WILLIAMS
PATENT CRUSHER and PULVERIZER Co., Inc.

CRUSHERS
GRINDERS
CONVEYORS
DRYER MILLS
AIR SEPARATORS

Phone: (314) 621-3348 Fax: (314) 436-2639
2701 NORTH BROADWAY
ST. LOUIS, MO 63102 U.S.A.

**THIS MANUAL PREPARED FOR:**

# Detroit Renewable Power

**dba Michigan Waste Energy, Inc.**
**5700 Russel St.**
**Detroit, Michigan 48211-2545**
**United States**

**Purchase Order No. GD-0400**

**NOTE**
**This information does not include changes that may have been made to the equipment after sale.**

**Williams Model 680 Reversible Secondary Shredder**

**Equipment List**

| | Serial No. | Shop Order |
|---|---|---|
| 680 Reversible Secondary Shredder | 18492, 94, 96 | 862235 |
| Model B-1 Lubrication Unit | 18493, 95, 97 | 862237 |
| Model “E” Hammer Bolt Puller | 18498 | 862238 |
| Air Sweep System | 18510, 11, 12 | 870258 |

# TABLE OF CONTENTS

## SHREDDER INSTRUCTIONS

## TABLE OF CONTENTS

## HAMMER BOLT PULLER



## HYDRAULIC COVER OPENING AND BEARING LUBRICATION SYSTEM

# TABLE OF CONTENTS

## SIEMENS SHREDDER MOTOR INFORMATION



## AIR SWEEP SYSTEM

# TABLE OF CONTENTS

## OTHER

WILLIAMS

# CRUSHER FOUNDATIONS

WILLIAMS PATENT CRUSHER and PULVERIZER CO., Inc.
2701 North Broadway, St. Louis, Missouri 63102 USA
Phone: (314) 621-3348 Fax: (314) 436-2639
www.williamscrusher.com

FORM 902R4

# FOUNDATIONS

Contrary to appearance, machinery foundations can be the most problematic component in a machine system. The motors, crushers, turbines, control panels, and ancillary meters, valves, and others appear more complex than a block of reinforced concrete or a simple arrangement of steel beams and columns between them and the earth. That may be why many machine buyers and installers find themselves in an expensive quagmire with a new machine performing out of specifications. Not enough engineering horsepower was applied to the machinery foundation design.

Machines such as steam turbines, centrifugal compressors, reciprocating compressors, fans, shredders, crushers, and others require foundations that have been designed and installed by experienced and knowledgeable engineers. The time to avoid problems is in the planning and design stage. There are the usual considerations of adequate static stiffness, stability, alignment with internal and external components, force path to earth, isolation from external influences, and isolation of the external world from machine. Then, **there is the need to avoid high vibrations**.

High level vibrations are harmful for the machine because they damage its structure and, if left uncorrected, cause breakdown. Vibrations also harm the machine surroundings by generating continuum vibrations in the soil and in buildings, propagating over long distances, and damaging buildings or other installations. Vibrations can insidiously result in damage to neighboring machinery. Moreover, vibrations represent an additional soil loading at the location of the foundation, they shake the soil particles that may lead to compaction and possibly to dangerous subsidence or tilting of the machine foundation.

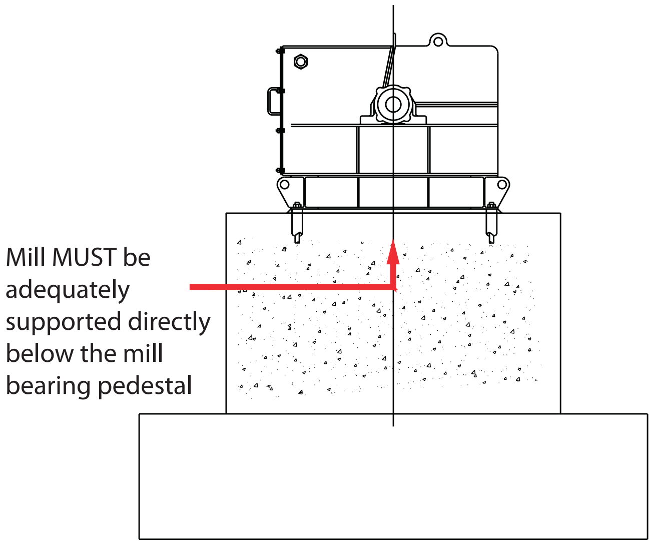
## BASIC CONSIDERATIONS

The best foundation is provided by a poured in place reinforced concrete structure under the crusher and its driver. The foundation must have the required rigidity to sustain the alignment of machinery on it and with external ancillary devices.

A generally accepted rule-of-thumb is the foundation weight (mass) be at least three times the mass of supported machinery for centrifugal machines and four to five times for impacting (crushers) or reciprocating type of machines. The mass acts as an inertia block to stabilize the foundation. The optimum distribution of the foundation mass would be to have as much weight as possible directly under the crusher and its bearings to provide the maximum inertia damping next to the rotating equipment. The height of the foundation should never be greater than the width perpendicular to the rotor unless an integral pad or spread footing is used beneath the structure.

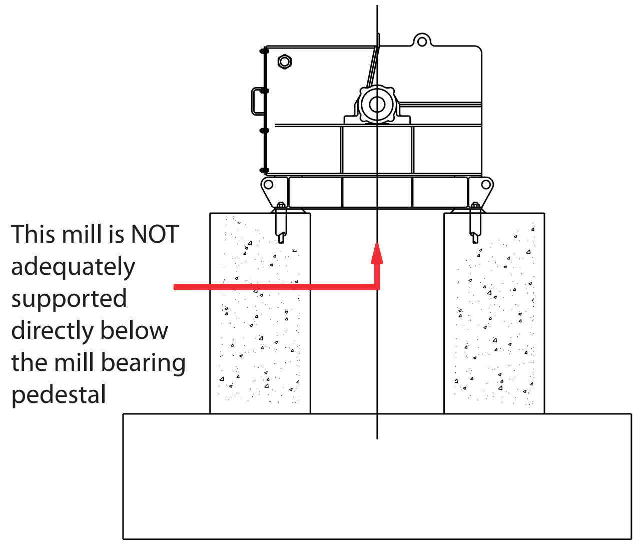
Whenever possible arrange the discharge from the crusher to be carried perpendicular to the rotor to allow solid support under the sides of the mill and the bearing pedestals.

## RECOMMENDED




**DO provide continuous support directly under the bearing pedestals.**

## NOT RECOMMENDED




**DO NOT mount mill on a foundation that does not provide support directly under the bearing pedestal.**

## RECOMMENDED

## NOT RECOMMENDED

The desirability of low soil loading under a foundation subject to vibration cannot be over-emphasized. It is not safe to use conventional static soil bearing support values for dynamic loading conditions.

The foundation should rest on bedrock or solid earth, completely independent of other foundations and separated from all adjacent concrete work by shock absorbing pads between the meeting surfaces. If necessary, pilings should be placed as the initial foundation layer. The tendency to consider pilings as a panacea for foundation/soil problems should be avoided. Their use also requires specialized engineering.

Batter piling may cause piles to lose the damping expected from them. Environmental considerations are important with their use as much as without them. Machinery center of gravity should be placed over a pile groupings' center of resistance to avoid rocking in operation, which can change the natural frequencies in a short time.

The foundation must be designed to avoid resonant vibration conditions, one of the most insidious problems because it amplifies normal vibrations and is usually expensive to cure. Engineering textbooks suggest foundation design include facility to change a foundation's properties (natural frequency , among others) after machine installation. That might include space for bracing, hollow columns to accept mass changing material, moisture control of subsoil (drainage), columnar collars for strengthening, etc.

Below is a plot showing how rapidly, as the operating frequency approaches a natural frequency, a vibration level is amplified at resonance:

E is the damping factor.

v is the floor natural frequency (cpm).

w is the operating speed (rpm).

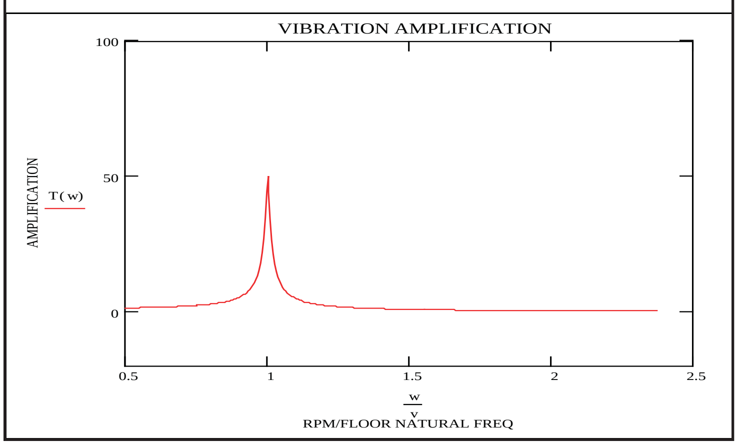
T is the amplification factor.

