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SERVICE INFORMATION

Your New Electric Shoe Brakes

Thank you for your purchase of Magnetek’s SA Electric Shoe Brakes. Magnetek has set a whole new standard in performance, dependability, and value with this unique new line of electric shoe brakes.

If your product ever needs modification or service, please contact one of our representatives at the following locations:

U.S. Service Information

For questions regarding service or technical information contact:
1-866-MAG-SERV
(1-866-624-7378)

International Service
262-783-3500

World Headquarters:

Magnetek, Material Handling
N49 W13650 Campbell Drive
Menomonee Falls, WI 53051

<table>
<thead>
<tr>
<th>Telephone:</th>
<th>800-288-8178</th>
</tr>
</thead>
<tbody>
<tr>
<td>Website:</td>
<td><a href="http://www.magnetek.com">www.magnetek.com</a></td>
</tr>
<tr>
<td>E-mail:</td>
<td><a href="mailto:mhcustomerservice@magnetek.com">mhcustomerservice@magnetek.com</a></td>
</tr>
</tbody>
</table>

Fax Numbers:

<table>
<thead>
<tr>
<th>Main:</th>
<th>800-298-3503</th>
</tr>
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<tr>
<td>Sales:</td>
<td>262-783-3510</td>
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<tr>
<td>Service:</td>
<td>262-783-3508</td>
</tr>
</tbody>
</table>

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161 Orenda Road
Unit 1
Brampton, Ontario
L6W 1W3 Canada

<table>
<thead>
<tr>
<th>Phone:</th>
<th>800-792-7253</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fax:</td>
<td>905-828-5707</td>
</tr>
<tr>
<td>416-424-7617 (24/7 Service pager)</td>
<td></td>
</tr>
</tbody>
</table>

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PREFACE AND SAFETY

Magnetek, Inc. (Magnetek) offers a broad range of radio remote control products, control products and adjustable frequency drives, and industrial braking systems for overhead material handling applications. This manual has been prepared by Magnetek to provide information and recommendations for the installation, use, operation and service of Magnetek’s material handling products and systems (Magnetek Products). Anyone who uses, operates, maintains, services, installs or owns Magnetek Products should know, understand and follow the instructions and safety recommendations in this manual for Magnetek Products.

The recommendations in this manual do not take precedence over any of the following requirements relating to cranes, hoists and lifting devices:

- Instructions, manuals, and safety warnings of the manufacturers of the equipment where the radio system is used,
- Plant safety rules and procedures of the employers and the owners of facilities where the Magnetek Products are being used,
- Regulations issued by the Occupational Health and Safety Administration (OSHA),
- Applicable local, state or federal codes, ordinances, standards and requirements, or
- Safety standards and practices for the overhead material handling industry.

This manual does not include or address the specific instructions and safety warnings of these manufacturers or any of the other requirements listed above. It is the responsibility of the owners, users and operators of the Magnetek Products to know, understand and follow all of these requirements. It is the responsibility of the owner of the Magnetek Products to make its employees aware of all of the above listed requirements and to make certain that all operators are properly trained. No one should use Magnetek Products prior to becoming familiar with and being trained in these requirements.

Product Warranty Information

Magnetek, hereafter referred to as Company, assumes no responsibility for improper programming and/or installation of a device (such as a drive or radio) by untrained personnel. A device should only be programmed/installed by a trained technician who has read and understands the contents of the relevant manual(s). Improper programming/installation of a device can lead to unexpected, undesirable or unsafe operation or performance of the device. This may result in damage to equipment or personal injury. Company shall not be liable for economic loss, property damage, or other consequential damages or physical injury sustained by the purchaser or by any third party as a result of such programming. Company neither assumes nor authorizes any other person to assume for Company any other liability in connection with the sale or use of this product.

WARRANTY INFORMATION

FOR INFORMATION ON MAGNETEK’S PRODUCT WARRANTIES BY PRODUCT TYPE, PLEASE VISIT WWW.MAGNETEK.COM.
DANGER, WARNING, CAUTION and NOTE Statements

Read and understand this manual before installing, operating or servicing this product. Install the product according to this manual and local codes.

The following conventions indicate safety messages in this manual. Failure to heed these messages could cause fatal injury or damage products and related equipment and systems.

DANGERS, WARNINGS and CAUTIONS

Throughout this document DANGERS, WARNING and CAUTION statements have been deliberately placed to highlight items critical to the protection of personnel and equipment.

---

**DANGER**

DANGER indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.

---

**WARNING**

WARNING indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

---

**CAUTION**

CAUTION indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It may also be used to alert against unsafe practices.

---

**NOTE:** A NOTE statement is used to notify people of installation, operation, programming or maintenance information that is important, but not hazard-related.

WARNINGS and CAUTIONS SHOULD NEVER BE DISREGARDED.

Registered Trademarks

Trademarks are the property of their respective owners.
1 General Description

Magnetek type SA spring-applied electromagnetic-actuated general-purpose pivoted twin external shoe brakes are designed for use on cranes and other industrial braking applications. Completely constructed from high-strength steel, they can be used with any drive type applied to hoisting or traveling motions.

Braking action is applied mechanically via dual torque springs, and brake release is achieved via electric power supplied to the electromagnetic actuator (coil). Braking torque is continuously adjustable from 100% to approximately 50% of the maximum rated torque via adjustment of the dual torque springs. Once the springs are adjusted, the brake will develop that single magnitude of torque while the brake is applied. This versatile, short-stroke, high-speed, low armature impact brake complies with both CSA and UL standards.

Magnet coils are permanently encapsulated to the magnet case via thermo-setting epoxy to seal the coil from contamination and assist heat transfer off the magnet to the magnet case and the environment. Coils are designed to class “F” NEMA standards. The wire and insulation reliability, the epoxy compound, and the operating temperature are all in accordance with class “F” requirements. Shunt-type coils are rated for continuous duty and typically have a power circuit independent from the motor. Series coils are rated for 30 min. or 60 min. duty to match the duty and wire in series with a series-wound motor.

Shunt-type coils are designed to be supplied with a single operating voltage. At maximum brake torque, maximum armature air gap, and normal operating temperature, SA shunt-type brakes are designed to release at 80% of rated line voltage. Standard rated coil voltages are available from 12VDC to 550VDC.

