	All Pass	—	—	—	—	—	—	—
12	1.70	(0.0661)	—	—	—	97% min	85% min	—	5% max	All Pass	—	—	—	—	—	—
14	1.40	(0.0555)	—	—	—	—	97% min	85% min	—	5% max	All Pass	—	—	—	—	—
16	1.18	(0.0469)	—	—	—	—	—	97% min	85% min	—	5% max	All Pass	—	—	—	—
18	1.00	(0.0394)	—	—	—	—	—	—	96% min	85% min	—	5% max	All Pass	—	—	
20	0.850	(0.0331)	—	—	—	—	—	—	—	96% min	85% min	—	10% max	All Pass	—	
25	0.710	(0.0278)	—	—	—	—	—	—	—	—	96% min	85% min	—	10% max	—	—
30	0.600	(0.0234)	—	—	—	—	—	—	—	—	—	96% min	85% min	—	All Pass	—
35	0.500	(0.0197)	—	—	—	—	—	—	—	—	—	—	97% min	—	10% max	—
40	0.425	(0.0165)	—	—	—	—	—	—	—	—	—	—	—	85% min	—	All Pass
45	0.355	(0.0139)	—	—	—	—	—	—	—	—	—	—	—	97% min	—	10% max
50	0.300	(0.0117)	—	—	—	—	—	—	—	—	—	—	—	—	80% min	—
80	0.180	(0.007)	—	—	—	—	—	—	—	—	—	—	—	—	90% min	80% min
120	0.125	(0.0049)	—	—	—	—	—	—	—	—	—	—	—	—	—	90% min
200	0.075	(0.0029)	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Suggested Removal Size for Cleaning Structural Steel(2)						0.0232	0.0165	0.0165	0.0138	0.0117	0.0117	0.0082	0.0070	0.0059	0.0049	0.0029

CAST GRIT SPECIFICATIONS FOR BLAST CLEANING

NBS Screen No.	Standard mm (3)	Screen Size (in)	Screen Opening Sizes and Screen Numbers with Minimum Cumulative Percentages Allowed on Corresponding Screens SAE Grit Number											
			G10	G12	G14	G16	G18 (4)	G25	G40	G50	G80	G120	G200	G325
4	4.75	(0.187)	—	—	—	—	—	—	—	—	—	—	—	—
5	4.00	(0.157)	—	—	—	—	—	—	—	—	—	—	—	—
6	3.35	(0.132)	—	—	—	—	—	—	—	—	—	—	—	—
7	2.80	(0.111)	All Pass	—	—	—	—	—	—	—	—	—	—	—
8	2.36	(0.0937)	—	All Pass	—	—	—	—	—	—	—	—	—	—
10	2.00	(0.0787)	80%	—	All Pass	—	—	—	—	—	—	—	—	—
12	1.70	(0.0661)	90%	80%	—	All Pass	—	—	—	—	—	—	—	—
14	1.40	(0.0555)	—	90%	80%	—	All Pass	—	—	—	—	—	—	—
16	1.18	(0.0469)	—	—	90%	75%	—	All Pass	—	—	—	—	—	—
18	1.00	(0.0394)	—	—	—	85%	75%	—	All Pass	—	—	—	—	—
20	0.850	(0.0331)	—	—	—	—	—	—	—	—	—	—	—	—
25	0.710	(0.0278)	—	—	—	—	85%	70%	—	All Pass	—	—	—	—
30	0.600	(0.0234)	—	—	—	—	—	—	—	—	—	—	—	—
35	0.500	(0.0197)	—	—	—	—	—	—	—	—	—	—	—	—
40	0.425	(0.0165)	—	—	—	—	—	80%	70%	—	All Pass	—	—	—
45	0.355	(0.0139)	—	—	—	—	—	—	—	—	—	—	—	—
50	0.300	(0.0117)	—	—	—	—	—	—	80%	65%	—	All Pass	—	—
80	0.180	(0.007)	—	—	—	—	—	—	—	75%	65%	—	All Pass	—
120	0.125	(0.0049)	—	—	—	—	—	—	—	—	75%	60%	—	All Pass
200	0.075	(0.0029)	—	—	—	—	—	—	—	—	—	70%	55%	—
325	0.045	(0.0017)	—	—	—	—	—	—	—	—	—	—	65%	20%
Suggested Removal Sizes for Cleaning of Structural Steel(2)			0.0232	0.0165	0.0165	0.0138	0.0117	0.0062	0.0059	0.0049	0.0029			

(1) Courtesy Society of Automotive Engineers (SAE J444a).
(2) See Discussion of Work Mix.
(3) Corresponds to ISO Recommendations.
(4) This is coarsest size in common use for blast cleaning structural steel for painting.