$E := .01$

$v := 1900$

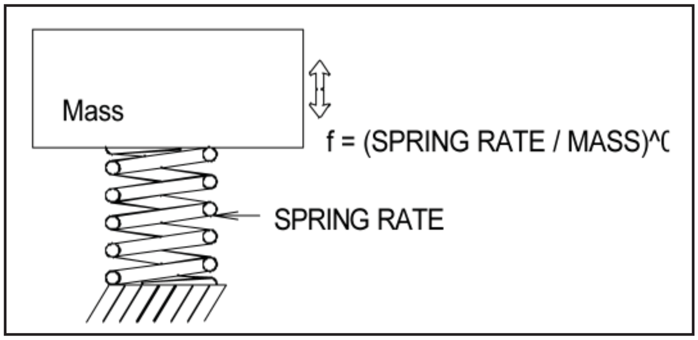
$w := 100, 110 .. 4500$

$$T(w) := \left[ \frac{\left[ 1 + \left( 2 \cdot E \cdot \frac{w}{v} \right)^2 \right]}{\left( 1 - \frac{w^2}{v^2} \right)^2 + \left( 2 \cdot E \cdot \frac{w}{v} \right)^2} \right]^{.5}$$




Resonance arises when the foundation or one of its major components has a natural frequency[1] at or close to the machinery running frequency. The most common vibration creator in machinery is the rotor unbalance that excites the rotor and from it the surrounding elements, at the rotor's turning speed (rpm). A crusher is especially susceptible to vibration problems because its unbalance changes and can become high, at a fast rate, due to the constant uneven wear on the hammers. That wear is a natural consequence of its work.

Any natural frequency (cpm or cycles per minute) of the foundation or a major component should be 20 to 25% away from the crusher's rotating speed (rpm or revolutions per minute). For example, if the crusher's rotating speed is 900 rpm, the foundation's natural frequency should be less than (900) – (900)(.25) cpm or greater than (900) + (900)(.25) cpm. "Greater than" is preferred since the crusher will not have to traverse the natural frequency to get to operating speed during start.[ii]




This is a simple model to demonstrate the basic concept of natural frequency. The mass will bounce (vibrate) up and down after being pushed down and released at a rate (frequency) determined by (spring rate (lbs/in) /mass (lb-sec$^2$))$^{.5}$.

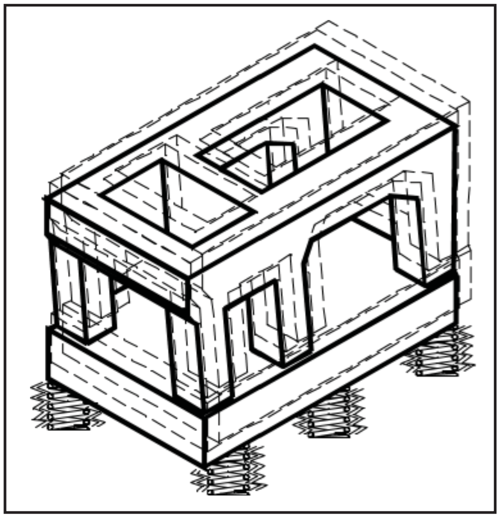
Avoiding the resonance situations requires competent engineering by all concerned. Williams Crusher Co. will supply the following information so that you can proceed with your foundation design.

- Certified drawing of machine assembly
- Functions of machine
- Weight of machine and its rotor components
- Location of center of gravity both vertically and horizontally
- Speed ranges of machine and components or frequency of unbalanced primary and secondary forces

Knowledge of the soil formation and its representative properties is required for static and dynamic analysis. The following parameters are generally required:

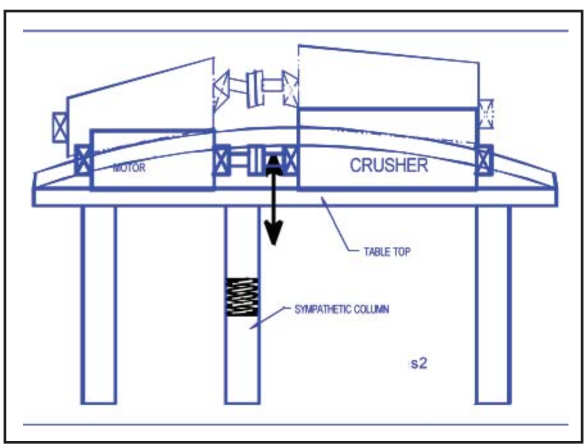
- Density of soil
- Poisson's ratio
- Shear modulus of soil at several levels of strain (or magnitude of bearing pressure)
- Coefficient of sub-grade reaction of soil, if the above parameters are not accurately known
- The foundation depth and the bearing pressure at which the above parameters are applicable
- Other information required for the static design of the footing

The soil becomes the spring for the entire machine system with the system as the mass. That translates into a situation similar to the one below. The coil springs show how the soil reacts and can form a condition of spring and mass bouncing as energetically as the small system mentioned previously.

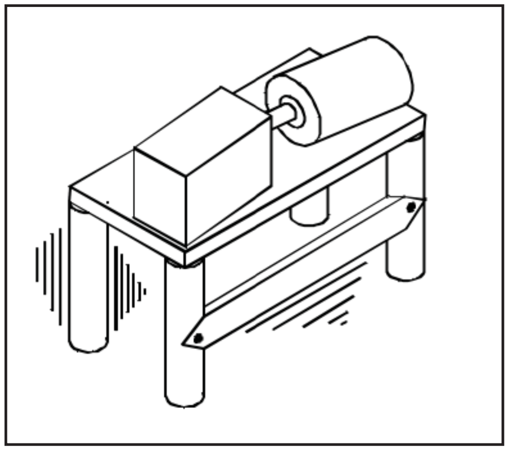


When that happens, it is usually time to start calculating the time and expense to change the mass and/or spring rates.

Vibration problems are not limited to the whole foundation and the supporting soil. Components of the foundation can have natural frequencies that will resonate with machine operating speeds. The drawing below shows the tabletop and a column beneath it vibrating together because their natural frequencies are close to the machine system operating speed.



Major components on a machine base are not the only trouble makers. A minor part can also resonate enough to cause problems to the mounted machinery and nearby personnel. The lower drawing suggests two of those.



**STRUCTURAL STEEL FOUNDATIONS**

If a structural steel foundation is required for any crusher installation, it should be carefully designed to avoid natural frequencies close to operating speed and its harmonics and sufficiently rigid to assure permanent alignment of the crusher and its driver. It must be designed to carry with minimum deflection the weight of the equipment, plus the loads imposed by the material handled and the dynamic forces set up from the crushing operation.

The crusher frame is to be rigidly connected to the structural foundations using shims to adjust for foundation and frame irregularities to prevent distortion of the crusher frame. The distortion can cause vibrations as problematic as vibrations from unbalance. Resilient mounting pads between the bottom flange of the crusher and the structural steel foundation are to be avoided at all times, unless they are beneath an inertia base supporting both the crusher and its driver. Vertical supports should be placed directly under the crusher bearings wherever possible. If this cannot be done, the bearing loads must be transferred properly to the nearest vertical load path.

Structural steel foundations are generally more sensitive to imbalance because more structural members are available to have natural frequencies matching the operating speed. Our crushers are dynamically balanced on a properly designed concrete foundation to 5 mils displacement or less prior to shipment from our factory. Crushers subsequently mounted on a structural steel foundation will most likely vibrate at a higher level if the steel foundation is more compliant than our balancing foundation.

All structural steel crusher foundation plans should be reviewed by a qualified structural engineer with experience and expertise in dynamic loading just as any other foundation plans.

## SWING HAMMER CRUSHERS ON STRUCTURAL STEEL FOUNDATIONS

The unique characteristic of a swing hammer crusher that is different from all other rotating machinery is the starting pulse generated by hammers extending from their position of rest to a radial position on start-up. Even a perfectly weight matched set of hammers will have a significant starting pulse until they are extended to a rigid radial position. This pulse is transmitted to the support structure which responds at its natural frequency or critical and is further excited by several more heavy shocks in rapid order until the hammers are fully extended at about 200 rpm. As the crusher continues to accelerate to operating speed it rapidly passes through any foundation or structural criticals below the operating speed until it attains full speed where the vibration pattern can then be determined in a few seconds while the rotor is at a constant speed.