Where AC power is available, shunt-type coils can be used in conjunction with “forcing” and “non-forcing” rectifiers. With the “voltage forcing” method, a standard coil is “forced” by the application of two to three times the normal voltage for approximately a half second, and then reduced to a percentage of normal voltage while the brake remains released. The initial voltage boost releases the brake quicker, and the reduced holding voltage allows the brake to set quicker. Other benefits of this include both a cooler coil during operation and an extended coil life. The forcing rectifier has standard inputs for 230/460/575VAC, single-phase, 60Hz supplies.

Where high-speed performance is not essential, SA brakes can be supplied with an integral terminal box rectifier for direct connection to 120/230/460/575VAC, single-phase, 60Hz supplies.

Series-type coils are designed to operate with the varying amperage of a series-wound DC motor. At maximum torque, maximum armature air gap, and normal operating temperature, SA series-type brakes are designed to release at 40% of full-load motor current and to set when the current decreases to 10% of full load. Standard series coils are available for 4 to 300 full-load amp ratings.

SA type brakes are available for brake wheel sizes between 4” to 16”.

For highly corrosive applications, special hardware, enclosures, and surface treatments are available.

NOTE: FOR AN UNUSUAL APPLICATION, OR A RECOMMENDATION FOR A BRAKE SIZE AND TYPE, CONTACT MAGNETEK CUSTOMER SERVICE.
Fig. 1: SA

1. Brake Base  
2. Brake Arms  
3. Brake Shoes  
4. Magnet Case  
5. Armature  
6. Pushrod  
7. Armature Air Gap Indicator  
8. Pushrod Adjustment Nut  
9. Torque Spring Bolts  
10. Coil Terminal Box  
11. Brake Nameplate, Shown Right Hand Side of Brake  
12. Manual Equalization Bolts/Shipping Bolts
2 Application

For a given wheel diameter, the Association for Iron and Steel Technology (AIST) determines the recommended torque, when applied to 30- and 60-minute series type and 1-hour and 8-hour continuously rated shunt-type motors in steel mill applications. This is based upon experience and agreement within the industry, but it is ultimately determined by each end user whether to follow recommendations or not.

When applied to four-quadrant drives or other applications where wheel heating can be accurately predicted and the thermal load is relatively small, brakes can be provided with torque values in excess of recommendations.

When the thermal load and wheel heating are relatively large and the load cycle requires a larger-than-normal wheel size, as is frequently the case on crane bridge drives, brakes can be provided with torques lower than recommendations.

For more demanding or corrosive environments, stainless steel hardware, National Electrical Manufacturer’s Association (NEMA)-grade enclosures and paint/surface treatments are available. A wide range of brake wheels, OEM spare parts, special add-ons, and product options are available. Consult Magnetek product brochures, Magnetek.com, and/or Magnetek customer service for more information.

All electromagnetic coils used in SA brakes are engineered by Magnetek. Coils are manufactured and tested by skilled technicians to ensure reliability of thermal, electrical, and magnetic performance. The coil is secured to the magnet case by thermosetting epoxy. The epoxy bonds directly to the interior of the magnet case, which efficiently transfers heat out of the coil through this direct conduction path. The air gap of the coil is easily determined by the air gap indicator atop the magnet case. When the air gap is maintained within correct limits, the coil will responsively actuate the brake. A dust shield is fastened to the magnet case to protect the interface of the armature and magnet from dust, debris, and possible magnetic particles in the environment. Coil replacements are easily performed by swapping out the coil assembly via one pin connection.

Brakes can operate between ambient temperatures of -40 to 158°F (-40 to +70°C) and in an altitude as great as 9,800 ft (3,000 m).
3 Description of Operation

Braking torque is applied via dual torque springs. Heavy-duty compression springs push the armature and magnet case, transmitting force through the brake linkage, and forcing the shoes against the wheel. The default mode of the brake, when electric power is not supplied to the coil, is to apply braking torque to stop and hold a load. This is referred to as “setting” the brake or described as “the brake is set.”

Fig. 2

1. Dual Torque Springs
2. Air Gap Open
Electric power supplied to the coil cancels the brake’s ability to apply braking torque to the drive system. When electric power is supplied, the armature is magnetically pulled toward the magnet case, the armature air gap closes, the brake linkage moves the shoes completely off the wheel, and a clearance is developed. This is referred to as “releasing” the brake or described as “the brake is released.”

![Diagram of a brake system]

Fig. 3

1. Magnetic Field Present
2. Air Gap Closed
3. Shoe Release Clearance

The magnetizing action of pulling in the armature to release the brake is also referred to as armature “pull-in.” When power is removed from the coil, the magnetic force overcoming the torque springs disappears, so the springs push out the armature and set the brake. This demagnetizing action of the armature is also referred to as armature “drop-out.”
3.1 Torque Springs

Braking torque is applied via dual torque springs. Torque springs are heavy-duty compression springs, so the force output of the springs is proportional to the amount of spring compression. More spring compression will make more braking torque. A measurement of the brake torque setting is made by measuring the distance from the magnet case face to the underside of the bolt heads of the torque spring bolts as shown in Fig. 4 on page 12.

Fig. 4

1. Torque Measurement
Braking torque is adjusted via the torque spring bolts. There is one torque spring bolt for each torque spring. Torque spring bolts are located on the exterior of the magnet case. Braking torque is increased by “tightening” the bolt into the magnet case and decreased by “loosening” the bolt the other direction.

The two torque spring bolts must always be set equally during operation. The desired braking torque and successful brake release may not be achieved if torque spring bolts are set unequally.

The torque spring bolts must always be set within the minimum and maximum limits in operation. Torque spring bolts set below their minimum measurement will make the coil struggle to release the brake. Torque spring bolts set above their maximum measurement will make the brake struggle to set within a typical response time.