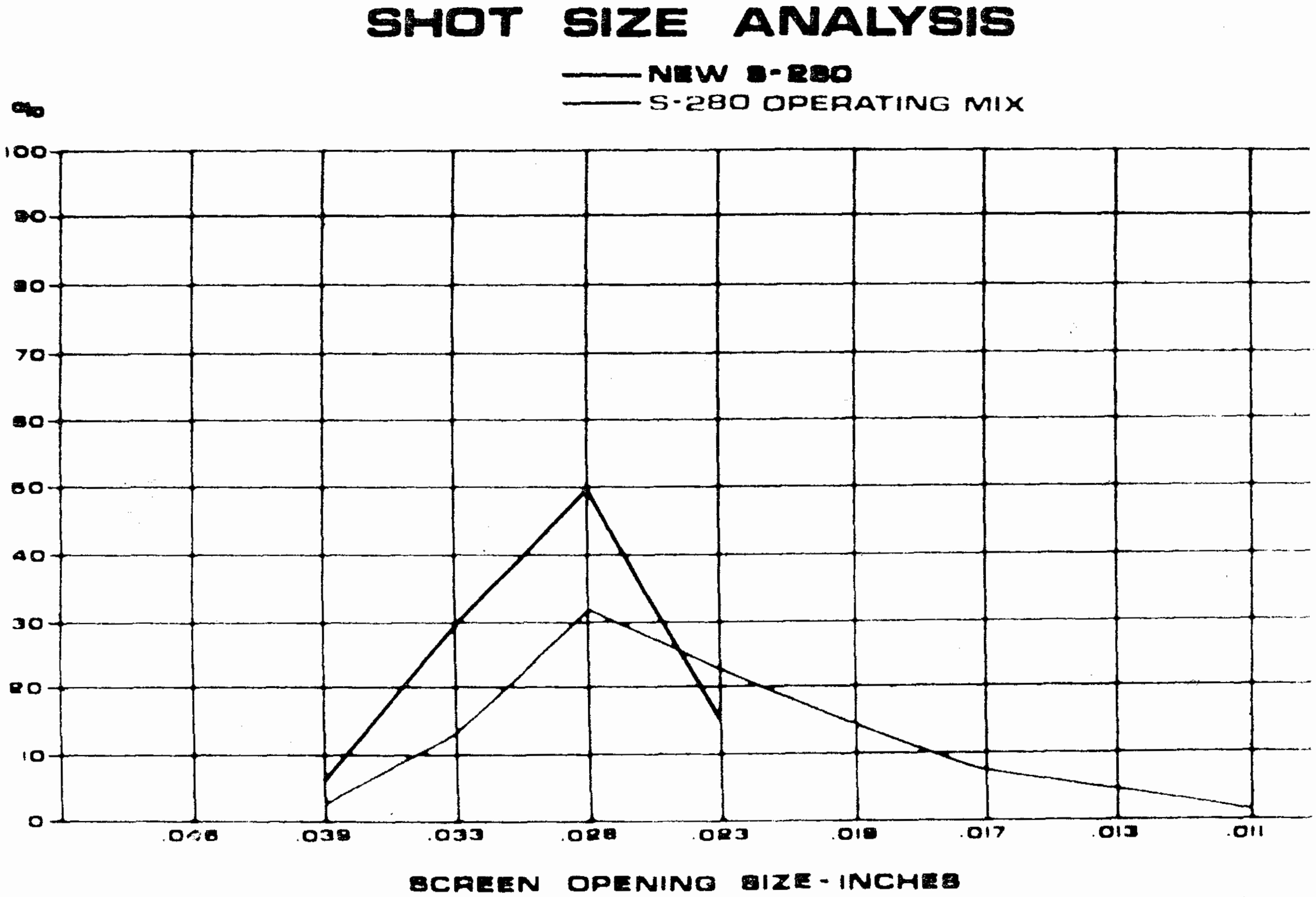


FIGURE 11
Particle Screen Size Ranges.

Courtesy of Wheelabrator-Frye, Inc.

result in "somewhere in-between" costs of abrasive consumption and wear on machine parts.

D. General

Selection of abrasive is greatly influenced by the actual experience of systems users and manufacturers. Preproduction trial runs should be used to select abrasive and establish machine operating conditions. (Such preproduction trials may also serve, and may be required by contract, to produce blast cleaned steel samples to be preserved for subsequent use as visual reference standards for cleanliness and surface profile.)

VI. PROCESS CONTROLS

Thorough understanding of (1) criteria for determining quality, (2) selection of the equipment and the abrasive to be used, and (3) establishment of operation procedures are essential in setting up a reliable, efficient blast cleaning operation. As with all production operations, continuity of quality can be sustained only if the production machines and tools (in this case, the abrasive operating mix) are properly maintained.

Blast cleaning equipment, by its very nature, tends to be self-destructive. Therefore, planned maintenance programs are essential. Efficient and trouble-free performance depends on the care and attention given the system by operating and maintenance personnel.

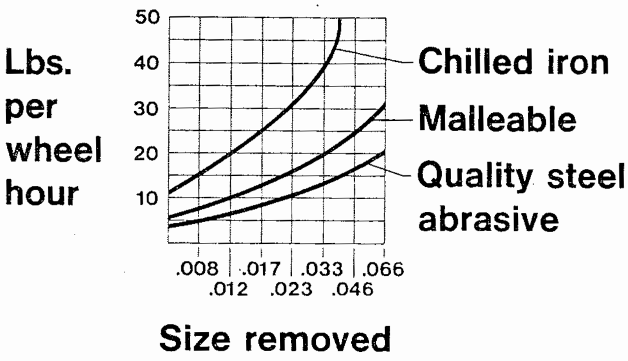
Comprehensive instruction manuals are provided by equipment manufacturers, and the user should be thoroughly familiar with them. These Guidelines emphasize only the aspects of maintenance that are of greatest importance in maintaining the quality of surface preparation, and in achieving efficient and economical production operations.

Generally speaking, as long as the *work handling system* properly delivers the workpieces to the blast of the wheels, only normal maintenance of the equipment is required. In the *cabinet,* the entry and exit seals and interior liners must be maintained. Sufficient ventilation must be provided to assure positive flow of air from the outside to the cabinet interior and positive withdrawal of dust to the dust collector. Sub-systems supplied by various equipment manufacturers will differ only slightly in design features and maintenance requirements.

Sub-systems that differ most in design detail, and have the most influence on the process and the control of

ABRASIVE CONSUMPTION

...Depends on size of pellets at removal



...The larger the pellets removed, the greater your CONSUMPTION RATE and ABRASIVE COST.

FIGURE 12
Monitoring Abrasive Consumption.
Courtesy of Wheelabrator-Frye, Inc.

product quality are
(a) the blast wheels,
(b) the abrasive recyling system — more specifically, the separator, and
(c) the dust collector.

Therefore, these sub-systems will receive the greatest attention in the Guidelines. The more common causes and cures for losses of operational efficiency or for deterioration of quality on the finished workpiece are discussed. Operation and maintenance manuals provided by the machine manufacturer contain more detailed information. The equipment user must be thoroughly familiar with and follow closely the manufacturer's recommended practices.

A. Wheel Units

1. ***General Description***

Abrasive from an overhead storage hopper is fed to the center of the wheel unit, which is driven at high speed either by belts and sheaves or by direct connection to the drive motor shaft. In one wheel design configuration (Fig. 13) the abrasive is fed into a cast steel impeller that rotates with the wheel. The impeller imparts initial velocity to the abrasive as it carries the abrasive to an opening in a stationary control cage, through which the abrasive is discharged onto the wheel blades. In another configuration (Fig. 14), abrasive is fed into an adjustable nozzle and is propelled into the wheel center and outward to the blades through the nozzle by high volume, low pressure air from a low horsepower blower. The direction of the blast from the wheel is controlled, in the first case, by the peripheral location of the control cage opening and, in the latter case, by the location of the nozzle outlet.