If the support structure is resonant at or near a multiple of the crusher operating speed the initial starting pulse is reinforced by the forcing frequency at operating speed to create a serious vibration disturbance in a non-uniform manner. This means that the vibration pattern of phase and amplitude is not the same on two consecutive starts of the crusher. This is particularly true if the critical frequency is at or near the crusher operation speed. A critical or resonant condition vibration pattern at or near operating speed is characterized by a significant increase in vibration amplitude for a very slight change in operating speed and a ninety degree or more shift in phase angle. This can best be demonstrated as the rotor coasts down from full speed and observed on the vibration analyzer meters in the filter out mode because the coast down time is considerably longer than the acceleration to full speed.

What a critical implies is that a very little force can be magnified significantly by the structures natural tendency to vibrate at or near the forcing frequency. This can be controlled sometimes by dynamic balancing to a more rigorous standard than normally required. When the crusher is mounted on a rigid or solid foundation that affords adequate damping of operating vibrations; criticals are seldom encountered. The crusher starting pulses are similar to bump test used to determine the structures natural frequencies. That test is performed by striking the structure with a sharp blow with sufficient energy to excite a vibration pulse or wave that can be measured and observed by a vibration analyzer. All structures have a natural frequency in both horizontal and vertical directions, which are influenced by their loading and sub-grade support. Steel structures have a much greater tendency to respond to vibration of equipment mounted on them because they have less inherent damping and are not normally designed to resist vibration. On the other hand concrete structures normally afford greater damping because of their lower natural frequencies due to the greater mass of concrete provided it is designed to meet nominal foundation criteria.

This is why a swing hammer crusher mounted on an elevated structural steel foundation can be easily dynamically balanced without hammers. Then when the matched weight set of hammers are installed on the rotor the vibration pattern changes dramatically where it is almost impossible to control the vibration or to see a repeat of the vibration pattern on two successive runs or starts.

The only effective answer for this situation is to provide a non-resonant foundation, which always entails considerable additional expense or to dynamically decouple the forcing frequency by changing the crusher operation speed. Options available for changing crusher speed include a different speed motor and changing to a belt drive that offers many possible speed variations by sheave combinations that permits operating the crusher out of the critical influence of the foundation.

## ANCHOR BOLT LOCATIONS

Check the certified dimension drawings for the anchor bolt location and size. When anchor bolts or inserts are cast in the concrete, it is very important to construct a well braced template to accurately locate and position the anchor bolts or inserts in the foundation until the concrete has set. To compensate for small measuring errors, place a sleeve around each bolt to allow for adjustments when the concrete has set. The sleeve should have about an inch clearance around the bolt, which will require a plug at the top to keep out the concrete, and center the bolt in the sleeve.

## BEDPLATES AND SHIMS

When the foundation design calls for a structural bedplate cast in the concrete foundation, the centerlines and elevation must be established by a survey so the crusher will be in the correct position called for on the certified dimension drawing when set on the bedplate.

To determine the necessary length the anchor bolt must project above the foundation, check the certified dimension drawings for shaft centerline elevation and its height above the foundation. Then allow for the grout or shim thickness, the crusher bottom flange thickness, the height of the nuts and washers and extra threads for draw-down.

When prepping the foundation area where the mill base or bed plate is to be installed. Make sure the anchor bolts were installed per the Williams supplied drawings and information.

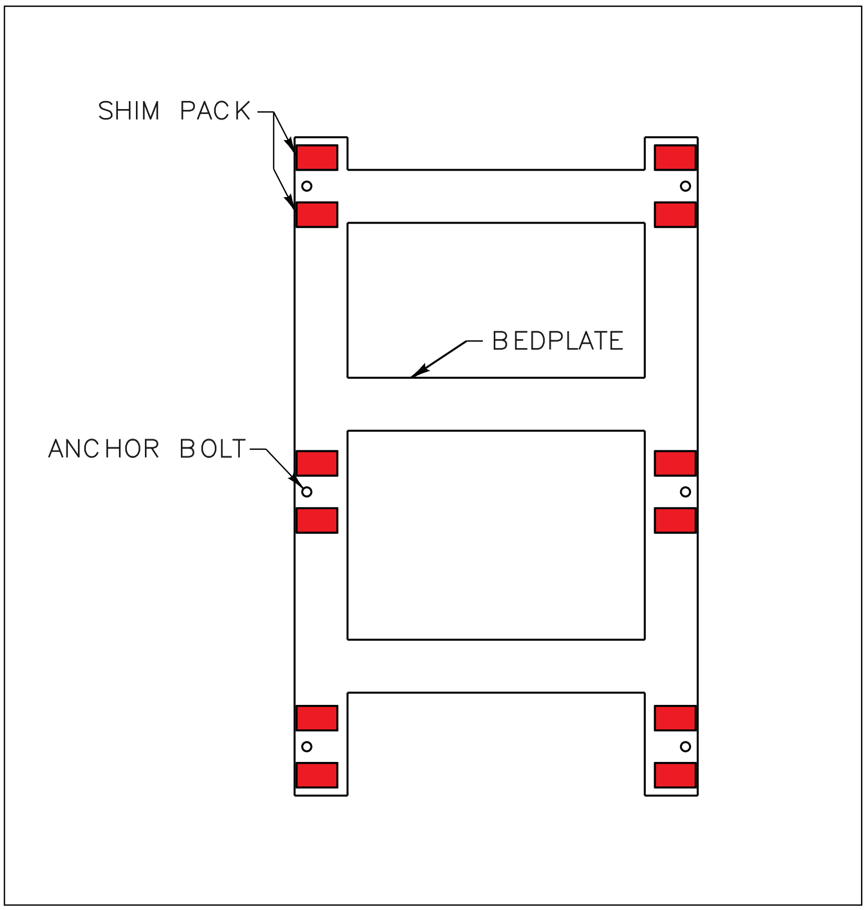
Make sure the foundation area is level and clean of any dirt and debris. Confirm that base plates and foundations are installed and leveled to specifications.

Make sure that baseplates and machine feet are clean, deburred and free from dents in the areas to which machinery will be mounted.

Use clean, flat shims. If you must cut thicker shims from steel stock, be sure they are clean, flat and deburred, shims should be uniform in size and shape. Typical shim sizes are 3-4” wide, and the full length of the mill flange.

Install shim packs on each side of the anchor bolts as shown above and below. This provides a solid support of the equipment once the anchor bolts are tightened and will help provide a solid bond between the bed plate/mill base and the foundation. Select shim thickness that results in no more than 3-4 shims in a shim pack to prevent a spring effect.

**NOTE: MINIMUM WIDTH OF SHIMS 3-4” LENGTH SHOULD BE THE SAME AS THE FLANGE OR THE WEB OF THE SUPPORT BEAM**



## GROUT

The crusher should be properly shimmed, leveled, aligned and grouted onto its foundation. Allow for 1 – 3 inches of grout to be placed between the crusher and its foundation. Look at your certified dimension print for depth of grout recommendation.

