RIGIMILL®

Installation, Operation and Maintenance Instructions

Table of Contents

Introduction

This manual was prepared especially for owners and operators of Machine and Process Design RIGIMILL® Hammer mills, and should be carefully read before attempting to use of maintain the machine.

The RIGIMILL® is precision engineered and fabricated, and will provide efficient, long lasting performance when installation, operation and maintenance procedures are carefully followed. The Machine and Process Design guarantee of performance is valid only if the procedures in this manual are followed.

Whenever ordering replacement parts, be sure to check the Bill of Material for the correct item numbers. Also, be sure to furnish the machine's Model, Serial and Order number given on the front cover of this manual.

In the event you have a question or problem relating to operation or maintenance of your machine, consult this manual first. If your question is still unanswered, contact Machine and Process Design at:

820 McKinley Street
Anoka, MN 55303

US Toll Free (877) 224-0653
Phone (763) 427-9991
Fax (763) 427-8777.

CAUTION

SAFETY MESSAGE – READ CAREFULLY

It is the responsibility of the contractor, installer, owner and user to install, maintain and operate equipment and component assemblies and parts manufactured and supplied by Machine and Process Design (MPD) in such a manner as to comply with the occupational safety and health act (OSHA), and in accordance with any and all other standards that may be applicable to your particular industry, location, local code or any other safety code that applies.

Our equipment is manufactured to meet OHSA Occupational and Health Administration) and ANSI (American National Standard Institute Safety Code) safety codes. However, we cannot be responsible for actual installations or unknown local codes. If, after receiving your equipment, you observe that guards or any other protective devices are missing –**DO NOT INSTALL THE EQUIPMENT** – call the factory at 763-427-9991. Please read the safety portion of the operating manual that applies to the particular equipment you have.

CAUTION – READ CAFEFULLY

This equipment is installed as an integral part of a complete process system. It is impossible to provide permanent protection for the inlet and outlet at the Machine and Process Design (MPD) factory. However, pre-installation, temporary shipping covers are provided. It is the responsibility of the buyer, installer, contractor and user to provide proper protection against the access to the inlet and outlet of the machine after it is installed and operating. MPD **cannot accept responsibility** for protection to inlets and outlets. I f this message is not thoroughly understood, please call the factory at (763) 427-9991.

WARNING

To prevent possible bodily injury and/or damage to equipment, operating instructions must be read and thoroughly followed by anyone starting this equipment or making repairs or adjustments. So not attempt to remove or open any doors, guards or access openings while machine is in operation. This machine will continue to rotate for a time after power is turned off. Make sure machine has come to a complete stop before attempting to open any access doors. Any equipment found to be damaged or not operating properly is to be repaired or replaced before starting.

In addition, please note the attached diagram of your machine with all instructions and warning signs attached. **Inspect your machine thoroughly** and if, for any reason, these signs are not in place or have become defaced in shipment, write or call us and

we will supply new signs immediately. Before substituting any equipment for that originally furnished, or making any changes in adjustments or settings, consult MPD.

TERMS

TITLE:

Unless expressly provided otherwise in this quotation, passing of title to items shall be FOB point of shipment, even where freight may be prepaid or allowed to destination by MPD.

STATEMENT OF WARRANTY:

Machine and Process Design, Inc. (MPD) warrants the machinery and materials manufactured by it to be free of defects in material and workmanship. Should any part of it be found to be so defective under normal use and service for the purpose for which it is manufactured within one (1) year from the date of start up or eighteen (18) months from the date of shipment, whichever occurs first, the purchaser may, with MPD's prior consent, return said part to MPD's plant for repair or replacement. Excluded in this warranty are purchased components, which shall only be covered by the terms and conditions of their manufacturer's warranty.

MPD limits any process warranties to those expressly written to suit specific product and process parameters. This is due to the multitude of variables beyond MPD’s control.

MPD's warranty is limited to replacement of/or repair of defective parts FOB MPD's plant, Anoka, Minnesota only. Any costs for dismantling or reinstallation of such parts, including freight for shipping such parts, will be at the purchaser's expense. Any replaced parts become MPD's property and are to be returned to MPD freight prepaid.

MPD will not assume any responsibility, expense, or liability for repairs made outside MPD's factory without prior written consent of MPD.

Prices quoted do NOT include freight, shipping or field installation charges unless otherwise stated. These items can be quoted on request. Prices quoted do not include federal/state taxes, if applicable.

Quoted machines may not meet all specific federal/state or local codes. Any changes resulting from special construction, electrical, hydraulic, or pneumatic compliance, at the time or point of installation, will be the responsibility of the customer unless otherwise stated in this proposal.

EXCLUDED ITEMS:

Equipment Start–Up
Field Installation
Field Wiring
Electrical Controls – unless specified or quoted with the project
Loading or Rigging

SAFETY

To prevent possible injury to personnel operating or maintaining the equipment, it is essential that these instructions be read and carefully followed.

- See Section 4 for safe types and locations for electrical interlocks and starting switches. By following these recommendations both safety and convenience can be attained. All electrical boxes and switch enclosures should be kept closed to ensure security of all electrical connections.

- No unauthorized operators or maintenance people should work on the machine. Only authorized people should operate or service the equipment.

- All covers, doors, and guards must be in place when the machine is started up and must not be removed during operation. The machine will continue to rotate for a period of time after the power is turned off. Do not attempt to open access doors until the machine has come to a complete stop.

- Any equipment found to be damaged or malfunctioning should be replaced or repaired before the machine is operated.

- Do not substitute equipment or parts for those originally furnished on or with the machine. Do not make machine modifications without consulting Machine and Process Design. Only authorized personnel should make changes in adjustments or settings.

- A number of safety decals have been placed on the machine before shipping. Should these warnings be defaced or are missing, contact Machine and Process Design for immediate replacement.

DESCRIPTION AND SPECIFICATIONS

Model 1612 RIGIMILL®

Material of Construction:	304 Stainless Steel Product Contact Surface
Interior Finish:	120 Grit
Exterior Finish:	Glass Bead Blasted
Motor Horsepower:	20 hp
Motor Power Requirements:	3Phase/60Hz/208-230/460Volt
Motor RPM:	1800
Rotor RPM:	939
Drive Type/Model:	V-Belt (3) 5VX680
Drive Ratio:	1.915:1
Hammer Tip Speed:	3933 fpm
Inlet Style:	Standard Top
Discharge Style:	Standard Bottom
Screen Perforation:	3/32 Dia.
Hammer Pattern:	Double ¼” Blunt
Seal Type:	2.75 Dia. Air Purge
Bearing Type/Model:	Dodge F4B-DL-211LL
Optional Items:	n/a

Installation

Receipt of shipment

Upon the receipt of your shipment immediately check for shortages and damage.

Check the shipment against the order information transmitted earlier. The mill shipment should include, in addition to the mill itself, miscellaneous instructions and parts information.

All equipment furnished is detailed in a file kept by Machine and Process Design, indicating exactly what was ordered, manufactured and shipped. If there are any questions concerning the completeness of the shipment, contact Machine and Process Design immediately.

Uncrating

All equipment is factory inspected and in perfect condition before shipment. If, upon arrival, the crates show evidence of damage, have the transporting company acknowledge this on the bill of lading. Carefully uncrate the equipment and examine all parts for obvious damage. Immediately notify the carrier and advise Machine and Process Design of any damage observed.

Location

The location of the machine will of course vary with the needs of the individual owners. However, it is important that the site selected provide a stable foundation and ample clearance around the machine for proper operation (changing hammers and screens), inspection and service. The must also be adequate ventilation to allow for dissipation of heat.

Foundation

A solid, level foundation is essential for heavy process equipment like the RIGIMILL®. For smaller machines a 4” to 6” thick concrete floor is satisfactory. For larger machines, a minimum 6” thick concrete base is preferred. The concrete base should be at least 6” larger than the Hammermill base. To allow for advanced preparation of the concrete base, MPD will provide a dimensional drawing for a setting plan.
Isolation pads, sheet cork, rubber or rubber belting may be used between the mill base and the foundation slab to reduce normal vibration and noise.
If the installation is on ground level where a new concrete slab will be installed, it may be preferable to provide an oversize foundation slab for the machine, isolated from the

surrounding floor slab. By doing this, normal machine vibrations will not be transmitted to the rest of the adjacent structural members.
For installation on upper floors of a building, the machine can be set on isolation pads with corner angles if there is concern about the machine moving.

Review of mounting by a structural engineer with the proper credentials for your area is highly recommended.

Electrical

When the equipment is received, check the nameplate data on the motor, or any other electrical devices to be sure that they correspond with the plant voltage. Also make sure the plant electrical service has sufficient capacity to accommodate the equipment to be installed.
The electrical installation should be in accordance with all national and local codes. The starting should be placed near (in sight of) the motor, so the operator may observe the motor when starting it up. A disconnect device should be installed adjacent to the motor, with a lockout to protect personnel working on the RIGIMILL®.
An ammeter should be installed in the vicinity of the RIGIMILL® to show the amount of electricity is being used when grinding. Having the ammeter in plain view of the operator allows the operator to easily adjust the feed going to the machine for optimum performance.
If a feeder has a separate motor, it should be interlocked with the RIGIMILL® so that the feeder cannot start without the RIGIMILL® being up to speed and can be stopped before the RIGIMILL®, so that the grinding chamber is empty when the RIGIMILL® is stopped.

Belt Tensioning or Coupling Alignment

Even though MPD RIGIMILL® belts or couplings are installed and properly installed at the factory before shipment, it is necessary to check belt tensioning or coupling alignment between the machine and the motor. The procedure for these checks is given in the maintenance section.

Direct-coupled RIGIMILLS® must be checked for proper alignment between the RIGIMILL® and motor after the mill is installed, prior to start up.

Auxiliary Equipment

Any auxiliary equipment furnished by MPD will be accompanied by installation instructions.

Operation

Basic Operation

The material enters the RIGIMILL® at the top of the grinding chamber. The rate of flow of the material into the grinder is controlled by some type of feeder such as a rotary feeder, an auger, or the flow gate that might be supplied with the RIGIMILL®.

Primary grinding is accomplished by impact on the material between the hammers and the back plate. Further grinding is done against the screen and against a cutting plate if your application requires a cutting plate. The screen, which is the classifier, retains the material until it is small enough to pass through the perforations in the screen.

Rotor fan action forces air through the screen, along with particles of the material.

When air conveying in not used with the RIGIMILL®, a vent system should be used to provide a negative pressure below the grinding chamber, and to maintain the airflow through the screen and out of the bottom of the mill.

Proper airflow through the RIGIMILL® will reduce the operating temperature in the mill, remove moisture, reduce temperature in the material and help prevent dust migration to the adjacent atmosphere.

Startup

Observe the following procedures and precautions:

- ***All doors must be closed and all protective covers and guards must be in place.***
- ***The rotor must be free to turn by hand.***
- ***The grinding chamber must be empty: the motor will not start with excess material in the grinding chamber.***
- ***The screens must be in place with the screen carriage securely fastened and all of the hand knobs on the batten strip and rear clamping plate tightened.***
- ***The feed rate of the material must be gradually increased, while observing an ammeter. The full load amps of the motor must not be exceeded during normal operation.***

Shutdown

Shutdown of the RIGIMILL® is a simple process, but it must be carefully followed to insure that the machine is empty of material when turned off:

- ***Shut off the feed to the RIGIMILL®, so that no additional material enters the grinding chamber.***
- ***Allow the mill to operate until the ammeter shows that there is no longer any load on the motor, indicating that the grinding chamber is empty.***
- ***Shut down the RIGIMILL® and then any auxiliary equipment.***

Vibration

The RIGIMILL® rotors are dynamically balanced at the factory without the hammers being bolted to the head plates. The hammers are then bolted to the head plates and the RIGIMILL® is test run at operating speed to assure smooth operation. If vibration exists after installation it is usually caused by uneven hammer wear, misalignment of the coupling or poor belt tensioning. See Section 6 Maintenance for troubleshooting procedures.

Operating speed of the mill could coincide with a structural members harmonic frequency in the mounting structure or surface. Usually this will be evident at the initial start-up.

Optional Equipment

Follow operating procedures given with optional equipment, to ensure proper operation of that equipment, whether furnished by MPD or by others.

MAINTENANCE

Basic Maintenance

To assure trouble-free operation and years of uninterrupted service, it is essential that a preventative maintenance program be implemented and followed for the Rigimill. Inspections and procedures recommended for your Rigimill are presented in this section.

If worn or damaged parts or improperly lubricated parts are found during inspections, immediate corrective actions must be taken to prevent the possibility of failure and major damage.

Bearings

All bearings are pre-lubricated by the bearing manufacturer and are ready to run. Reference the attached manufacturer's literature to determine grease type, greasing frequency and the required grease charge quantity.

In most cases the bearing lubricant used is NLGI Grade 2 lithium based grease. In food product contact applications the lubricant used will have a complex that is not lithium based. Reference the bearing listing on the equipment Bill of Material to see if food grade lubricant is used. ***Do not mix greases that have different base complexes. Check with your lubricant supplier to insure compatibility between different greases.***

We recommend that the bearings be checked routinely every day. It is a good idea to do this after the machine has been running for about 2 hours. The bearings should be cool or warm to the touch by your hand. If the temperature exceeds 160°F, immediate attention is required.

Most bearing overheating and failure can be traced to:

- ***Over lubrication of the bearing***
- ***Under lubrication of the bearing***
- ***Foreign matter in the bearing***
- ***Overloading of the bearing***

It is extremely important to keep the bearings clean and properly lubricated.

Motors

When material is fed into the Rigimill faster than it can be discharged, the motor will be overloaded. If the overload protection in the motor starter is properly adjusted, the motor should stop without any damage being caused to the motor or mill. If the grinding chamber is full of material, it will have to be removed before the machine can be started again. A decal arrow on the housing of the machine indicates the direction of rotation of the Rigimill rotor.

Note: It is extremely important that the motor and particularly the housing of the motor be kept clean to maintain proper operating temperature.

Hammers

Based on testing and/or customer supplied information about the intended application of the RIGIMILL®, MPD installs the appropriate number and length of hammers in the mill. Should the application requirements, product or product characteristics change, or it becomes necessary to replace the hammers due to wear, the hammer changing procedure is included later in this section.

Screens

If it is necessary to achieve a finer or coarser final particle distribution, this may be accomplished by installing a screen with smaller or larger perforations. The screen changing procedure is included later in this section.

ROTOR BALANCE DATA SHEET

MPD Project Number: 33976 Date 5/5/16

MPD Rotor Part Number: 155459C

Rotor Operating Speed: 3600_RPM_

Rotor Balance Class: G1

Balancer: _____EMS

MPD Purchase Order Number: P0225961

The following data is to be supplied by the Balancer

Date of Balancing: 7-14-16

TOL. = 1.9 gin

Rotor Weight: 82 lb

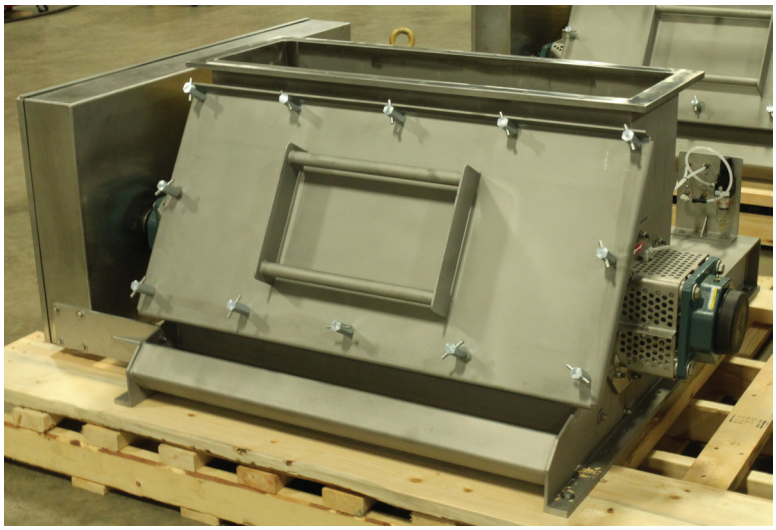
Measured Residual Unbalance: L 1.9 R 0.5 ~~lb-in/lb~~ gin

Balancing Operator's Initials: _____

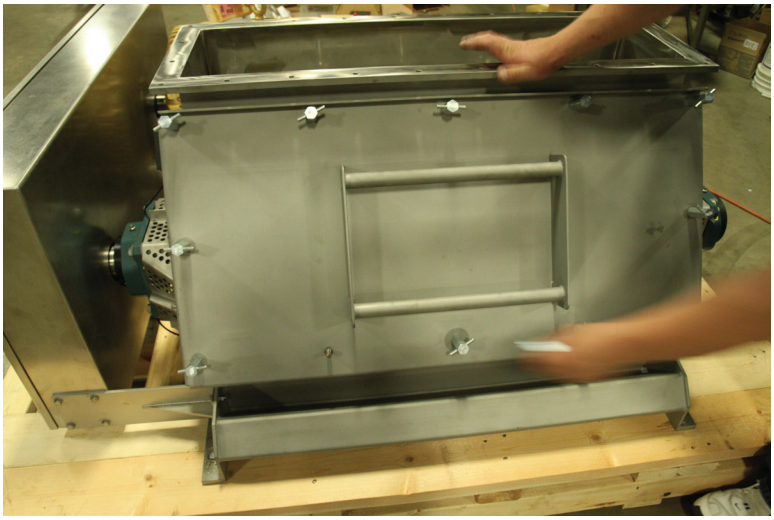
Screen Changing Procedure

1. Make sure to shut off the power supply to the Rigimill® and lock the power supply at the nearest disconnect as per OSHA specifications. Re-check and make sure that the power supply is properly shut-off and locked out.

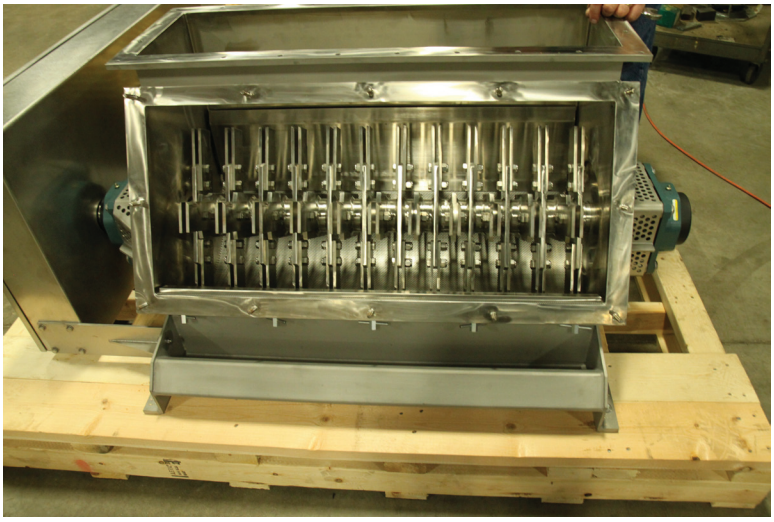
2. Visually check to make sure the rotor has STOPPED Spinning.



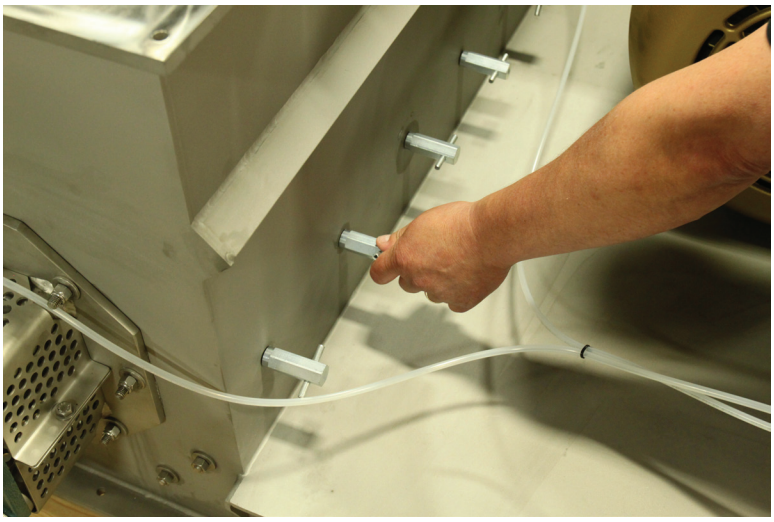
3. Loosen and remove the hand knobs that fasten the access door to the housing of the Rigimill®.



4. Remove the access door.

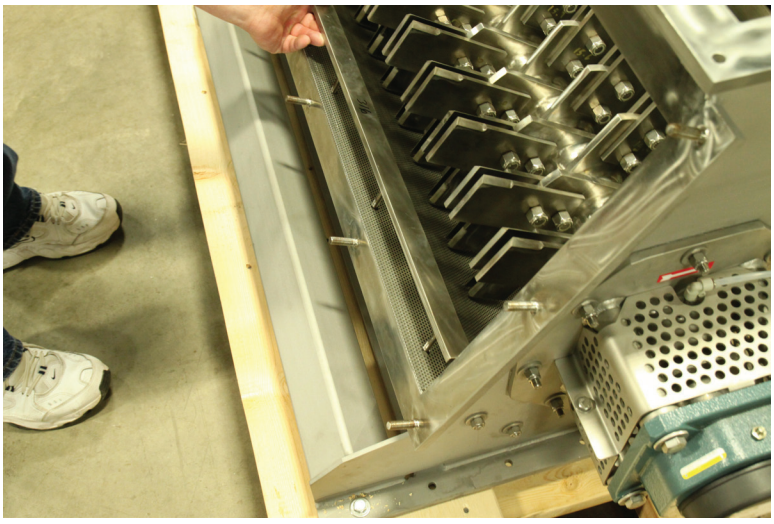


5. Loosen but do not REMOVE the hand knobs that fasten the screen retention back plate to the housing. This back plate is on the opposite side of the housing from the access door.



6. Remove the hand knobs that fasten the batten strip and front edge of the screen to the lower flange of the access door opening.

7. Remove the batten strip with the threaded studs by pulling it upwards.



8. Grasp the front edge of the screen and rotate it up and over the top of the rotor. If the screen seems to be resisting removal, rotate the rotor to aid in pulling the screen over the top of the rotor.

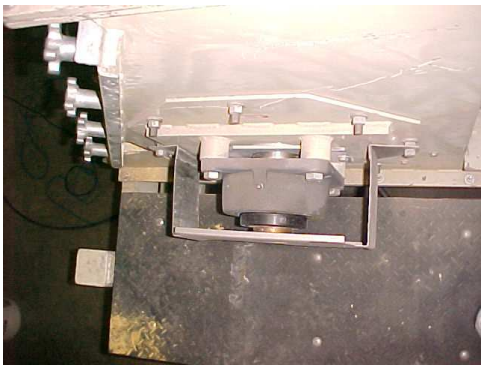
9. Grasp the screen and lift it towards you and out of the Rigimill®.

10. To install, please reverse the above process.

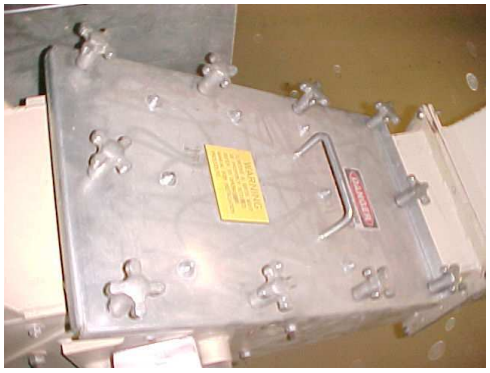
Hammer Changing Procedure

1) Be sure to shut-off the power supply to the RIGIMILL® and lock the power supply at the nearest disconnect as per OSHA specifications. Re-check to make sure that the power supply is properly shut-off and locked out.

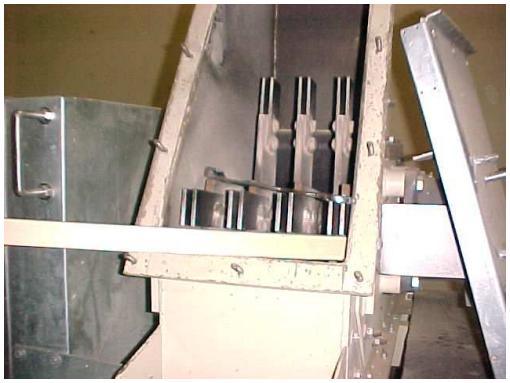
2) Visually check to make sure that the rotor has stopped spinning.



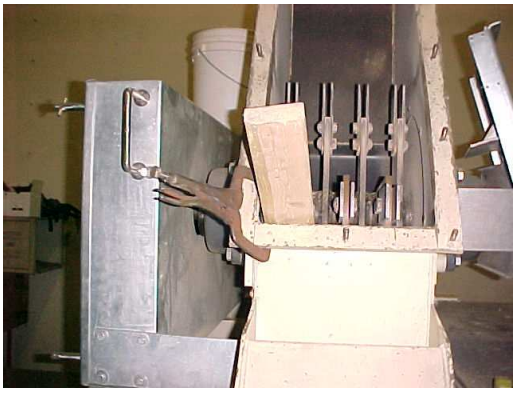
3) Loosen and remove the hand knobs that fasten the access door to the housing of the RIGIMILL.



4) Remove the access door.

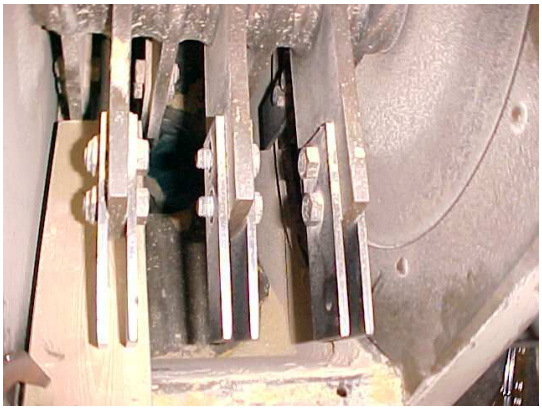


5) Place a block of wood (we use a 2" x 4") under one row of hammers and on top of the lower ledge of the access door opening. We recommend clamping the block in place. This will keep the rotor from spinning while you work on the rotor.



6) Use two wrenches (one for the bolt head and one for the nut) to loosen and remove the two bolts and nuts for each hammer. Then remove the hammer. It is recommended to twist the bolt and hold the nut in place, to minimize the chance of rounding the corners on the nut.

7) Replace the old hammer with a new hammer or flip the existing hammer to use the opposite side. Reinstall the bolts and nuts through the hammer mounting holes and tighten them to 40-45 ft-lbs for stainless fasteners and 90-100 ft lbs for grade 8 zinc fasteners.