2. ***Blast Pattern Adjustment***

When the blast wheel is properly adjusted and the individual components of the wheel are in good

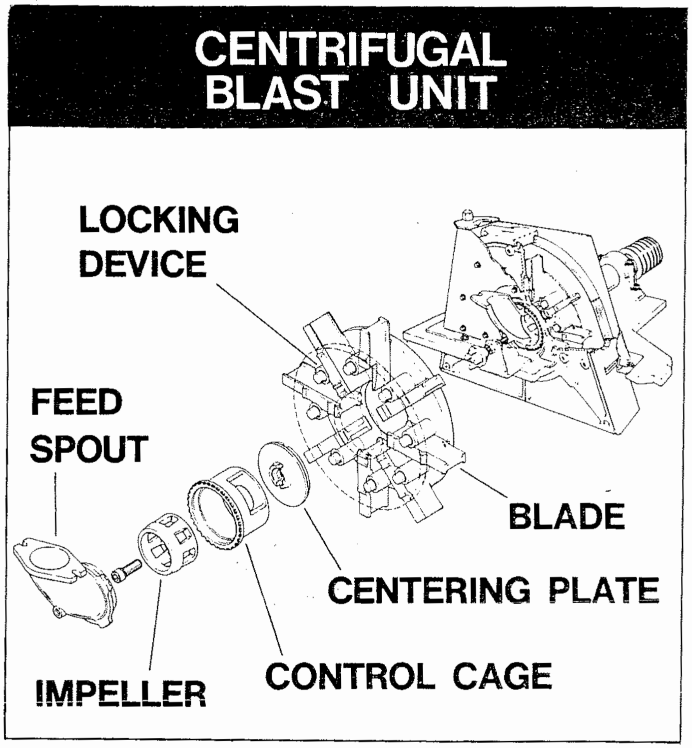


FIGURE 13
Configuration Designed to Feed Abrasive into a Cast Steel Impeller.
Courtesy of Wheelabrator-Frye, Inc.

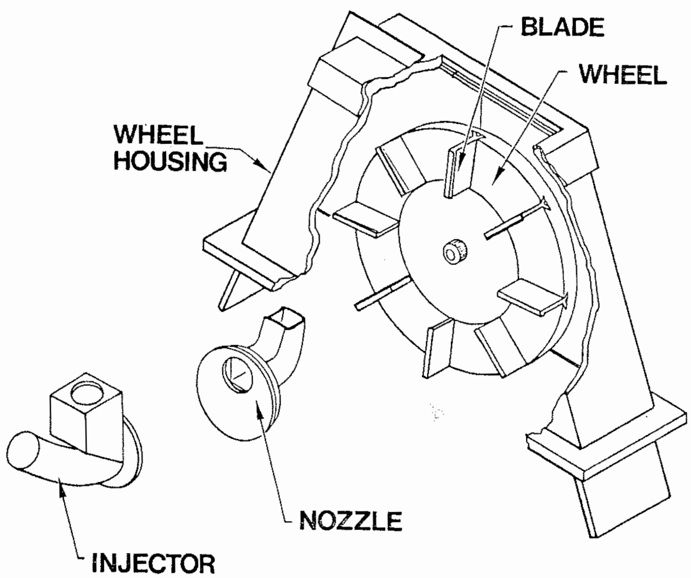


FIGURE 14
Configuration Designed to Feed Abrasive into a Nozzle.
Courtesy of Wheelabrator-Frye, Inc.

condition, the full effect of the blast stream will be attained for maximum efficiency. The occurrence of longer than normal cleaning cycles, inadequate cleaning, and accelerated wear on cabinet interiors can usually be traced to loss of directional control of the blast pattern.

The blast pattern can be inspected by a procedure commonly referred to as "checking the hot-spot". A metal target plate (painted or unpainted) is placed in line with the blast. The metal target will become hot when subjected to a blast of 30 seconds or longer. The heat can readily be felt in the area where the abrasive is impacting the target most heavily. The target plate will also show visibly the area over which the blast has effectively impacted the surface. Rotation of the control cage or nozzle will adjust the blast pattern to the desired location (Figs. 15 and 16).

The principal causes of changes in the blast pattern are the wear on the wheel parts that control the direction and length of the pattern: the impeller and control cage, the nozzle (or blower malfunction), and the blades. These parts must be inspected regularly and replaced as soon as excessive wear or malfunction is detected (Fig. 17).

Wear on the impeller vanes and control cage spreads out (lengthens) the blast pattern and moves and cools off the "hot spot". Abrasive leaving the worn vanes of the impeller will hit the back edges of the blades and land high on the face of the following

CONTROL CAGE SETTING GOVERNS BLAST DIRECTION

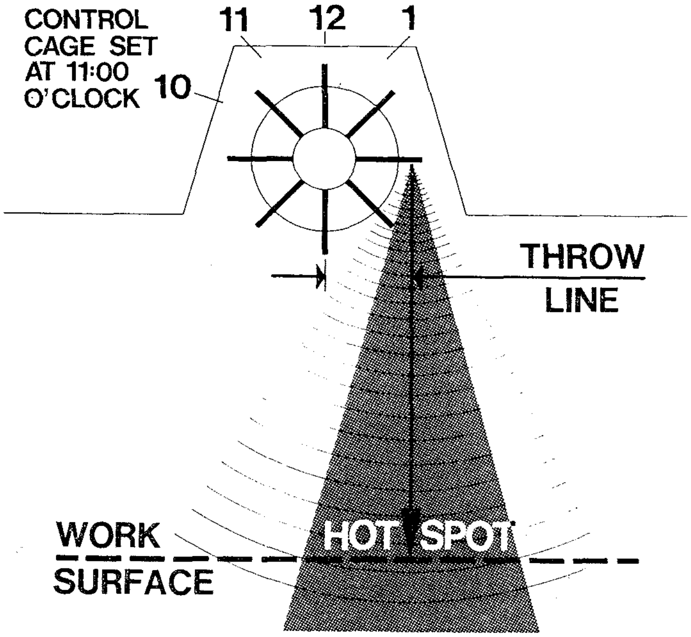


FIGURE 15
Finding the Hot Spot in the Blast Pattern.
Courtesy of Wheelabrator-Frye, Inc.