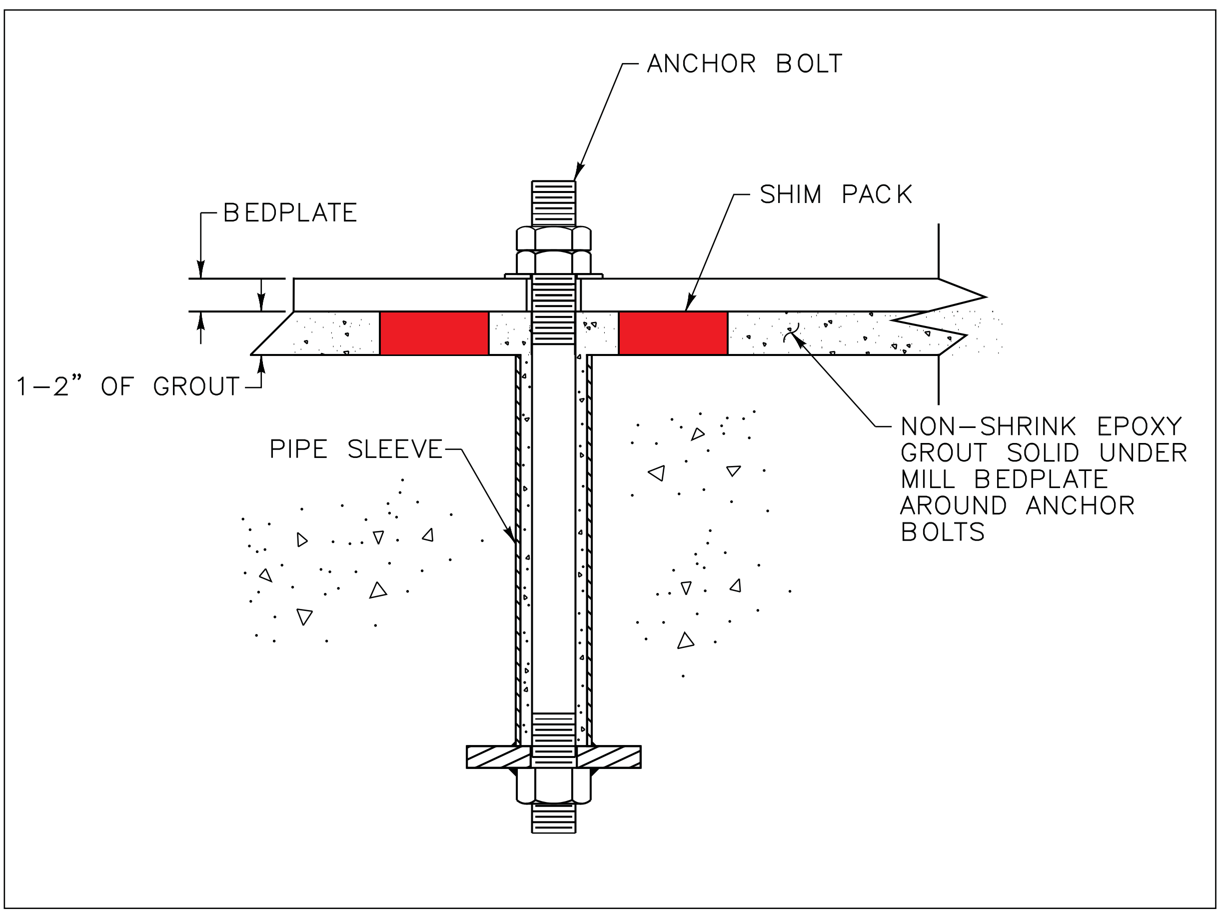
When new equipment is being commissioned, high vibrations often are caused by improper grouting performed by hurried construction crews. As equipment ages, many vibration problems arise that can again be traced to the foundation. Shims and hold-down bolts tend to loosen over the years, causing grout to turn to dust. Result is a condition known as "soft foot." Grout, therefore, is one of the keys to establishing and maintaining precise alignment of rotating equipment.

We only recommend a two-part epoxy grout.

Epoxy grouts offer quick curing, high tensile and compressive strengths, and the ability to bond to both concrete foundation and machinery steel.

Five Star Products Inc., Fairfield, Connecticut, offers a full line of epoxy grouts for your consideration.

Grout must be placed to provide for full support under the base flanges of the mill or the structural steel bedplate provided with the mill.



[ii] "Any beam, column, floor, or other material system (bearing pedestal, rotor/bearing/pedestal/foundation/earth, building/earth), having the properties of mass (weight) and elasticity is capable of making a free or natural vibration. If the system is displaced from its rest or unstrained (not stretched) configuration, elastic strain introduces internal forces and moments which oppose the strain. For brevity and by analogy with a simple mass-spring (weight hanging from a spring or a cantilevered beam or a tuning fork) system we shall refer to the effects of this elastic strain as a "restoring force." If, the system is suddenly released, the restoring force accelerated the system back toward its rest position but by the time it has arrived there it has acquired momentum and overshoots the rest position. This brings into action a restoring force in the opposite direction which resists the overshoot, brings the system momentarily to rest, and immediately accelerates it back again through the rest position, and so an. This free vibration goes on until the system is brought to rest by damping which dissipates (as heat) the energy of the free vibration.

The frequency of this free vibration is the "inherent **natural frequency**."

P.146, <u>Seismic Mountings for Vibration Isolation,</u> Macinante, Wiley Interscience, John Wiley & Sons, 1984.

"A bridge or, for that matter, any structure, is capable of vibrating with natural frequencies. If the regular footsteps of a column of soldiers were to have a frequency equal to one of the natural frequencies of a bridge which the soldiers are crossing, a vibration of dangerously large amplitude might result. Therefore, in crossing a bridge, a column of soldiers is told to break step."

P.376, <u>University Physics,</u> Sears and Zemansky, Addison Wesley, Reading, MA, 1962.

[ii] Decades ago resonance caused less trouble in engineering design than today, and it is precisely the higher probability of resonances that is a primary reason for this paper. Older type constructions, machines, buildings, and steel structures used thicker and more rigid parts, resulting in fairly high natural frequencies. At the same time machine speeds used to be relatively low, so that the troublesome high vibrations arising from resonance, that is, the coincidence of a speed of rotation with a natural frequency, occurred less often. With the progress of engineering techniques, structures became more slender and flexible, their natural frequencies decreased while machine speeds increased. Thus, the range of natural frequencies approached that of rotational speeds, leading more frequently to resonance and its associated high vibration levels and problems.

WILLIAMS

PATENT CRUSHER & PULVERIZER CO., INC.

# CRUSHER SYSTEM START-UP & MAINTENANCE

THE WILLIAMS PATENT CRUSHER & PULVERIZER CO. ST. LOUIS, MO. U.S.A.
TRADE MARK

2701 North Broadway, St. Louis, Missouri 63102 USA
phone (314) 621-3348 fax (314) 436-2639
sales@williamscrusher.com www.williamscrusher.com

FORM 912

# CRUSHER SYSTEM

## START-UP & MAINTENANCE

When starting up a large crusher system, a definite check-out procedure should be established and followed. Even when the assembly and installation are followed to the letter, there is always the chance of an error or something being overlooked.

It is recommended that before the initial start-up of any crushing system that the procedures listed below, which apply to the particular model crusher and its auxiliary equipment, be completed.

1. All operating and maintenance personnel have been familiarized with Williams Form 936- *Safety Procedures for Operation of Williams Equipment* - and know the location of emergency stop switches and the proper start-up and shutdown sequence of the system.

2. Check to see that all signal and alarm systems are functioning properly and any safety cut-off devices or trip lines are connected to the control circuitry.

3. The crusher chamber is empty and clear of all debris with the hammers free to swing on their pivots so the rotor can turn without interference while it accelerates to operating speed.

4. The infeed conveyor or chute cleared of all material that could enter the crusher until the rotor attains full operating speed. See the conveyor start-up sequence in Williams Form 898- *Conveyor Assembly* for additional details.

5. All bearing housing holddown bolts are properly torqued and bearing housing locking devices are firmly in place. After a few minutes initial operation even when the vibration on the bearings is at a minimum, recheck the torque on the bearing housing holddown bolts, and check them periodi cally for the next couple of days.

6. Anchor bolts drawn down to maximum tightness for both the crusher and its driver, then verify the alignment is within the prescribed tolerances of Williams Form 901- *Alignment of Rotating Machinery.*

7. All protective covers on the coupling drive connection are fastened properly in place as well as the shaft end cover or flywheel guards are mounted per OSHA regulations on the crusher and its auxiliary equipment.

8. All access doors and inspection covers on the crusher and the infeed or material handling system are closed and securely fastened.

9. All liner and wear plate attachment bolts, as well as any external adjustment bolts, checked for tightness to make certain they have not loosened in shipping and handling or during erection.

After the first few hours operation, check all bolts on the crusher for tightness to insure they have not loosened from operating vibrations.

10. When the crusher is equipped with an adjustable breaker plate, determine the spacing between the hammer tips and the closest face of the breaker plate using the method described in Williams Form 755R- *Instructions for Reversible Impactors*. If the crusher is equipped with a hydraulically adjustable breaker plate, make certain the breaker plate is fully forward against the stops or shims before making these measurements. Mechanically adjusted breaker plates are usually shipped with a nominal hammer tip clearance, which may have to be changed within the limits of the breaker plate adjustment when the crusher is operating to be able to determine the particle size produced by the setting.

11. The drive motor starting and control devices should be checked for compliance with the manufacturer's installation instructions by a qualified electrician or engineer. On large units, the motor should be run separately before connecting the coupling to determine the rotation direc tion and the no load current demand as well as the vibration pattern. Follow the motor manu facturer's recommendation for lubrication of the motor bearings.