8) Continue the above operation until all four rows of hammers have been replace or flipped.

9) Replace the access door and reinstall the hand knobs.

Bearing Replacement Procedure

Bearing housings are aligned at the factory with centering rings to properly position the shaft in the shaft seal opening in the RIGIMILL® housing. The bearing housings are drilled and pinned to ensure proper re-alignment of the shaft in the shaft opening after maintenance operations.

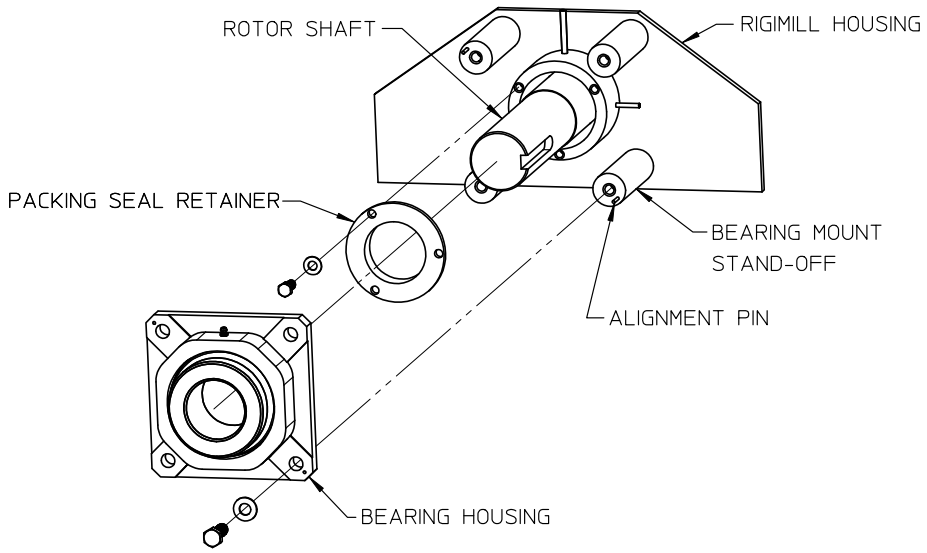
1. Be sure to shut-off the power supply to the RIGIMILL® and lock the power supply at the nearest disconnect as per OSHA specifications. Re-check to make sure that the power supply is properly shut-off and locked out.

2. Visually check to make sure that the rotor has stopped spinning.

3. Support the rotor shaft and remove the bearing housing fasteners. The rotor **must** be properly supported to prevent seal and alignment pin damage.

4. Remove the bearing housing by carefully sliding the bearing off the rotor shaft and alignment pins so that the pins are not bent or causing damage the housing.

5. Remove the fasteners and packing seal retainer.



The following paragraphs describe how to replace only the bearing insert. If the bearing housing is also to be replaced skip to paragraph 12.

6. Remove the grease fitting on the top of the housing and also remove the locking pin that is below the grease fitting.

7. Place a large screwdriver through the inside diameter of the bearing insert and apply pressure across the top and bottom of the insert to separate the insert from the housing.

8. To install the new bearing insert, position the new insert so that the dimple in the insert is lined up with the grease fitting hole in the housing. Then a small brass or rubber headed hammer to lightly tap the bearing insert into place.

9. Replace the bearing alignment pin in the grease-fitting hole.

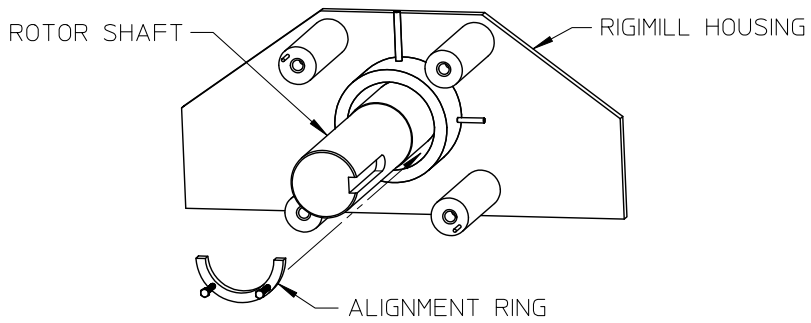
10. Replace the grease fitting in the housing hole above the locking pin.

11. Lubricate the bearing.

12. Reinstall the bearing insert and housing on the stand-offs and alignment pins on the housing of the RIGIMILL®. If a new bearing housing is being installed, remove the alignment pins.

IMPORTANT Proper clearance must be maintained between the rotor shaft and the opening in the mill housing.

To properly align the Rotor with the mill housing, use the split alignment ring provided with the Rigimill. Place one half of the ring between the rotor and the inside of the housing opening at each end of the mill. The rings are provided with tapped holes and fasteners on the face to assist in their removal after the alignment procedure is completed. Install the bearing on the shaft and hold it in place by hand tightening the bearing fasteners. Final shaft alignment is performed by positioning the shaft and bearing such that the alignment ring can be completely revolved between the shaft and the mill housing opening on both ends of the mill. When completed, tighten the bearing fasteners to the torque specifications (75 to 80 lbs-ft for
1/2-13NC cap screw) with tread locking solution, remove the alignment rings and re-check that the clearance has been maintained between the shaft and the opening of the mill.

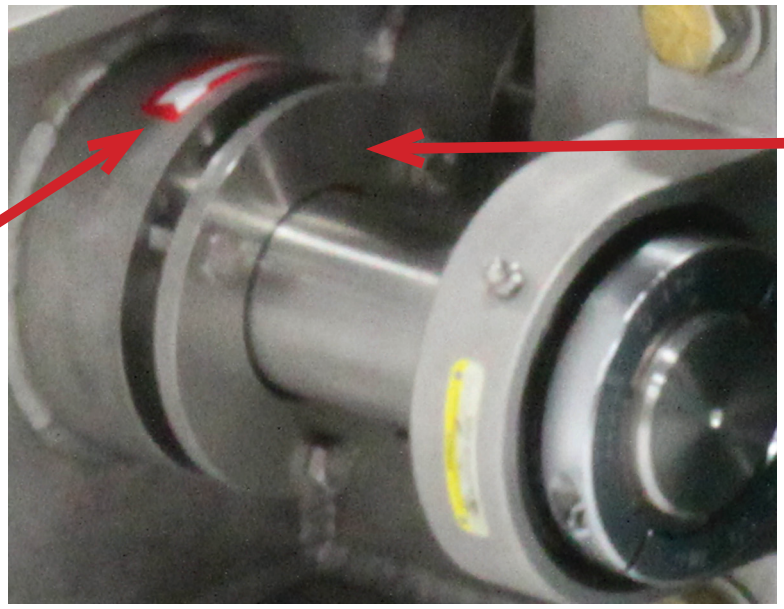


Flexible Packing Or Air Purge Seal Changing Procedure

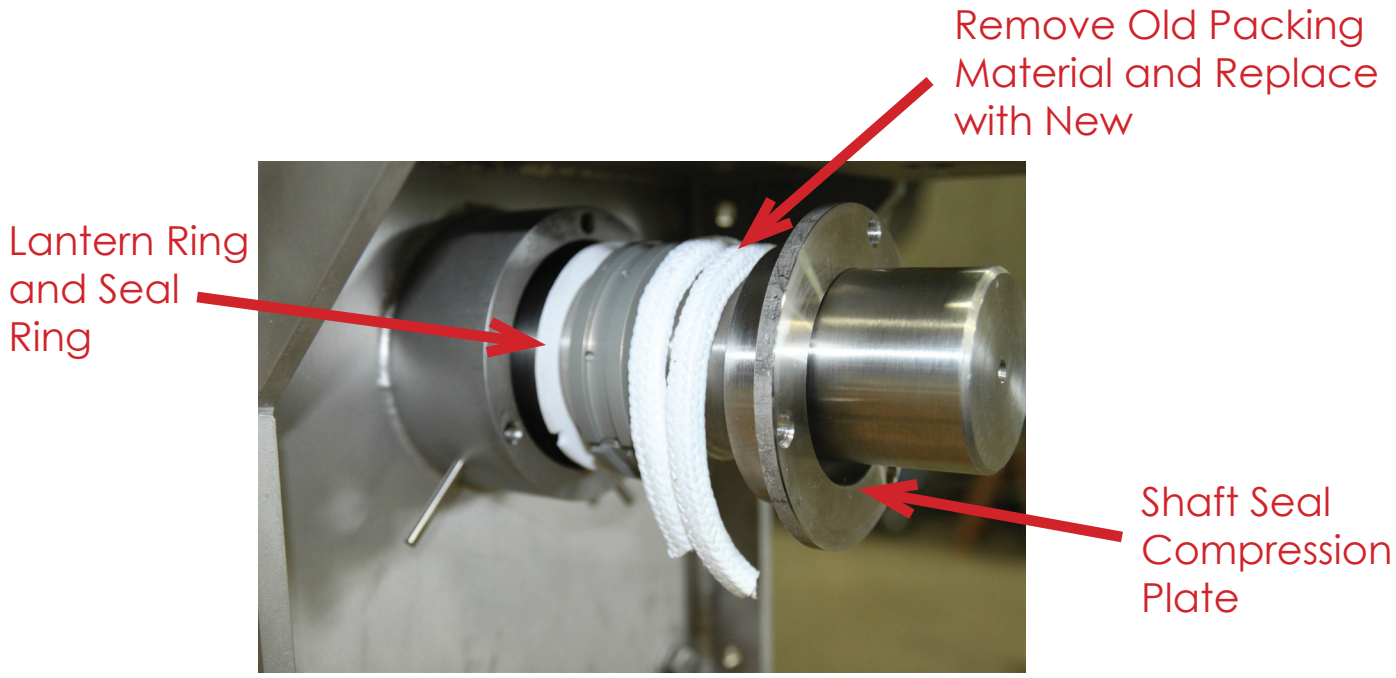
1. Shut off the power supply to the Crusher and lock the power supply at the nearest disconnect as per OSHA specifications. Re-check and make sure that the power supply is properly shut-off and locked out.

2. Visually check that the rotor has STOPPED spinning.

3. Loosen and remove the bolts that fasten the shaft seal compression plate to the housing of the Crusher.



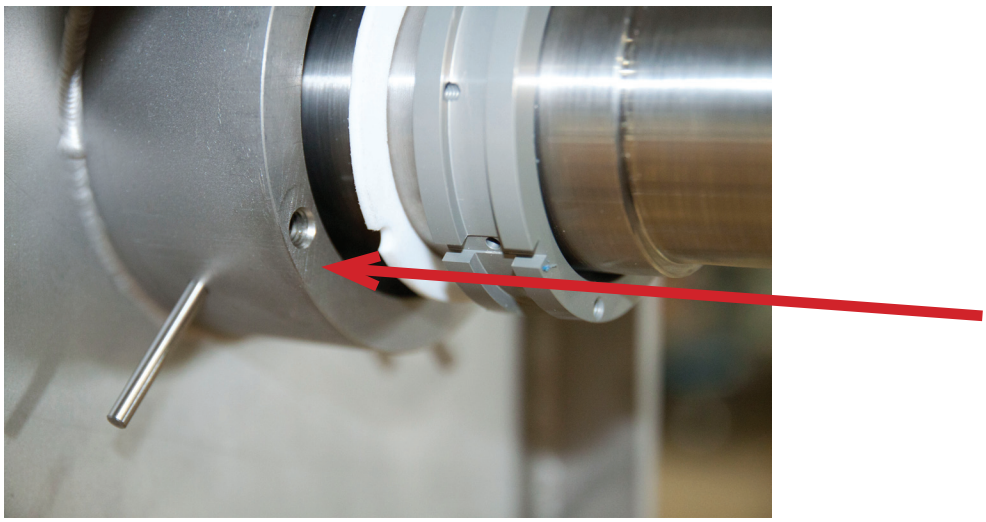
4. Slide the shaft seal compression plate away from the Crusher housing.



5. Remove old packing material. A hooked tool can be used to assist in the removing the old packing material. At this time, remove and inspect the lantern ring and seal ring if they are present.

6. Cut the new packing material to size by using the measured length of the old material.

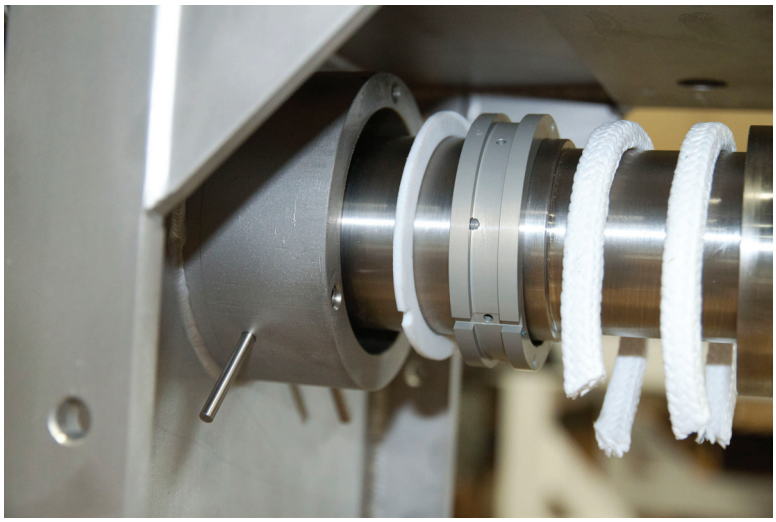
7. If they are present, reinstall first the seal ring & then the lantern ring all the way to the bottom of the housing making sure that the lantern ring notch lines up with the seal housing.



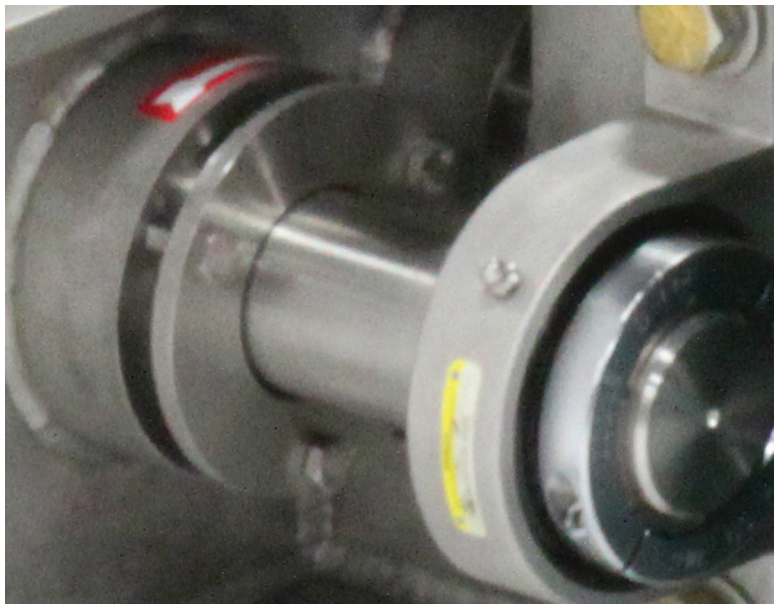
8. Install the new packing material individually seating each ring as far as possible into the housing before installing the next ring. Rotate the joint of each packing ring by 90 degees.

Caution

In food grade applications where the shaft speed is greater than 2500 RPM or if the shaft diameter is greater than 3 inches, the inner surfacses of the packing should be pre-lubricated with a light coating of Lubriplate FM085AW or equivalent to insure proper run-in.



9. Install the seal compression plate and gently tighten the fasteners evenly. Do not jam the packing by excessive compression plate loading. Check for seal leakage at machine startup and adjust the compression plate fasteners if needed. On air purge shaft seals, no air should be felt escaping from around the housing and shaft on the outside of the machine.



Instruction Manual for DODGE®
Setscrew, Eccentric Collar, D-Lok, H-E Series & EZ-Kleen Mounted Ball Bearings

These instructions must be read thoroughly before installation or operation.

WARNING: To ensure that drive is not unexpectedly started, turn off and lock out or tag power source before proceeding. Failure to observe these precautions could result in bodily injury.

CAUTION: Under certain operating conditions. It is possible for static electric charge to build up on EZ-KLEEN Polymer Housings. Do not operate these bearings in an environment where a sudden static discharge may cause either an operating hazard or personnel discomfort.

INSTALLATION:

1. Clean shaft and bearing bore thoroughly. Measure and confirm shaft size and tolerance. File flats on shaft at setscrew locations to permit easy removal of bearing.
2. Slip bearing into position. Be sure that bearing is not on a worn section of the shaft. For tighter fits, tap inner ring face only with soft driver. DO NOT HAMMER ON HOUSING.
3. The bearing outer ring OD is spherical and swivels in the housing to accommodate misalignment. Snug holddown bolts and use shaft to swivel each bearing until its final position is in the center of free movement top to bottom as well as side to side. Pass shaft through both bearings without forcing. This will prevent preloading of the bearings. Housing slippage depends on the mounting hold-down bolt tightening torque, number of bolts and friction characteristics between mounting surfaces. Auxiliary load carrying devices such as shear bars are advisable for side or end loading of pillow blocks and radial loads for flange units where normal to heavy loading or shock loading is encountered.

NOTE: On coated and non-metallic housings, hold-down bolts should be tightened carefully with flat washers to prevent damage to the coating. Coated housings have reduced friction characteristics, so auxiliary load carrying devices are even more important in those applications.

WARNING Because of the possible danger to persons(s) or property from accidents which may result from the improper use of products, it is important that correct procedures be followed: Products must be used in accordance with the engineering information specified in the catalog. Proper installation, maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure safe operation under prevailing conditions. Proper guards and other suitable safety devices or procedures as may be desirable or as may be specified in safety codes should be provided, and are neither provided by Baldor Electric Company nor are the responsibility of Baldor Electric Company. This unit and its associated equipment must be installed, adjusted and maintained by qualified personnel who are familiar with the construction and operation of all equipment in the system and the potential hazards involved. When risk to persons or property may be involved, a holding device must be an integral part of the driven equipment beyond the speed reducer output shaft.

4. Tighten hold-down bolts to proper torque (Table 1). Turn shaft by hand. Resistance to turning should be the same as before full tightening of hold-down bolts.
5. For setscrew mounted bearings: **After final alignment of the shaft, tighten both setscrews hand tight**, then the setscrews should be tightened alternately and in small increments to the torque specified in Table 1. After 24 hours operation, the setscrews should be retightened to the torque in Table 1 to assure full locking of the inner race to the shaft. Care should be taken that the socket key or driver is in good condition with no rounded corners and the key is fully engaged in the setscrew and held square with the setscrew to prevent rounding out of the setscrew socket when applying maximum torque. Do not drill through the setscrew holes for spot drilling of the shaft. (Some inner rings have tempered setscrew threads and can be damaged by a drill.) If spot drilling is required, locate bearings on the shaft and center punch through the setscrew hole. Remove bearing and spot drill the shaft, then reassemble over the spot drilled position and assemble as above. Milled or filed flats are preferable to spot drilling.

NOTE: On all Setscrew Product the setscrews can be re-torqued many times without damage to the bearing system. To achieve maximum shaft holding power it is highly recommended that setscrews be replaced with new hardware after any disassembly operation.

6. For eccentric collar mounted bearings, slide collar against cam end of inner race. Use a punch in the hole provided in the collar, tap collar smartly in the direction of shaft rotation. Tighten setscrews to proper torque (Table 1). To remove bearings, loosen setscrew and tap collar in the direction opposite of shaft rotation.
7. For D-LOK mounted bearings, be sure collar is square and tight against shoulder on inner ring. Tighten cap screw to recommended torque shown in Table 1.
8. For expansion bearings (H-E Series), locate inner unit in housing to allow expansion in the desired direction before locking to the shaft.

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Table 1 - Recommended Torque

Setscrews					D-LOK			Mounting Bolts					
		Recommended Torque						Metal Housings		EZ-KLEEN Housed Bearings			
Set-screw Size	Key Hex Across Flats	Standard Ball Bearing Insert		Corrosion Resistant Stainless Steel	Cap Screw Size	Recom. Torque	EZ-Kleen Recom. Torque	Bolt Size	Recom. Dry Torque (Grade 2)	2-Bolt PB, 2 & 4 Bolt Flg. and Flg. Brackets		Tapped-Base PB	
		Min	Max							Bolt Size	Torque ①	Bolt Size	Torque ②
(in.)	(in.)	(in-lbs.)	(in-lbs.)	(in-lbs.)	(in.)	(in-lbs.)	(in-lbs.)	(in.)	(in-lbs.)	(in.)	(in-lbs.)	(in.)	(in-lbs.)
#10	3/32	28	33	25	#8-32	58	46	3/8-16	240	3/8-16	225	3/8-16	175
1/4	1/8	66	80	60	#10-32	90	72	7/16-14	384	7/16-14	350	7/16-14	350
5/16	5/32	126	156	117	1/4-28	180	144	1/2-13	600	1/2-13	500	1/2-13	400
3/8	3/16	228	275	206	5/16-24	400	320	5/8-11	1200	9/16-12	650		
7/16	7/32	342	428	321	3/8-24	750	600	3/4–10	1950	5/8-11	1000		
								7/8–9	2890				
(mm)	(mm)	(N-m)	(N-m)	(N-m)	(mm)	(N-m)	(N-m)	(mm)	(N-m)	(mm)	(N-m)	①Torque for Austenitic (18-8) Stainless ②Max. torque values published. Do not exceed.	
M5	2.5	3.2	3.7	2.8	M4	5.85	4.68	M10	29	M8	15		
M6	3	6.2	7.7	5.8	M5	10.75	8.6	M12	50	M10	25		
M8	4	14.2	17.8	13.4	M6	20.5	16.4	M16	124	M12	50		
M10	5	26	31	23	M8	45	36	M20	238	M14	75		
M12	6	46	57	43				M22	322	M18	125		

Lubrication

High Speed Operation - In the higher speed ranges, too much grease will cause over-heating. The amount of grease that the bearing will take for a particular high speed application can only be determined by experience. If excess grease in the bearing causes overheating, it will be necessary to remove grease fitting to permit excess grease to escape. The bearing has been greased at the factory and is ready to run. When establishing a relubrication schedule, note that a small amount of grease at frequent intervals is preferable to a large amount at infrequent intervals.

Lubrication Guide

Use a No. 2 Lithium complex base grease or equivalent*

Hours Run per Day	Suggested Lubrication Period in Weeks							
	1 to 250 RPM	251 to 500 RPM	501 to 750 RPM	751 to 1000 RPM	1001 to 1500 RPM	1501 to 2000 RPM	2001 to 2500 RPM	2501 to 3000 RPM
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	1	1
24	10	5	3	2	1	1	1	1

*For EZ-Kleen series bearings, use an aluminum complex base grease.

Lubrication recommendations are intended for standard products applied in general operating conditions. For modified products, high temperature applications, and other anomalous applications contact product engineering at 864-284-5700.

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How to Tension V-Belt Drives

General Method

Tension of the belts on a V-belt is usually not critical. A few simple rules about tensioning will satisfy most of your requirements:

1. The best tension for a V-belt drive is the lowest tension at which the belts will not slip under the highest load condition.
2. Check the tension on a new drive frequently during the first day of operation.
3. Check the drive tension periodically, thereafter.
4. Too much tension shortens belt and bearing life.
5. Keep belts and sheaves free from any foreign material which may cause slip.
6. If a V-belt slips, **tighten it.**

NOTE: For quarter-turn drives, follow the tensioning instructions on Page 253.

Numerical Method

While designing a drive, it is well to specify data for use in tensioning the drive. Many users of V-belt drives rely on their experience and the above general rules for tensioning drives, but it has become common practice to actually measure the tension in a drive. Numerical methods for measuring tension have several advantages. For example, they prevent inexperienced personnel from drastically overtensioning or undertensioning a drive, thus preventing possible bearing or belt damage. Even with experienced personnel, it helps the individual get a feel for the tension needed in a particular drive. This is especially important with modern drives, where each V-belt is rated for higher horsepower than were previous belts. If a belt is to carry more horsepower, it must be installed proportionally tighter. Experience with older drives may lead to undertensioning of modern drives unless tension is measured at least once to help get the feel for correct tension.

The procedure in numerically tensioning a drive is:

1. Determine the correct tension for the stopped drive, called static tension, so that the tension will be correct when the drive is operating.
2. Measure the static tension so that it can be set at the correct value.

NOTE: Do not use this section if your drive uses a spring-loaded idler or other means of automatic drive tensioning. See your local Gates representative.

Tension Tester Method

1. Measure the span length (t).

2. Position the lower of the two “O” Rings using **either** of these methods:
   a. On the scale reading “Deflection inches”, set the “O” Ring(s) to show a deflection equal to $\frac{1}{64}$" per inch of span length (t).
   b. On the scale reading “Inches of Span Length”, set the “O” Ring(s) to show a deflection equal to the inches of measured span length (t).

3. At the center of the span (t), apply force with the Gates Tension Tester perpendicular to the span, large enough to deflect one belt of a multiple belt set on the drive until the bottom edge of the lower “O” Ring(s) is even with the tops of the remaining belts. For drives with only one belt, a straight edge across the pulleys will assure accuracy of positioning.

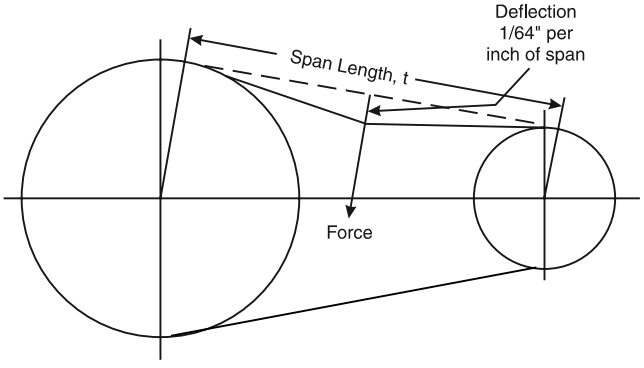
4. Find the amount of deflection **force** on the upper scale of the Tension Tester. The Sliding Rubber “O” Ring(s) slides up the scale as the tool compresses — and stays up for accurate reading of pounds force. Read at the bottom edge of the ring(s) (Slide ring down before reusing).

5. Compare the deflection force with the range of forces recommended. If **less** than **minimum** recommended deflection force, belts should be tightened. If **more** than **maximum** recommended deflection force, drive is tighter than necessary.

NOTE: There normally will be a rapid drop in tension during the “run-in period” for V-belt drives. Check tension frequently during the first day of operation.