BLAST PATTERN SETTINGS

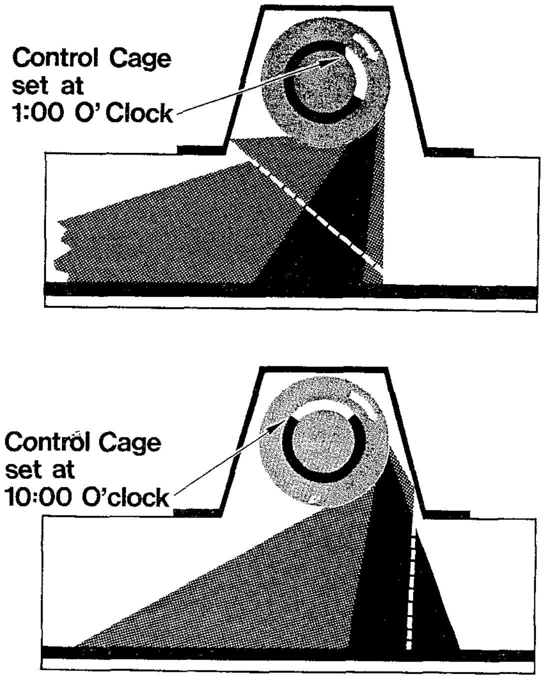


FIGURE 16
Rotating the Control Cage to Adjust the Blast Pattern.
Courtesy of Wheelabrator-Frye, Inc.

blades rather than on the inner ends or proper spot on the blade faces (Fig. 18). Wear on the control cage opening alters the location of the "hot spot" because it allows a greater opening through which the abrasive is thrown. The "hot spot" becomes badly diffused, resulting in a loss of abrasive velocity and impact force.

Badly worn or pitted blades offer resistance to abrasive flow along the blade face. As a result, the "hot spot" shifts and the total pattern may be lengthened, as abrasive velocity is decreased.

An increase in the percentage of fines in the abrasive operating mix, caused either by neglecting to add new abrasive to the system on a regular basis, or by a malfunctioning separator, will also change the location of the blast pattern, since the finer abrasive particles tend to hang up on the wheel blade faces for a longer time. It should be noted that a 10 percent misalignment of the pattern can reduce cleaning efficiency by 25 percent or more.

3. ***Abrasive Flow***

Cleaning efficiency can be maintained only with continuous full flow of abrasive through the blast wheels. An ammeter is provided on the machine control panel for each blast wheel, so that the operator can detect any erratic flow of the abrasive. For example, for a typical 19-1/2" diameter, 2-1/2" wide wheel using a 15 HP motor on a 440 volt circuit, approximately 8 amperes will be required to

BLAST PATTERN CHANGES AS WHEEL PARTS WEAR

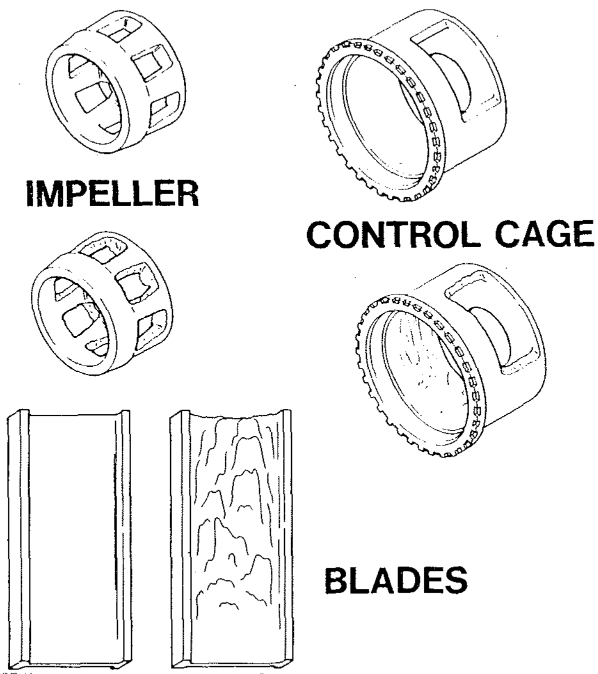


FIGURE 17
Excessive Wear on Wheel Parts.
Courtesy of Wheelabrator-Frye, Inc.

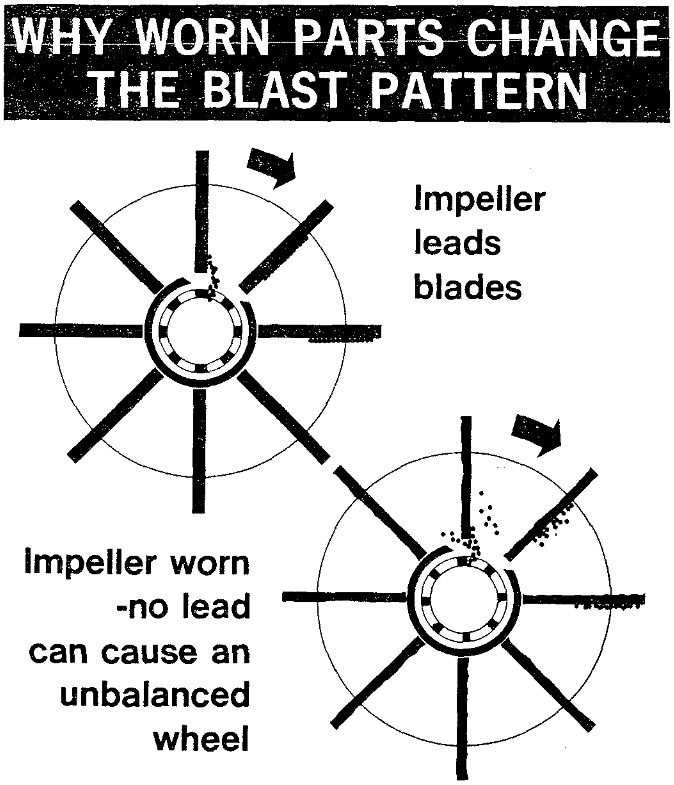


FIGURE 18
Abrasive Leaving a Worn Impeller.
Courtesy of Wheelabrator-Frye, Inc.

rotate the wheel without abrasive flow. Under a full load of abrasive flow at approximately 375 pounds per minute, approximately 20 amperes will be required (Fig. 19).

Abrasive is thus propelled at the rate of approximately 31 pounds per minute per ampere difference between "no-load" and "full-load" current. A reduction to about 17 amperes would correspond to an abrasive flow reduction of about 93 pounds per minute, with a resulting loss in cleaning efficiency of about 25 percent.

When the wheel is operating at less than full amperage, the usual cause is an insufficient supply of abrasive to the wheel, which may indicate the need to add abrasive to the system. However, low wheel amperage may also indicate that the wheel is being flooded with excessive abrasive flow.