12. When it has been determined the motor runs satisfactorily in the right direction, and the motor vibration pattern has been recorded while it operated without load, recheck the alignment and install stop blocks or dowels at the motor feet.

13. Lubricate the coupling if required, when the alignment has been approved, and complete the connection making certain the coupling cover is securely bolted together and all gaskets and grease plugs are in position. Then install the coupling guard on the crusher structure to comply with OSHA regulations before operating the system.

14. Crushers equipped with hydraulic cover opening systems should have the crusher cover opened fully as soon as the hydraulic system is hooked up and functioning to insure the cover operates properly before running the system.

15. The bearing lubrication system is operating with the specified grade of lubricant so the oil level can be seen at the center of the sight glass on the side of the bearing housing while the hydraulic power unit flow control valves are adjusted to maintain this level- see Williams Form 874- *Hydraulic and Lubrication Unit Installation and Service* for additional details in completing the hydraulic system check-out.

16. Before placing the equipment into production, the operators should be instructed in limitations regarding maximum feed size, type of feed materials to be excluded, maximum feed rate and feed type, and how to avoid overload conditions and damage to the equipment.

## MAINTENANCE

A properly organized inspection and maintenance program is the best assurance of trouble-free operation for any crusher installation.

Major elements of a controlled maintenance program are:

1. Trained personnel to KNOW the work and how the crusher system is to operate.

2. An established schedule for inspecting all operating components and rotating parts.

3. Systematic records, which contain at least the following:

    a. Complete nameplate data for the crusher, the drive motor, and all auxiliary equipment and their drives along with the manufacturer's recommended operating data.

    b. Parts drawings and lists of repair parts for complete system.

    c. Wiring and hydraulic diagrams, certified dimension drawings, and section views.

    d. Lubrication data and frequency of application for various components of system.

    e. Stock of essential spare parts and their storage locations.

## REGULAR MAINTENANCE

Several of the more important items of good maintenance are discussed in the following paragraphs. Other considerations should be added when adverse or unusual conditions exist.

## INSPECTION

The frequency and thoroughness of crusher inspection depends upon the severity of operation and the environment. Inspection should be daily for the first week or so, in order to set up the schedule, then the interval can be extended for various components of the system as conditions and experience may warrant.

After the first several hours' operation, check the tightness of all crusher liner and breaker plate bolts, and re-torque them if necessary. The cage ring clamp bolts should be inspected daily for the first week of operation, the about once a week should be often enough to catch any tendency for them to loosen as the cage seats tighter on its support rings.

After the first hour of operation, check the torque on the holddown or mounting bolts on all auxiliary equipment and their drive motors. Then, afterwards, if no excessive vibration is encountered, a once-a-week inspection should suffice to check the possibility of these bolts loosening during operation.

After each day's operation, when the crusher has been shut down and locked out, the cover or hopper access door should be opened to inspect the hammers and cage bars for damage or wear. At the same time, the crusher frame should be given a routine visual inspection for loose bolts, lubrication system leaks, or unusual wear.

When the crusher is closed up and running without material being fed or the auxiliary equipment operating, check for changes in the noise and vibration patterns, which are good indicators of developing problems.

On crushers equipped with circulating lubrication systems, check the oil pressure and flow as well as the oil condition and the oil cooling system at least once a shift.

Refer to Williams Form 874- Hydraulic and Lubrication Unit Installation and Service for additional details on the operation of the circulating lubrication system.

**BEARINGS**

Normally, bearings on large crushers tend to rum fairly warm with a usual temperature on the bearing housing up to 80°F above the ambient air. At the same time, direct contact temperature sensors inside the bearing housing, monitoring the surface temperature of the bearing, can have readings up to 200°F or 20°F higher than the outside of the housing before serious concern needs to be made about the cause. These readings will depend upon the use of the proper lubrication and the efficiency of the lubrication oil cooling system and whether it is clean and functioning properly.

Use an electronic or contact thermometer on the bearing housing to measure the temperature accurately when the bearing feels uncomfortably warm to the touch.

If the lubrication oil become cloudy or dark, indicating contamination, it should be drained and the system flushed with warm turbine oil or kerosene, and them completely remove the flushing oil from the system before replacing the proper grade of lubricating oil to prevent its dilution by traces of solvent in the lines and reservoir.

Refer to Williams Form 911- *Roller Bearings* for roller bearing operation and inspection guidelines.

**HAMMERS**

The majority of the crushing work is done by the hammers, which normally requires the most frequent maintenance on a hammer mill. The continued efficiency of a crusher is largely dependent upon keeping the hammers close to their original profile by either building them up or replacing them. On some crushers, it is possible to reverse the hammers for extended wear, but these too will eventually have to be replaced or built up by welding on the hammers, with the appropriate type of rod or wire. Some hammer wear can be compensated for by adjustment of the breaker plate where this is possible, but the product size is mainly governed by the hammer efficiency. Maintaining the hammers in good condition, therefore, is necessary to keep the crusher operating properly at peak efficiency. The condition of the hammers should be checked during the routine re-operating inspection each time the crusher is used. Any hammers with fractures in critical areas, or having pieces missing, should be repaired or replaced before operating the crusher.

A sheet metal template of the new hammer profile that will fit on the hammer suspension bolt and provide a gauge to measure the hammer ear and serve as a pattern for rebuilding the hammers should be available for the crusher maintenance crew. If the hammers have not worn off more than a half inch of material, it is possible to rebuild the hammers while they are on the rotor at a considerable savings of labor, provided the proper safety precautions are followed.

**CAUTION:** When welding hammers in the crusher, always ground direct to the rotor and never let the current feed through the bearings. Always open the crusher cover and lock out the drive motor starter when working on the crusher rotor.

When much more than a half inch of build up is required to restore the hammers to their original profile, it is better to remove them from the rotor for welding in a shop. This way, the welding meat can be controlled to avoid changing the hammer metallurgy and there would be time to do a complete job, as well as keeping the rebuilt hammer weights equal.

See Williams Form 843- *Large Crusher Cage and Hammer Replacement* for details.

When rebuilding Hadfield manganese steel hammers, it is important to control the buildup of heat in the base metal which could change the metallurgy and destroy the hardness which is the wear quality of the hammer. Often times, it is advisable to weld on the hammers when they are in a water bath to control the heat when a lot of buildup or hard surfacing is required to keep the temperature of the base metal less than 500°F to avoid changing the metallurgy developed by the heat treatment and work harding. The second consideration is to avoid applying hard surfacing directly on manganese steel without first coating it with a proper build up rod. This prevents carbon dilution of the hard surface coating that is drawn out of the manganese steel base. The carbon changes the chemical composition and softens the hard surface coating so it is not as effective as if it were applied on top of a layer of buildup.

On hammers made from materials other than manganese steel with less than 1% carbon content, the hard surface coating can be applied direct to the new or worn hammer, without a buildup coating.

It is almost impossible to give a general rule for the amount of material that can be processed by a set of hammers between changes or rebuilding because service conditions for each installation are different. The best criteria is experience with the material being crushed and the particular size or model of crusher and type of hammer to decide when hammer maintenance is necessary or if unusual hammer wear is taking place.

## CAGE BARS

The cage bars are probably the second most frequently serviced item in a crusher after the hammers. They should be inspected regularly for distortion or wear at a frequency depending on the application. There is no template to check cage bar wear, but a stringline stretched taut along the wear face of the cage bar from one end to the other will show how much wear or distortion has taken place. When the working surface of a cage bar has worn off, it's efficiency is reduced considerably and it should be repositioned or replaced. Some cage bars have more than one working surface, which can be repositioned to compensate for wear rather than replacing the bars when the original working surface has worn away.

Never operate a crusher with badly deformed or cracked cage bars because of the hazard of their breaking and causing injuries or extensive damage to the rotor and the rest of the system.

Refer to Williams Form 843- *Large Crusher Cage and Hammer Replacement* for further details about the service of cage bars in large crushers.

## CAGE BAR HOLD DOWN CLAMPS

For the first two weeks of operation of a new crusher or when the cage bars have been changed, make a daily check of the torque on the bolts holding the cage bar clamp segments in place on the side of the crusher. Then a weekly inspection of these bolts should be scheduled to insure they remain tight as the cage bars settle tighter on the cage support ring.

## BREAKER PLATES

Large non-reversible crusher have replaceable liners on the breaker plate to absorb wear from the crushing operation. When the working surface has worn to the point where the efficiency is impaired, the breaker plates should either be replaced or reversed to maintain operating efficiency and product size.