Fig. No. 1

Tension Measurement By Deflection



How to Tension V-Belt Drives (continued)

Tension Tester Method (continued)

Table No. 54

Recommended Deflection Force Per Belt For Super HC® V-Belts, Super HC PowerBand® Belts, Super HC Molded Notch V-Belts or Super HC Molded Notch PowerBand Belts*

V-Belt Cross Section	Small Sheave Diameter Range (In.)	Small Sheave RPM Range	Speed Ratio Range	Recommended Deflection Force (Lbs.) Minimum	Maximum
3V	2.65 - 2.80 3.00 - 3.15 3.35 - 3.65 4.12 - 5.00 5.30 - 6.90	1200-3600 1200-3600 1200-3600 900-3600 900-3600	2.00 to 4.00	3.0 3.3 3.7 4.4 4.8	4.3 4.8 5.4 6.4 7.1
3VX	2.20 2.35 - 2.50 2.65 - 2.80 3.00 - 3.15 3.35 - 3.65 4.12 - 5.00 5.30 - 6.90	1200-3600 1200-3600 1200-3600 1200-3600 1200-3600 900-3600 900-3600	2.00 to 4.00	2.8 3.2 3.5 3.8 4.1 4.8 5.8	4.1 4.7 5.1 5.5 6.0 7.1 8.6
5VX	4.40 - 4.65 4.90 - 5.50 5.90 - 6.70 7.10 - 8.00 8.50 - 10.90 11.80 - 16.00	1200-3600 1200-3600 1200-3600 600-1800 600-1800 400-1200	2.00 to 4.00	9.0 10.0 11.0 13.0 14.0 15.0	13.0 15.0 17.0 19.0 20.0 23.0
5V	7.10 - 8.00 8.50 - 10.90 11.80 - 16.00	600-1800 600-1800 400-1200	2.00 to 4.00	11.0 13.0 14.0	16.0 18.0 21.0
8V	12.50 - 17.00 18.00 - 24.00	600-1200 400- 900	2.00 to 4.00	28.0 32.0	41.0 48.0

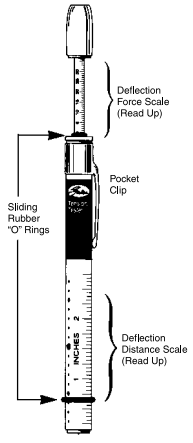
Table No. 55

Recommended Deflection Force Per Belt For Hi-Power II™ V-Belts, Hi Power II PowerBand Belts or Tri-Power® Molded Notch V-Belts*

V-Belt Cross Section	Small Sheave Diameter Range (In.)	Small Sheave RPM Range	Speed Ratio Range	Recommended Deflection Force (Lbs.) Hi-Power II Minimum	Hi-Power II Maximum	Tri-Power Molded Notch Minimum	Tri-Power Molded Notch Maximum
A AX	3.0 3.2 3.4 - 3.6 3.8 - 4.2 4.6 - 7.0	1750 to 3600	2.00 to 4.00	2.7 2.9 3.3 3.8 4.9	3.8 4.2 4.8 5.5 7.1	3.8 3.9 4.1 4.3 4.9	5.4 5.6 5.9 6.3 7.1
B BX	4.6 5.0 - 5.2 5.4 - 5.6 6.0 - 6.8 7.4 - 9.4	1160 to 1800	2.00 to 4.00	5.1 5.8 6.2 7.1 8.1	7.4 8.5 9.1 10.0 12.0	7.1 7.3 7.4 7.7 7.9	10.0 11.0 11.0 11.0 12.0
C CX	7.0 7.5 8.0 - 8.5 9.0 - 10.5 11.0 - 16.0	870 to 1800	2.00 to 4.00	9.1 9.7 11.0 12.0 14.0	13.0 14.0 16.0 18.0 21.0	12.0 12.0 13.0 13.0 13.0	18.0 18.0 18.0 19.0 19.0
D	12.0 - 13.0 13.5 - 15.5 16.0 - 22.0	690 to 1200	2.00 to 4.00	19.0 21.0 24.0	27.0 30.0 36.0	19.0 21.0 25.0	28.0 31.0 36.0

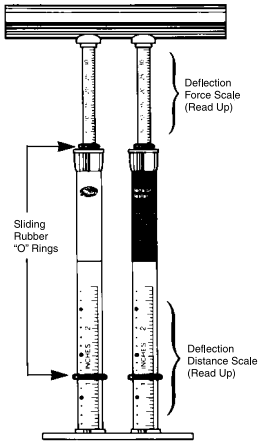
***Note: This information is for Horsepower Ratings which are mentioned in this manual only. Use with older drives could result in overtensioning.**

— up to 30 lbs.

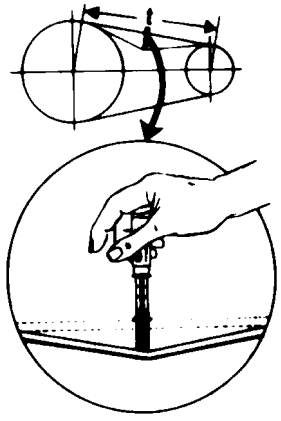


Read the scales at the bottom edge of the "O" Ring. Leave the upper "O" Ring in maximum "down" position

— up to 66 lbs.



Read the scales at the bottom edge of the "O" Ring. Leave the upper "O" Ring in maximum "down" position



Part No.	Force Limitation
7401-0076	Up to 30 Lbs.
7401-0075*	Up to 66 Lbs.

*Dual Tensioner

NOTE: Lay a steel bar or a narrow block of wood across the PowerBand® belt and apply the deflection force to the bar so that all of the individual strands in the band are deflected the same amount. If more than one PowerBand Belt is used on the drive, the neighboring band can be used as a reference for measuring the deflection, just as is done with individual V-belts. If only one band is used, lay a straightedge or stretch a string from sheave-to-sheave to use as a reference for measuring deflection. Lay the straightedge or string across the back of the PowerBand Belt on the sheaves.

In tensioning Gates PowerBand Belts, multiply the pounds of deflection forces by the number of belts in the band. The tension tester can be applied as indicated above to deflect the entire PowerBand Belt, providing a small board or metal plate is placed on top of the band so that all belts in the band are deflected a uniform amount. A straight-edge can be laid across the sheaves to use as a reference for measuring deflection.

How to Tension V-Belt Drives—continued
Regular V-Belt Tensioning Method

Step 1 Find the Required Tension Per Strand of Belt (Static Tension)

A. The **static tension per strand** (T_{st}) is given by this formula:

Formula No. 6

$$T_{st} = 15\left(\frac{2.5^{*} - K\phi}{K\phi}\right)\left(\frac{(\text{Design HP})\,(10^3)}{(N)(V)}\right) + \frac{MV^2}{10^6}$$

Where: $K\varphi$ = arc correction factor from Table No. 48 on Page 205 or Table No. 89 on Page 251 for V-Flat drives.
N = Number of belts. (This is the number of strands in the case of PowerBand® Belts.)
V = Belt speed, ft./min.
M = Constant from Table No. 56.
*2.67 for Micro-V® Belts.

Table No. 56
Factor M and Factor Y

Cross Section	M	Y
Super HC® Molded Notch		
3VX	0.29	4
5VX	0.78	13
Super HC® Molded Notch PowerBand®		
3VX	0.39	4
5VX	0.98	13
Super HC		
5V	1.0	11
8V	2.6	22
Super HC PowerBand		
3V	0.46	4
5V	1.2	11
5VP	1.2	39
8V	3.0	22
Hi-Power® II		
A	0.51	7
B	0.80	8
C	1.5	18
D	3.0	27

Cross Section	M	Y
Hi-Power II PowerBand		
A	0.66	7
B	1.0	9
C	1.8	18
D	3.4	28
Tri-Power® Molded Notch		
AX	0.47	7
BX	0.76	8
CX	1.31	15
Micro-V® Belt		
J*	0.035	0.56
L	0.130	1.90
M	0.520	6.30
Polyflex® JB®		
5M**	0.05	1.2
7M	0.14	4.6
11M	0.31	8.5

*If the calculated T_{st} value is less than 2.81 lbs for a J cross section Micro-V belt, use 2.81 lbs to calculate upper and lower deflection forces in step 2.
**If the calculated T_{st} value is less than 7.87 lbs for a 5M cross section Polyflex belt, use 7.87 to calculate upper and lower deflection forces in step 2.
These minimum T_{st} values must be used on lightly loaded drives due to belt stiffness so the belt will properly conform to the sheave.

Step 2 Determine the Lower and Upper Recommended Forces to Deflect One Belt 1/64" Per Inch of Span Length

A. Measure the **span length** (t) of your drive (or see Formula No. 35 on Page 261 to calculate span length).

B. If your drive uses **two or more** PowerBand Belts or individual belts, calculate the lower and upper recommended deflection forces by these formulas:

Formula No. 7

$$\text{Lower Recommended Force} = \frac{T_{st} + Y}{16}$$

Formula No. 8

$$\text{Upper Recommended Force} = \frac{1.5\,T_{st} + Y}{16}$$

Where: T_{st} = tension per strand from Step 1.
Y = constant from Table No. 56.

C. If your drive has only **one** PowerBand Belt (See D top right) or individual belt, calculate the lower and upper recommended deflection forces by these formulas:

Formula No. 9

$$\text{Lower Recommended Force} = \frac{T_{st} + \left(\frac{t}{L}\right)Y}{16}$$

Formula No. 10

$$\text{Upper Recommended Force} = \frac{1.5\,T_{st} + \left(\frac{t}{L}\right)Y}{16}$$

Where: T_{st} = tension per strand from Step 1.
Y = constant from Table No. 56.
t = span length (see Figure No. 1 on Page 212).
L = belt length

D. The deflection forces calculated in Step 2B or 2C are for an individual belt. Multiply these forces by the number of individual strands in a band to get the lower and upper recommended forces for a PowerBand Belt. (If your drive uses 2 or more PowerBand Belts, use the band with the fewest number of strands.)

Step 3 Determine If the Belts are Properly Tensioned

A. At the center of the span(t) **measure the force** required to deflect one belt on the drive 1/64" per inch of span length from its normal position. Be sure to apply the force perpendicular to the belt. See Figure No. 1 on Page 212. If your drive is a single belt drive or uses only one PowerBand Belt, be sure that at least one sheave is free to rotate. For PowerBand, see Step 1C of the Simplified Method for instructions on how to apply the measuring force and how to measure deflection.

B. If the measured force is less than the lower recommended force, the belts should be tightened. If it is more than the upper recommended force, the drive is tighter than it needs to be.

Gates PowerBand Belt Tensioning Information

When the cross section and number of strands in a Gates PowerBand Belt become so large that the deflection force is greater than can reasonably be imposed on the belt, a method of measuring tension other than the deflection method may be used.

The alternate method of checking PowerBand Belt tension is the Elongation Method. The principle is simple. A known amount of tension elongates a belt a known amount. Therefore the elongation of a PowerBand Belt as it is installed on a drive and tensioned is a measure of the static tension in the belt.

Elongation Method for Tensioning PowerBand Belts

Step 1 Find the Required Tension Per Strand of Belt (Static Tension)

A. Find the **required static tension, T_{st},** using Formula No. 6 in Step 1A of the Regular V-Belt Tensioning Method.

B. Find a range or recommended tensions.

Low Tension = T_{st}

Upper Tension = 1.5 x T_{st}

Step 2 Find the Amount to Elongate the Belt (On the Drive) to Obtain the Above Tension

A. Measure the **outside circumference** of the belt at no tension. This can be done with the belt either on or off the drive.

NOTE: If you are retensioning a used drive, slack off on the drive until there is no tension, then tape the outside circumference of the belt while it is still on the drive.

B. Find the correct **belt length multiplier** from Table No. 57 on Page 215 for each of the static tensions you calculated above.

C. Multiply the taped outside circumference of the PowerBand Belt of each of the belt length multipliers. This gives the **elongated outside circumference** of the PowerBand Belt corresponding to each of the calculated tensions.

Step 3 Tension the Drive

A. With the PowerBand Belt installed on the drive, tighten it until the taped outside circumference falls between the elongated outside circumferences calculated above.

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Table No. 57

Belt Length Multipliers for Tensioning PowerBand® Belts

	Super HC® Molded Notch PowerBand Belts & Super HC PowerBand Belts					Hi-Power® II PowerBand Belts					
	Cross Section										
						A*	B		C		D
Tst Per Strand (Lbs.)	3V	3VX	5VX	5V	8V	Equal To or Less Than 210" Length	Equal To or Less Than 210" Length	Over 210" Length	Equal To or Less Than 210" Length	Over 210" Length	
10	1.00122	1.00091	1.00033	1.00053	1.00029	1.00048	1.00042	1.00050	1.00025	1.00033	1.00017
12	1.00146	1.00109	1.00040	1.00063	1.00034	1.00057	1.00050	1.00060	1.00030	1.00040	1.00021
14	1.00171	1.00127	1.00047	1.00074	1.00040	1.00067	1.00058	1.00070	1.00035	1.00047	1.00024
16	1.00195	1.00145	1.00053	1.00084	1.00046	1.00076	1.00067	1.00080	1.00040	1.00053	1.00028
18	1.00220	1.00164	1.00060	1.00095	1.00051	1.00086	1.00075	1.00090	1.00045	1.00060	1.00031
20	1.00244	1.00182	1.00067	1.00105	1.00057	1.00095	1.00083	1.00100	1.00050	1.00067	1.00034
24	1.00293	1.00218	1.00080	1.00126	1.00069	1.00114	1.00100	1.00120	1.00060	1.00080	1.00041
28	1.00341	1.00255	1.00093	1.00147	1.00080	1.00133	1.00117	1.00140	1.00070	1.00093	1.00048
32	1.00390	1.00291	1.00107	1.00168	1.00091	1.00152	1.00133	1.00160	1.00080	1.00107	1.00055
36	1.00439	1.00327	1.00120	1.00189	1.00103	1.00171	1.00150	1.00180	1.00090	1.00120	1.00062
40	1.00488	1.00364	1.00133	1.00211	1.00114	1.00190	1.00167	1.00200	1.00100	1.00133	1.00069
45	1.00549	1.00409	1.00150	1.00237	1.00129	1.00214	1.00187	1.00225	1.00112	1.00150	1.00078
50	1.00610	1.00455	1.00167	1.00263	1.00143	1.00238	1.00208	1.00250	1.00125	1.00167	1.00086
55	1.00671	1.00500	1.00183	1.00289	1.00157	1.00262	1.00229	1.00275	1.00137	1.00183	1.00095
60	1.00732	1.00545	1.00200	1.00316	1.00171	1.00286	1.00250	1.00300	1.00150	1.00200	1.00103
65	1.00793	1.00591	1.00217	1.00342	1.00186	1.00309	1.00271	1.00325	1.00162	1.00217	1.00112
70	1.00854	1.00636	1.00233	1.00368	1.00200	1.00333	1.00292	1.00350	1.00175	1.00233	1.00121
75	1.00915	1.00682	1.00250	1.00395	1.00214	1.00357	1.00312	1.00375	1.00187	1.00250	1.00129
80	1.00976	1.00727	1.00267	1.00421	1.00229	1.00381	1.00333	1.00400	1.00200	1.00267	1.00138
85	1.01037	1.00773	1.00283	1.00447	1.00243	1.00405	1.00354	1.00425	1.00212	1.00283	1.00146
90	1.01098	1.00818	1.00300	1.00474	1.00257	1.00428	1.00375	1.00450	1.00225	1.00300	1.00155
95	1.01159	1.00864	1.00317	1.00500	1.00271	1.00452	1.00396	1.00475	1.00237	1.00317	1.00164
100	1.01220	1.00909	1.00333	1.00526	1.00286	1.00476	1.00417	1.00500	1.00250	1.00333	1.00172
120	1.01463	1.01091	1.00400	1.00632	1.00343	1.00571	1.00500	1.00600	1.00300	1.00400	1.00207
140	1.01707	1.01273	1.00467	1.00737	1.00400	1.00667	1.00583	1.00700	1.00350	1.00467	1.00241
160	1.01951	1.01455	1.00533	1.00842	1.00457	1.00762	1.00667	1.00800	1.00400	1.00533	1.00276
180	1.02195	1.01636	1.00600	1.00947	1.00514	1.00857	1.00750	1.00900	1.00450	1.00600	1.00310
200	1.02439	1.01818	1.00667	1.01053	1.00571	1.00952	1.00833	1.01000	1.00500	1.00667	1.00345
240	1.02927	1.02182	1.00800	1.01263	1.00686	1.01143	1.01000	1.01200	1.00600	1.00800	1.00414
280	1.03415	1.02545	1.00933	1.01474	1.00800	1.01333	1.01167	1.01400	1.00700	1.00933	1.00483
320	1.03902	1.02909	1.01067	1.01684	1.00914	1.01524	1.01333	1.01600	1.00800	1.01067	1.00552
360	1.04390	1.03273	1.01200	1.01895	1.01029	1.01714	1.01500	1.01800	1.00900	1.01200	1.00621
400	1.04878	1.03636	1.01333	1.02105	1.01143	1.01905	1.01667	1.02000	1.01000	1.01333	1.00690
450	1.05488	1.04091	1.01500	1.02368	1.01286	1.02143	1.01875	1.02250	1.01125	1.01500	1.00776
500	1.06098	1.04545	1.01667	1.02632	1.01429	1.02381	1.02083	1.02500	1.01250	1.01667	1.00862
550	1.06707	1.05000	1.01833	1.02895	1.01571	1.02619	1.02292	1.02750	1.01375	1.01833	1.00948
600	1.07317	1.05455	1.02000	1.03158	1.01714	1.02857	1.02500	1.03000	1.01500	1.02000	1.01034
650	1.07927	1.05909	1.02167	1.03421	1.01857	1.03095	1.02708	1.03250	1.01625	1.02167	1.01121
700	1.08537	1.06364	1.02333	1.03684	1.02000	1.03333	1.02917	1.03500	1.01750	1.02333	1.01207
750	1.09146	1.06818	1.02500	1.03947	1.02143	1.03571	1.03125	1.03750	1.01875	1.02500	1.01293
800	1.09756	1.07273	1.02667	1.04211	1.02286	1.03809	1.03333	1.04000	1.02000	1.02667	1.01379
850	1.10366	1.07727	1.02833	1.04474	1.02429	1.04048	1.03542	1.04250	1.02125	1.02833	1.01466
900	1.10976	1.08182	1.03000	1.04737	1.02571	1.04286	1.03750	1.04500	1.02250	1.03000	1.01552
950	1.11585	1.08636	1.03167	1.05000	1.02714	1.04524	1.03958	1.04750	1.02375	1.03167	1.01638
1000	1.12195	1.09091	1.03333	1.05263	1.02857	1.04762	1.04167	1.05000	1.02500	1.03333	1.01724

* A Section PowerBand Belts are not a standard. For availability, check with your local Gates representative.

Tensioning Example Using Super HC® V-Belts

Given:

Existing Drive

Design Horsepower = 90

DriveR = 6 grooves 5V 11.8" O.D.

DriveR RPM = 870

DriveN = 6 grooves 5V 46.0" O.D.

V-Belts = 5VX1800

Center Distance = 41.0"

Belt Speed = 2665 ft./min.

Factor Kø = 0.86

This drive meets all the requirements for the Simplified Tensioning Method except it uses one more belt than the number recommended, so simplified tensioning would put more tension in the drive than needed. Use the regular V-belt tensioning method shown below.

Step 1 Find the Required Tension Per Strand of Belt, Using Formula No. 6 on Page 214.

$$T_{st} = 15\left(\frac{2.5 - 0.86}{0.86}\right)\left[\frac{(90)(1000)}{(6)(2665)}\right] + \frac{(1.0)\ (2665)^2}{10^6}$$

$$= (15)(1.91)(5.63) + 7.10$$

$$= 161.3 + 7.10 = 168.4 \text{ or } 168 \text{ Lbs.}$$

Step 2 Lower and Upper Forces for Deflection of One Belt.

A. Span length can be calculated from Formula No. 35 of Page 261.

$$t = 41.0\ [1 - 0.125\ (0.83)^2]$$

$$= 41.0\ (1 - 0.0861)$$

$$= 37.5"$$

The deflection should be $^{38}/_{64}$" or $^{19}/_{32}$"

B. Lower recommended force $= \frac{168 + 13}{16} = 11.3$ Lbs.

Upper recommended force $= \frac{(1.5)(168) + 13}{16} = 16.6$ Lbs.

PRODUCT APPLICATION NOTES

Volume 53, No. 8
October, 2006

Taper-Lock® and QD® Bushing Installation and Removal

Taper-Lock® and QD® bushing installation is critical to good belt drive performance. Improper installation can damage the bushing and/or the sprocket/sheave. Sprockets/sheaves are commonly mounted to a shaft with a tapered bushing that fits a mating tapered bore in the sprocket/sheave. Bushings are available in numerous bore diameters to accommodate a broad range of shaft sizes used in industry.

Taper-Lock Bushing Installation and Removal

To Install TAPER-LOCK Type Bushings

1. Clean the shaft, bore of bushing, outside of bushing and the sprocket/sheave hub bore of all oil, paint and dirt. File away any burrs.

Note: The use of lubricants can cause hub fracture. DO NOT USE LUBRICANTS when installing tapered bushings.

2. Insert the bushing into the sprocket/sheave hub and align the holes. All of the holes should be half threaded. The installation holes will be threaded on the sprocket side, but not the bushing side. The removal holes will be threaded on the bushing side, but not the sprocket side. See Figure 1 below.

3. "LIGHTLY" oil the bolts and thread them into the half-threaded installation holes indicated by the white installation holes in Figure 1.

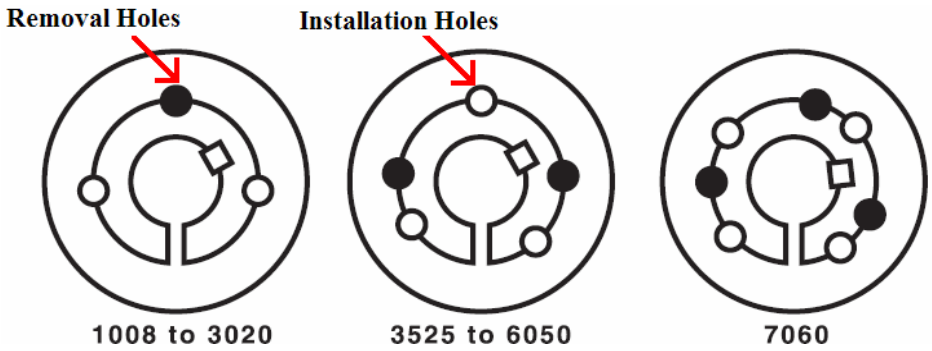


Figure 1 – Taper–Lock Bushing Installation Diagrams

Note: Do not lubricate the bushing taper, hub taper, bushing bore, or the shaft. Doing so may result in sprocket/sheave hub fracture. DO NOT USE LUBRICANTS

4. With the key resting in the shaft keyway, position the sprocket/sheave and bushing assembly onto the shaft allowing for small axial movement of the sprocket/sheave which will occur during the tightening process.

Note: When mounting sprockets/sheaves on a vertical shaft, precautions must be taken to positively prevent the sprocket/sheave and/or bushing from falling during installation.

5. Alternately torque the bushing bolts until the sprocket/sheave and bushing tapers are completely seated together (use approx. half of the recommended bolt torque; see Table 1).

Note: Do not use worn hex key wrenches. Doing so may result in a loose assembly or may damage bolts.

6. Check the alignment and axial sprocket/sheave run out (wobble), and correct as necessary.

7. Continue alternate tightening of the bolts to the recommended torque values specified in Table 1 below.

Taper-Lock® Bushings

Bushing Style	Bolts		Torque Wrench	
	Qty.	Size	lb-ft	lb-in
1008	2	1/4-20 x 1/2	4.6	55
1108	2	1/4-20 x 1/2	4.6	55
1210	2	3/8-16 x 5/8	14.6	175
1610	2	3/8-16 x 5/8	14.6	175
2012	2	7/16-14 x 7/8	23.3	280
2517	2	1/2-13 x 1	35.8	430
3020	2	5/8-11 x 1 1/4	66.7	800
3525	3	1/2-13 x 1 1/2	83.3	1000
4030	3	5/8-11 x 1 3/4	141.7	1700
4535	3	3/4-10 x 2	204.2	2450
5040	3	7/8-9 x 2 1/4	258.3	3100
6050	3	1 1/4-7 x 3 1/2	651.7	7820
7060	4	1 1/4-7 x 3 1/2	651.7	7820

Caution: Excessive bolt torque can cause sprocket/sheave and/or bushing breakage.

Note: To insure proper drive performance, full bushing contact on the shaft is recommended.

Table 1 – Taper–Lock Bushing Bolt Torque Values

8. To increase the bushing gripping force, firmly tap the face of the bushing using a brass drift or punch (Do not hit the bushing directly with the hammer).

9. Re-torque the bushing bolts after Step 8. After reaching the recommended bolt torque value once, stop. Continued tightening to the recommended torque level will over insert the bushing.

10. Recheck all bolt torque values after the initial drive run-in, and periodically thereafter. Repeat steps 5 through 9 if loose.

To Remove TAPER-LOCK® Type Bushings

1. Loosen and remove all mounting bolts.

2. Insert bolts into all jack screw holes indicated by dark removal holes in Figure 1 on page 1.

3. Loosen the bushing by alternately tightening the bolts in small but equal increments until the tapered sprocket/sheave and bushing surfaces disengage.

QD® Bushing Installation and Removal

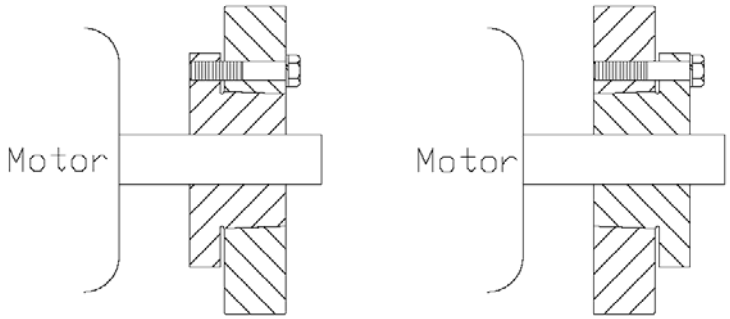


Figure 2 – Conventional and Reverse Mounting

Conventional mounting is accomplished by placing the bolts through the sprocket/sheave first and then threading into the bushing. The assembly is then placed onto the shaft with the bushing flange facing inward and the bolt heads facing outward. See Figure 2.

Reverse mounting is accomplished by placing the bolts through the bushing first and then threading into the sprocket/sheave. The assembly is then placed onto the shaft with the sprocket/sheave facing inward and the bolt heads facing outward. See Figure 2. Conventional mounting is generally the preferred method.

To Install QD Type Bushings

1. Clean the shaft, bushing bore, outside of bushing and the sprocket/sheave hub bore of all oil, paint and dirt. File away any burrs.