Fig. 5

Rated torque spring bolt settings (inch) and associated torques (lb-ft) for each brake size are shown in Table 1 on page 14.
3.2 Air Gap Indicator

With torque set within minimum and maximum limits, proper brake operation is further maintained by measuring the air gap between the armature and magnet case, via the air gap indicator, and also maintaining it within minimum and maximum limits. The air gap is measured only when the brake is set. The minimum and maximum limits are stated physically on the air gap indicator, and in Table 2 on page 15. The air gap is measured from the face of the indicator to the face of the armature feature.
If the air gap exceeds its maximum limit, the torque springs are no longer compressed enough. The springs are outputting insufficient force, so the brake is developing torque less than the intended magnitude. The excessive air gap creates more resistance for the coil to overcome and makes the brake struggle to release. When the drive system moves a load in this condition the brake may not release. This may cause the move to fail or may overheat and damage the brake and the drive system.

The air gap will change naturally during operation. The wear of friction linings during normal use will increase the air gap. The thermal expansion of a brake wheel may decrease the air gap. A recent brake

Table 2: Armature Air Gap Settings

<table>
<thead>
<tr>
<th>BRAKE</th>
<th>Minimum Air Gap</th>
<th>Maximum Air Gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&quot;</td>
<td>1/16&quot;</td>
<td>7/64&quot;</td>
</tr>
<tr>
<td>6&quot;</td>
<td>1/16&quot;</td>
<td>7/64&quot;</td>
</tr>
<tr>
<td>8&quot;</td>
<td>5/64&quot;</td>
<td>1/8&quot;</td>
</tr>
<tr>
<td>10&quot;</td>
<td>5/64&quot;</td>
<td>5/32&quot;</td>
</tr>
<tr>
<td>12&quot;</td>
<td>7/64&quot;</td>
<td>11/64&quot;</td>
</tr>
<tr>
<td>13&quot;</td>
<td>7/64&quot;</td>
<td>11/64&quot;</td>
</tr>
<tr>
<td>15&quot;</td>
<td>5/32&quot;</td>
<td>1/4&quot;</td>
</tr>
<tr>
<td>16&quot;</td>
<td>5/32&quot;</td>
<td>1/4&quot;</td>
</tr>
</tbody>
</table>
installation or adjustment may affect the air gap even after making proper adjustments. The air gap is controlled via adjustments to the pushrod.

---

**DANGER**

Always keep the armature air gap within minimum and maximum bounds. Measure the air gap, then make pushrod adjustments as necessary. Exceeding the maximum bound results in a hazardous condition of insufficient or potentially zero braking power available to a load that may lead to serious injury or death.

### 3.3 Pushrods

High-performance friction linings are bonded to the brake shoes and the thickness of the linings will naturally diminish over time as the brake is used. As the lining material diminishes, the brake linkage will naturally shift, causing the torque springs to decompress and the air gap to increase. Pushrod adjustments must be performed to compensate for this phenomenon.

Pushrods are described as having a “length.” The pushrod length is the distance between the pushrod adjustment nut and the pivot pin axis as shown in **Fig. 7 on page 16**.

---

![Fig. 7](image)

1. Pushrod Length
The pushrod must decrease in length incrementally over the lifetime of a pair of friction linings to maintain correct air gap and brake torque. When brake shoes are replaced, the pushrod must return to the approximate length it was set to upon initial installation of the brake.

The pushrod controls the air gap, but the air gap must be maintained by periodic manual adjustment. An adjustable nylon hex nut with a pushrod collar makes a connection between the magnet case and pushrod. Adjustment of the nylon hex nut controls the pushrod length. At the other end of the pushrod is a non-adjustable trunnion block, which never requires adjustment for normal operation and maintenance.

### 3.4 Shoe Equalization Bolts

The total available shoe clearance is proportional to the armature air gap. The greater the armature air gap, the more clearance will be given to the brake shoes when the brake is released. The distribution of the available shoe clearance between the two brake shoes is determined by the positions of the two manual equalization bolts.

When the brake releases, the brake arms pivot about their connection to the brake base and away from the wheel. The shoe equalization bolts act as stops for the brake arms. Given enough space to do so, a brake arm will pivot away from the wheel and rest upon its equalization bolt. Raising the height of the bolt head above the base will reduce the travel space available to that brake arm and therefore reduce the clearance given to that brake shoe. One shoe equalization bolt, typically the bolt opposite the coil, should be set to a position that limits the clearance given to that brake shoe, so that equal clearance is given to the other shoe as well.

![Fig. 8](image)

**NOTE:** Only make pushrod adjustments per the procedure in Section 4.2 on page 21.
As the friction lining material diminishes, the brake shoes will move closer to the wheel and the brake arms will pivot further inward toward the brake wheel.

**NOTE:** When each pushrod length adjustment is made to compensate for lining wear, the manual equalization bolts should also be adjusted to compensate for the inward shift of the brake arms.

For adjustment procedure of the shoe equalization bolts, see **Section 4.4 on page 23.**

### 3.5 Hand Release Mechanism

A hand-release mechanism is not required for brake operation but is a useful option to install. A hand release allows for mechanical release of the brake, which is very useful for various maintenance procedures and other purposes.

To use the hand release, rotate the handle to release the brake. When the handle is not in use, the brake operates as it would normally if there were no hand release installed at all.

The SA hand release is a non-latching, also known as self-resetting, type. The hand release can release the brake but the handle must be maintained in position to maintain brake release.

Hand releases are easily installed on the right or left side of the brake.

### 3.6 Limit Switches

SA brakes can be used with limit switches to indicate brake set, brake release, or hand release. Combinations of limit switches are also possible. The pushbutton-type limit switch provided by Magnetek offers a rugged enclosure meant to withstand harsh environments while being extremely reliable and requiring minimum maintenance.

Limit switches are attached to the magnet case via a bracket and actuated by adjustable screws. The brake should be released and/or the hand release engaged before adjusting the actuating screws.

The “brake set” and “brake release” limit switches are actuated in the same way. The actuating screw is attached to the armature via an adapter. The armature pulls in and mechanically actuates the limit switch.

The “hand release” limit switch is actuated when the hand-release handle is used to release the brake. The actuating screw is attached to the handle, which moves toward the magnet case and actuates the limit switch.

Limit switches are easily installed on the left or right side of the brake.