A very simple test can be conducted to determine whether low wheel amperage is caused by either insufficient or excessive abrasive flow (Fig. 20). When low amperage is discovered, block the flow of abrasive to the wheel. If the amp reading jumps to full load capacity before falling off to a no-load reading, the cause is an excessive flow of abrasive (a "choked" or "flooded" wheel). If the amp reading simply declines, there is insufficient flow of abrasive (a "starved" wheel). In either case, the difficulty may be a malfunctioning flow control valve, worn wheel parts, worn parts or obstructions in the abrasive recirculating system, or a loss of power

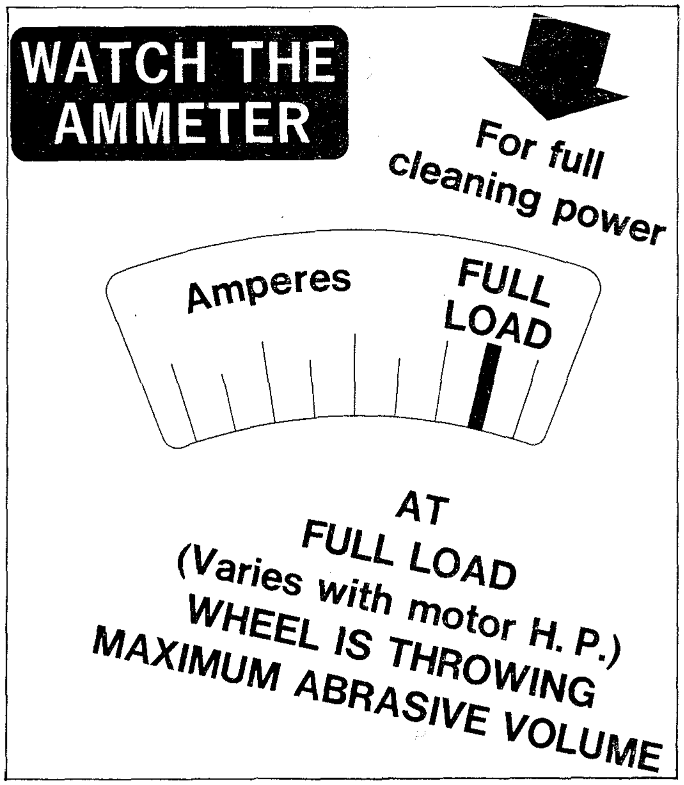


FIGURE 19
Using the Ammeter to Detect Erratic Flow.
Courtesy of Wheelabrator-Frye, Inc.

A SIMPLE TEST TO ISOLATE THE PROBLEM OF LOW AMPERAGE

1 With wheel running, turn on abrasive, turn off abrasive flow.

2 If amperage increases before falling to "NO LOAD" problem is a "FLOODED WHEEL"

3 If amperage falls to "NO LOAD" problem is a "STARVED WHEEL"

FIGURE 20
Determining the Reason for Low Amperage.
Courtesy of Wheelabrator-Frye, Inc.

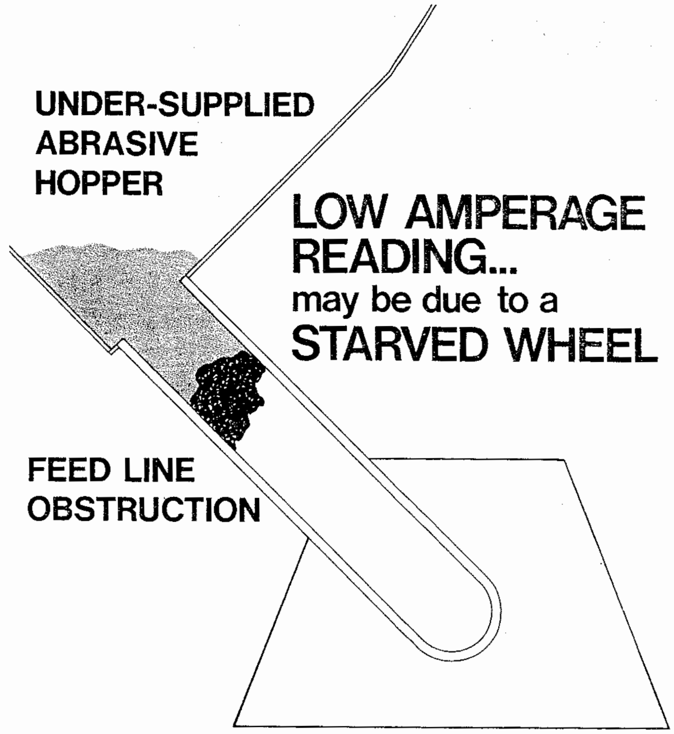


FIGURE 21
Possible Reasons for a Starved Wheel.
Courtesy of Wheelabrator-Frye, Inc.

due to worn or loose drive belts at the wheel shaft (Figs. 21 and 22).

B. Abrasive Recycling System

1. *General Description*

Abrasive handling and recycling systems for centrifugal wheel blast machines include the following elements (Fig. 23):

a. abrasive elevator;

b. a method of transferring abrasive from the elevator to the separator (Transfer may be accomplished by gravity or rotary screw conveyor. In some installations a rotary screen may also be provided to remove foreign objects that have passed through other screening devices. Such objects may include pieces of welding rod, steel punchings, cigarette butts and wrappers, etc.);

c. an air-wash separator to remove abrasive particles that have been reduced to unusable size, fine particles and dust that has been generated in the removal of mill scale, rust, paint, and other materials;

d. a hopper to store the cleaned, reusable abrasive;

e. a hopper to collect refuse removed from the abrasive;

f. a device to control and meter flow of abrasive to the wheel; and

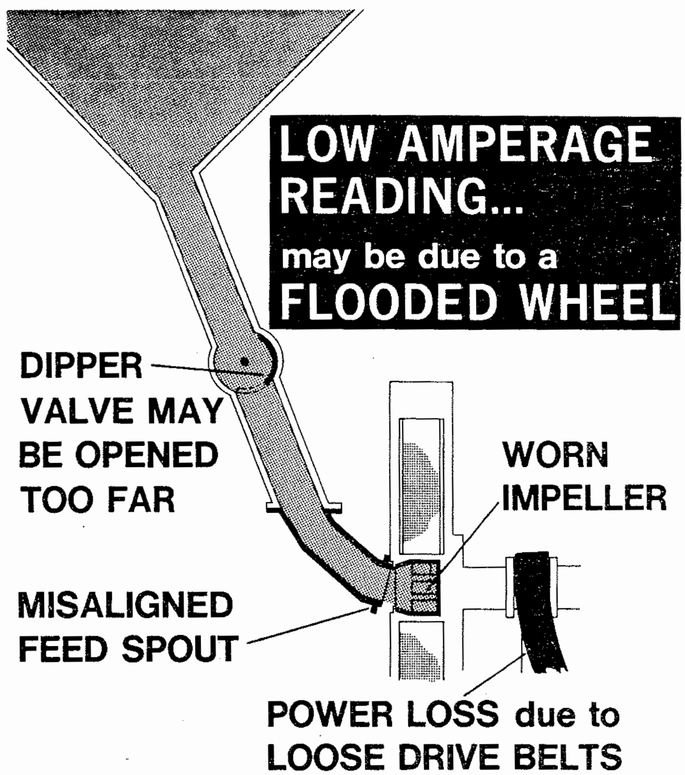


FIGURE 22
Possible Reasons for a Flooded Wheel.
Courtesy of Wheelabrator-Frye, Inc.