Note: Do not lubricate the bushing taper, hub taper, bushing bore or the shaft. Doing so may result in sprocket/sheave hub fracture. DO NOT USE LUBRICANTS.

2. For a *conventional mount*, assemble the sprocket/sheave and bushing combination by sliding the sprocket/sheave taper bore into position over the mating tapered bushing surface. Align the unthreaded holes in the sprocket/sheave hub with the threaded holes in the flange of the bushing. Hand-tighten the cap screws with lock washers installed. The sprocket/sheave and bushing assembly will mount onto the shaft, with the bushing flange facing inward.

Some sprocket/sheave assemblies will allow a reverse mount procedure. This results in the bushing flange facing outward, but still allows the cap screw installation from the outside of the assembly. The cap screws fit through the unthreaded holes of the bushing flange and into the threaded holes of the sprocket/sheave hub.

3. With the key resting in the shaft keyway, position the assembly onto the shaft allowing for small axial movement of the sprocket/sheave, which will occur during the tightening process.

When installing large or heavy parts in a conventional mount, it may be easier to mount the key and bushing on the shaft first, then place the sprocket/sheave on the bushing and align the holes.

Note: When mounting sprockets/sheaves on a vertical shaft, pre-cautions must be taken to prevent the sprocket/sheave and/or bushing from falling during installation.

4. Alternately tighten the cap screws until the sprocket/sheave and bushing tapers are completely seated together (use approx. half of the recommended bolt torque; see Table 2).

5. Check the alignment and axial sprocket/sheave run out (wobble), and correct as necessary.

6. Continue alternate tightening of the cap screws to the recommended torque values specified in Table 2 below. Do not tighten cap screws further once the recommended torque is reached.

Note: Excessive bolt torque can cause sprocket/sheave and/or bushing breakage. When properly mounted, a gap between the bushing flange and sprocket/sheave should exist.

QD® Bushings

Bushing Style	Bolts (in)		Torque Wrench	
	Qty.	Size	lb-ft	lb-in
H	2	1/4 x 3/4	7.9	95
JA	3	10-24 x 1	4.5	54
SH & SDS	3	1/4-20 x 1 3/8	9.0	108
SD	3	1/4-20 x 1 7/8	9.0	108
SK	3	5/16-18 x 2	15.0	180
SF	3	3/8-16 x 2	30.0	360
E	3	1/2-13 x 2 3/4	60.0	720
F	3	9/16-12 x 3 5/8	75.0	900
J	3	5/8-11 x 4 1/2	135.0	1620
M	4	3/4-10 x 6 3/4	225.0	2700
N	4	7/8-9 x 8	300.0	3600
P	4	1-8 x 9 1/2	450.0	5400
W	4	1 1/8-7 x 11 1/2	600.0	7200
S	5	1 1/4-7 x 15 1/2	750.0	9000

Caution: Excessive bolt torque can cause sprocket/sheave and/or bushing breakage.
Note: To insure proper drive performance, full bushing contact on the shaft is recommended.

Table 2 – QD Bushing Bolt Torque Values

7. Tighten the set screw, when available, to hold the key securely during operation.

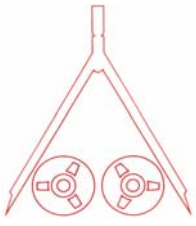
To Remove QD Type Bushings

1. Loosen and remove all mounting bolts.

2. Insert cap screws into all threaded jack screw holes.

3. Loosen the bushing by first tightening the screw furthest from the bushing saw slot, then, alternately tighten remaining screws. Keep tightening the screws in small but equal increments until the tapered sprocket/sheave and bushing disengage.

Note: Excessive or unequal pressure on the bolts can break the bushing flange, making removal impossible without destroying the sprocket/sheave.



BALDOR • RELIANCE

Integral Horsepower
AC Induction Motors
ODP, WPI, WPII Enclosure
TEFC Enclosure
Explosion Proof

Installation & Operating Manual

2/07 MN400

Table of Contents

Section 1
General Information

Overview This manual contains general procedures that apply to Baldor Motor products. Be sure to read and understand the Safety Notice statements in this manual. For your protection, do not install, operate or attempt to perform maintenance procedures until you understand the Warning and Caution statements. A Warning statement indicates a possible unsafe condition that can cause harm to personnel. A Caution statement indicates a condition that can cause damage to equipment.

Important: **This instruction manual is not intended to include a comprehensive listing of all details for all procedures required for installation, operation and maintenance. This manual describes general guidelines that apply to most of the motor products shipped by Baldor. If you have a question about a procedure or are uncertain about any detail, Do Not Proceed. Please contact your Baldor distributor for more information or clarification.**

Before you install, operate or perform maintenance, become familiar with the following:

- NEMA Publication MG-2, Safety Standard for Construction and guide for Selection, Installation and Use of Electric Motors and Generators.
- The National Electrical Code
- Local codes and Practices

Limited Warranty

1. Most Baldor products are warranted for 18 months from the date of shipment to Baldor's customer from Baldor's district warehouse or, if applicable, from Baldor's factory. Baldor Standard-E® standard efficient motors are warranted for 24 months. Standard-E is limited to three phase, general purpose, 1-200 HP ratings that fall under the Energy Policy Act (EPAct). Baldor Super-E® premium efficient motors are warranted for 36 months. Baldor IEEE841 motors are warranted for 60 months. All warranty claims must be submitted to a Baldor Service Center prior to the expiration of the warranty period.
2. Baldor will, at its option repair or replace a motor which fails due to defects in material or workmanship during the warranty period if:
   a. the purchaser presents the defective motor at or ships it prepaid to, the Baldor plant in Fort Smith, Arkansas or one of the Baldor Authorized Service Centers and
   b. the purchaser gives written notification concerning the motor and the claimed defect including the date purchased, the task performed by the Baldor motor and the problem encountered.
3. Baldor will not pay the cost of removal of any electric motor from any equipment, the cost of delivery to Fort Smith, Arkansas or a Baldor Authorized Service Center, or the cost of any incidental or consequential damages resulting from the claimed defects. (Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply to you.) Any implied warranty given by laws shall be limited to the duration of the warranty period hereunder. (Some states do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.)
4. Baldor Authorized Service Centers, when convinced to their satisfaction that a Baldor motor developed defects in material or workmanship within the warranty period, are authorized to proceed with the required repairs to fulfill Baldor's warranty when the cost of such repairs to be paid by Baldor does not exceed Baldor's warranty repair allowance. Baldor will not pay overtime premium repair charges without prior written authorization.
5. The cost of warranty repairs made by centers other than Baldor Authorized Service Centers **WILL NOT** be paid unless first authorized in writing by Baldor.
6. Claims by a purchaser that a motor is defective even when a failure results within one hour after being placed into service are not always justified. Therefore, Baldor Authorized Service Centers must determine from the condition of the motor as delivered to the center whether or not the motor is defective. If in the opinion of a Baldor Authorized Service Center, a motor did not fail as a result of defects in material or workmanship, the center is to proceed with repairs only if the purchaser agrees to pay for such repairs. If the decision is in dispute, the purchaser should still pay for the repairs and submit the paid invoice and the Authorized Service Center's signed service report to Baldor for further consideration.
7. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Safety Notice:

This equipment contains high voltage! Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt installation, operation and maintenance of electrical equipment.

Be sure that you are completely familiar with NEMA publication MG-2, safety standards for construction and guide for selection, installation and use of electric motors and generators, the National Electrical Code and local codes and practices. Unsafe installation or use can cause conditions that lead to serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

WARNING: Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that all grounding instructions have been followed. Electrical shock can cause serious or fatal injury. National Electrical Code and Local codes must be carefully followed.

WARNING: Avoid extended exposure to machinery with high noise levels. Be sure to wear ear protective devices to reduce harmful effects to your hearing.

WARNING: This equipment may be connected to other machinery that has rotating parts or parts that are driven by this equipment. Improper use can cause serious or fatal injury. Only qualified personnel should attempt to install operate or maintain this equipment.

WARNING: Do not by-pass or disable protective devices or safety guards. Safety features are designed to prevent damage to personnel or equipment. These devices can only provide protection if they remain operative.

WARNING: Avoid the use of automatic reset devices if the automatic restarting of equipment can be hazardous to personnel or equipment.

WARNING: Be sure the load is properly coupled to the motor shaft before applying power. The shaft key must be fully captive by the load device. Improper coupling can cause harm to personnel or equipment if the load decouples from the shaft during operation.

WARNING: Use proper care and procedures that are safe during handling, lifting, installing, operating and maintaining operations. Improper methods may cause muscle strain or other harm.

WARNING: Before performing any motor maintenance procedure, be sure that the equipment connected to the motor shaft cannot cause shaft rotation. If the load can cause shaft rotation, disconnect the load from the motor shaft before maintenance is performed. Unexpected mechanical rotation of the motor parts can cause injury or motor damage.

WARNING: Disconnect all electrical power from the motor windings and accessory devices before disassembly of the motor. Electrical shock can cause serious or fatal injury.

WARNING: Do not use non UL/CSA listed explosion proof motors in the presence of flammable or combustible vapors or dust. These motors are not designed for atmospheric conditions that require explosion proof operation.

Safety Notice Continued

WARNING: **Motors that are to be used in flammable and/or explosive atmospheres must display the UL label on the nameplate along with CSA listed logo.**

Specific service conditions for these motors are defined in NFPA 70 (NEC) Article 500.

WARNING: **UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.**

Caution: **To prevent premature equipment failure or damage, only qualified maintenance personnel should perform maintenance.**

Caution: **Do not over-lubricate motor as this may cause premature bearing failure.**

Caution: **Do not lift the motor and its driven load by the motor lifting hardware. The motor lifting hardware is adequate for lifting only the motor. Disconnect the load from the motor shaft before moving the motor.**

Caution: **If eye bolts are used for lifting a motor, be sure they are securely tightened. The lifting direction should not exceed a 20° angle from the shank of the eye bolt or lifting lug. Excessive lifting angles can cause damage.**

Caution: **To prevent equipment damage, be sure that the electrical service is not capable of delivering more than the maximum motor rated amps listed on the rating plate.**

Caution: **If a HI POT test (High Potential Insulation test) must be performed, follow the precautions and procedure in NEMA MG1 and MG2 standards to avoid equipment damage.**

If you have any questions or are uncertain about any statement or procedure, or if you require additional information please contact your Baldor distributor or an Authorized Baldor Service Center.

Receiving

Each Baldor Electric Motor is thoroughly tested at the factory and carefully packaged for shipment. When you receive your motor, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your motor.
2. Verify that the part number of the motor you received is the same as the part number listed on your purchase order.

Storage

If the motor is not put into service immediately, the motor must be stored in a clean, dry and warm location. Several precautionary steps must be performed to avoid motor damage during storage.

1. Use a "Megger" periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
2. Do not lubricate bearings during storage. Motor bearings are packed with grease at the factory. Excessive grease can damage insulation quality.
3. Rotate motor shaft at least 10 turns every two months during storage (more frequently if possible). This will prevent bearing damage due to storage.
4. If the storage location is damp or humid, the motor windings must be protected from moisture. This can be done by applying power to the motors' space heater (if available) while the motor is in storage.

Unpacking

Each Baldor motor is packaged for ease of handling and to prevent entry of contaminants.

1. To avoid condensation inside the motor, do not unpack until the motor has reached room temperature. (Room temperature is the temperature of the room in which it will be installed). The packing provides insulation from temperature changes during transportation.
2. When the motor has reached room temperature, remove all protective wrapping material from the motor.

Handling

The motor should be lifted using the lifting lugs or eye bolts provided.

1. Use the lugs or eye bolts provided to lift the motor. Never attempt to lift the motor and additional equipment connected to the motor by this method. The lugs or eye bolts provided are designed to lift only the motor. Never lift the motor by the motor shaft or the hood of a WPII motor.
2. When lifting a WPII (Weather Proof Type 2) motor, do not lift the motor by inserting lifting lugs into holes on top of the cooling hood. These lugs are to be used for hood removal only. A spreader bar should be used to lift the motor by the cast lifting lugs located on the motor frame.
3. If the motor must be mounted to a plate with the driven equipment such as pump, compressor etc., it may not be possible to lift the motor alone. For this case, the assembly should be lifted by a sling around the mounting base. The entire assembly can be lifted as an assembly for installation. Do not lift using the motor lugs or eye bolts provided.

   If the load is unbalanced (as with couplings or additional attachments) additional slings or other means must be used to prevent tipping. In any event, the load must be secure before lifting.

Section 2
Installation & Operation

Overview

Installation should conform to the National Electrical Code as well as local codes and practices. When other devices are coupled to the motor shaft, be sure to install protective devices to prevent future accidents. Some protective devices include, coupling, belt guard, chain guard, shaft covers etc. These protect against accidental contact with moving parts. Machinery that is accessible to personnel should provide further protection in the form of guard rails, screening, warning signs etc.

Location

It is important that motors be installed in locations that are compatible with motor enclosure and ambient conditions. Improper selection of the motor enclosure and ambient conditions can lead to reduced operating life of the motor.

Proper ventilation for the motor must be provided. Obstructed airflow can lead to reduction of motor life.

1. **Open Drip-Proof/WPI** motors are intended for use indoors where atmosphere is relatively clean, dry, well ventilated and non-corrosive.
2. **Totally Enclosed and WPII** motors may be installed where dirt, moisture or dust are present and in outdoor locations.

Severe Duty, IEEE 841 and Washdown Duty enclosed motors are designed for installations with high corrosion or excessive moisture conditions. These motors should not be placed into an environment where there is the presence of flammable or combustible vapors, dust or any combustible material, unless specifically designed for this type of service.

Mounting

The motor must be securely installed to a rigid foundation or mounting surface to minimize vibration and maintain alignment between the motor and shaft load. Failure to provide a proper mounting surface may cause vibration, misalignment and bearing damage.

Foundation caps and sole plates are designed to act as spacers for the equipment they support. If these devices are used, be sure that they are evenly supported by the foundation or mounting surface.

After installation is complete and accurate alignment of the motor and load is accomplished, the base should be grouted to the foundation to maintain this alignment.

The standard motor base is designed for horizontal or vertical mounting. Adjustable or sliding rails are designed for horizontal mounting only. Consult your Baldor distributor or authorized Baldor Service Center for further information.

Alignment

Accurate alignment of the motor with the driven equipment is extremely important.

1. **Direct Coupling**
   For direct drive, use flexible couplings if possible. Consult the drive or equipment manufacturer for more information. Mechanical vibration and roughness during operation may indicate poor alignment. Use dial indicators to check alignment. The space between coupling hubs should be maintained as recommended by the coupling manufacturer.
2. **End-Play Adjustment**
   The axial position of the motor frame with respect to its load is also extremely important. The motor bearings are not designed for excessive external axial thrust loads. Improper adjustment will cause failure.
3. **Pulley Ratio**
   The pulley ratio should not exceed 8:1.
4. **Belt Drive**
   Align sheaves carefully to minimize belt wear and axial bearing loads (see End-Play Adjustment). Belt tension should be sufficient to prevent belt slippage at rated speed and load. However, belt slippage may occur during starting.

Caution: Do not over tension belts.

5. Sleeve bearing motors are only suitable for coupled loads.

Doweling & Bolting

After proper alignment is verified, dowel pins should be inserted through the motor feet into the foundation. This will maintain the correct motor position should motor removal be required. (Baldor motors are designed for doweling.)

1. Drill dowel holes in diagonally opposite motor feet in the locations provided.
2. Drill corresponding holes in the foundation.
3. Ream all holes.
4. Install proper fitting dowels.
5. Mounting bolts must be carefully tightened to prevent changes in alignment. Use a flat washer and lock washer under each nut or bolt head to hold the motor feet secure. Flanged nuts or bolts may be used as an alternative to washers.

Power Connection

Motor and control wiring, overload protection, disconnects, accessories and grounding should conform to the National Electrical Code and local codes and practices.

Conduit Box

For ease of making connections, an oversize conduit box is provided. The box can be rotated 360° in 90° increments. Auxiliary conduit boxes are provided on some motors for accessories such as space heaters, RTD's etc.

AC Power

Connect the motor leads as shown on the connection diagram located on the name plate or inside the cover on the conduit box. Be sure the following guidelines are met:

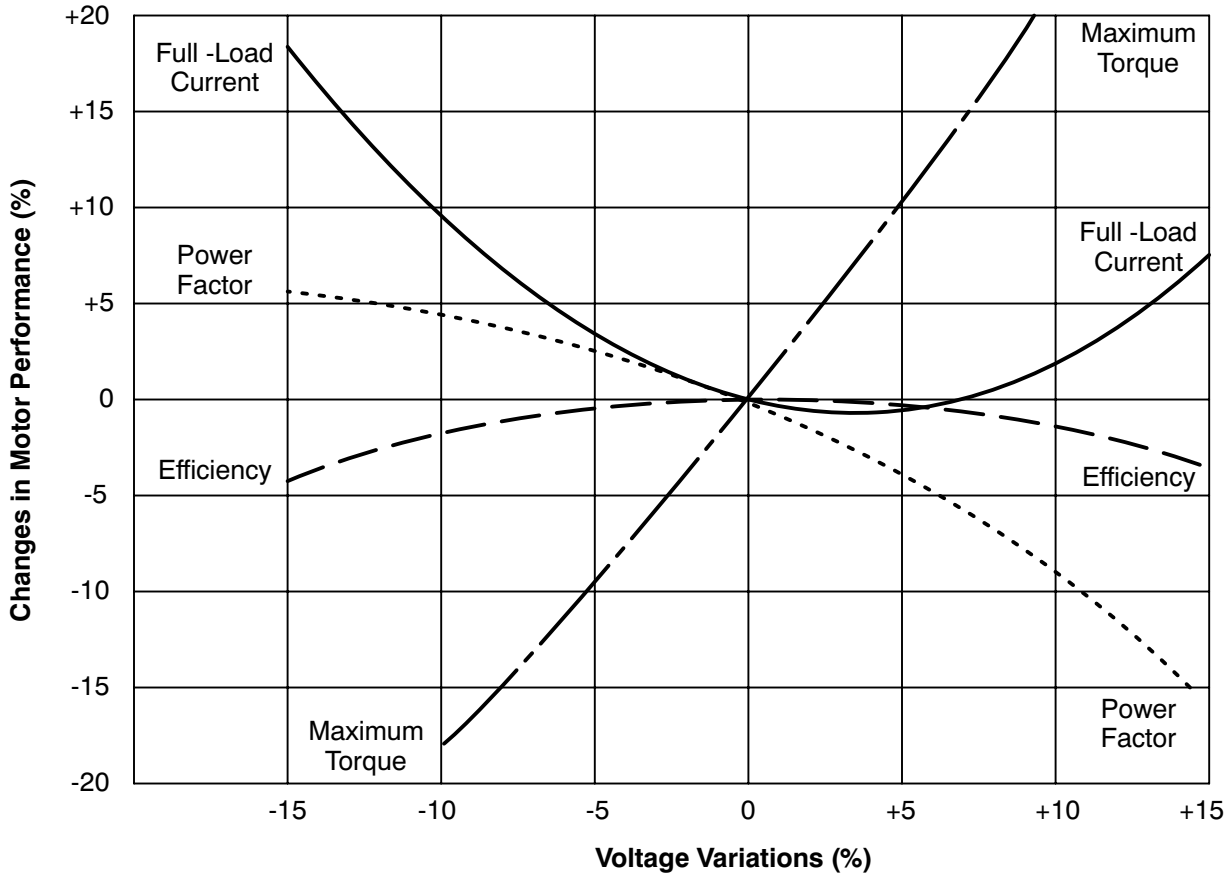
1. AC power is within ±10% of rated voltage with rated frequency. (See motor name plate for ratings).
   OR
2. AC power is within ±5% of rated frequency with rated voltage.
   OR
3. A combined variation in voltage and frequency of ±10% (sum of absolute values) of rated values, provided the frequency variation does not exceed ±5% of rated frequency.

Performance within these voltage and frequency variations are shown in Figure 2-2.

Figure 2-1 Accessory Connections

HEATERS H1 — H2 H1 — H2	One heater is installed in each end of motor. Leads for each heater are labeled H1 & H2. (Like numbers should be tied together).
THERMISTERS T1 — T2	Three thermisters are installed in windings and tied in series. Leads are labeled T1 & T2.
WINDING RTDS RED RED WHITE	Winding RTDs are installed in windings (2) per phase. Each set of leads is labeled W1, W2, W3, W4, W5, & W6.
BEARING RTD RED RED WHITE	* One bearing RTD is installed in Drive endplate (PUEP), leads are labeled RTDDE. * One bearing RTD is installed in Opposite Drive endplate (FREP), leads are labeled RTDODE. * Note RTD may have 2-Red/1-White leads; or 2-White/1-Red Lead.

Figure 2-2 Typical Motor Performance VS Voltage Variations



First Time Start Up

Be sure that all power to motor and accessories is off. Be sure the motor shaft is disconnected from the load and will not cause mechanical rotation of the motor shaft.

1. Make sure that the mechanical installation is secure. All bolts and nuts are tightened etc.
2. If motor has been in storage or idle for some time, check winding insulation integrity with a Megger.
3. Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity.
4. Be sure all shipping materials and braces (if used) are removed from motor shaft.
5. Manually rotate the motor shaft to ensure that it rotates freely.
6. Replace all panels and covers that were removed during installation.
7. Momentarily apply power and check the direction of rotation of the motor shaft.
8. If motor rotation is wrong, be sure power is off and change the motor lead connections. Verify rotation direction before you continue.
9. Start the motor and ensure operation is smooth without excessive vibration or noise. If so, run the motor for 1 hour with no load connected.
10. After 1 hour of operation, disconnect power and connect the load to the motor shaft. Verify all coupling guards and protective devices are installed. Ensure motor is properly ventilated.

Coupled Start Up

This procedure assumes a coupled start up. Also, that the first time start up procedure was successful.

1. Check the coupling and ensure that all guards and protective devices are installed.
2. Check that the coupling is properly aligned and not binding.
3. The first coupled start up should be with no load. Apply power and verify that the load is not transmitting excessive vibration back to the motor though the coupling or the foundation. Vibration should be at an acceptable level.
4. Run for approximately 1 hour with the driven equipment in an unloaded condition.

The equipment can now be loaded and operated within specified limits. Do not exceed the name plate ratings for amperes for steady continuous loads.

Jogging and Repeated Starts Repeated starts and/or jogs of induction motors generally reduce the life of the motor winding insulation. A much greater amount of heat is produced by each acceleration or jog than by the same motor under full load. If it is necessary to repeatedly start or jog the motor, it is advisable to check the application with your local Baldor distributor or Baldor Service Center.

Heating - Duty rating and maximum ambient temperature are stated on the motor name plate. Do not exceed these values. If there is any question regarding safe operation, contact your local Baldor distributor or Baldor Service Center.

Section 3
Maintenance & Troubleshooting

WARNING: UL Listed motors must only be serviced by UL Approved Authorized Baldor Service Centers if these motors are to be returned to a hazardous and/or explosive atmosphere.

General Inspection

Inspect the motor at regular intervals, approximately every 500 hours of operation or every 3 months, whichever occurs first. Keep the motor clean and the ventilation openings clear. The following steps should be performed at each inspection:

WARNING: Do not touch electrical connections before you first ensure that power has been disconnected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt the installation, operation and maintenance of this equipment.

1. Check that the motor is clean. Check that the interior and exterior of the motor is free of dirt, oil, grease, water, etc. Oily vapor, paper pulp, textile lint, etc. can accumulate and block motor ventilation. If the motor is not properly ventilated, overheating can occur and cause early motor failure.
2. Use a "Megger" periodically to ensure that the integrity of the winding insulation has been maintained. Record the Megger readings. Immediately investigate any significant drop in insulation resistance.
3. Check all electrical connectors to be sure that they are tight.

Relubrication & Bearings

Bearing grease will lose its lubricating ability over time, not suddenly. The lubricating ability of a grease (over time) depends primarily on the type of grease, the size of the bearing, the speed at which the bearing operates and the severity of the operating conditions. Good results can be obtained if the following recommendations are used in your maintenance program.

Type of Grease

A high grade ball or roller bearing grease should be used. Recommended grease for standard service conditions is Polyrex EM (Exxon Mobil).

Equivalent and compatible greases include:
Texaco Polystar, Rykon Premium #2, Pennzoil Pen 2 Lube and Chevron SRI.

Relubrication Intervals

Recommended relubrication intervals are shown in Table 3-1. It is important to realize that the recommended intervals of Table 3-1 are based on average use.

Refer to additional information contained in Tables 3-2, 3-3 and 3-4.

Table 3-1 Relubrication Intervals *

NEMA / (IEC) Frame Size	Rated Speed - RPM					
	10000	6000	3600	1800	1200	900
Up to 210 incl. (132)	**	2700 Hrs.	5500 Hrs.	12000 Hrs.	18000 Hrs.	22000 Hrs.
Over 210 to 280 incl. (180)		**	3600 Hrs.	9500 Hrs.	15000 Hrs.	18000 Hrs.
Over 280 to 360 incl. (225)		**	* 2200 Hrs.	7400 Hrs.	12000 Hrs.	15000 Hrs.
Over 360 to 5800 incl. (300)		**	*2200 Hrs.	3500 Hrs.	7400 Hrs.	10500 Hrs.

* Relubrication intervals are for ball bearings.
For vertically mounted motors and roller bearings, divide the relubrication interval by 2.

** For motors operating at speeds greater than 3600 RPM, contact Baldor for relubrication recommendations.

Table 3-2 Service Conditions

Severity of Service	Hours per day of Operation	Ambient Temperature Maximum	Atmospheric Contamination
Standard	8	40° C	Clean, Little Corrosion
Severe	16 Plus	50° C	Moderate dirt, Corrosion
Extreme	16 Plus	>50° C* or Class H Insulation	Severe dirt, Abrasive dust, Corrosion, Heavy Shock or Vibration
Low Temperature		<-29 ° C **	

* Special high temperature grease is recommended (Dow Corning DC44). Note that Dow Corning DC44 grease does not mix with other grease types. Thoroughly clean bearing & cavity before adding grease.

** Special low temperature grease is recommended (Aeroshell 7).

Table 3-3 Relubrication Interval Multiplier

Severity of Service	Multiplier
Standard	1.0
Severe	0.5
Extreme	0.1
Low Temperature	1.0

Some motor designs use different bearings on each motor end. This is normally indicated on the motor nameplate. In this case, the larger bearing is installed on the motor Drive endplate. For best relubrication results, only use the appropriate amount of grease for each bearing size (not the same for both).