<table>
<thead>
<tr>
<th>Limit Switch Property</th>
<th>Detail</th>
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</thead>
<tbody>
<tr>
<td><strong>EATON Cutler-Hammer</strong></td>
<td>ED50 Double Throw, Double Pole (2 N.O. – 2 N.C.)</td>
</tr>
<tr>
<td>Switch Body</td>
<td>E50SB</td>
</tr>
<tr>
<td>Receptacle</td>
<td>E50RB</td>
</tr>
<tr>
<td>Operating Head</td>
<td>E50DT1</td>
</tr>
<tr>
<td>Environmental Ratings</td>
<td>NEMA 1, 3, 3S, 4, 4X, 6, 6P, 13, IP67</td>
</tr>
<tr>
<td>Conduit Entrance</td>
<td>1/2” NPT</td>
</tr>
<tr>
<td>Mechanical Life</td>
<td>10,000,000 operations minimum</td>
</tr>
<tr>
<td>Electrical Life</td>
<td>100,000 operations typical at full load</td>
</tr>
<tr>
<td>Ambient Temperature Range</td>
<td>14°F to 250°F (-10°C to 121°C)</td>
</tr>
<tr>
<td>Wire Size</td>
<td>Will accept AWG #18 though #12 (0.33 mm² through 3.31 mm²) single or stranded wire</td>
</tr>
</tbody>
</table>
3.7 Other

Magnetek Engineering will supply any custom design that is required. Various special features such as hydraulic and pneumatic overrides, lining wear measuring devices, custom coils, special enclosures, stainless steel components, lockout/tagout devices, etc. can be made available upon request. If any custom features are installed, consult the brake’s engineering drawing for supplementary instructions.
4 Adjustment

An armature air gap exceeding the maximum setting as physically stated on the air gap indicator will result in loss of braking torque. Under no circumstances should the brake be allowed to function with an air gap in excess of the maximum limit. Such operation can result in the loss of load control, which can lead to serious injury or death.

Adjustments to the quality of the brake wheel and limits for brake wheel runout are given below.

Table 4: Allowable Brake Wheel Properties

<table>
<thead>
<tr>
<th>Brake Wheel Size</th>
<th>Minimum Brake Wheel Diameter After Resurfacing¹</th>
<th>Maximum Full Speed Brake Wheel Runout²</th>
</tr>
</thead>
<tbody>
<tr>
<td>4&quot;</td>
<td>3.94&quot;</td>
<td>0.004&quot;</td>
</tr>
<tr>
<td>6&quot;</td>
<td>5.94&quot;</td>
<td>0.006&quot;</td>
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<tr>
<td>16&quot;</td>
<td>15.87&quot;</td>
<td>0.016&quot;</td>
</tr>
</tbody>
</table>

Notes:

¹ Per the recommendations of AISE Technical Report No. 11, which only apply for wheel sizes 8" and greater.

² Evaluate brake wheel run-out at full speed.

4.1 Manual Operation

To safely perform a brake installation, shoe replacement, coil assembly replacement, and other work requires that the brake be released and reapplied without energizing the coil.

This is done by either using the hand release or adjusting the pushrod length to release and set the brake.
4.2 Pushrod

DANGER

Disconnect, lock out and tag out the disconnect switch that feeds this equipment to prevent power from being applied while service is being performed.

WARNING

Always safely secure loads from gravity, wind and any external energy source that may inadvertently move the drive system. Follow facility safety procedures to prevent drive system movement when performing pushrod adjustments.

WARNING

Releasing the brake electrically (via the coil) creates a threat from an unexpected power outage while work is being performed. The stored mechanical energy in the torque spring will instantly move the brake linkage and create hazardous pinch points for technicians performing work on the brake.

Pushrod length is adjusted via the pushrod adjustment nut. When the brake is set, it may be difficult to “loosen” the pushrod adjustment nut to release the brake, due to the internal forces in the brake linkage. It may also be difficult to “tighten” the adjustment nut when bringing the brake back to an operational state and closing the air gap, as internal forces would build with each turn of the adjustment nut. A hand release can help by mechanically releasing the brake to relieve these forces while the adjustment nut is simultaneously moved.

“Tighten” the nut along the pushrod in order to decrease the pushrod length. This is necessary in order to decrease the armature air gap, compensate for lining wear, and press the shoes onto the brake wheel if the brake was in a disassembled or disengaged state, among other things.

“Loosen” the nut off the pushrod in order to increase the pushrod length. This is necessary to release the brake shoes from the brake wheel if the brake was in an operational state, increase the armature air gap, and remove internal forces from the linkage in order to perform maintenance, among other things.

Sufficiently increasing the pushrod length will allow for disconnection of the pushrod from the magnet case without removing the adjustment nut from the pushrod entirely. The pushrod collar can be forced against the pushrod spring and out of the magnet case thru-hole, which allows the pushrod to be pulled through the magnet case slot, completing the disconnection. It is best if this can be done without disturbing the torque spring bolts. However, if torque spring bolts are “loosened” out of the magnet case, the distance required for the pushrod adjustment nut to move can be reduced. If the torque spring bolts are disturbed for this purpose, always ensure that they are returned to their operational position before returning the brake to operation.
4.3 Torque Spring Bolts

**NOTE:** The National Electrical Manufacturer’s Association (NEMA) states: “The torque ratings apply at a worn lining condition defined as the point where re-adjustment is required as recommended by the manufacturer.”

The rated torque, as shown on the nameplate, will be developed when the following conditions are met:

- The brake is applied and aligned properly.
- The brake wheel is aligned and in good condition.
- The armature air gap is within the allowable range.
- The torque spring bolts setting per *Table 1 on page 14* matches the torque on the data plate.
- Magnetek-supplied friction linings are installed.

---

**DANGER**

The air gap must be periodically checked and adjusted to ensure that it is always within minimum and maximum limits per *Table 2 on page 15*. The air gap will naturally increase as the friction lining material wears away while the brake is in service.
• A Magnetek-supplied brake wheel is installed.
• The linings are in good condition.
• Burnishing has been completed.

The brake torque can be infinitely adjusted within minimum and maximum values per Table 1 on page 14. Should adjustment to the torque setting be necessary, follow this procedure:

1. Loosen the holding nuts locking the torque spring bolts to the magnet case.
2. Adjust the setting of the torque spring bolts to effect the desired torque per Table 1 on page 14.
   a. Always measure from the underside of the bolt head to the magnet case face.
   b. Always set the two torque spring bolts to the same dimension.
3. Re-tighten the holding nuts to full torque per hardware manufacturer recommendations.
4. Measure the armature air gap and confirm it is within the allowable limits per Table 2 on page 15. If the air gap is no longer within allowable limits, then adjust the pushrod length per Section 4.2 on page 21.