Some crusher models have adjustable breaker plates that can be positioned to change the product size within limits of the cage openings or to compensate for hammer wear. See Williams Form 755R- *Instructions for Williams Reversible Impactors* for the procedure to determine the adjustable breaker plate position and its adjustment.

## COUPLINGS AND DRIVES

After the initial two weeks of operation, it is recommended that the alignment of the crusher and its driver be checked to the tolerances outline in Williams Form 901- Alignment of Rotating Equipment using the appropriate procedures.

All metal flexible couplings require periodic lubrication inspections which should be at no greater than size month intervals, at which time the alignment should also be checked.

Grease is the recommended lubricant for all steel flexible couplings and should be grade 2 with EP additives for proper service life. When re-greasing, open the coupling covers to remove the old grease and then repack grid or teeth by hand until entire cavity is full to insure complete lubrication. Close coupling covers with the gasket in place to prevent loss of grease in operation. Using a grease fitting in the cover of the coupling for re-lubrication often leaves voids that do not have lubrication so it is best to open the covers and pack the coupling by hand to guarantee a complete job.

If any alignment change is noted, check foundation bolts, bearing hold down bolts, and any external adjustment bolts for tightness which may have allowed the crusher to shift relative to its drive.

## DRIVES

CAUTION: The maximum operating speed for which the crusher was designed must never be exceeded. These limits are given in our catalog or in the order write up, or on Williams Crusher Company's drawings.

## V-BELT DRIVES

Alignment of the belt drive must be checked with a straight edge or a taut string or wire. Belt tension must be properly adjusted to assure normal belt and bearing service life. Worn sheaves will not grip the belt properly and will reduce belt life by half and the excessive tension required to prevent slipping will result in bearing failure. Sheave faces should be aligned within a sixteenth of an inch (1/16"). It is normal for V-belts to squeal on start-up, but they should be tight enough not to slip at full running speed. Normal belt tension can be determined by being able to depress a belt at mid-point a distance equal to one belt width with normal finger pressure. When necessary to replace belts, use only all new matched belts from the same manufacturer that are installed properly without forcing them on their sheaves.

VIBRATION

Large crusher rotors are balanced statically and dynamically at the factory without hammers and, if undamaged, should require no further balancing. The match weighted set of hammers is installed in the rotor by the factory after it has been determined the rotor ran satisfactorily at rated speed on the test black.

Smaller crushers shipped completely assembled have had a running test to check balance, with the hammers installed in the rotor.

Before any attempt is made at balancing, make certain the cause of the vibration is unbalance of the crusher rotor. Electronic equipment is available that will enable an experienced technician to determine the cause of the vibration from the vibration pattern of the crusher. Some of the causes of vibration that have to be corrected to insure smooth operation are as follows:

Misalignment
Unstable foundation
Loose connection bolts on bearings, feed hopper, liners, or driver

Build up of foreign matter on rotor or broken hammer

Distortions of frame from improperly leveled bed plate

By far, the most common cause of vibration in a crusher installation is unbalance, either from unmatched hammers or unequal wear on the rotor, but the causes listed above should be investigated when excessive vibration develops that cannot be solved by balancing corrections. The subject of vibration analysis is far too complex to be covered in this discussion and it is recommended the factory be contacted for assistance with vibration problems when normal unbalance corrections do not work.

# WILLIAMS

**CRUSHERS • PULVERIZERS • SHREDDERS • GRINDERS**

**OLDEST & LARGEST MANUFACTURER OF HAMMER MILLS IN THE WORLD**

# CRUSHER INSTALLATION

**Williams Patent Crusher & Pulverizer Company, Inc.**
2701 North Broadway, St. Louis, Missouri 63102 USA
Phone: (314) 621-3348 Fax: (314) 436-2639
sales@williamscrusher.com www.williamscrusher.com

FORM 852R

# CRUSHER INSTALLATION

Congratulations on your ownership of a Williams Crusher. Whether you purchased it new and specifically built for your application, or it is a previously owned crusher, it will provide years of trouble-free service if the proper installation and service procedures are followed.

It is not unusual to find one of our crushers starting a second or third career after a long, productive service life for the original owner.

The purpose of this brochure is to provide a helpful guide or checklist for the various necessary steps to insure the safe and successful installation of Williams crushing equipment.

In planning the installation of a crusher, the primary consideration must be operating safety. Proper feeding, material handling, and provisions for service are necessary operating provisions. The power of the motor and speed of the crusher rotation will be determined by the quantity and size of the product desired within the design limitations of the particular size crusher.

## OPERATING CONTROLS

A uniform load on the crusher motor is the most efficient method of operation for both the crusher and its motor. This can be accomplished in several ways, but the best arrangement is by a feed control device that measures the current the motor is drawing, which in turn controls the feed equipment to maintain a selected percentage of the crusher motor full load by sequencing the feed device to regulate the material flow into the crusher.

This load control is the surest way to prevent overloading and plugging of the crusher and to protect the crusher motor from overheating and tripping the circuit breaker or causing other electrical and mechanical problems.

The electrical circuit breaker or starter to control the crusher motor should be conveniently located within sight of the crusher and clearly identified with provisions for lockout during service operations. The control circuit should have an interlock to prevent the feed device from operating when the crusher motor is not energized or running. This will prevent the crushing chamber from being filled with material that would not allow the rotor to start or plug up when the crusher motor was de-energized purposely or by overload.

When the control circuit has provisions for remote starting of the crusher, ample warning signs shall be posted near every access opening on the crusher and its inlet and outlet hoppers.

## SERVICE PROVISIONS

When locating the crusher in a building or near other machinery, always allow sufficient clearance to open the crusher cover and perform necessary service operations. The hammer bolts are usually removed from the side of the crusher opposite the drive to allow sufficient clearance to withdraw the full length of the hammer bolt from the rotor. When rebuilding or replacing the hammers, which is the most frequent service operation, it is always necessary to open the crusher cover. Hammers are sometimes built up to original profile by welding while they are in position on the rotor. It is almost always necessary to use a mechanical lifting device to open the cover unless the crusher is equipped with a hydraulic cover opening system. Where mechanical equipment will be used to open the crusher cover, provisions should be made for the safe, secure attachment of the lifting devices which will allow for the movement of the cover as it lifts off or pivots open. The lifting equipment for the cover need not to be permanently mounted, but the brackets or track it is supported by should be securely installed either on the surrounding structure or the crusher feed hopper; whichever provides for the safest opening of the crusher cover.

## FEED CONVEYORS

The most common way of feeding a crusher is by a conveyor - either a belt or apron pan that dumps into a hopper above the crusher. Other alternatives are bucket elevators, vibratory pan feeders, or screw conveyors, and sometimes rotary pocket feeders are used to introduce the material into the feed hopper. Whichever feed device is used, it is important to avoid surges in loading and keep the bed of material flowing into the crusher as uniform as possible.

Feed devices such as bucket conveyors and screw conveyors are somewhat self-metering in that only a given amount of material is carried by each flight or bucket. Apron pan and belt conveyors, on the other hand, do not usually carry uniform height or width load so more careful control is necessary in the loading volume regulation with this type of material handling equipment. When material is dumped onto a conveyor either by a bucket loader of a truck, some type of height regulating or strike off device is needed to level the bed of material to a uniform height as it travels along the conveyor. This is sometimes done with two-stage conveyors, each traveling at different speeds, to spread the load or else using a surge bin to maintain an even flow into the crusher. Whichever conveyor or feed device is used, it should be freestanding or self-supported and not connected rigidly to the crusher or feed hopper to avoid vibration problems transmitted through the structure.

Normally, the infeed conveyor is on am incline for a portion of its length up to the feed hopper, which usually requires cleats or pushers attached to the belt or apron pans to elevate the bed of material without slipping. There should be no offsets or projections of the side skirts or shrouds along the conveyor that would catch or snag material on the infeed conveyor and cause blockage on the flow of material into the crusher. Where possible, the infeed conveyor should run horizontal for a few feet before it enters the feed hopper so the material will glow off the end of the conveyor more uniformly and keep the gap under the conveyor to a minimum where it exits the feed hopper. Where the conveyor enters the feed hopper, the opening should be high enough to permit the longest item going up the conveyor to pivot off the end into the crusher without jamming in the feed hopper or against the conveyor shroud.