Table 3-4 Bearings Sizes and Types

Frame Size NEMA (IEC)	Bearing Description (These are the "Large" bearings (Shaft End) in each frame size)			
	Bearing	Weight of Grease to add * oz (Grams)	Volume of grease to be added	
			in^3	teaspoon
56 to 140 (90)	6203	0.08 (2.4)	0.15	0.5
140 (90)	6205	0.15 (3.9)	0.2	0.8
180 (100-112)	6206	0.19 (5.0)	0.3	1.0
210 (132)	6307	0.30 (8.4)	0.6	2.0
250 (160)	6309	0.47 (12.5)	0.7	2.5
280 (180)	6311	0.61 (17)	1.2	3.9
320 (200)	6312	0.76 (20.1)	1.2	4.0
360 (225)	6313	0.81 (23)	1.5	5.2
400 (250)	6316	1.25 (33)	2.0	6.6
440 (280)	6319	2.12 (60)	4.1	13.4
5000 to 5800 (315-450)	6328	4.70 (130)	9.2	30.0
5000 to 5800 (315-450)	NU328	4.70 (130)	9.2	30.0
360 to 449 (225-280)	NU319	2.12 (60)	4.1	13.4
AC Induction Servo				
76 Frame 180 (112)	6207	0.22 (6.1)	0.44	1.4
77 Frame 210 (132)	6210	0.32 (9.0)	0.64	2.1
80 Frame 250(160)	6213	0.49 (14.0)	0.99	3.3

* Weight in grams = .005 DB of grease to be added

Note: Not all bearing sizes are listed. For intermediate bearing sizes, use the grease volume for the next larger size bearing.

Caution: To avoid damage to motor bearings, grease must be kept free of dirt. For an extremely dirty environment, contact your Baldor distributor or an authorized Baldor Service Center for additional information.

Relubrication Procedure

Be sure that the grease you are adding to the motor is compatible with the grease already in the motor. Consult your Baldor distributor or an authorized service center if a grease other than the recommended type is to be used.

Caution: Do not over-lubricate motor as this may cause premature bearing failure.

With Grease Outlet Plug

1. With the motor stopped, clean all grease fittings with a clean cloth.
2. Remove grease outlet plug.

Caution: Over-lubricating can cause excessive bearing temperatures, premature lubrication breakdown and bearing failure.

3. Add the recommended amount of grease.
4. Operate the motor for 15 minutes with grease plug removed. This allows excess grease to purge.
5. Re-install grease outlet plug.

Without Grease Provisions

Note: Only a Baldor authorized and UL or CSA certified service center can disassemble a UL/CSA listed explosion proof motor to maintain it's UL/CSA listing.

1. Disassemble the motor.
2. Add recommended amount of grease to bearing and bearing cavity. (Bearing should be about 1/3 full of grease and outboard bearing cavity should be about 1/2 full of grease.)
3. Assemble the motor.

Sample Relubrication Determination

Assume - NEMA 286T (IEC 180), 1750 RPM motor driving an exhaust fan in an ambient temperature of 43° C and the atmosphere is moderately corrosive.

1. Table 3-1 list 9500 hours for standard conditions.
2. Table 3-2 classifies severity of service as "Severe".
3. Table 3-4 shows that 1.2 in^3 or 3.9 teaspoon of grease is to be added.

Note: Smaller bearings in size category may require reduced amounts of grease.

Table 3-5 Troubleshooting Chart

Symptom	Possible Causes	Possible Solutions
Motor will not start	Usually caused by line trouble, such as, single phasing at the starter.	Check source of power. Check overloads, fuses, controls, etc.
Excessive humming	High Voltage.	Check input line connections.
	Eccentric air gap.	Have motor serviced at local Baldor service center.
Motor Over Heating	Overload. Compare actual amps (measured) with nameplate rating.	Locate and remove source of excessive friction in motor or load. Reduce load or replace with motor of greater capacity.
	Single Phasing.	Check current at all phases (should be approximately equal) to isolate and correct the problem.
	Improper ventilation.	Check external cooling fan to be sure air is moving properly across cooling fins. Excessive dirt build-up on motor. Clean motor.
	Unbalanced voltage.	Check voltage at all phases (should be approximately equal) to isolate and correct the problem.
	Rotor rubbing on stator.	Check air gap clearance and bearings.
		Tighten “Thru Bolts”.
	Over voltage or under voltage.	Check input voltage at each phase to motor.
	Open stator winding.	Check stator resistance at all three phases for balance.
	Grounded winding.	Perform dielectric test and repair as required.
	Improper connections.	Inspect all electrical connections for proper termination, clearance, mechanical strength and electrical continuity. Refer to motor lead connection diagram.
Bearing Over Heating	Misalignment.	Check and align motor and driven equipment.
	Excessive belt tension.	Reduce belt tension to proper point for load.
	Excessive end thrust.	Reduce the end thrust from driven machine.
	Excessive grease in bearing.	Remove grease until cavity is approximately $^3/_4$ filled.
	Insufficient grease in bearing.	Add grease until cavity is approximately $^3/_4$ filled.
	Dirt in bearing.	Clean bearing cavity and bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.
Vibration	Misalignment.	Check and align motor and driven equipment.
	Rubbing between rotating parts and stationary parts.	Isolate and eliminate cause of rubbing.
	Rotor out of balance.	Have rotor balance checked are repaired at your Baldor Service Center.
	Resonance.	Tune system or contact your Baldor Service Center for assistance.
Noise	Foreign material in air gap or ventilation openings.	Remove rotor and foreign material. Reinstall rotor. Check insulation integrity. Clean ventilation openings.
Growling or whining	Bad bearing.	Replace bearing. Clean all grease from cavity and new bearing. Repack with correct grease until cavity is approximately $^3/_4$ filled.

Suggested bearing and winding RTD setting guidelines

Most large frame AC Baldor motors with a 1.15 service factor are designed to operate below a Class B (80°C) temperature rise at rated load and are built with a Class H winding insulation system. Based on this low temperature rise, RTD (Resistance Temperature Detectors) settings for Class B rise should be used as a starting point. Some motors with 1.0 service factor have Class F temperature rise.

The following tables show the suggested alarm and trip settings for RTDs. Proper bearing and winding RTD alarm and trip settings should be selected based on these tables unless otherwise specified for specific applications.

If the driven load is found to operate well below the initial temperature settings under normal conditions, the alarm and trip settings may be reduced so that an abnormal machine load will be identified.

The temperature limits are based on the installation of the winding RTDs imbedded in the winding as specified by NEMA. Bearing RTDs should be installed so they are in contact with the outer race on ball or roller bearings or in direct contact with the sleeve bearing shell.

Winding RTDs - Temperature Limit In °C (40°C Maximum Ambient)

Motor Load	Class B Temp Rise ≤ 80°C (Typical Design)		Class F Temp Rise ≤ 105°C		Class H Temp Rise ≤ 125°C	
	Alarm	Trip	Alarm	Trip	Alarm	Trip
≤ Rated Load	130	140	155	165	175	185
Rated Load to 1.15 S.F.	140	150	160	165	180	185

Note: • Winding RTDs are factory production installed, not from Mod-Express.
• When Class H temperatures are used, consider bearing temperatures and relubrication requirements.

Bearing RTDs - Temperature Limit In °C (40°C Maximum Ambient)

Bearing Type Oil or Grease	Anti-Friction		Sleeve	
	Alarm	Trip	Alarm	Trip
Standard*	95	100	85	95
High Temperature**	110	115	105	110

Note: * Bearing temperature limits are for standard design motors operating at Class B temperature rise.
** High temperature lubricants include some special synthetic oils and greases.

Greases that may be substituted that are compatible with Polyrex EM (but considered as "standard" lubricants) include the following:

- Texaco Polystar
- Rykon Premium #2
- Chevron SRI #2
- Mobilith SHC-100
- Pennzoil Pennzlube EM-2
- Chevron Black Pearl
- Darmex 707
- Darmex 711
- Petro-Canada Peerless LLG

See the motor nameplate for replacement grease or oil recommendation.
Contact Baldor application engineering for special lubricants or further clarifications.

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BANNER®
the machine safety specialist

GM-FA-10J Gate Monitoring Safety Module

24V ac/dc operation, 1- or 2-Channel Input

Features

- Monitors one or two safety switches for a contact failure or wiring fault
- Two output switching channels for connection to control-reliable power interrupt circuits
- Auto reset or monitored manual reset
- Design complies with standards UL991, ISO 14119, and ISO 13849-1 (EN954-1) (Safety Category 2, 3 or 4)
- For use in functional stop category 0 applications per NFPA 79 and IEC 204-1
- 6 amp safety output contacts
- Plug-in terminal blocks
- If terminal blocks are swapped, Gate Monitor Module remains functional with no loss of safety function

Important ... read this page before proceeding!

Banner Engineering Corp. has made every effort to provide complete application, installation, operation, and maintenance instructions. In addition, any questions regarding the use or installation of this Safety Module should be directed to the factory applications department at the telephone numbers or address shown on back cover.

The user shall ensure that all machine operators, maintenance personnel, electricians, and supervisors are thoroughly familiar with and understand all instructions regarding the installation, maintenance, and use of this Safety Module, and with the machinery it controls.

The user and any personnel involved with the installation and use of this Safety Module must be thoroughly familiar with all applicable ANSI/NFPA standards. The standards, listed below, directly address the use of this Safety Module. Banner Engineering Corp. makes no claim regarding a specific recommendation of any organization, the accuracy or effectiveness of any information provided, or the appropriateness of the provided information for a specific application.

The user has the responsibility to ensure that all local, state, and national laws, rules, codes, and regulations relating to the use of this Safety Module in any particular application are satisfied. Extreme care is urged that all legal requirements have been met and that all installation and maintenance instructions contained in this manual are followed.

Applicable U. S. Standards

ANSI B11	Standards for Machine Tools Available from:	Safety Director AMT – The Association for Manufacturing Technology 7901 Westpark Drive McLean, VA 22102-4269 Tel.: 703-827-2900
NFPA79	"Electrical Standard for Industrial Machinery Available from:	National Fire Protection Association 1 Batterymarch Park, P.O. Box 9101 Quincy, MA 02269-9101 Tel.: 800-344-3555
ANSI/RIA R15.06	"Safety Requirements for Industrial Robots and Robot Systems" Available from:	Robotic Industries Association 900 Victors Way, P.O. Box 3724 Ann Arbor, MI 48106 Tel.: 734-994-6088

Applicable European Standards

ISO/TR12100-1 & -2 (EN292-1 & -2)	"Safety of Machinery – Basic Concepts, General Principals for Design, Part 1: Basic Terminology, Methodology" and "Part 2: Technical Principles and Specifications"
IEC/EN60204-1	"Electrical Equipment of Machines: Part 1: General Requirements" Also, request a type "C" standard for your specific machinery.
ISO13849-1 (EN954-1)	"Safety of Machinery – Safety Related Parts of Control Systems"
ISO13855 (EN999)	"Safety of Machinery – The Positioning of Protective Equipment"
ISO14119 (EN1088)	"Safety of Machinery – Interlocking Devices Associated with Guards"
Available from:	Global Engineering Documents 15 Inverness Way East Englewood, CO 80112-5704 Tel.: 800-854-7179

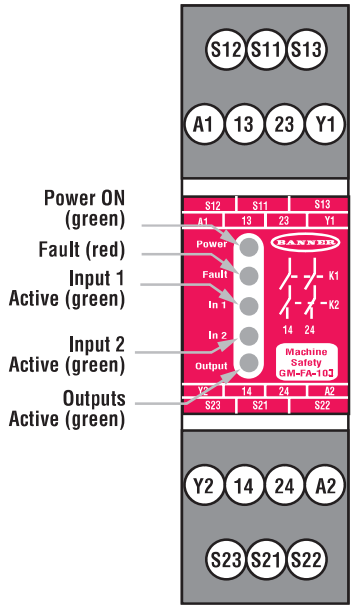


Figure 1. GM-FA-10J features and terminal locations

WARNING . . .

It must not be possible for personnel to reach any hazard point through an opened guard (or any opening) before hazardous machine motion has completely stopped. Please reference the appropriate standards (see page 2) for information on determining safety distances and safe opening sizes for your guarding devices.

Overview

The purpose of the GM-FA-10J Gate Monitor Safety Module is to verify the proper operation of coded magnetic safety switches and positive-opening safety switches by monitoring a normally open (NO) and a normally closed (NC) contact from each switch. In a typical application, two safety switches (individually mounted) indicate the open or closed status of a gate, moveable guard, or barrier (all called "guards" throughout this document).

The Safety Module monitors each switch for complementary switching (each channel must have one open input and one closed input at all times). These inputs must always be in opposite states and must switch state within 1 second of each other. Channel 1 has a "guard closed" condition when S11/S13 is closed and S11/S12 is open. Similarly, Channel 2 has a "guard closed" condition when S21/S23 is closed and S21/S22 is open (see Figures 2 and 3). The Safety Module also will detect and properly respond to a short circuit between the channels and a short circuit to other sources of power. The Safety Module will open the safety outputs within 15 milliseconds of the switching of either channel when the guard opens.

When the guard closes, debounce logic in the Safety Module's inputs increases the reliability and repeatability of successfully resetting the Safety Module and reduces the necessity of re-cycling the guard. This feature can result in increased efficiency of the machine, even if the guard is misaligned or vibration is present.

The GM-FA-10J Safety Module may be configured via DIP switches for two-channel (redundant switches on a single guard), or one-channel operation (individual switches on two guards). In two-channel operation, each channel must switch within 3-second simultaneity of the other when the guard closes. If not, the guard must be re-opened and closed until the timing requirement is met. When the guard opens, the two channels operate concurrently (both channels must switch, but without the timing requirement).

In one-channel operation, each channel operates individually, except to reset the device (in which case both guards must be closed). If only one switch is being monitored, the closed input of the unused channel must be jumpered (S11/S13 or S21/S23).

The reset function has two options, selected by DIP switch: Automatic reset or Monitored Manual reset. See Figure 7 for configuration information.

The reset input also can be used for an External Device Monitoring (EDM) circuit. The EDM circuit consists of a normally closed, force-guided contact from each device being controlled by the GM-FA-10J, all wired in series with the Reset button (if used) and terminated at terminals Y1 and Y2. See Figure 6 for further information.

The output of the Gate Monitor Safety Module consists of two redundant output switching channels, each of which is the series connection of two forced-guided relay contacts (K1 and K2 in Figure 6). Each of the switching outputs is rated for up to 250V ac at up to 6 amps.

Safety Switch Requirements

The following general requirements and considerations apply to the installation of interlocked gates and guards for the purpose of safeguarding. In addition, the user must refer to the relevant regulations and be sure to comply with all necessary requirements.

Hazards guarded by the interlocked guard must be prevented from operating until the guard is closed; a stop command must be issued to the guarded machine if the guard opens while the hazard is present. Closing the guard must not, by itself, initiate hazardous motion; a separate procedure must be required to initiate the motion. The safety switches must not be used as a mechanical or end-of-travel stop.

The guard must be located an adequate distance from the danger zone (so the hazard has time to stop before the guard is opened sufficiently to provide access to the hazard), and it must open either laterally or away from the hazard, not into the safeguarded area. The guard also should not be able to close by itself and activate the interlocking circuitry. The installation must prevent personnel from reaching over, under, around or through the guard to the hazard. Any openings in the guard must not allow access to the hazard (see the appropriate standard). The guard must be strong enough and designed to protect personnel and contain hazards within the guarded area that can be ejected, dropped or emitted by the machine.

The safety switches, actuators and magnets used with the Safety Module must be designed and installed so that they cannot be easily defeated. They must be mounted securely, so that their physical position can not shift, using reliable fasteners that require a tool to remove. Mounting slots in the housings are for initial adjustment only; final mounting holes must be used for permanent location.

Positive-Opening Interlocking Switches

Safety interlock switches used with the GM-FA-10J module must satisfy several requirements. Each switch must provide electrically isolated contacts: at minimum, one normally closed (NC) contact and one normally open (NO) contact to interface with the module.

The contacts must be of “positive-opening” design, with one or more normally closed contacts rated for safety. Positive-opening operation causes the switch to be forced open, without the use of springs, when the switch actuator is disengaged or moved from its home position (see the Banner Safety Catalog for examples). In addition, the switches must be mounted in a “positive mode,” to move/disengage the actuator from its home position and open the normally closed contact, when the guard opens.

Coded Magnetic Safety Switches

Similar to positive-opening safety switches, coded magnetic switches used with the GM-FA-10J module must provide one normally closed contact and one normally open contact (typically a four-wire switch). (See Banner Safety Catalog or page 15 for more information.)

The switch and its magnet must be mounted a minimum distance of 15 mm (0.6") from any magnetized or ferrous materials for proper operation. If either the switch or magnet is mounted on a material that can be magnetized (a ferrous metal, such as iron), the switching distance will be affected. Although the switch and magnet are coded to minimize the possibility of false actuation, they should not be used within known fields of high-level electromagnetic radiation.

Depending on the model of switch and magnet used, the installation must be designed to provide the correct direction of approach (see page 17). **The speed of approach must be fast enough to meet the simultaneity-monitoring period of 1.0 second, approximately equal to or greater than 0.1 m (4") per second.** If the simultaneity requirement is not met, the Safety Module can not be reset and will not close its safety output contacts.

Switch Hookups, Typical Applications

Requirements vary widely for the level of control reliability or safety category (per ISO 13849) in the application of interlocked guards. While Banner Engineering always recommends the highest level of safety in any application, it is the responsibility of the user to safely install, operate and maintain each safety system and comply with all relevant laws and regulations. The applications shown in Figures 2 and 3 meet or exceed the requirements for control reliability and Safety Category 3 or 4, per ISO 13849 (EN954-1).

Mechanical Installation

Route the switch cable to the Safety Module location. The Safety Module must be installed inside an enclosure; it is not designed for exposed wiring. It is the user's responsibility to house the Safety Module in an enclosure with a NEMA (or IEC) rating suitable for the operating environment. The Safety Module may be mounted directly onto standard 35 mm DIN rail.

For reliable operation, the user must ensure that the operating specifications are not exceeded. The enclosure must provide adequate heat dissipation, so the air closely surrounding the Module does not exceed its maximum operating temperature. Methods to reduce heat build-up include venting, forced airflow (e.g., exhaust fans), adequate enclosure exterior surface area, and spacing between modules and other sources of heat. (See Specifications, Operating Conditions: Temperature.)

Electrical Installation

Each Safety Module is powered by 24V ac/dc (at less than 150 mA). The Safety Module, in turn, supplies power to each switch.

Two functions of the Safety Module are:

1) To monitor the contacts and wiring of safety switches for certain failures and to prevent the machine from restarting if the switch or the Module fails, and

2) To provide a reset routine after closing the guard and returning the inputs to their "closed" condition – this prevents the controlled machinery from restarting automatically when the guard closes. This necessary reset function is required by ANSI B11 and NFPA 79 machine safety standards.

See Figures 2 through 5 for connection of safety switches.

Monitoring Series-Connected Safety Switches

When monitoring two individually mounted safety switches (as shown in Figures 2 and 3), a faulty switch will be detected if it fails to switch as the guard opens. In this case, the Gate Monitor Module will de-energize its output relays and disable its reset function until the input requirements are met (i.e., the faulty switch is replaced). However, when a series of interlocking safety switches is monitored by a single Gate Monitor Module, the failure of one switch in the system may be masked or not detected at all (refer to Figures 4 and 5).

Series-connected interlock switch circuits do not meet ISO 13849 (EN954-1) Safety Category 4 and may not meet Control Reliability requirements because of the potential for an inappropriate Gate Monitor reset or a potential loss of the safety stop signal. A multiple connection of this type should not be used in applications where loss of the safety stop signal or an inappropriate reset can lead potentially to serious injury or death. The following two scenarios assume two positive-opening safety switches on each guard:

1) **Masking of a failure.** If a guard is opened but a switch fails to open, the redundant safety switch will open and cause the Safety Module to de-energize its outputs. If the faulty guard is then closed, both Safety Module input channels also close, but because one channel did not open, the Safety Module will not reset. However, if the faulty switch is not replaced and a second "good" guard is cycled (opening and then closing both of the Module's input channels), the Module considers the failure to be corrected. With the input requirements apparently satisfied, the Module allows a reset. This system is no longer redundant and, if the second switch fails, may result in an unsafe condition (i.e., the accumulation of faults results in the loss of the safety function).

2) **Non-detection of a failure.** If a good guard is opened, the Safety Module de-energizes its outputs (a normal response). But if a faulty guard is then opened and closed before the good guard is re-closed, the failure on the faulty guard is not detected. This system is no longer redundant and may result in a loss of safety if the second safety switch fails to switch when needed.

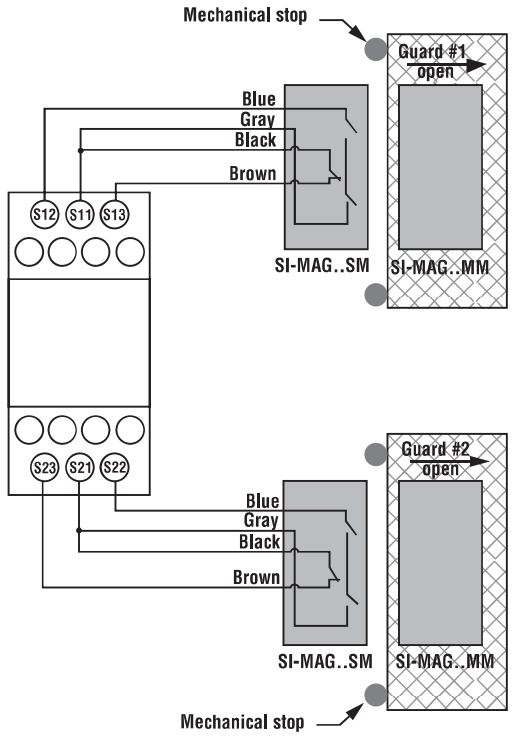
The systems in either scenario do not inherently comply with the safety standard requirements of detecting single faults and preventing the next cycle. In multiple-guard systems using series-connected safety switches, it is important to periodically check the functional integrity of each interlocked guard individually. **Operators, maintenance personnel, and others associated with the operation of the machine must be trained to recognize such failures and be instructed to correct them immediately.**

Open and close each guard separately while verifying that the Gate Monitor outputs operate correctly throughout the check procedure. Follow each gate closure with a manual reset, if needed. If a contact set fails, the Safety Module will not enable its reset function. If the Safety Module does not reset, a switch may have failed; that switch must be immediately replaced.

This check must be performed and all faults must be cleared, at a minimum, during periodic checkouts. **If the application can not exclude these types of failures and such a failure could result in serious injury or death, then the series connection of safety switches must not be used.**

One-Channel Monitoring

Configured for one-channel monitoring of either one or two guards. This application is considered to meet or exceed requirements for Control Reliability and Safety Categories 3 and 4 per ISO 13849-1 (EN954-1).

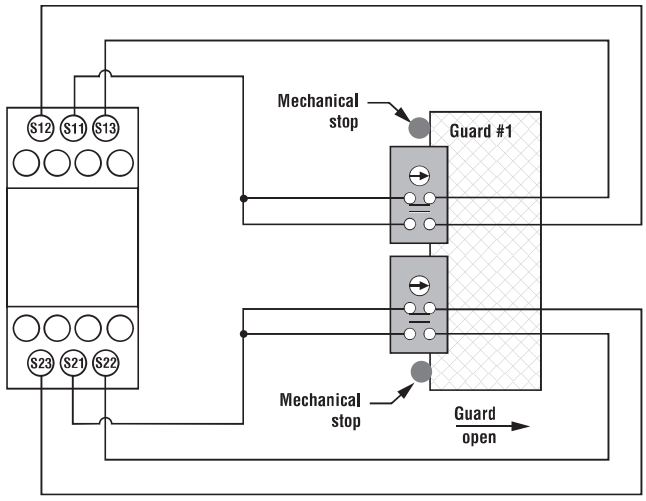


NOTE: If only one magnetic safety switch is used, select 1-channel input and jumper S23 to S21.

Figure 2. Hookup to two 4-wire coded magnetic safety switches

Two-Channel Monitoring

Configured for two-channel monitoring of one guard. This application is considered to meet or exceed requirements for Control Reliability and Safety Categories 3 and 4 per ISO 13849-1 (EN954-1).



NOTE: Guard shown in closed position.

Figure 3. Hookup to two positive-opening safety interlock switches

One-Channel Monitoring

Configured for one-channel monitoring of multiple guards with single switches at each guard (see Warning). Up to 10 Banner magnetic switches may be connected to each channel in this series/parallel method.

WARNING . . . Not a Safety Category 4 Application

When monitoring multiple guards with a series connection of multiple safety interlock switches, a single failure may be masked or not detected at all.

When such a configuration is used, procedures must be performed regularly to verify proper operation of each switch. See "Monitoring Series-Connected Safety Switches" (page 6) for more information.

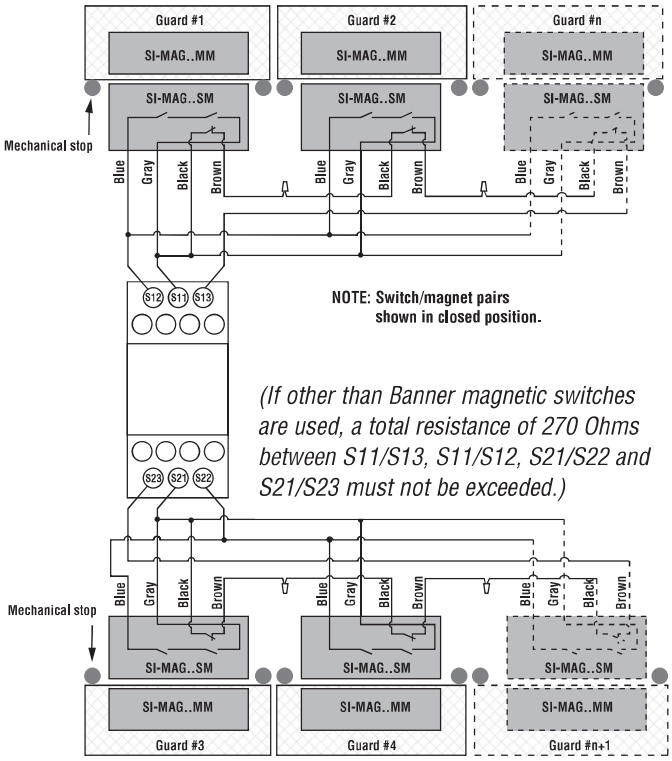


Figure 4. Alternate hookup for one-channel monitoring of multiple guards

Two-Channel Monitoring

Configured for two-channel monitoring of multiple guards with two safety switches mounted individually on each guard (see Warning).

The number of mechanical switches is limited by the max. resistance of 270 ohm between S11/S13, S11/S12, S21/S22 and S21/S23. The total resistance is calculated by adding the resistance of all guard switch contacts and the resistance of the cables that connect the switches and the switches to the module.