4.4 Shoe Equalization Bolts

Adjust the shoe equalization bolts according to the following procedure:

1. Loosen the jam nut that secures the bolt position.
2. Turn the bolt to adjust the height of the bolt head above the base. This can be done easily via a wrench or by hand.
3. Maintain the adjusted bolt position and tighten the jam nut into the base to full torque per hardware manufacturer recommendation.

NOTE: When each pushrod length adjustment is made to compensate for lining wear, the shoe equalization bolts should also be adjusted to compensate for the shift of the brake arms toward the brake wheel.

4.5 Anti-drag Feature

The brake shoes have a degree of freedom that allows them to pivot about their pin connection to the brake arm. This is necessary to ensure proper contact of the friction linings and brake wheel.

When the brake releases, gravity acts to pivot the shoes via their self-weight. When the brake releases, this would undesirably drag the shoes upon the brake wheel. For this reason, every brake includes the anti-drag feature.

Bending springs hold the position of the shoes relative to the brake arms. The weight of the shoes is not enough to overcome the force of the plate springs. However, the force of the torque springs transferred to the shoes will easily overcome the plate springs and pivot the shoes as necessary for operation.

To adjust the shoe position manually, simply push the shoe by hand or use a soft-faced mallet to tap the upper or lower edge of the shoes.
4.6 Hand-Release Mechanism

The hand-release mechanism uses an auxiliary linkage to mechanically release the brake by pulling the hand-release handle. The hand-release leaves the factory correctly installed and set up for operation. Should the hand release be disturbed, it can be reinstalled via simple bolted and pinned connections according to the engineering drawing.

The hand-release control bolt adjusts the position of the hand-release handle. The control bolt is threaded into the hand-release block, and the block is pinned to the handle. While the handle is unused, “tighten” the control bolt into the block to rotate the handle away from the magnet case, and vice versa.

The control bolt must be used to position the handle to be vertical (vertical handle for a standard horizontal brake mounting arrangement) or, in other words, parallel to the armature/magnet case interface, when the hand-release is actively releasing the brake.

The hand-release handle has a bolted extension grip to aid operation. If it is preferred to reduce the envelope dimension of the brake, then the grip and its hardware can be discarded.

![Fig. 10](image)

1. Hand-Release Control Bolt
2. Hand-Release Handle
3. Block
4. Correct Handle Position for Active Hand Release
4.7 Limit Switches

Limit switches are mounted to the magnet case and indicate states of the brake via actuating screws. Once wired correctly, the only adjustments to possibly be made are adjustments to the actuating screws which press the pushbutton-type limit switch. The limit switches leave the factory correctly installed and set up for operation. The actuating screw for a limit switch indicating brake position is located on an adapter bolted to the armature. The actuating screw for a limit switch indicating hand-release action is located on the hand-release handle.

Should the actuating screws be disturbed, they can be easily readjusted. Hex nuts lock the actuating screw to either the adapter or the hand-release handle. Simply loosen the nuts, reposition the actuating screw, and re-tighten the nuts.

WARNING

Via the hand-release control bolt, place the hand-release handle to be parallel to the armature/magnet case interface when the hand release is actively releasing the brake. Significantly misplacing the handle may create a loss of brake torque.
5 Electrical Detail

DANGER

Avoid contact with "live" terminals and prevent contaminant entry. Disconnect, lock out, and tag out the power source that feeds this device to prevent power from being applied while work is being performed. Install the coil terminal box cover as soon as connections are complete.

WARNING

The coil must be connected to its electrical supply through a flexible cable or sealed flexible conduit. The coil pivots about its connection to the brake base during operation, so the electrical connection must be permitted to move.

For shunt coils, verify that the utility line voltage (and frequency, if applicable) matches the information on the brake nameplate. For series coils, verify the full load amps of the motor are less than or equal to the amperage rating of the brake nameplate.

If applicable, connect the ground before connecting the coil to the supply.

Every SA brake is fitted with a weather-proof NEMA Type 3R gasketed and sealed terminal box on the back of the magnet case. The bottom of the terminal box has a 7/8" diameter thru-hole for cable entry. The thru-hole or terminal box can be modified for the end user’s needs, but if modifications are made, replacement parts may not work directly. Always keep the terminal box clean, secure the cover tightly, and maintain the seal.

Ensure that the input cable is attached properly to the coil terminals and the terminal box is sealed in accordance with the environmental protection requirement for the application.

Use flexible cable or sealed flexible conduit. Use type SO- or HAR-approved cable suitable for the rated temperature. The coil must be allowed a few degrees of movement about its connection to the brake base.

The coil is independent of polarity, but the conventional connection for DC supply lines is positive line (+) to the red wired terminal, and negative line (-) to the black wired terminal.
1. VDC Input, Independent of Polarity
2. Red Wire or Black Wire to Electromagnet, Independent of Polarity
3. Ground Terminal Lug
4. Terminal Block and Hardware
5. Thru-hole for Cable Entry
Brakes with a single-phase rectifier installed inside the terminal box can also be supplied for 120, 230, 460, or 575 VAC, single-phase, 60Hz input and continuous duty.

Fig. 12

1. VAC Input
2. DC Positive Line to Electromagnet
3. DC Negative Line to Electromagnet
4. Ground Terminal Lug
5. Suppressor for 460VAC and 575VAC Inputs
6. Terminal Block and Hardware, Slot Shown for Orientation
7. Thru-hole for Cable Entry
Many coils are available to work with various voltages and series DC motors to conform to the end user’s facility. Standard shunt voltages are in the range of 12VDC to 550VDC. Standard series coils are in the range of 4 Amp to 300 Amp rated input. External “forcing” rectifiers are available to improve brake reaction time, coil operating temperature, and extend coil life. External “non-forcing” rectifiers are available as well.

Fig. 12A
6 Installation

**DANGER**

All electrical power to this equipment must be disconnected by competent personnel. Consult specific wiring diagrams to identify and isolate all live power inputs to the equipment.