The greater distance above the crusher rotor that the infeed conveyor introduces material into the feed hopper, the less chance there is of material being blown or thrown back down the infeed conveyor. There is, of course, a limit of how high above the rotor the conveyor entry is practical, but two out of three times the hammer circle diameter is a general rule for a minimum feed heights of most material handled by the conveyor.

Depending upon the height above the rotor where the conveyor enters the feed hopper, the conveyor should be covered or shrouded for a considerable distance back from the opening to prevent the material that is being crushed from blowing or flying down the infeed conveyor.

In most instances, a shroud two or three times the conveyor width in length extending back from the feed hopper entry with substantial curtain at the beginning of the shroud will provide sufficient emission control for most crushing operations where dust or powder is not being produced by the grinding process. Dust control will require additional precautions and very possibly a separate collecting system to eliminate the hazard or nuisance of dust because the large volume of air that is moved by the crusher rotor during operation.

It is very difficult to seal under an infeed conveyor equipped with cleats or pushers where it exits from the feed hopper, a dribble chute is often required to catch the material blown or thrown out under the conveyor and carry it to the discharge conveyor. The dribble chute should not have any offsets or constrictions that would cause the material to plug and fill up the chute. As a matter of precaution, the dribble chute should have an access door conveniently located near floor level for clean out.

Where damp material is conveyed into the crusher, it may be necessary to provide drip pans beneath the exposed return side of the conveyor.

Conveyors need lubrication and service which should be included in the installation plans to provide convenient access for maintenance of bearings and rolling members of the conveyor, as well as, the drive equipment.

## FEED HOPPERS

The purpose of the feed hopper or chute is to spread the material being crushed uniformly across the full width of the rotor and to contain the crushing action inside the crusher. The feed hopper should be substantially constructed of steel plate and structural sections proportional to the size of the crusher it is to be used with and the type of material being crushed.

Whenever possible, the crusher feed hoppers should be isolated from both the crusher and its conveyor while it is supported by a separate structure independent of the crusher foundation.

Even when the hopper is isolated from the crusher, it should have sufficient stiffening and cross bracing to prevent any unsupported spans of metal from acting as a drum due to air or material flow or from vibration of the crusher transmitted through the foundation or support structure. Often, a slight vibration of the crusher can be magnified by a feed chute or hopper through it's structural resonance until a serious vibration condition develops which can best be corrected by isolating the hopper. The minimum isolation for the feed hopper should be a 1/2 inch resilient pad inserted between the hopper flange and the top of the crusher frame.

The hopper should have easy access for service, designed so the segment of the hopper above the crusher cover will have a flanged section that can be unbolted from the hopper and pivoted open as part of the crusher cover. Provisions for this should be made when planning the crusher installation to allow sufficient room to fully open the cover without interference from the building or adjacent machinery. Where possible, provide a separate reinforced access door for the hopper in addition to the crusher cover opening. When material is not evenly introduced through the feed opening of the hopper, it is often necessary to provide baffles or guide chutes inside the hopper to spread the material across the full width of the rotor for equal utilization of the crusher hammers.

## DISCHARGE CONVEYORS

The discharge conveyor or crushed product removal equipment should have capacity greater than the infeed conveyor plus an allowance for surges and any increase in volume due to fluffing of material being crushed.

The operating controls for the feed equipment should be interlocked with the discharge conveyor controls to prevent material from being introduced into the crusher unless the crusher and the discharge conveyor is operating.

The section of conveyor immediately under the crusher is subject to impacts from the grinding operation, so shock protection in this area is required. Belt conveyors should be provided with closely spaced impact idlers in this area. An apron pan conveyor or a vibratory conveyor is usually suitable for service in this location under a crusher. Allow as much distance as possible beneath the crusher for the discharge conveyor to provide room for surges and to center the load on the conveyor without interfering with the crusher foundation. This is especially important when using a vibratory pan conveyor which is best installed with a downward slope away from the crusher to positively move the crushed material, which may change its density from moment to moment.

Whenever possible, the discharge equipment should carry the product away from the crusher perpendicular to the rotor so the maximum foundation support will be provided beneath the crusher bearings. The discharge conveyor should be tightly shrouded to control dust and noise emissions or reverse airflow through the crusher.

Air swept hogging or shredding operations require careful design of the discharge chute and blast gate to maintain the proper velocity and volume of air through the pneumatic conveying duct to insure that material does not accumulate in the bottom of the crusher or duct that would impede the air flow and its carrying capabilities.

Additional conveyor operating information is available in Williams Form 898.

# FOUNDATIONS

The foundation of the crusher has a most significant role in the successful operation of the installation and control of vibration.

The foundation provides the mass to dampen the crusher's normal operating vibration and absorb impact shocks. The general rule for crusher foundations is to provide a reinforced concrete pedestal extending as one unit under both the crusher and its drive that weighs at least three times the equipment it will support.

The arrangement of the foundation geometry is very important to react against the forces developed by the crusher operation. The height of the foundation should never be greater than its width unless spread footing is used under the foundation to prevent rocking and distribute the weight so that the soil loading is never more than 500 pounds per square foot.

The foundation pressure on the supporting soil is very important when dealing with a dynamic condition. The soil loading should not cause an interaction of the crusher vibration with the soil's natural frequency due to its deflection that would result in foundation critical. This is especially important when moisture in the soil is involved to insure the foundation had adequate support and impose a soil loading no more than a quarter of the recommended static values for the particular type of soil under the proposed crusher foundation.

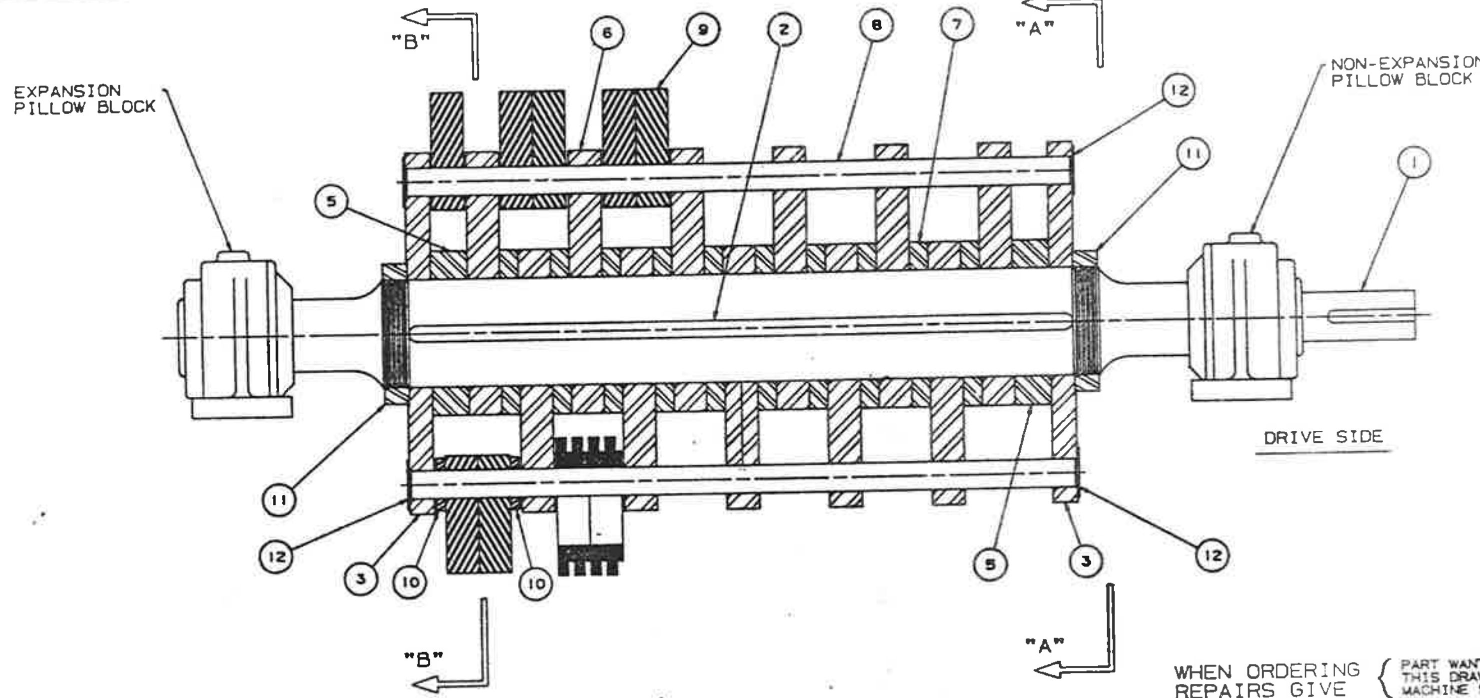
Additional information is available in Williams Form 902 - Crusher Foundations.