WARNING . . . Not a Safety Category 4 Application

When monitoring multiple guards with a series connection of multiple safety interlock switches, a single failure may be masked or not detected at all.

When such a configuration is used, procedures must be performed regularly to verify proper operation of each switch. See "Monitoring Series-Connected Safety Switches" (page 6) for more information.

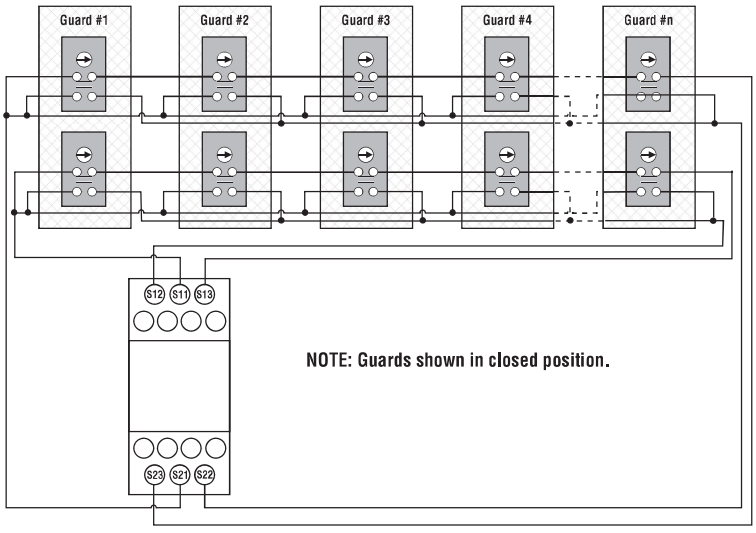


Figure 5. Alternate hookup for two-channel monitoring of multiple guards

WARNING . . .
Wiring of Arc Suppressors

If arc suppressors are used, they MUST be installed as shown across the actuator coil of the master stop control elements (MPCE1 and MPCE2). **NEVER install suppressors directly across the output contacts of the Safety Module.** It is possible for suppressors to fail as a short circuit. If installed directly across the output contacts of the Safety Module, **a short-circuited suppressor will create an unsafe condition which could result in serious injury or death.**

WARNING . . .
Interfacing MPCEs

NEVER wire an intermediate device (for example, a programmable logic controller), other than a Safety Relay, between Safety Module outputs and the Machine Primary Control Element it switches. To do so sacrifices the control reliability of the control-to-machine interface and creates an unsafe condition, which could result in serious injury or death. Whenever forced-guided, mechanically linked relays are added as intermediate switching devices, a normally closed monitor contact of those relays must be added to the series feedback loop between Safety Module terminals Y1 and Y2.

Connection to the Guarded Machine

The machine interface hookup diagram (Figure 6) shows a generic connection of the Gate Monitor Safety Module's two redundant output circuits to machine primary control elements MPCE1 and MPCE2. A machine primary control element is an electrically powered device, external to the Safety Module, which stops the guarded machinery by immediately removing electrical power to the machine and (when necessary) by applying braking to dangerous motion. The stop is accomplished by removing power to the actuator coil of either MPCE.

To satisfy the Safety Category 4 requirements of ISO 13849 (EN 954-1), each MPCE must offer a normally closed, forced-guided monitor contact. One normally closed monitor contact from each MPCE is wired in series to the Y1-Y2 feedback/reset input (see Figure 6). In operation, if one of the switching contacts of either MPCE fails in the shorted condition, the associated monitor contact will remain open, preventing the reset of the Gate Monitor Safety Module.

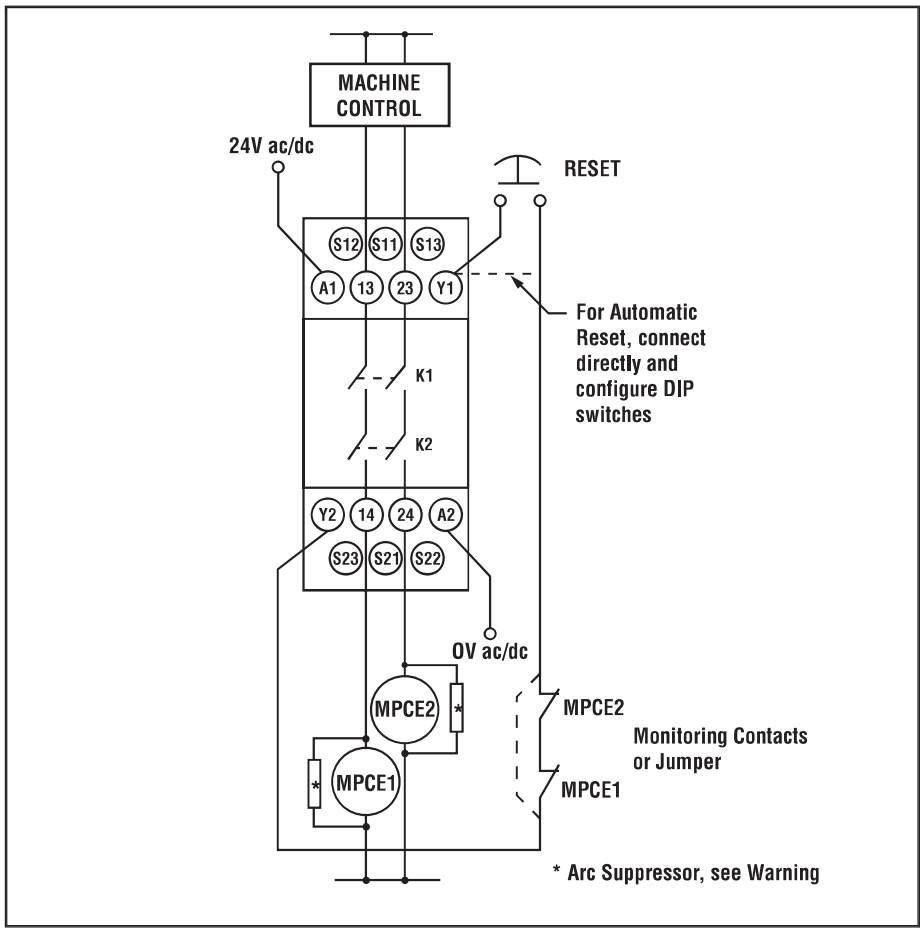


Figure 6. Hookup to the guarded machine

Manual Reset and Reset Switch Connection

The Safety Module may be configured for Manual Reset by setting switches S1.2 and S2.2 in Banks A and B to OFF. The Reset switch may be any mechanical normally open switch, but should be a momentary switch or a two-position keyed switch. To reset the Safety Module, both guards must be closed, at which time the output LED will flash (signaling that the Reset switch must be cycled). This action is a monitored manual reset (open-closed-open), where the "closed" phase is approximately 0.25 to 2 seconds long.

The Reset switch must be capable of reliably switching 15 to 30V dc at 5 to 50 mA. As shown in Figure 6, the Reset switch connects between terminals Y1 and Y2 of the Safety Module. The Reset switch must be located outside of – and not accessible from – the area of dangerous motion, and it must be positioned so the switch operator can see all areas of dangerous motion during the Reset procedure.

Configuration

Automatic Reset Mode

The Safety Module may be configured for Automatic Reset by setting switches S1.2 and S2.2 in Banks A and B to ON. If no MPCE contacts are monitored, a jumper must be installed between terminals Y1 and Y2 (see Figure 6). The Safety Module will reset (and its outputs will energize) as soon as the guards return to their closed position.

Automatic Reset is useful for some automated processes. However, if Automatic Reset is used, an alternate means must be provided to prevent resumption of hazardous machine motion until an alternate reset procedure is performed. The alternate means must include a Reset switch, located outside the area of dangerous motion, and positioned so that the switch operator can see all areas of dangerous motion during the reset procedure.

1-Channel or 2-Channel Input

Model GM-FA-10J may be configured for 1-channel or 2-channel operation by setting DIP switches S1.1 and S2.1 in Banks A and B. In 1-channel operation (S1.1 and S2.1 – ON), the input channels function independently. The two guards can be monitored individually, but both channels must be in the closed position for the Safety Module to be reset.

In 2-channel operation (S1.1 and S2.1 – OFF) the input channels must function together. Both channels must switch within a 3-second simultaneity of the other when the guard closes. If not, the guard must be re-opened and closed until the timing requirement is met. When the guard opens, the channels function concurrently (both must open, but without the timing requirement).

In either configuration, the "closed" inputs of each channel must be closed before the Safety Module can be reset (continuity S11 to S13 and S21 to S23). If in 1-channel mode and monitoring only one switch, a jumper must be installed at the unused input (e.g., S21 to S23; see Figure 2).

NOTE: "1-channel" is also known as "single channel," and "2-channel" is also known as "dual channel."

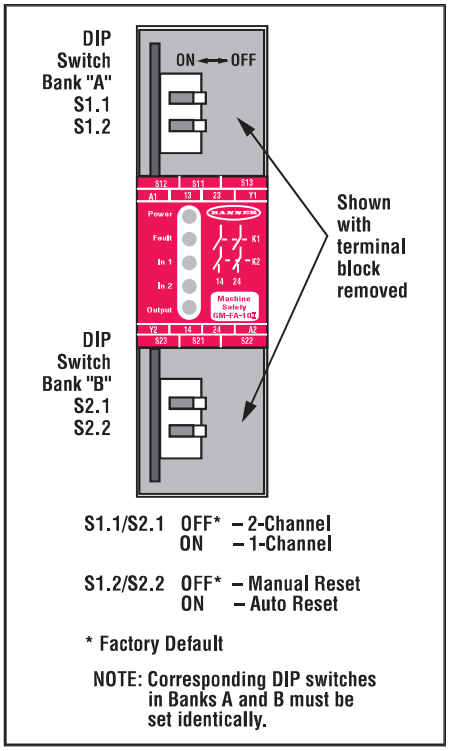


Figure 7. DIP switch configuration settings for reset mode and 1- or 2-channel operation

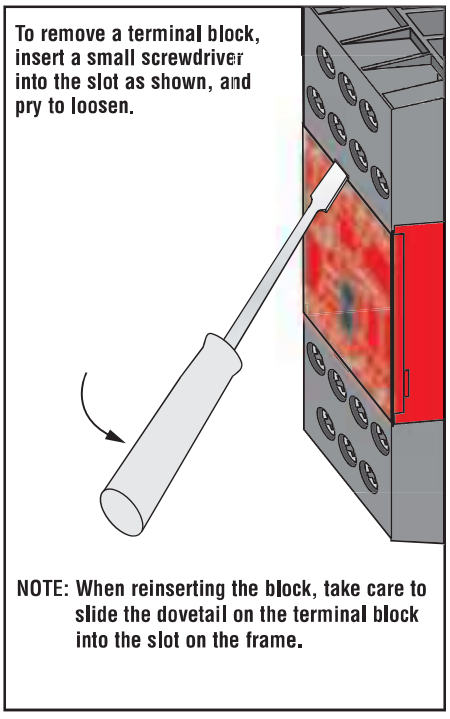


Figure 8. Removal of terminal blocks

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CAUTION . . .
Disconnect Power Prior to Checkout

Before performing the initial checkout procedure, make certain all power is disconnected from the machine to be controlled. Dangerous voltages may be present along the E-stop Safety Module wiring barriers whenever power to the machine control elements is ON. **Exercise extreme caution whenever machine control power is or may be present. Always disconnect power to the machine control elements before opening the enclosure housing of the Safety Module.**

Initial Checkout Procedure

1) Remove power from the machine control elements.
2) Close all monitored guards. If the Module is wired to 1-channel input, the second input (S21/S23 or S11/S13) must be jumpered if unused.
3) Apply input power (only) to the Gate Monitor Module at terminals A1 and A2 (see Figure 6). The following LEDs should come ON:
   Power
   Input 1
   Input 2

   If the Power LED comes ON, but either or both Input LEDs are not ON, disconnect input power and check the wiring of the connected switch(es) and/or the jumper. Check if the jumper is installed correctly on the unused input. Return to step 2 after the cause of the problem has been corrected.
4) **If the Module is set to 1-channel operation:** After the Power, Input 1, and Input 2 LEDs all are ON, open and close all connected guards one at a time. When each individual guard opens, the corresponding Input LED must turn OFF, and when the guard closes its LED must come ON again.

   If the Module is set to 2-channel operation: After the Power, Input 1, and Input 2 LEDs all are ON, open the guard; both switches must open within 3 seconds, and both Input LEDs must turn OFF. If the red Fault LED comes ON, simultaneity between the switches or within one switch (between its NO and NC contacts) was not met. Check all wiring and the switches.

   If the Module is set to Auto Reset (Y1/Y2 closed and DIP switches set to Auto Reset), the output LED will come ON as soon as both Input LEDs are ON (output contacts 13/14 and 23/24 close).

   If the Module is set to Manual Monitored Reset the Output LED should come ON only if Input 1 and 2 LEDs are ON and the Reset button connected to Y1 and Y2 went from open to closed and back to open position.
5) Repeat step 4 individually for each guard that is being monitored.
6) Close the guard. Apply power to the machine control elements and perform the Periodic Checkout Procedure on page 12.

NOTE: Make sure that both Input 1 and 2 LEDs are ON *only when ALL connected guards are closed.* If the guards are closed and the Input LEDs are OFF, the guard switches may be wired incorrectly, which could reset the Module inappropriately (safety output contacts close as soon as one of the connected guards opens).

Do not continue operation until all checks are completed and all problems are corrected. See the Warning on page 12, and Repair and Troubleshooting on pages 18 and 19 for further information.

Periodic Checks

At each shift change or machine setup, a Designated Person* should do the following checks on all safety switches:

1) Breakage or damage of the switch, actuator, or magnet.

2) Good alignment between the switch and actuator or magnet.

3) Confirmation that the switches are not being used as an end-of-travel stop.

4) Loosening of the mounting hardware.

5) Verification that it is not possible to reach any hazard point through an opened guard (or any opening) before hazardous machine motion stops completely.

6) Open and close each guard separately while verifying that the Gate Monitor outputs operate correctly throughout the check procedure. Follow each gate closure with a manual reset, if needed. If a contact set fails, the Safety Module will not enable its reset function. If the Safety Module does not reset, a switch may have failed; that switch must be immediately replaced.

In addition, a Qualified Person* should do the following on a periodic schedule (determined by the user, based upon the severity of the environment and the frequency of switch actuations):

1) Inspect the electrical wiring for continuity and damage.

2) Confirm that wiring conforms to the instructions given in this installation manual.

Do not continue operation until all checks are completed and all problems are corrected. See Repair and Troubleshooting on pages 18 and 19 for further information.

* A Designated Person is identified in writing by the employer as being appropriately trained to perform a specified checkout procedure. A Qualified Person possesses a recognized degree or certificate or has extensive knowledge, training, and experience to be able to solve problems relating to safety switch installation.

WARNING . . . Do Not Use Machine Until System Is Working Properly

If all of these checks cannot be verified, do not attempt to use the guarded machine until the defect or problem has been corrected.

Attempts to use the guarded machine under such conditions could result in serious bodily injury or death.

Specifications

Supply Voltage and Current	24V ac/dc ± 20% **Power consumption:** approx. 3 VA / 3 W
Supply Protection Circuitry	Protected against transient voltages and reverse polarity
Output Configuration	Each normally open output channel is a series connection of contacts from two forced-guided (mechanically linked) relays, K1-K2. **Contacts:** AgNi, 5 µm gold-plated **Low Current Rating** **Caution: The 5 µm gold-plated contacts allow the switching of low current/low voltage. In these low-power applications, multiple contacts can also be switched in series (e.g., "dry switching").** To preserve the gold plating on the contacts, do not exceed the following max. values at any time: **Min. voltage:** 1V ac/dc — **Max. voltage:** 60V **Min. current:** 5 mA ac/dc — **Max. current:** 300 mA **Min. power:** 5 mW (5 mVA) — **Max. power:** 7 W (7 VA) **High Current Rating** If higher loads must be switched through one or more of the contacts, the minimum and maximum values of the contact(s) changes to: **Min. voltage:** 15V ac/dc — **Max. voltage:** 250V ac/dc **Min. current:** 250 mA ac/dc — **Max. current:** 6 A **Min. power:** 5 W (5 VA) — **Max. power:** 200 W (1,500 VA) **Mechanical life:** 50,000,000 operations **Electrical life:** 150,000 cycles typical, @ 200 W (1,500 VA) switched power, resistive load **NOTE: Transient suppression is recommended when switching inductive loads. Install suppressors across load. Never install suppressors across output contacts (see Warning, page 9).**
Output Response Time	15 ms
Input Requirements	Each switch or sensor must have a normally closed contact and a normally open contact capable of switching 5 to 50 mA @ 15 to 30 V dc. Reset switch must have one normally open contact capable of switching 5 to 50 mA @ 15 to 30 V dc. Max. external resistance between terminals S11/S12, S11/S13, S21/S22 and S21/S23: 270 ohms each.
Simultaneity Monitoring	**2-Channel operation:** 3 seconds **1-Channel operation:** infinite
Status Indicators	**1 red LED:** Fault (see "Troubleshooting," page 18) **4 green LEDs:** Power – power is supplied to Safety Module Channel 1 – inputs satisfied (guard closed) Channel 2 – inputs satisfied (guard closed) Output – K1 and K2 energized, safety outputs closed
Housing	Polycarbonate Rated NEMA 1, IEC IP40, Terminals IP20
Mounting	Mounts to standard 35 mm DIN rail track. Safety Module must be installed inside an enclosure rated NEMA 3 (IEC IP54), or better.
Vibration Resistance	10 to 55 Hz @ 0.35 mm displacement per IEC 68-2-6
Operating Conditions	**Temperature:** 0° to +50°C (+32° to 122°F) **Maximum Relative Humidity:** 90% @ +50°C (non-condensing)
Dimensions	See Figure 9.
Safety Category	4 per ISO 13849-1 (EN954-1) (depending on application)
Certifications	CE c SA us

Dimensions

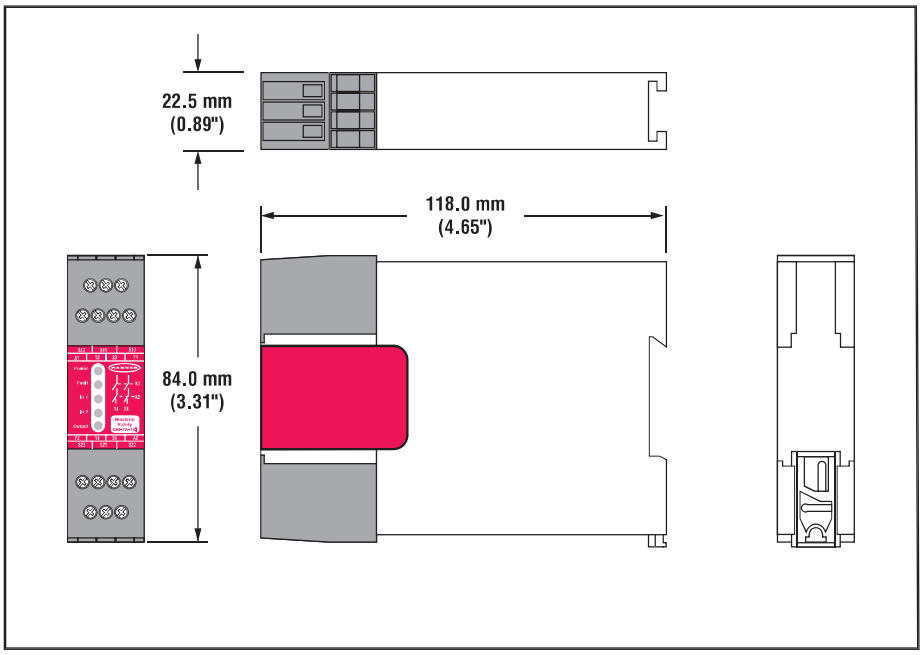


Figure 9. Model GM-FA-10J Gate Monitoring Safety Module enclosure dimensions

Accessories

Mechanical-Style Safety Switch Models

A full selection of appropriate safety interlock switches is available from Banner. See your current Banner Safety Products catalog or the website at w ww.bannerengineering.com for complete information.

Magnetic Switch Models

Magnet Sensor*		Coded Magnet		Control Module	Sensor Cable	Switching Distance Min. ON	Switching Distance Max. OFF
SI-MAG1SM SI-MAG1SMCO†		SI-MAG1MM SI-MAG1MM90††		SI-MAG1C	3 m (10')	3 mm (0.12")	14 mm (0.55")
		SI-MAG1MMHF				8 mm (0.31")	16 mm (0.63")
SI-MAG2SM		SI-MAG2MM				4 mm (0.16")	8 mm (0.32")
SI-MAG3SM		SI-MAG3MM				3 mm (0.12")	7 mm (0.28")

* 9 m (30') cables are available for magnet sensors by adding suffix "**w/30**" to the model number (e.g., **SI-MAG1SM w/30**).

† Cable opposite see Figure 10b, page 16)
†† 90° orientation (see Figure 13a, page 17)

Magnetic Switch Specifications

Switching Elements	Three pole-stable reed switches
Repeat Switching Accuracy	±0.1 mm (±0.004")
Construction	Epoxy-encapsulated circuit in polyamide housing
Environmental Rating	NEMA 4X, IEC IP67
Switching Capacity	30V dc max @ 0.25W
Operating Temperature	-5° to +70°C (+23° to +158°F)
Connections	Integral PVC-jacketed 3 m (10') 4-wire cable. Cable O.D. is 5 mm (0.2"). Wires are 24 AWG (0.25 mm^2).
Hardware	All mounting hardware is supplied by user. Use of permanent fasteners or locking hardware is recommended to prevent loosening or displacement of the actuator and switch body. Mounting holes in the magnet and sensor accept M4 (#6) hardware (see drawings on page 16).