**WARNING**

Anyone involved in the installation or service of this brake must have:

- Received specific training.
- Had experience on similar equipment.
- Knowledge of the equipment on which the brake is installed.
- The ability to understand the terminology.
- The ability to understand the diagrams.

Do not proceed unless technically qualified for the work involved.

**CAUTION**

The integrity of the brake may be compromised or a replacement part may not fit if alterations are made to the brake to achieve required alignment or otherwise.

**CAUTION**

If the alterations to the brake supporting structure are required, they must be done under the direction of a competent authority.
Before installing the brake:

1. After unpacking, visually inspect the brake assembly to ensure that damage has not occurred during shipment and that there are no loose or missing parts.

2. If the brake has been shipped from the factory with steel wire holding the armature and magnet case together, do not remove the wire until the brake is mounted upon the brake supporting structure.

3. Remove and discard any wedges used to secure the brake against vibration during transportation.

4. Prepare the brake supporting structure and ensure the brake wheel rim is at least 1/4" (5 mm) wider than the brake shoes.

To install the brake:

1. Allow adequate clearance between the brake and adjacent obstructions to allow access for adjustment and maintenance. Consult the brake engineering drawing and/or 200S Brakes Technical Specifications manual (part number 452039) for pertinent dimensions.

   **NOTE:** Brake shoe replacement requires space for complete withdrawal of the link arm pivot pins.

2. Whether mounting a brake in a new or existing installation, the base mounting bolts need a reasonable clearance in the base mounting holes to allow the brake to be aligned to the brake wheel. The Technical Specifications manual and brake engineering drawing show the recommended bolt size for brake mounting and the size and depth of the associated thru-hole in the brake base.

3. Circumstances of the end user’s machinery layout may determine the best order of installation for the brake and the wheel. This may be due to the available space or handling facilities onsite. Generally, the wheel is installed first on a horizontal table surface with brake mounting features already built into the structure, and that is what this procedure assumes.

4. Type SA brakes cannot be partially disassembled and inserted perpendicular to the wheel axis. The brake must be inserted from in front of the wheel and moved parallel to the wheel axis.

---

**DANGER**

Unexpected movement or hazardous voltage can cause injury or death. Disconnect, lock out and tag out the power source that feeds this device to prevent power from being applied while inspection and repairs are being performed. Before beginning repairs, try the operational controls to verify that the intended power source is disconnected.
5. The brake supporting structure surface should be flat and parallel to the motor and brake wheel axis. It is acceptable to place shims under the brake base for vertical placement.

6. Observe the following correct lift points and place the brake upon the supporting structure.
7. Slide the brake upon the supporting structure to center the brake shoes across the width of the brake wheel.
   
a. Centering the brake shoes avoids ridge formation on the brake linings, which can otherwise become a dangerous situation as the linings wear.

b. If the brake is being installed for the first time, the armature and magnet case may be held together via steel wire. The wire is mechanically maintaining a “brake released” state, so the brake can easily slide past the brake wheel in this condition.

c. Alternatively, release the brake or increase the pushrod length as necessary per Section 4.2 on page 21 to slide the brake.

8. After placing the brake and installing the wheel, insert the mounting hardware and tighten less than hand tight.

9. Connect the coil to the electrical supply using flexible sealed conductor suitable for the rated temperature.
   
a. Use flexible cable or sealed flexible conduit. Use type SO- or HAR-approved cable suitable for the rated temperature.

---

**CAUTION**

Never lift the brake by lifting the pushrod. This will cause irreversible damage to the pushrod and make the brake unsafe to use.
b. The coil must be allowed a few degrees of movement about its connection to the brake base.

10. Decrease the pushrod length to establish the minimum air gap (if necessary, cut the steel wire holding the armature and magnet case together). Ensure the torque bolts are in the position to make the rated torque per Section 3.1 on page 12. Establishing the air gap and torque setting will apply the brake, causing the brake to align itself to the wheel and maximize shoe contact area.

11. Verify approximately equal clearance in all four of the base mounting holes for the mounting bolts. If necessary, increase the pushrod length to unclamp the brake, center the brake to the mounting holes, and then re-establish the air gap.

NOTE: Magnetek does not recommend “dowelling” or “keeper plates” to maintain alignment. The correct mounting bolts with correct bolt torque will secure the brake properly and allow for minor adjustment to the alignment in the future when replacement shoes are installed.

12. Power the coil on and off several times, ensuring that the air gap is correct. This will use the strength of the torque springs to best align the brake to the wheel and mounting hardware.

13. With the brake set at rated torque, tighten the mounting hardware to full torque per the hardware manufacturer recommendations for the specific bolt size.

14. Set one of the shoe equalization bolts (typically the one opposite the coil) to a position that, when the brake is released, gives equal clearance from the wheel to both shoes.

15. Ensure again that the air gap is within the acceptable limits.

Consult the factory for non-standard mounting arrangements.

The brake assembly must always be parallel and aligned to the brake wheel within a maximum of 1/32 inch, in three axes (horizontal, vertical, and longitudinal).

DANGER

Failure to install the brake wheel correctly may result in total loss of braking torque. Do not operate the brake unless the wheel is secured to the shaft. Failure to properly center the brake and obtain uniform lining contact results in localized heating and, ultimately, reduced torque, which can lead to serious injury or death.
7 Burnishing

**NOTE:** The National Electrical Manufacturer’s Association (NEMA) states: “The torque ratings apply at a worn lining condition defined as the point where re-adjustment is required as recommended by the manufacturer”.

Once the brake is correctly mounted upon the brake supporting structure and all adjustments are properly set, the brake will still not achieve the rated torque. This is because the friction linings are not yet burnished, they have not established an operational interface with the brake wheel.

For any friction braking application, burnishing once the system is initially installed is critical to long-term performance. Burnishing is a method to:

- Prepare the compounds of the friction linings for thermal load
- Form the working surface flat by eliminating localized high spots
- Deposit friction material onto the brake wheel, to improve the coefficient of friction

Burnishing is always required to make the rated torque. Burnishing should always be performed upon an initial brake installation, brake realignment, brake shoe replacement, or brake wheel replacement. For shoe and wheel replacement, realigning the brake by loosening the mounting hardware, cycling the brake open and closed, then retightening the mounting hardware may reduce the amount of time spent burnishing.