ABRASIVE HANDLING SYSTEM

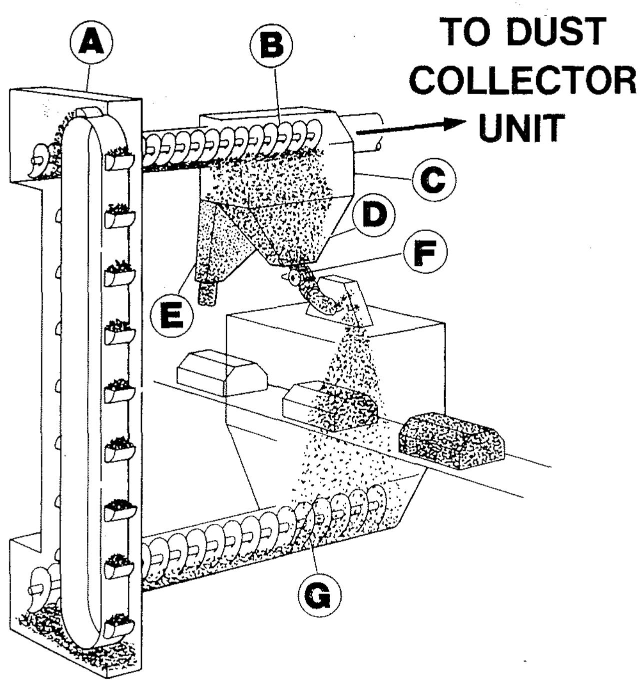


FIGURE 23
Elements of the Abrasive Handling and Recycling Systems.
Courtesy of Wheelabrator-Frye, Inc.

g. a means of moving spent abrasive and contaminant particles from the base of the cabinet to the elevator, such as by gravity, by helicoid screw, or shaker conveyor.

While proper functioning of each of these elements is important, efficient operation of the separator is vital in its influence on cleaning efficiency and operating costs (Fig. 24).

2. ***Separator Functions***

All separators use the air-wash principle because of the ultra-fine adjustment possible with this device. The separator works much like a vacuum cleaner to remove dust, fines, and undersized abrasive from a curtain of falling abrasive. Uniform air flow through a uniformly distributed curtain of abrasive (Fig. 25) is essential. A separator has the following basic functions:

a. Removes contaminant fines (rust, scale, paint particles, dirt and sand granules, etc.) so that only good, clean abrasive is fed to the wheels. The presence of highly abrasive particles, such as mill scale oxide fines, or of granules of sand and dirt on the incoming workpiece, can drastically increase the wear on wheel parts if they are not removed. An extreme example is found in foundry cleaning operations, where sand removal is a principal objective; it has been shown that as little as 2 percent sand by volume in an abrasive operating mix may increase the rate of wear on wheel parts by as much as 100 percent.

b. Controls abrasive consumption rates. Other than losses due to leakage in the system and carry-out on the workpieces, abrasive consumption is determined by the size of the abrasive pellets removed from the recirculating abrasive.

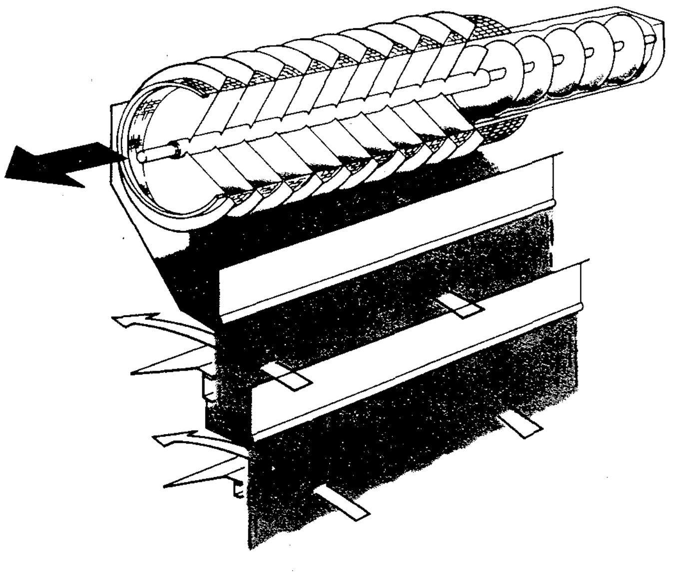
c. Controls the sizing of the abrasive operating mix. This is an extremely important function and a major influence on surface quality and system operating efficiency.

3. ***Problems and Corrections***

Excessive air flow in the separator can remove too large a size abrasive particle; too little air flow can permit the retention of fines. Air flow can be corrected by adjusting a slide gate in the duct between the separator and dust collector (Fig. 26).

Another common problem is an uneven curtain of abrasive flow through the air stream. This condition can occur for a number of reasons: (a) foreign objects lodging against spreader bars or baffle plates after passing through wear-enlarged and/or torn holes in the scalping screen above the separator lip, (b) warped or missing spreader bars or baffle plates, or (c) uneven adjustment of spreader bars or baffles. Any one of these conditions will disrupt the uniformity of the abrasive curtain, causing large abrasive particles to be sucked out where the

THE SEPARATOR SYSTEM



REMOVES CONTAMINANTS
Scale,/fines and tramp metal

FIGURE 24
Abrasive Separator System.
Courtesy of Wheelabrator-Frye, Inc.

abrasive flow is sparse, and leaving contaminants in the abrasive where the flow is heavy.

Effective operation of the separator also depends on the air flow following a specific channel, rather than entering the separator through holes or air leaks in the separator housing. If air enters the separator at points other than the proper openings, the volume of air at the separation point and the cleaning efficiency of the separator will be reduced.