Magnetic Switch Dimensions

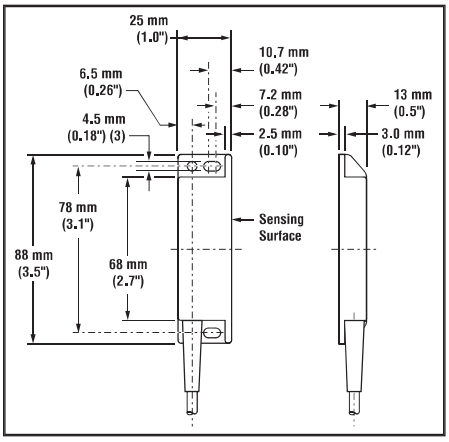


Figure 10a. SI-MAG1SM Sensor

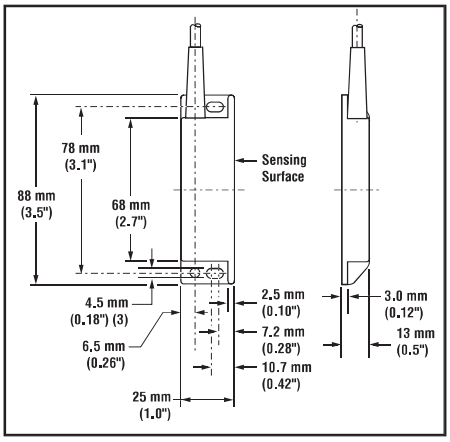


Figure 10b. SI-MAG1SMCO Sensor

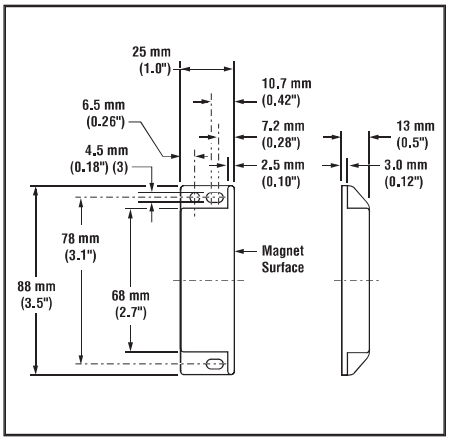


Figure 10c. SI-MAG1MM/MM90/MMHF Magnet

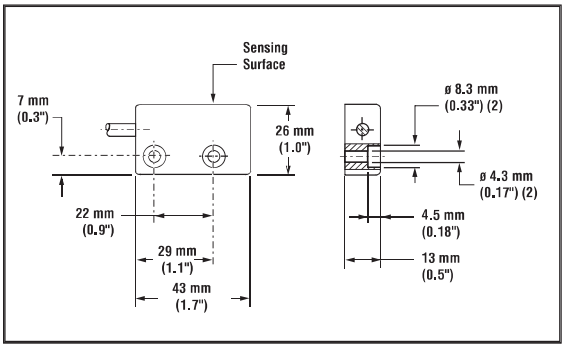


Figure 11a. SI-MAG2SM Sensor

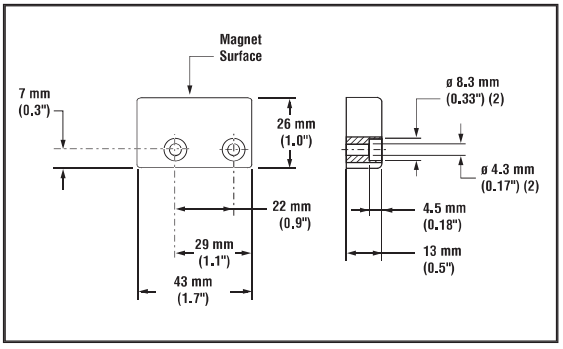


Figure 11b. SI-MAG2MM Magnet

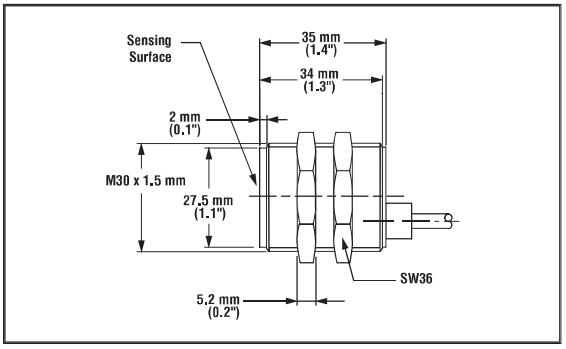


Figure 12a. SI-MAG3SM Sensor

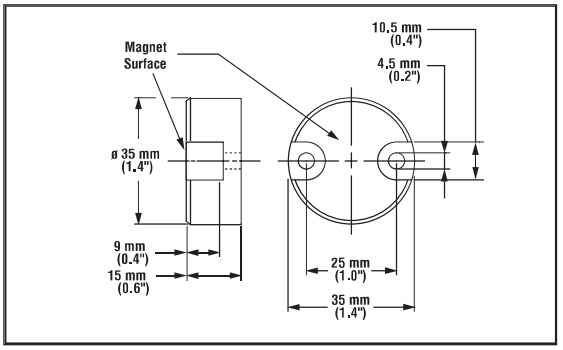


Figure 12b. SI-MAG3MM Magnet

"Direction of Approach" Options for Sensor/Magnet Pairs

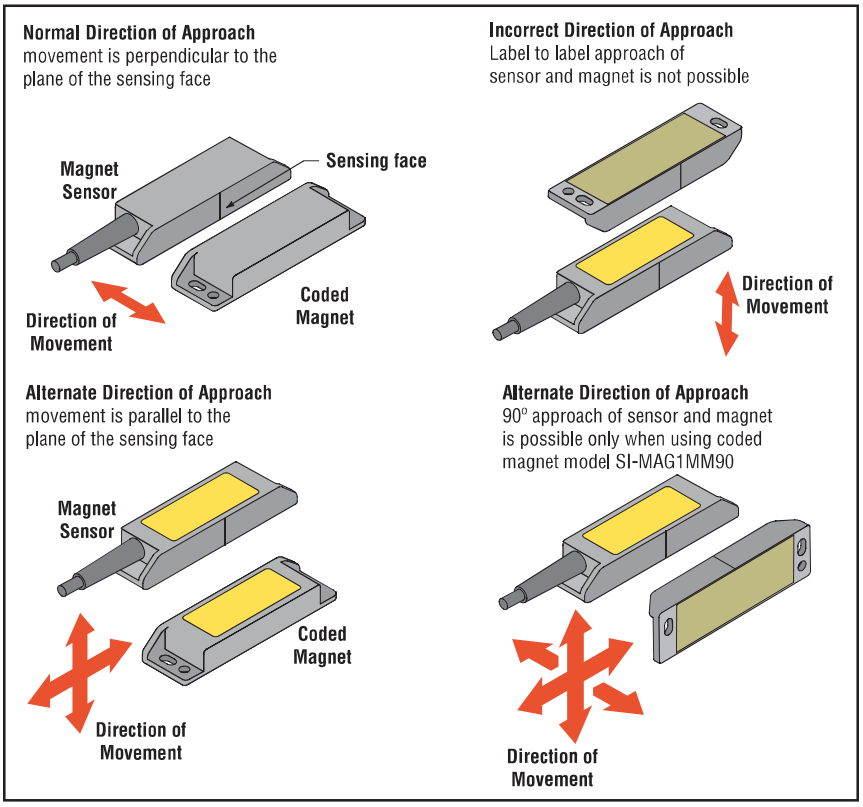


Figure 13a. Direction of Approach for SI-MAG1.. sensor/magnet pairs

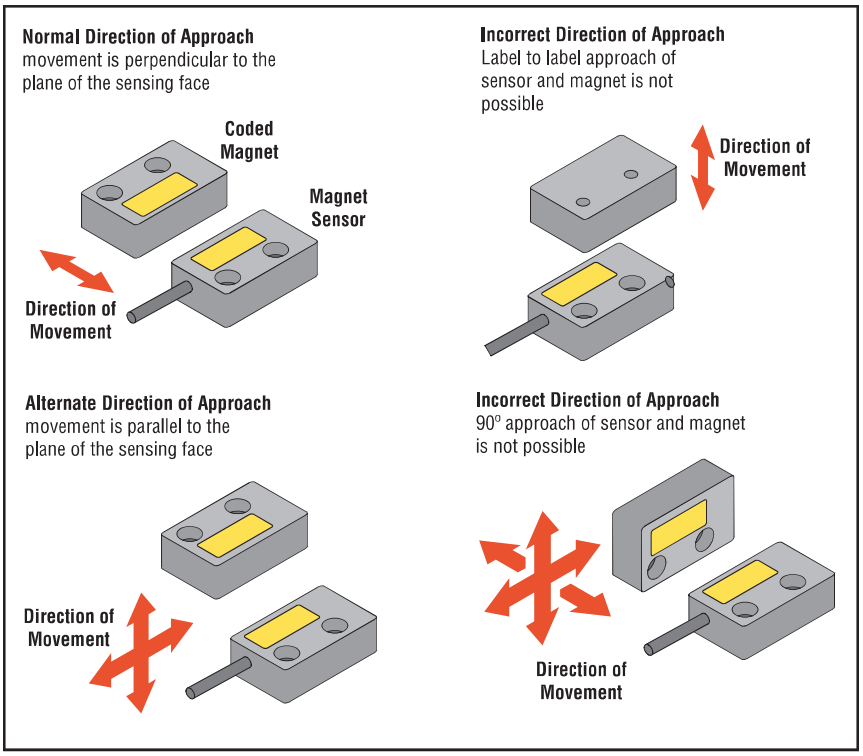


Figure 13b. Direction of Approach for SI-MAG2.. sensor/magnet pairs

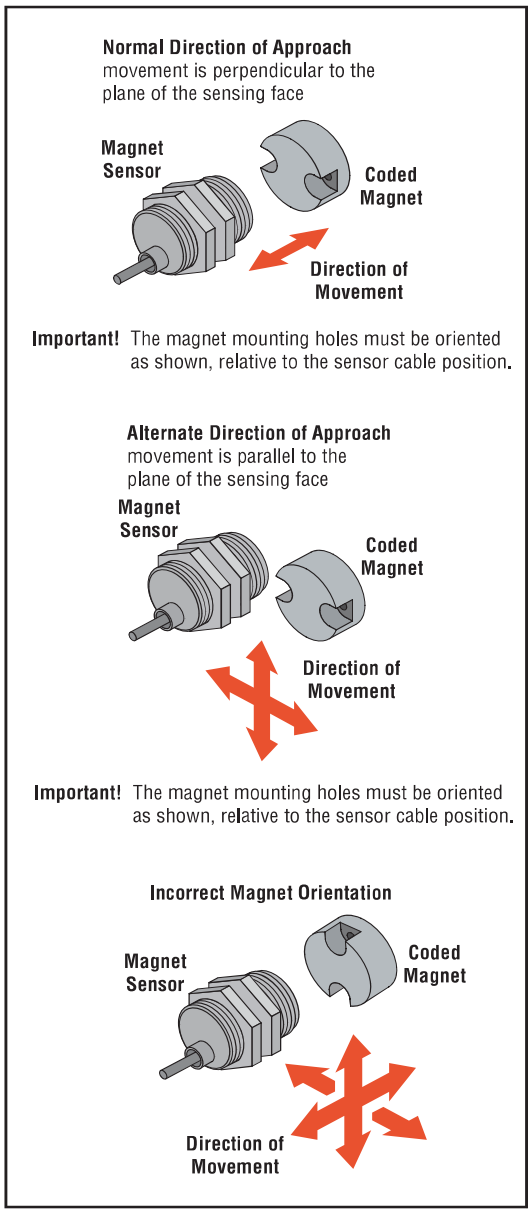


Figure 13c. Direction of Approach for SI-MAG3.. sensor/magnet pairs

NOTE: For all magnet style switches, approach speed must be greater than 0.1 m/s to allow for proper switching. (See page 5.)

Repairs

Do not attempt any repairs to the GM-FA-10J Safety Module. It contains no field replaceable components. Return the Interface Module to the factory for warranty repair or replacement.

If it ever becomes necessary to return a Safety Module to the factory, contact the Banner Factory Application Engineering Group at the address or numbers listed at the bottom of the back page. They will attempt to troubleshoot the system from your description of the problem. If they conclude that a component is defective, they will issue an RMA (Return Merchandise Authorization) number for your paperwork and give you the proper shipping address. Pack the Safety Module carefully. Damage which occurs in return shipping is not covered by warranty.

CAUTION . . . Abuse of Module After Failure

If an Internal Fault occurs and the Module will not reset, do not tap, strike, or otherwise attempt to correct the fault by a physical impact to the housing. An internal relay may have failed in such a manner that its replacement is required. **If the Module is not immediately replaced or repaired, multiple simultaneous failures may accumulate and the safety function can not be guaranteed.**

Troubleshooting

Model GM-FA-10J Gate Monitoring Safety Module provides 5 LED indicators.

LED	LED Indicators
Power (green)	**ON -** Power is connected to terminals A1-A2. **OFF -** No power or low power to terminals A1-A2, or internal power supply failure.
Fault (red)	**ON -** External fault or configuration fault. The corresponding function LED will flash to indicate the area where the fault has been detected. See page 19 for probable cause. **Flashing** (only) **-** Internal Fault. See page 12 for repair. **Flashing** (with flashing power LED) **-** DIP Switch configuration fault. Check that switch positions are the same for both Banks A and B.
Input 1 (green)	**ON -** Guard 1 is closed and the inputs of Channel 1 are satisfied. **OFF -** Guard 1 is open or the inputs of Channel 1 are not satisfied. **Flashing** (Fault LED ON) **-** See page 19 for probable cause.
Input 2 (green)	**ON -** Guard 2 is closed and the inputs of Channel 2 are satisfied. **OFF -** Guard 2 is open or the inputs of Channel 2 are not satisfied. **Flashing** (Fault LED ON) **-** See page 19 for probable cause.
Output (green)	**ON -** Both internal relays K1 and K2 are energized (13/14 and 23/24 are closed). **OFF -** Both internal relays K1 and K2 are de-energized (13/14 and 23/24 are opened). **Flashing -** Reset requested. The Reset input (button) must be cycled (open, closed, open), to enter RUN mode. **Flashing** (Fault LED ON) **-** See page 19 for probable cause.

Clearing Faults

To clear a fault condition, first correct the problem and then cycle the input channels to the module (open and close the guards). When the Fault LED lights, the corresponding Function LED will flash to indicate the problem. If the Fault LED is flashing, refer to "Repairs," page 18.

LED			Fault, Probable Cause and Procedures
Power	ON	●	**INPUT CHANNEL 1 FAULT (S11/S12/S13)**
Fault	ON	●	a) S13 Open (guard closed)
Input 1	FLASHING	☀	b) S12 Open (guard open)
Input 2	ON or OFF	●○	c) S11 Open (guard is open or closed)
Output	OFF	○	d) Short between S11 and S12
Power	ON	●	**INPUT CHANNEL 2 FAULT (S21/S22/S23)**
Fault	ON	●	a) S23 Open (guard closed)
Input 1	ON or OFF	●○	b) S22 Open (guard open)
Input 2	FLASHING	☀	c) S21 Open (guard is open or closed)
Output	OFF	○	d) Short between S21 and S22
Power	ON	●	**SHORT BETWEEN INPUT CHANNELS**
Fault	ON	●	a) Short between S11 and S21
Input 1	FLASHING	☀	
Input 2	FLASHING	☀	
Output	OFF	○	
Power	ON	●	**SIMULTANEITY FAULT**
Fault	ON	●	a) 2-channel simultaneity > 3 seconds (configured for 2-channel operation)
Input 1	ON or OFF	●○	b) Channel simultaneity > 1 second (NO/NC did not switch within 1 second)
Input 2	ON or OFF	●○	See page 3 for description of complementary switching and 2-channel operation.
Output	OFF	○	
Power	FLASHING	☀	**DIP-SWITCH ERROR**
Fault	FLASHING	☀	a) DIP-switch settings are incorrect; Bank A does not match Bank B
Input 1	OFF	○	See page 10 for DIP-switch configuration.
Input 2	OFF	○	
Output	OFF	○	
Power	ON	●	**OPEN RESET FAULT**
Fault	ON	●	a) Y1/Y2 open when configured for Auto Reset
Input 1	ON	●	See page 10 for Manual/Auto Reset information.
Input 2	ON	●	
Output	FLASHING	☀	
Power	ON	●	**INTERNAL FAULT (See page 18 for Repairs)**
Fault	FLASHING	☀	a) Incorrect check sum
Input 1	OFF	○	b) Internal relay failure (e.g., welded contact due to inductive load arcing.)
Input 2	OFF	○	c) Low input power
Output	OFF	○	d) Other internal fault

Gate Monitoring Safety Module – Model GM-FA-10J

the machine safety specialist

WARRANTY: Banner Engineering Corp. warrants its products to be free from defects for one year. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture found to be defective at the time it is returned to the factory during the warranty period. This warranty does not cover damage or liability for the improper application of Banner products. This warranty is in lieu of any other warranty either expressed or implied.

P/N 60998 rev. C

Banner Engineering Corp., 9714 Tenth Ave. No., Minneapolis, MN 55441 • Phone: 763.544.3164 • www.bannerengineering.com • Email: sensors@baneng.com

Machine and Process Design, Inc. 820 McKinley Street Anoka, MN 55303 **Bill of Materials - Engineering Release**	Part Number: **155448 N**	Rev.
Job: **33976** Customer: **HERSHEY** Title: **1612 RIGIMILL, LO**	Date: 04/28/2016 Sheet 1 of 1	

Item	Part No.	Qty.	Unit	*	Description
1	155449 C	1	EA	AY	1612 RIGIMILL, AY
2	155041 B	0	-	RD	1612 RIGIMILL, HOPPER & SUPPORT STAND, G.A.
3	155041 B	1	EA	PP	SAFETY MONITOR, BANNER GM-FA-10J
4	155041 B	1	EA	PP	POWER RELAY IDAC #RH2B-UAC120V, DPDT, 10AMP, 110-120VAC (FOR OPTIONAL AUXILARY OUTPUTS)
5	155041 B	1	EA	PP	BLADE RELAY SOCKET, IDAC, SH2B-05, FOR DPDT, RH SERIES RELAY, DIN RAIL/PANEL MOUNT (FOR OPTIONAL AUXILARY OUTPUTS)
6	129389 A	1	EA	FP	ALIGNMENT RING, 2.75 DIA SEAL
7	121021 C	1	EA	FP	GAGE, 16IN RIGIMILL SCREEN
8	140403 A	1	EA	FP	CLAMP BAR, SCREEN, 1612 RIGIMILL, C.S.
9	155725 B	1	EA	AY	INFEED HOPPER, 1612 RM, ASSEMBLY
10	155810 A	1	EA	AY	SUPPORT STAND, 1612 RM, ASSY
11	155811 A	1	EA	AY	TRANSITION, 1612 RM TO ROTARY VALVE

Machine and Process Design, Inc. 820 McKinley Street Anoka, MN 55303 **Bill of Materials**	Part Number: **155449 C**	Rev.
Title: 1612 RIGIMILL, AY	Drawn By: Mike Pease Date: 04/28/2016 Sheet 1 of 4	

Item	Part No.	Qty.	Unit	*	Description
1	155452 D	1	EA	WD	HOUSING, 1612 RM, 2.75 3-R SEAL, 254/56T, 304SS
2	111296 C 01	1	EA	FP	RAIL, GRID SUPPORT, 16" RM, 304SS
3	111296 C 02	0	EA	FP	RAIL, GRID SUPPORT, 16" RM, 304SS
4	145595 B	1	EA	WD	END CAP, 16XX RM, 2.75 DIA, 304SS
5	128506 A	8	EA	WD	KNOB, COVER, RIGI-MILL, HEX BODY WITH ROLL PIN, 304SS
6	112758 A	2	EA	WD	KNOB, SCRN BATTEN, 16XX RM, SST
7	103808 A	2	EA	FP	PACKING GLAND, SEAL, 2.75 DIA SHFT
8	131907 A 01	28	EA	FP	HAMMER, PLAIN, 16" RM, LIGHT GAGE SCREEN, 304SS (NO FLAME SPRAY)
9	105068 B 01	1	EA	FP	PLATE,NUT,304, 254/256T, RIDGI
10	105068 B 02	1	EA	FP	PLATE,NUT,304, 254/256T, RIDGI
11	155457 C	1	EA	FP	GUARD, DRIVE, 16RM, 254/56T
12	155458 B	1	EA	FP	COVER, DRIVE GUARD, 16RM
13	155454 A	1	EA	FP	BRACKET, GUARD, STRAIGHT
14	155455 A	1	EA	WD	BRACKET, GUARD, ANGLE
15	106862 C	1	EA	WD	PLATE, WEAR 16 X 12 SST

Date Printed: 07/20/2016

Machine and Process Design, Inc. 820 McKinley Street Anoka, MN 55303 **Bill of Materials**	Part Number: **155449 C**	Rev.
Title: 1612 RIGIMILL, AY	Drawn By: Mike Pease Date: 04/28/2016 Sheet 2 of 4	

Item	Part No.	Qty.	Unit	*	Description
16	143573 C	1	EA	WD	COVER, 1612 RM, BANNER SWITCH, 304SS
17	104736 A 01	1	EA	FP	GASKET, COVER (BUNA-N)
18	111268 A	1	EA	WD	BATTEN, SCRN, 1612RM, 304SS
19	155459 C	1	EA	WD	ROTOR, 1612 RM, 2.75 DIA SEAL, 304SS
20	114431 D 01	1	EA	FP	SCREEN, 16 X 12 RIGI-MILL, LIGHT GUAGE, 304SS (.090 DIAMETER)
21		2	EA	PP	BEARING, DODGE #F4B-DL-211LL
22		6	EA	PP	PACKING, FDA COMPLIANT, 3/8 X 3/8 X 2.75 DIA. SHAFT, MCM #94695K892
23		1	EA	PP	SWITCH, BANNER #SI-MAG1SM, 3 METER CABLE, NEMA 4X, IP67
24		1	EA	PP	MOTOR, 20 HP, 1800/60/3PH 230/460, TEFC, 256T, BALDOR #EM2334T
25		1	EA	PP	SHEAVE, QD3/5V 5.90
26		1	EA	PP	BUSHING, SDS 1-5/8
27		1	EA	PP	SHEAVE, QD3/5V 11.3
28		1	EA	PP	BUSHING, SF 2-11/16
29		3	EA	PP	DRIVE BELT, 3-5VX 680
30		1	EA	PP	MAGNET, CODED, BANNER #SI-MAG1MMHF, NEMA 4X, IP67

Machine and Process Design, Inc. 820 McKinley Street Anoka, MN 55303 **Bill of Materials**	Part Number: **155449 C**	Rev.
Title: 1612 RIGIMILL, AY	Drawn By: Mike Pease Date: 04/28/2016 Sheet 3 of 4	

Item	Part No.	Qty.	Unit	*	Description
31		20	EA	PP	HHCS, 1/2-13NC X 1-1/2, ALLOY 20 (HAMMERS)
32		20	EA	PP	NUT, NYLOCK, 1/2-13NC, 18-8 SST, (HAMMERS)
33		8	EA	PP	HHCS, 1/2-13NC X 1-1/4, ALLOY 20 (HAMMERS, END HEAD PLATE)
34		8	EA	PP	NUT, NYLOCK, THIN, 1/2-13NC, 18-8SST, MCM #90101A252 (HAMMERS, END HEAD PLATES)
35		1	EA	PP	HHCS, 1/2-13NC X 6, FULLY THREADED, GRD8, ZINC, MCM #91257A736 (MOTOR TENSIONSER)
36		2	EA	PP	DECAL, WATCH HANDS
37		1	EA	PP	DECAL, BELT/CHAIN DRIVE
38		1	EA	PP	DECAL, POWER LOCKOUT
39		1	EA	PP	DECAL, DO NOT ENTER UNTIL POWER LOCKOUT PROCEDURE HAS BEEN COMPLETED
40		1	EA	PP	DECAL, SCREEN REPLACEMENT
41	145829 C 01	1	EA	FP	GUARD, SHAFT, UPPER, DR SIDE, 16XX RM
42	145830 B 01	1	EA	WD	GUARD, SHAFT, LOWER, DR SIDE, 16XX RM, WD
43	145830 B 02	1	EA	WD	GUARD, SHAFT, LOWER, DR SIDE, 16XX RM, WD
44	145832 B	1	EA	WD	GUARD, SHAFT, BOTTOM, DR SIDE, 16XX RM, WD
45	145834 C	1	EA	FP	GUARD, SHAFT, UPPER, OPP DR SIDE, 16XX RM

Machine and Process Design, Inc. 820 McKinley Street Anoka, MN 55303 **Bill of Materials**	Part Number: **155449 C**	Rev.
Title: 1612 RIGIMILL, AY	Drawn By: Mike Pease Date: 04/28/2016 Sheet 4 of 4	

Item	Part No.	Qty.	Unit	*	Description
46	145835 B	1	EA	WD	GUARD, SHAFT, LOWER, OPP DR SIDE, 16XX RM, WD
47	145838 B	1	EA	WD	GUARD, SHAFT, UPPER, DR SIDE, 16XX RM, WD
48	145847 B	1	EA	FP	GUARD, BEARING, NON-DRV, 16XX RM
49		6	EA	PP	HHCS, 1/2-13NC X 1-3/4, GRADE 8 ZINC (MOTOR)
50		6	EA	PP	F-WASH, 1/2 ID, C.S. (MOTOR)
51		8	EA	PP	HHCS, 1/2-13NC X 1-1/2 GRADE 8 ZINC (BEARINGS)
52		8	EA	PP	F-WASH, 1/2ID, C.S. (BEARINGS)
53		8	EA	PP	HEX NUT, 3/8-16 NC, 18-8 SST (END CAP)
54		8	EA	PP	F-WASH, 3/8 ID, 18-8 SST (END CAP)

Machine and Process Design, Inc. 820 McKinley Street Anoka, MN 55303 **Bill of Materials**	Part Number: **155725 B**	Rev.
Title: INFEED HOPPER, 1612 RM, ASSEMBLY	Drawn By: Mike Pease Date: 06/23/2016 Sheet 1 of 1	

Item	Part No.	Qty.	Unit	*	Description
1	155716 C	1	EA	WD	INFEED HOPPER, 1612 RIGIMILL
2	155724 A	1	EA	FP	COVER, HOPPER
3	155723 A	1	EA	FP	CURTAIN, HOPPER
4	120954 A	1	EA	FP	BATON BAR, CURTAIN, 304SS
5		3	EA	PP	NUT, NYLOCK, 5/16-18NC, SST, CARR 91831A030 (CURTAIN BATTEN BAR)
6		12	EA	PP	HHCS, 5/16-18NC X 1-1/2, 18-8 SST (HOPPER TO RIGIMILL)
7		12	EA	PP	HEX NUT, 5/16-18NC, 18-8 SST (HOPPER TO RIGIMILL)
8		24	EA	PP	F-WASH, 5/16 ID, 18-8 SST (HOPPER TO RIGIMILL)
9		50	IN	PP	1/8 INCH X 2 POLYETHYLENE FOAM CARR 93565K28 (HOPPER TO RIGIMILL)
10		8	EA	PP	HHCS, 5/16-18NC X 3/4, 18-8 SST (HOPPER COVER)
11		8	EA	PP	HEX NUT, 5/16NC, 18-8 SST (HOPPER COVER)
12		16	EA	PP	F-WASH, 5/16 ID, 18-8 SST (HOPPER COVER)

Date Printed: 07/20/2016

Machine and Process Design, Inc. 820 McKinley Street Anoka, MN 55303 **Bill of Materials**	Part Number: **155810 A**	Rev.
Title: SUPPORT STAND, 1612 RM, ASSY	Drawn By: Mike Pease Date: 07/13/2016 Sheet 1 of 1	

Item	Part No.	Qty.	Unit	*	Description
1	155706 C	1	EA	WD	SUPPORT STAND, 1612 RM, SST
2		6	EA	PP	HHCS, 1/2-13NC X 2-1/4 18-8SST
3		6	EA	PP	HEX NUT, 1/2-13 NC, 18-8 SST
4		12	EA	PP	F-WASH, 1/2 ID, 18-8SST

Date Printed: 07/20/2016

Machine and Process Design, Inc. 820 McKinley Street Anoka, MN 55303 **Bill of Materials**	Part Number: **155811 A**	Rev.
Title: TRANSITION, 1612 RM TO ROTARY VALVE	Drawn By: Mike Pease Date: 07/13/2016 Sheet 1 of 1	

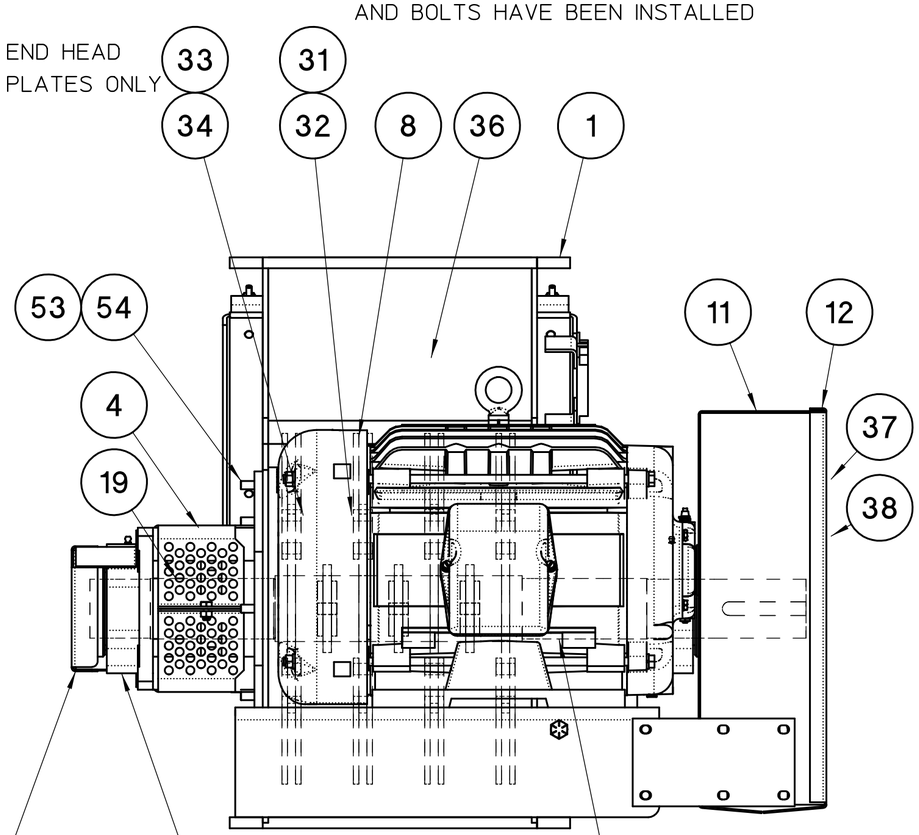
Item	Part No.	Qty.	Unit	*	Description
1	155726 B	1	EA	WD	TRANSITION, 1612 RM TO ROTARY VALVE
2		16	EA	PP	HHCS 5/16-18 NC X 1-1/2 18-8 SST (TRANSITION TO RIGIMILL)
3		16	EA	PP	HEX NUT, 5/16-18NC, 18-8 SST (TRANSITION TO RIGIMILL)
4		32	EA	PP	F-WASH, 5/16 ID, 18-8 SST, (TRANSITION TO RIGIMILL)
5		70	IN	PP	1/8 INCH X 2 POLYETHYLENE FOAM CARR 93565K28