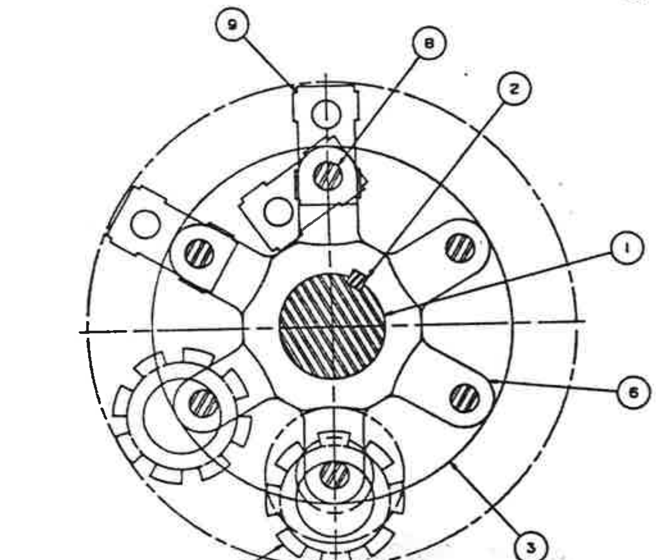
When the crusher is set on the foundation, make certain it is level and supported uniformly to avoid distortion of the bearing pedestals when the anchor bolts are drawn tight. Assemblies shipped from the factory that are mounted on structural base plates should be properly aligned before connecting the drive motor after they are mounted on the foundation.

Additional information is available in Williams Form 901 - Alignment.

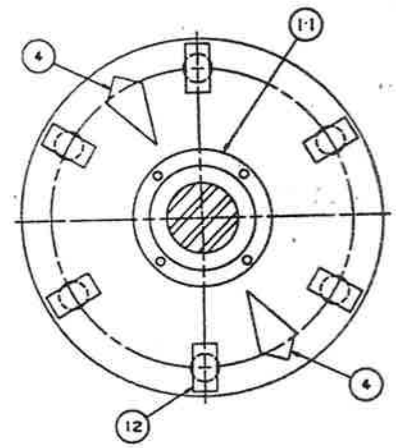
We suggest you have your foundation plans reviewed by qualified structural engineers having expertise in dynamic loading.

WILLIAMS PATENT CRUSHER and PULVERIZER CO., Inc.




SECTION "B-B"



SECTION "A-A"

MILL SERIAL No. 18492, 94, 96
BILL OF MAT'L No. 1158E9743

WHEN ORDERING REPAIRS GIVE { PART WANTED, ALSO QUANTITY, THIS DRAWING NUMBER AND MACHINE SERIAL NUMBER

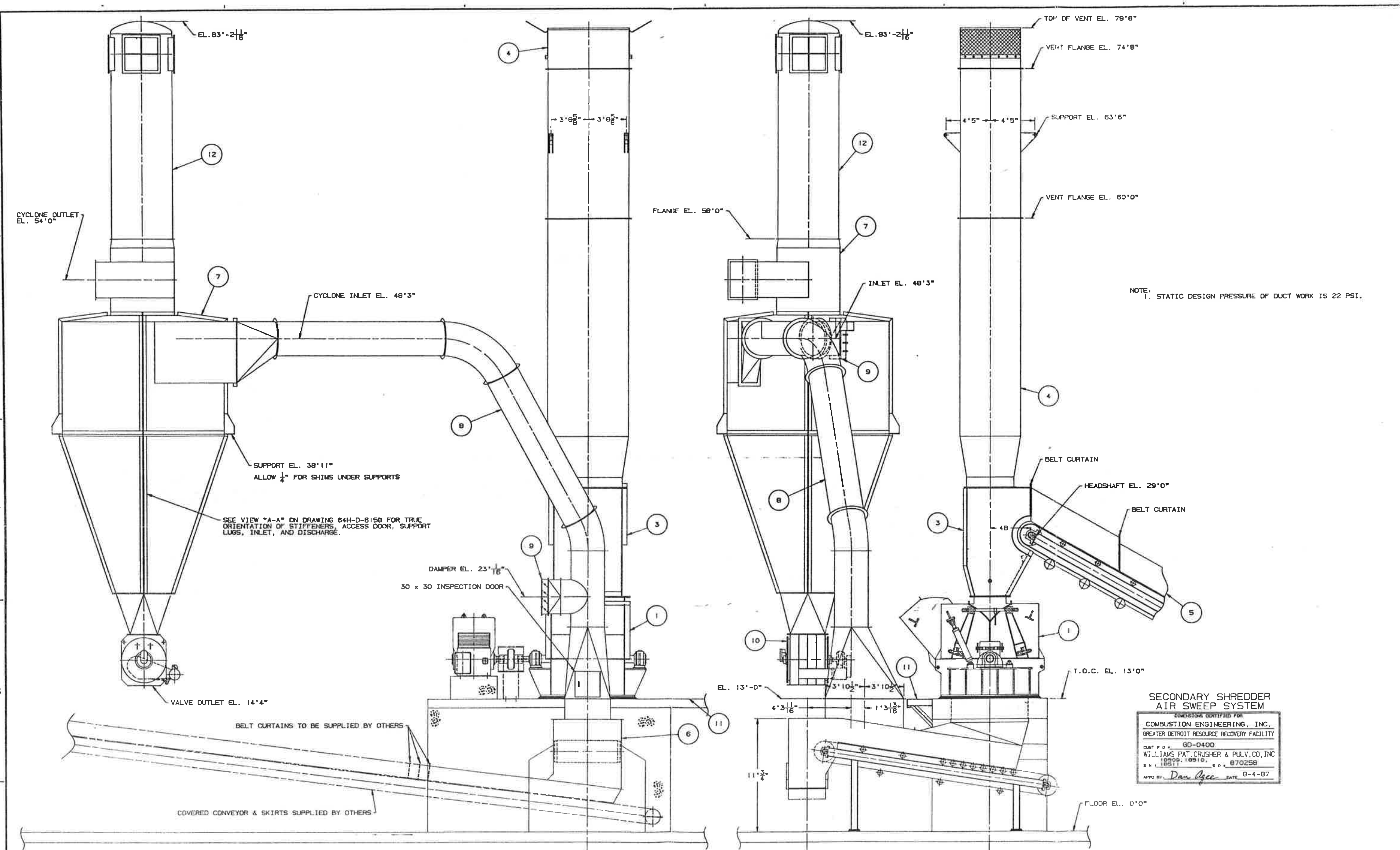
| PART | DESCRIPTION OF PART | QUANTITY IN MACHINE |
|---|---|---|
| 1 | MAIN SHAFT | 1 |
| 2 | MAIN SHAFT CENTER KEY | 1 |
| 3 | END DISC | 2 |
| 4 | END DISC DIAMOND WIPER | 4 |
| 5 | END DISC SPACER | 2 |
| 6 | CENTER DISC | 11 |
| 7 | CENTER DISC SPACER | 10 |
| 8 | HAMMER BOLT | 6 |
| 9 | HAMMER | 72 |
| 10 | HAMMER SPACER | 12 |
| 11 | SHAFT LOCKNUT | 2 |
| 12 | HAMMER BOLT PLUG | 12 |
| | FOR PILLOW BLOCKS, SEE SEPARATE PARTS LIST | |

WILLIAMS PATENT CRUSHER AND PULVERIZER CO.
ST. LOUIS, MO.

ROTOR PARTS DRAWING FOR 680 SECONDARY SHREDDER

DA | TT-HS-YA | NONE

267J-D-10553




| ZONE | SYM. | DATE | INITIALS | REVISION DESCRIPTION |
|---|---|---|---|---|
| ALL | C | 8-4-87 | DA | ADD AIR PLENUM TRANSITION |
| B3/6 | B | 5-11-87 | DA | ROTATE ROTARY VALVE 90° CCW |
| ALL | A | 4-7-87 | DA | ADD C.E. COMMENTS & GORED ELBOWS |

**WILLIAMS PATENT CRUSHER AND PULVERIZER CO.**
ST. LOUIS, MO.

ELEVATION VIEWS FOR COMBUSTION ENGINEERING
GREATER DETROIT RESOURCE RECOVERY FACILITY

DRAWN BY: CF, CB
DATE: 2-16-87
SCALE: 1/4" = 1'
DWG NO. 267K-E-9971
REVISION: C

SHEET 2 of 2