4. ***Checking (Monitoring) Operation***

A regular schedule should be established for monitoring and checking the operation of the separator. Since the actual use of a blast cleaning machine will differ greatly in different shops, it is impossible to recommend a specific time schedule or frequency for such inspections. However, it is recommended that an inspection schedule be established by the user, with the assistance of the machine manufacturer or abrasive supplier or both. An inspection may include:

a. routine, visual examination by assigned, experienced personnel. (1) The discharge from the separator into the refuse hopper should be examined visually for presence of usable size abrasive particles. (2) A similar examination should be made of the abrasive as it falls at a point below the air-wash curtain and into the abrasive hopper to detect the presence of dust or fines, or the absence of usable sizes of abrasive particles. (3) The abrasive curtain should be examined to assure uniform flow across the entire width of the separator.

These are simple checks. They are non-quantitative but can serve well to reveal early indications of separator malfunction. It is strongly suggested these simple checks be made on a daily basis.

b. screen analyses. This is a quantitative analysis that provides an exact measure of the abrasives according to particle size. The data, when plotted graphically, provides a visual picture of the abrasive mix. Screen analyses should be performed on a regular basis by qualified personnel, generally once each week, or, depending on the machine usage, as frequently as each working day.

Screen analysis procedures are too lengthy to be included in detail in the Guidelines. Complete instructions and procedures on the general use of test sieves are contained in ASTM STP 447, Manual on Test Sieving Methods.[13] Recommended procedures specifically applicable to blast cleaning operations can be provided and demonstrated by the machine

A SEPARATOR WORKS LIKE A VACUUM CLEANER

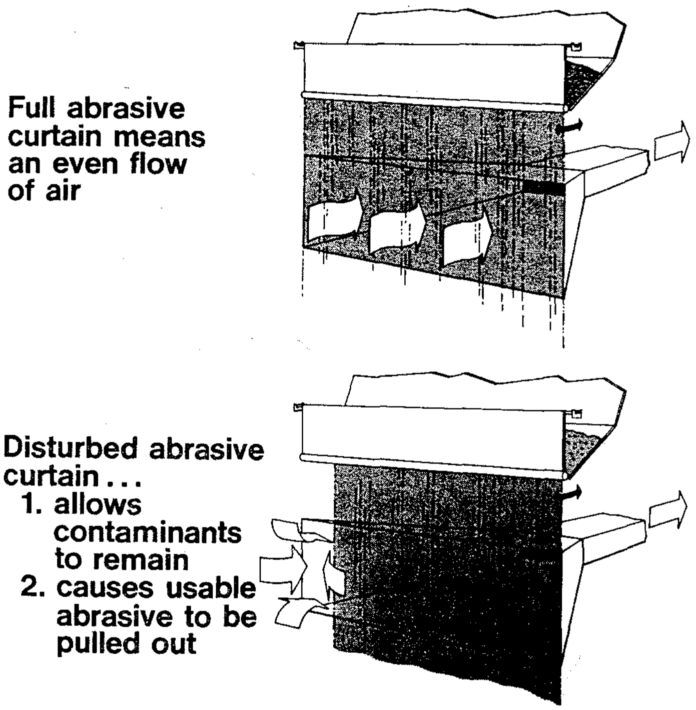


FIGURE 25
Consequences of a Disturbed Abrasive Curtain.
Courtesy of Wheelabrator-Frye, Inc.

THE SEPARATOR SYSTEM

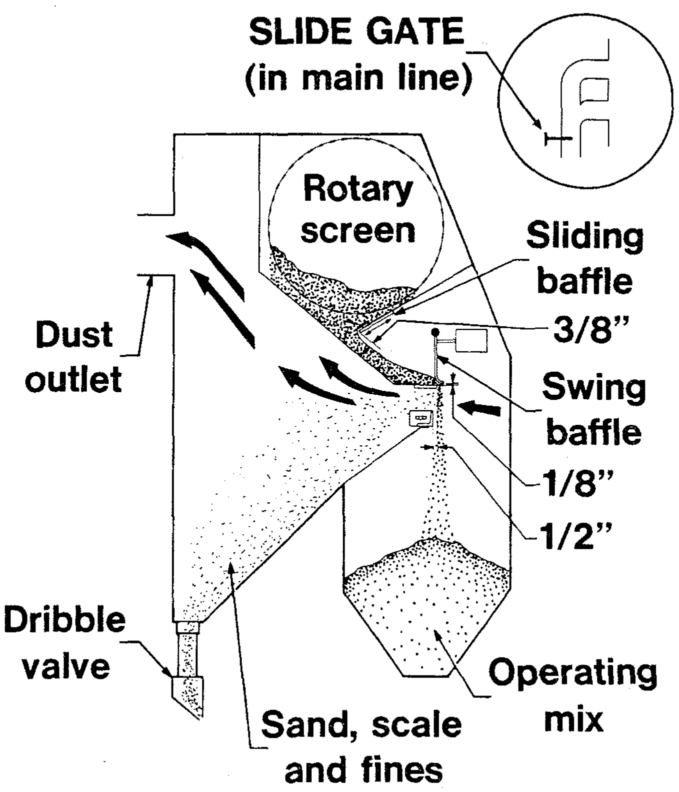


FIGURE 26
Adjusting the Separator Air Flow.
Courtesy of Wheelabrator-Frye, Inc.

manufacturer or abrasive supplier. However, two significant screen analyses should be conducted:

- The cleaned abrasive being fed to the wheel should be analyzed. Preferably, the abrasive sample should be taken at a point just prior to entry into the blast wheel. When access to the abrasive flow at this point is impeded, the abrasive sample may be taken at the abrasive curtain in the separator, at a point below the air-wash area, where the abrasive falls into the hopper. Care must be exercised to assure that *the entire curtain width of the abrasive flow is sampled.*
- The abrasive discharged from the separator into the refuse hopper should be analyzed to determine whether or not abrasive of usable size is being withdrawn from the system. Abrasive samples should be taken directly from the discharge tube rather than from the bulk material in the discharge container.

In either of the cases above, a sample of approximately 100 grams should be obtained for the screen analysis.

Usable abrasive may sometimes be drawn into the dust collector, and can be detected by examination of the collector "dust". When good abrasive is found, screen analysis of the collector discharge, together with the analyses of the separator discharge, can be used to establish abrasive losses, and emphasize the importance of efficient separator adjustment. Dust collector screen analyses are more difficult to perform; procedures can be demonstrated by the machine or abrasive supplier.