The key to burnishing is to apply successive braking stops with small inertial loads and to limit the overall temperature rise in the brake wheel.

On hoists, well-spaced, short bursts of energy, such as an E-stop at high speed with no load, are best to achieve initial “burnishing.”

On traveling motions, well-spaced moves, without other loads, at medium speed are best to achieve burnishing.

Burnishing may involve between 100-200 cycles of this nature.

![CAUTION]

A minimum of 60% contact area on both friction linings, or a torque measuring method to prove the brake is achieving rated torque, is required before subjecting the brake to full-service capacity. Failure to do so means the brake will not produce rated torque. The percentage of the working surface that has been burnished is visually apparent on the friction linings.

Modern linings, although hard-wearing, cannot support the heat transferred to the brake without burnishing. “Glazing” is a condition where the linings have been heated beyond their working temperature range and are no longer capable of their designed coefficient of friction. “Glazing” will seldom be removed by further braking operations or burnishing attempts. Serious glazing damage may only be resolved by brake shoe replacement.

“Glazing” is prevented by ensuring a minimum of 60% contact area, or a torque measuring method to prove the brake is achieving rated torque, before placing the brake in service.

As an alternative to the burnishing methods above, and if the drive system permits, power can be removed from the coil and the drive can power through the braking torque. Very slow speeds are recommended if this method is used.
Do not exceed a maximum of 300°F of the brake wheel during burnishing.

Wear will be more rapid when the linings are new, while the localized high spots are wearing down as the burnishing process takes place. Adjustment may be required soon after the brake has been put into service.

Always use genuine Magnetek-lined brake shoes. This will maintain brake performance and ensure that the braking torque is neither more nor less than the specified rating.

Refurbished or re-lined brake shoes using friction materials and adhesives other than genuine Magnetek parts are not tested for performance, wear, or reliability.

Do not use re-lined shoes where the castings are damaged, worn or distorted.
8 Operational Test

**WARNING**

Before conducting an operational test, remove all tools, chocks and other equipment, which may create a hazard when drive machinery is operated.

**WARNING**

Following any repair or adjustment, and before conducting an operational test, verify that all brake adjustments are complete in accordance with *Section 4 on page 20*.

**CAUTION**

Always perform an operational test of the brake after any installation, realignment, brake replacement, shoe replacement, wheel replacement or repair. Read and understand the intent of the warnings published in this document.

Follow all installation, adjustment, and burnishing procedures described above.

Check brake wheel runout. Verify the radial runout does not exceed 0.001" (0.025 mm) per inch of brake wheel diameter at all drive speeds. See *Table 4 on page 20*.

Proceed through the next steps. If the brake succeeds at each step, then proceed. If the brake fails, then perform more burnishing before returning to the operational test.

1. Begin the operational test with no-load and slow speed conditions. Ensure the brake can stop and hold an empty hook, or stop a traveling motion within an acceptable distance and time.
2. Increase load and speed to medium settings. Ensure a hoist load can be stopped and held and there is no creep or drift of the load. Ensure a traveling motion is stopped within an acceptable distance and time.
3. Increase the load and speed to maximum operational settings. Ensure a hoist load can be stopped and held and there is no creep or drift of the load. Ensure a traveling motion is stopped within an acceptable distance and time.

If burnishing or correct measurement of torque has been achieved and all of these tests are acceptable, then the brake is ready for full service.

Consult AIST and/or The Crane Manufacturers Association of America (CMAA) for recommendations for suggested stopping distances and times.
9 Maintenance and Repair

**WARNING**

When replacing a brake wheel or associated drive line components on an existing installation, verify that the brake is centered with uniform lining contact as described in Section 6 on page 30. Incorrect repair or replacement can result in death or injury.

**WARNING**

Always safely secure loads from gravity, wind and any external energy source that may inadvertently move the drive system. Follow facility safety procedures to prevent drive system movement when replacing brake shoes.

**WARNING**

Releasing the brake electrically (via the coil) creates a threat from an unexpected power outage while work is being performed. The stored mechanical energy in the torque springs will instantly throw the armature, move the brake linkage, and create hazardous pinch points for technicians performing work. It is always recommended to release the brake manually to perform work.

**CAUTION**

During operation, the temperature of the coil will increase. Switch off power to the coil and allow it to cool to ambient temperature before performing any work.
9.1 Replacing the Brake Shoes

To remove the brake shoes:

1. Lower both manual equalization bolts as far down as necessary.
2. Increase the pushrod length to relieve internal forces in the brake linkage and prepare to support the coil assembly after the following step.
3. Disconnect the pushrod per Section 4.2 on page 21 and Fig. 15 on page 39.
4. Move the coil assembly and brake arms away from the wheel.
5. Remove the retaining hardware from the shoe pivot pins.
6. Withdraw the shoe pivot pins and take care to not lose the roller from the coil side shoe pivot pin.
7. Separate the shoes from the arms by pulling them or using a soft-faced mallet to release the shoes from the arms.

![Fig. 15]

1. Shoe Being Removed
2. Roller Attached Only to this Shoe Pivot Pin

Other methods, such as removing the brake wheel, may allow for shoe removal.

**NOTE:** Always replace shoes as a pair.

**NOTE:** Use caution when removing retaining hardware, pivot pins, and the roller to prevent brake parts from dropping uncontrollably.
Before starting shoe installation, check that the brake surface of the wheel is clean and free from oil, grease, cracking, or other damage.

Check that all bending springs fastened to the brake arms are secured by their screws and that no screws are loose. If necessary, use thread locking adhesive (such as Loctite 277) and retighten the screws. Check that the roller is in good condition.

Install the replacement shoes in the reverse order of the steps previously described (steps 7 to 5). Add a minimum amount of lubricant such as Anti-Seize or grease for ease of assembly, applying to all pivot pins that were removed.

Ensure all retaining pins have been reinstalled.

Make pushrod adjustments per Section 4.2 on page 21 and reestablish the minimum armature air gap.

Make shoe equalization bolt adjustments per Section 4.4 on page 23 and reestablish equal shoe clearance when the brake is released.

Burnish the new shoe linings per Section 7 on page 35.

Perform an operational test per Section 8 on page 37.