Date Printed: 07/20/2016

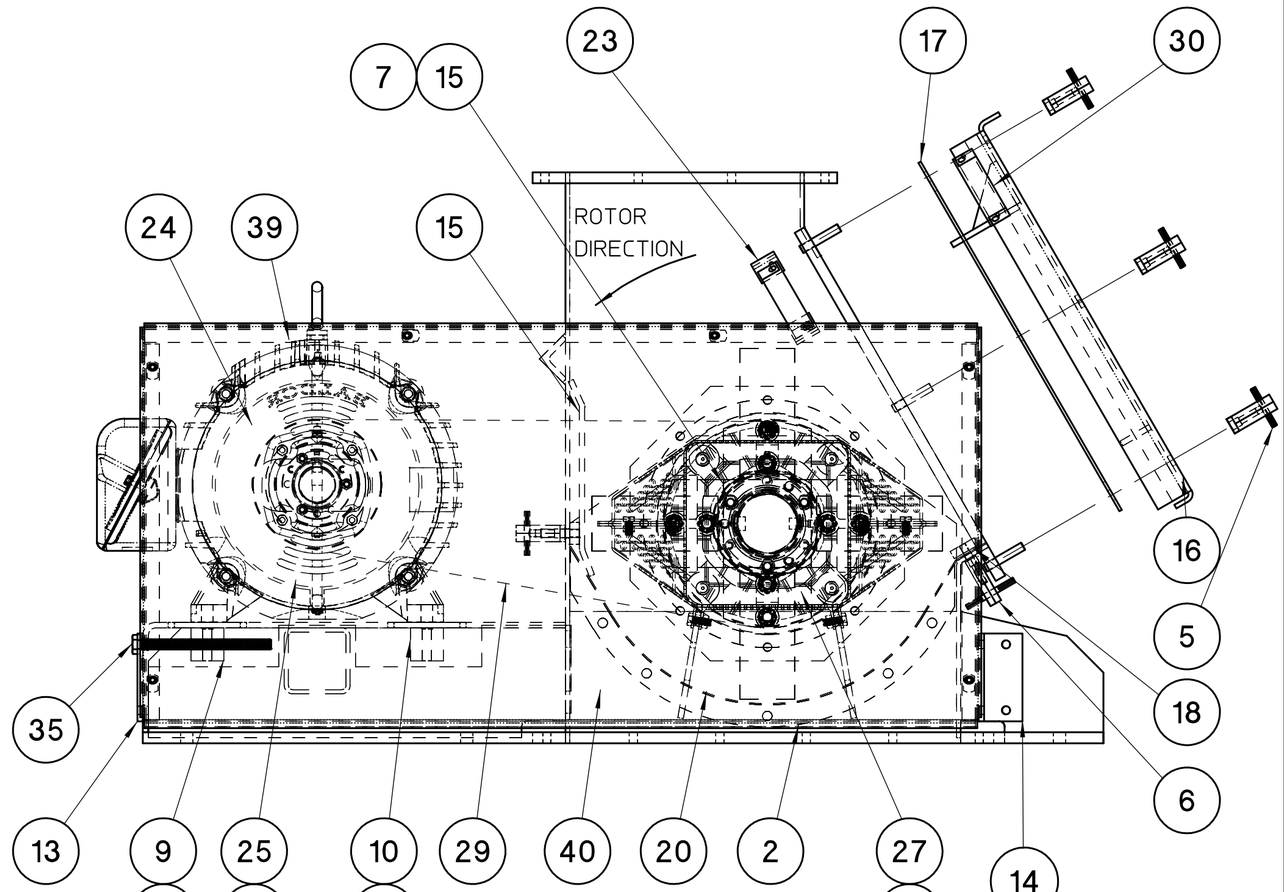
ITEM	QTY	DESCRIPTION

TO FACILITATE HAMMER INSTALLATION, DO NOT TIGHTEN HAMMER BOLTS UNTIL THE ADJACENT HAMMER AND BOLTS HAVE BEEN INSTALLED

END HEAD PLATES ONLY

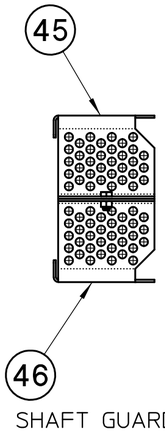


USE 129389A SHAFT ALIGNMENT RING TO LOCATE AND PIN BEARINGS

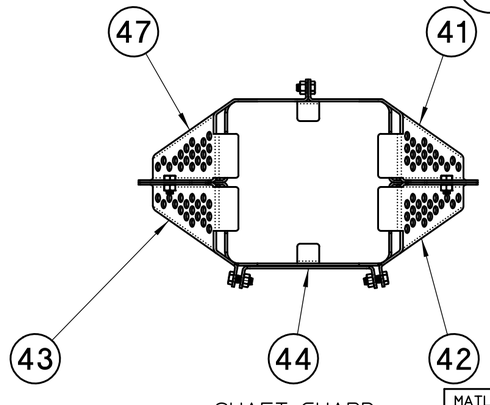


.26" OUTER HAMMER TIP TO SCREEN HOOP CLEARANCE

USE 140403A CLAMP BAR FOR SCREEN INSTALLATION



SHAFT GUARD
NON-DRIVE END



SHAFT GUARD
DRIVE END

MATL: 304SS	CUST:	PROJ:
FINISH: REF JOB SPEC	U/O:	QTY:
GEN. TOL. ±0.015		

INSPECTION SIGN OFF — SEE INSTRUCTIONS ON TRAVLERS

LASER	SAW	FAB	MACH	WELD	FINAL

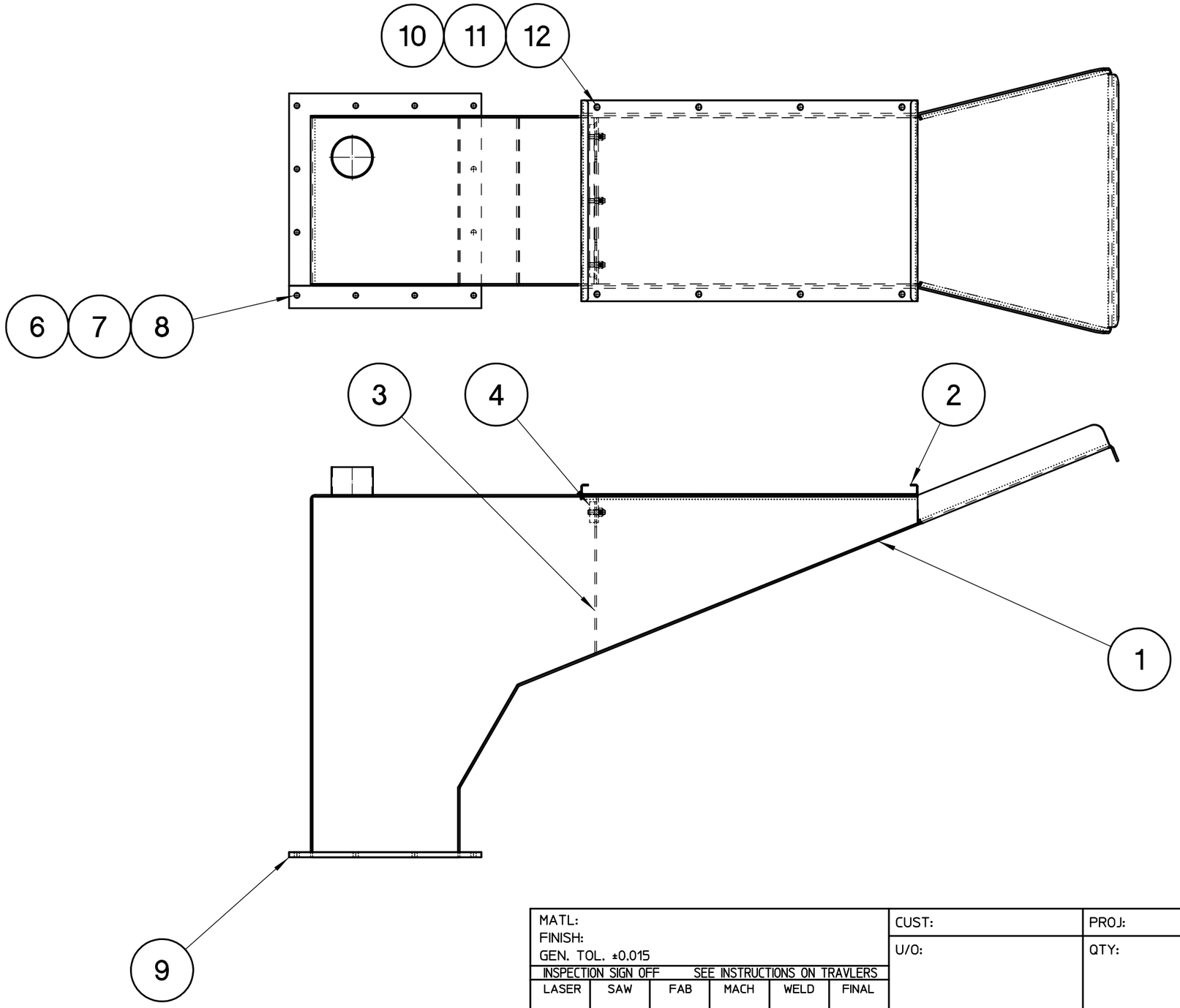
REV	DESCRIPTION	BY	DATE

MACHINE & PROCESS DESIGN, INC.
820 McKINLEY STREET, ANOKA, MN 55303, WWW.MPD-INC.COM

TITLE: 1612 RIGIMILL, ASSEMBLY DRAWING

BY: MLP.
DATE: 5/4/16
SCALE: 3/16

155449C



MATL:	CUST:	PROJ:
FINISH:	U/O:	QTY:
GEN. TOL. ±0.015		

INSPECTION SIGN OFF					SEE INSTRUCTIONS ON TRAVLERS
LASER	SAW	FAB	MACH	WELD	FINAL

REV	DESCRIPTION	BY	DATE

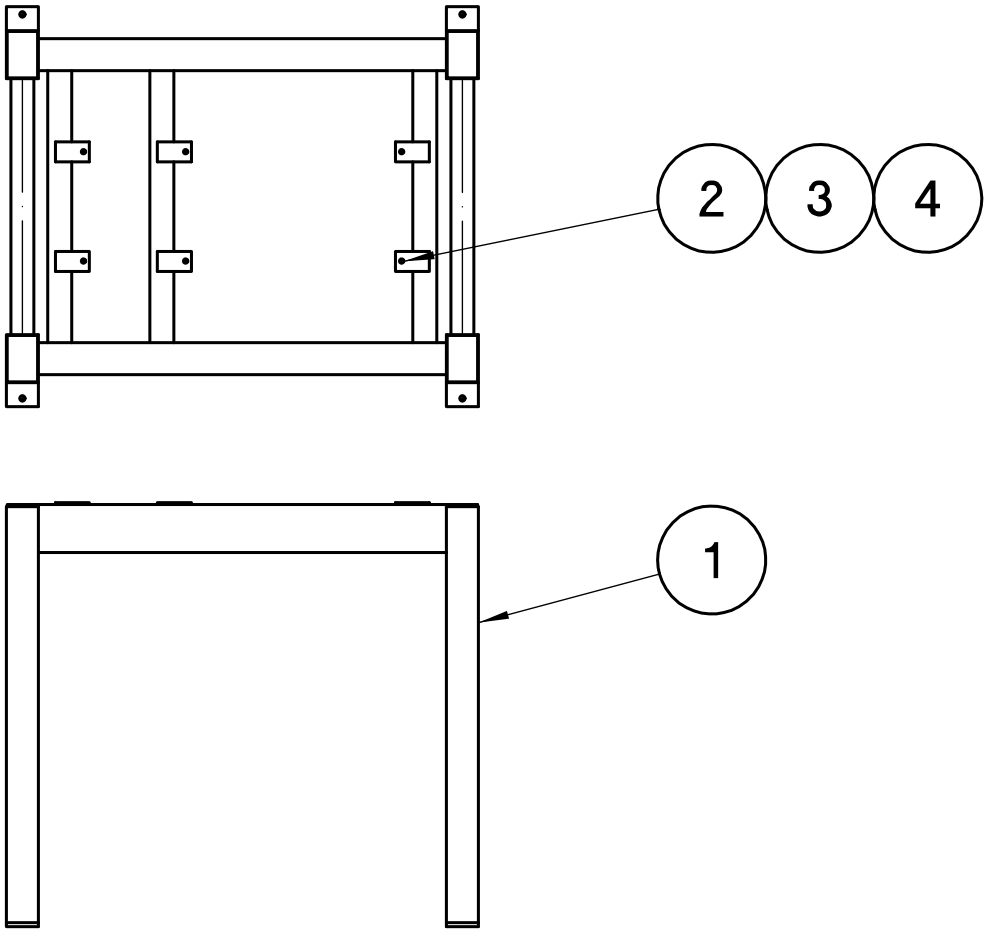
MACHINE & PROCESS DESIGN, INC.
820 McKINLEY STREET, ANOKA, MN 55303, WWW.MPD-INC.COM

TITLE: HOPPER, 1612 RM, ASSY

BY: MLP
DATE: 7/15/16
SCALE: 1/8

155725B

ITEM	QTY	DESCRIPTION



REV	DESCRIPTION	BY	DATE

MATL:
FINISH:
GEN. TOL. ±0.015

INSPECTION SIGN OFF — SEE INSTRUCTIONS ON TRAVELERS

LASER	SAW	FAB	MACH	WELD	FINAL

CUST:

U/O:

PROJ:

QTY:

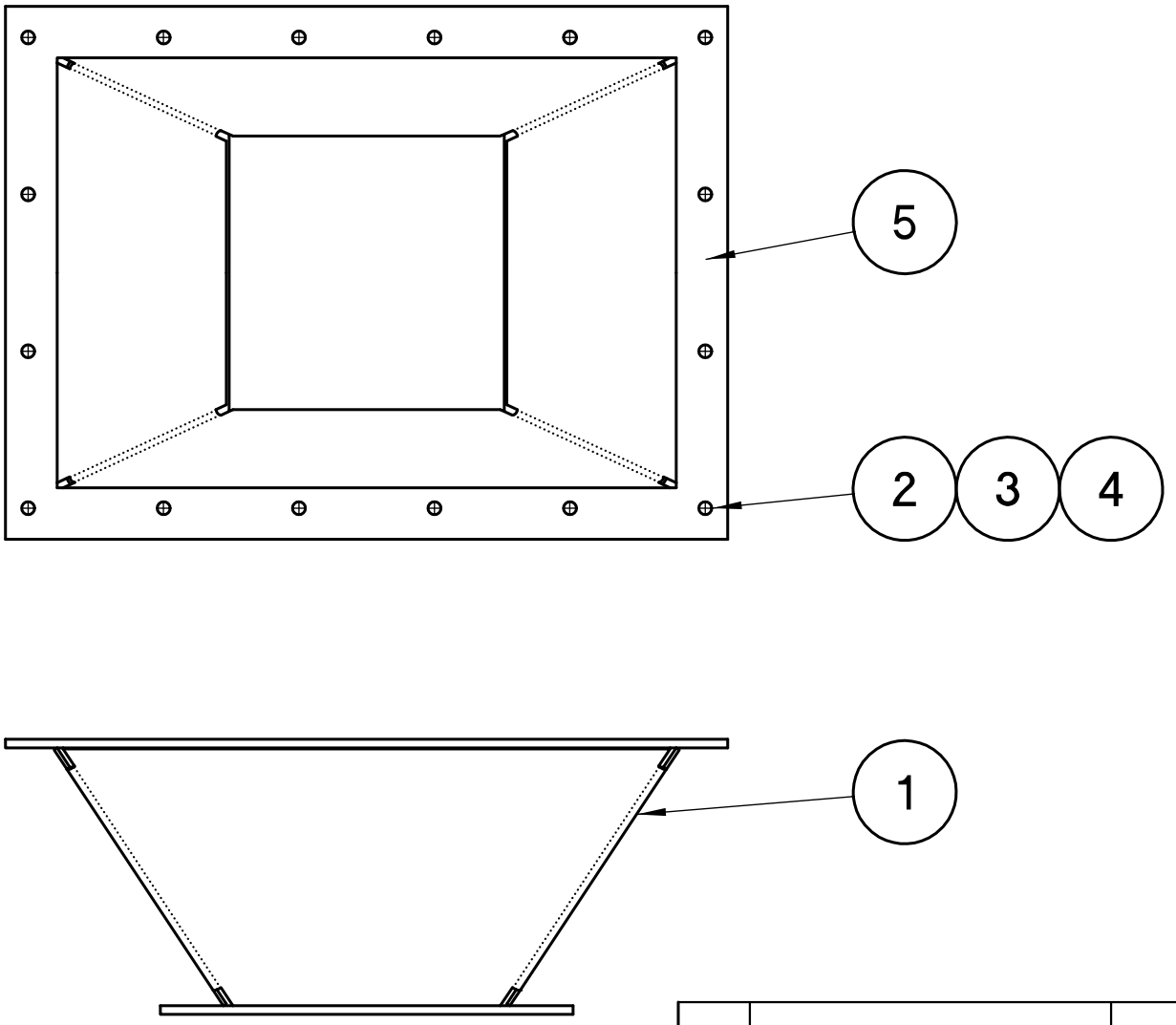
MACHINE & PROCESS DESIGN, INC.
820 McKINLEY STREET, ANOKA, MN 55303, WWW.MPD-INC.COM

TITLE: SUPPORT STAND, 1612 RM, AY

BY: MLP
DATE: 7/14/16
SCALE: 3/16

155810A

ITEM	QTY	DESCRIPTION



REV	DESCRIPTION	BY	DATE

MATL:
FINISH:
GEN. TOL. ±0.015

INSPECTION SIGN OFF — SEE INSTRUCTIONS ON TRAVELERS

LASER	SAW	FAB	MACH	WELD	FINAL

CUST:
U/O:
PROJ:
QTY:

MACHINE & PROCESS DESIGN, INC.
820 McKINLEY STREET, ANOKA, MN 55303, WWW.MPD-INC.COM

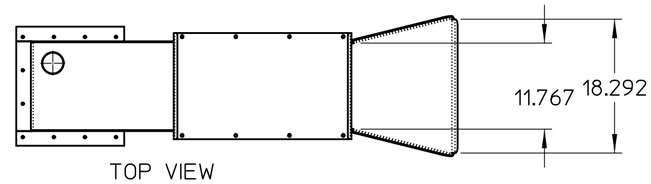
TITLE:TRANS. 1612RM-ROT. VALVE, AY

BY: MLP
DATE: 7/14/16
SCALE: 3/16

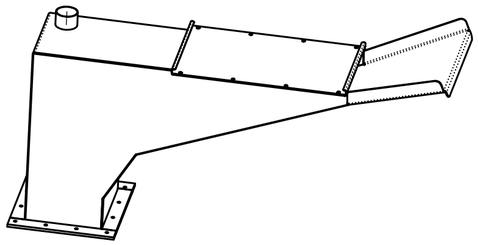
155811A

ITEM	QTY	DESCRIPTION

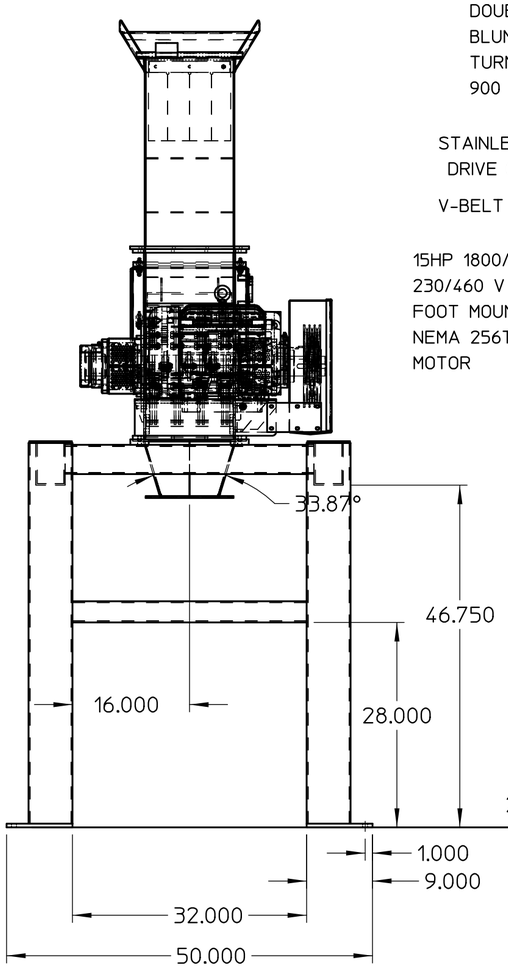
NOTES:
-304SS MATERIAL
- 120 GRIT PRODUCT CONTACT SURFACES
- BLASTED NON-PRODUCT CONTACT SURFACES
-PROTECTION OF PERSONNEL FROM ROTOR AT RIGIMILL DISCHARGE AND INLET MUST BE PROVIDED BY OTHERS
-RIGIMILL ROTOR IS BALANCED TO QUALITY GRADE G 1.0 OF THE ASA STANDARDS AT 3600 RPM..
-MAXIMUM DYNAMIC LOAD AT 3600 RPM
VERTICAL-1G/ HORIZONTAL-1G
- APPROX WEIGHTS
HOPPER - 150 LBS
RIGIMILL - 1000 LBS
SUPPORT STAND - 545 LBS
SCREEN ACCESS COVER - 30 LBS

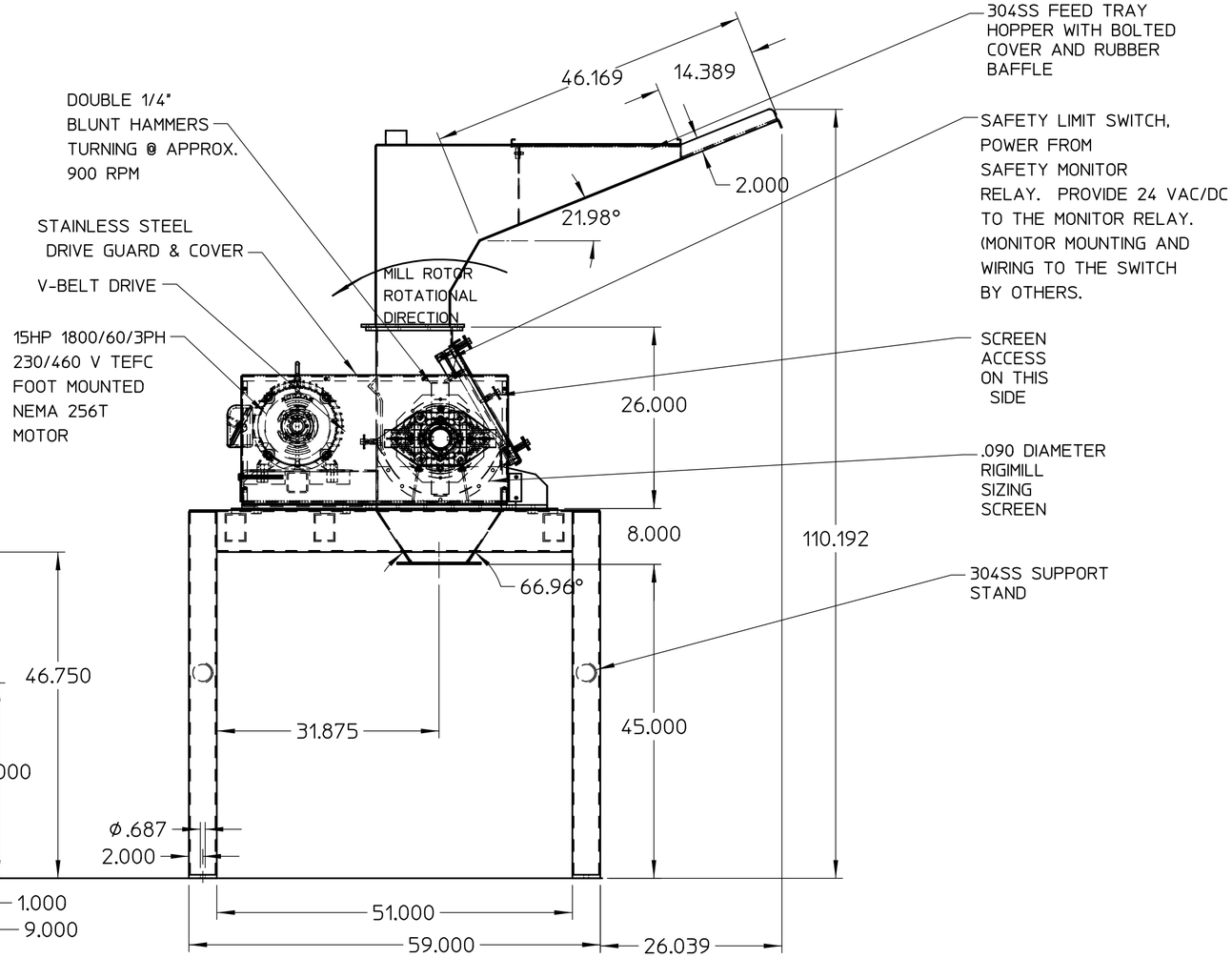


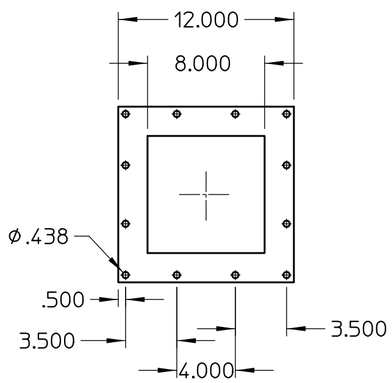
TOP VIEW
HOPPER ONLY



ISO VIEW
OF HOPPER







SQUARE TRANSITION
DSCH FLANGE

REV	DESCRIPTION	BY	DATE
B	REMOVED HOPPER LIP, CHANGED	MLP	6/24/16
	SUPPORT DIM AND WEIGHT		
A	CHANGED HOPPER, ADDED DSCH	MLP	4/12/16
	TRANS, CHANGED HEIGHT		

MATL: SEE NOTES
FINISH: SEE NOTES
GEN. TOL. ±0.015

INSPECTION SIGN OFF			SEE INSTRUCTIONS ON TRAVLERS		
LASER	SAW	FAB	MACH	WELD	FINAL

CUST: PROJ:
U/O: QTY:

MACHINE & PROCESS DESIGN, INC.
820 McKINLEY STREET, ANOKA, MN 55303

TITLE: 1612 RIGIMILL, HOPPER, & SUPPORT STAND

BY: MLP
DATE: 1/4/16
SCALE: 1/16

155041C