5. ***Abrasive Cleanliness***

Extra care must be exercised during production operations to prevent contamination of the abrasive by contact with workpieces that have oils and greases on the surfaces. (See Section 1-A).

Should the abrasive become contaminated, commercially available products such as Factory Dry or Floor-Dri may be used for cleaning the abrasive. The separator vent to the dust collector should be closed, and the blast wheels run with full abrasive flow for a period of 20 to 30 minutes. While the wheels are running, pour the cleaning agent into the abrasive hopper; a single 40- to 50-lb bag of the cleaning material should be sufficient. After about 20 minutes, open the separator vent and continue running the machine to remove the cleaning material, dust, and fines.

It is advisable to have workpieces in the machine during this process to prevent excessive blast wear on the work conveyor and cabinet interior. Dust may accumulate around the exterior of the machine during the process. Therefore, the amount of cleaning agent should be minimized. The dust collector bags should be thoroughly shaken, and the dust collector hopper emptied and cleaned immediately following the abrasive cleaning operation.

C. Dust Collector

An adequate and properly operating dust collector system is necessary to assure positive ventilation of the blast machine, to eliminate dusting around the machine, and to minimize the presence of dust on the blast cleaned surfaces. Most structural cleaning machines are also equipped with brushes or air blow-off systems or both to remove dust and abrasive from the workpiece as it exits from the cabinet.

Dust collectors for the blast machines vary in design, but all of them use cloth filter tubes through which the air is drawn, with the dust being deposited and collected on one side of the cloth tube (inside or outside of the tube, depending on design).

A simple, yet highly efficient type of collector is shown in Figure 27. Dust-laden air entering the collector first strikes a baffle plate. The sudden change in velocity and direction causes heavier particles to drop into the hopper, leaving only the finest floating dust particles to reach the tubes. The tubes are shaken when limp to remove dust build-up.

DUST COLLECTOR

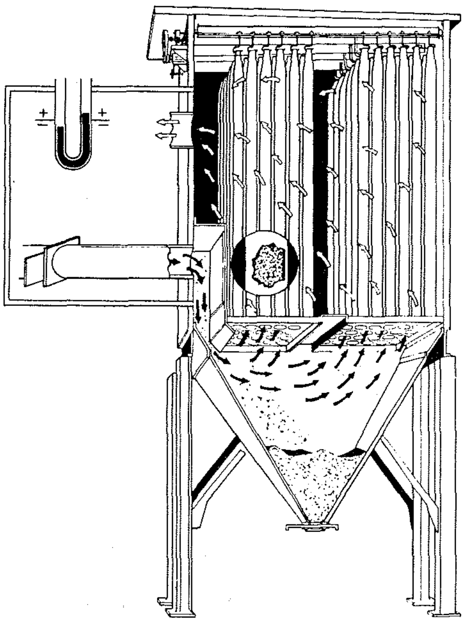


FIGURE 27
Function of the Dust Collector.
Courtesy of Wheelabrator-Frye, Inc.

The dust collector is the vacuum cleaner that pulls air through the machine cabinet and the separator. A predetermined and balanced flow of air through the machine must be maintained since a change in air flow from the machine cabinet will also effect a change in air flow through the separator. Failure to maintain this flow may cause a reduction in cleaning efficiency, dusting conditions around the machine, and the presence of fine abrasive particles and contaminants in the operating mix. A periodic check on air volumes will reduce the possibility of a gradual degradation of operation. Recommended steps to be taken on a regular schedule to assure efficient operation of the dust collector are shown in Figure 28.

DUST COLLECTOR MAINTENANCE TIPS

1	Empty hopper regularly
2	Inspect shaker mechanism
3	Check fan drive for loose belts and correct direction
4	Dust on cell plate floor indicates leakage between clean and dirty side of collector
5	Inspect for worn vent piping
6	Check manometer reading

FIGURE 28
Maintenance of the Dust Collector.
Courtesy of Wheelabrator-Frye, Inc.

VII. OPERATIONS AND MAINTENANCE PROGRAM

The centrifugal blast cleaning machines are designed and built to produce steel surfaces cleaned to a consistently high degree of quality — efficiently and economically. It should be noted that the machines can also produce cleaned surfaces of acceptable quality even though major components such as the wheels and separator(s) perform poorly because of wear or maladjustment. The result of this poor performance, however, is reduction of cleaning rates, increase in direct operating costs, major repairs, and production down-time.

Production quality at optimum rates and costs can be expected only if the system is properly and routinely monitored and maintained.

The machine operator assumes a major role in the ongoing production cleaning process. The operator should be a capable, intelligent person who takes pride in the work and the machine. All operators must be thoroughly familiar with the machine and the operation of the major subsystems, and able to detect problems when cleaning quality deteriorates or when cleaning time is increased.

The management should establish and enforce a program of record-keeping for blast cleaning operations, of routine inspections, and of preventive maintenance. This can be a very simple or quite an involved program, depending on the individual job. The equipment manufacturer should be consulted to provide the expertise and assistance needed in organizing a workable inspection program, to assist in setting up an adequate spare parts and abrasive inventory, to recommend desirable controls and appropriate production and cost records, and to provide training programs for management and shop personnel.

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A 1939 Aeronautical Engineering graduate of Tri-State University, Duke held various positions in Design and Sales Engineering and Marketing in the Aircraft Landing Gear and Nuclear Reactor Components Groups of the Bendix Corporation. In 1963 he joined Douglas Aircraft where he held positions of Design Engineer and Systems Design Analyst in Hydraulics, Landing Gear and Control Systems Engineering Groups.

In 1966, Duke joined the Materials Cleaning Systems Division of Wheelabrator-Frye, Inc. as a Project Engineer. He was later appointed Manager of Technical Development, Marketing Department, and in 1974 assumed the additional position of Manager of Product Planning for the Division.

Since 1971, Duke has actively represented Wheelabrator-Frye in the Steel Structures Painting Council working and Advisory Committee activities in steel surface preparation cleanliness and profile studies, and in similar activities of the National Association of Corrosion Engineers (NACE) and American Society for Testing and Materials (ASTM) and, through NACE, the International Standards Organization (ISO). He has served as Chairman of several working committees of these associations, authored several technical articles for publication, and presented many technical papers on the subject of blast cleaning for surface preparation.

Since his retirement early in 1982, Duke has been engaged in special project and consultant activities by Materials Cleaning Systems Division of Wheelabrator-Frye, Inc.

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