NOTE: It is not recommended that shoes be re-lined with friction materials other than genuine Magnetek parts. New bonded shoe assemblies can be ordered as repair parts. Factory rebuilt shoes are also available from Magnetek. Under this program, credit will be allowed for old brake shoes in usable condition.

9.2 Coil Assembly

The coil assembly must be removed and replaced as a complete unit.

DANGER

Unexpected movement or hazardous voltage or current can cause injury or death. Disconnect, lock out, and tag out the power source that feeds this device to prevent power from being applied while inspection and repairs are being performed. Before beginning repairs, try the operational controls to verify that the intended power source is disconnected.

To remove the coil assembly:

1. Remove the coil terminal box cover and disconnect the power source.

2. Prepare to support the coil assembly, then disconnect the pushrod from the coil assembly via Section 4.2 on page 21.

3. Remove retaining hardware from the base/armature/magnet case pivot pin.

4. Use a lifting device to support the coil assembly and remove its weight against the pivot pin.

5. Withdraw the pivot pin from the brake base.
   a. This can be achieved by tapping the pin with a soft-face mallet or pin removal tool.
b. Tapping the pin clear through the base and clear through one pair, but not both pairs, of the armature and magnet case thru-holes will keep the coil assembly together and can aid transport when the coil assembly is separated from the brake.

6. Lift out the magnet case with appropriate lifting devices.

Install a replacement coil assembly in the reverse order of the steps above (steps 6 to 3). Ensure all retaining hardware is reinserted before returning brake to operation.

Restore the pushrod connection to the coil assembly and decrease the pushrod length per Section 4.2 on page 21 to bring the armature air gap to the minimum setting.

Restore the power supply and reassemble the new terminal box. Power the coil on and off several times to verify the coil releases the brake and establishes proper shoe clearance.

9.3 Pushrods

It is recommended to replace the pushrod and pushrod hardware as a complete unit. Disconnect the pushrod from the coil assembly per Section 4.2 on page 21, then remove the retaining hardware and pushrod/arm pivot pin to isolate the pushrod components. Reinstallation is achieved in the reverse order.

9.4 Other

Removing and reinstalling other components on the brake can be done similar to a shoe replacement or a coil assembly replacement procedure.
Disconnecting the pushrod from the coil assembly via Section 4.2 on page 21 will relieve the torque springs of their stored mechanical energy and remove internal forces within the brake linkage. Once this is achieved, further components may be disassembled.

Major brake components are all pinned together and some components involve rivets or threaded hardware. Disassembling the brake involves removing retaining hardware, pivot pins, and threaded hardware. Consult the brake engineering drawing for exploded views and parts lists.

A small amount of thread-locking adhesive (such as Loctite 277) is used on the screws holding the bending springs attached to the brake arms. A small amount of lubricant such as Anti-Seize or grease is applied to all brake pivot pins for ease of assembly.

Maintenance and inspection periods depend on operating conditions. High duty cycle applications obviously require more frequent inspections than brakes operating in low duty cycle applications. In either case, Magnetek recommends a general inspection every 100 operating hours or once every month at a minimum.

Pivot pins may experience surface wear, and a corresponding loss of pin diameter will occur. Monitor pivot pins, replace as necessary, or at least:

- Replace all stainless steel pivot pins every 500,000 braking cycles.
- Replace all aluminum bronze pivot pins every 150,000 braking cycles.

Pushrods may fail from fatigue stress without obvious signs of wear. Replace pushrod assemblies no later than every 500,000 braking cycles.

**NOTE:** Always use genuine Magnetek replacement parts. This will ensure correct geometry, tolerancing and material strength to prolong the service life of a brake.

### 9.5 Inspection

Electrical connections and mechanical fasteners should be checked for tightness. Inspect the brake mounting bolts for tightness.

Inspect the brake wheel to ensure its connection to the motor shaft or drive system is in good condition. Check for unusual signs of scoring, over-heating, cracking, or wear. Replace any damaged, cracked, or excessively worn brake wheels.

Check for signs of wear and/or deformation on the following components, and replace if necessary:

- Various pivot pins and all retaining hardware should be in good condition.
- Various hardware should be in good condition; inspect the threads on bolts, nuts, and the pushrod.

Replace pushrod assemblies if there are signs of deformation, if excessive rust has built up or for any other reason that would lead to strength degradation.

A full rebuild of the brake every three years or 1,500,000 cycles (whichever comes first) is suggested.

### 9.6 Lubrication

Periodic lubrication is not required. A minimum amount of lubricant such as Anti-Seize or grease applied to pivot pins is recommended for ease of assembly.
10 Replacement Parts

NOTE: Magnetek recommends that brake linings be replaced when the linings wear down to 1/16" minimum thickness.

Table 5 lists the minimum permissible brake lining thickness prior to replacement. Information for wheel sizes 8", 10", 13", and 16" conforms to NEMA standard ICS 9-1993, Part 1; Electro-magnetic Brakes. The information for 4", 6", 12", and 15" brakes is provided by Magnetek, which NEMA does not have specifications for. Table 5 covers both bonded and riveted-type linings.

Table 5: Wheel Properties and Minimum Shoe Lining Thickness

<table>
<thead>
<tr>
<th>Wheel Diameter (Inches)</th>
<th>Maximum RPM</th>
<th>Lining Thickness (Inches)(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Riveted(2)</td>
</tr>
<tr>
<td>4</td>
<td>5000</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>5000</td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>5000</td>
<td>0.010</td>
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<tr>
<td>15</td>
<td>2600</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>2600</td>
<td>0.015</td>
</tr>
</tbody>
</table>

(1) Minimum permissible prior to replacement.
(2) Above rivet head at maximum wear point.

For parts replacement, part number identification, or complete disassembly and rebuild, refer to the brake engineering drawing.

Magnetek can supply a variety of replacement part “kits” and individual parts. Quick turnaround brake refurbishment and recertification at Magnetek’s factory is also available to Magnetek brake owners.

Always quote the Magnetek serial number when ordering parts.

For optimum brake life and performance use only genuine Magnetek parts.
11 Long-Term Storage

If a brake assembly will not be installed immediately, it can be stored indoors in a dry location indefinitely, or outdoors for a reasonable time if adequately protected from moisture and corrosive atmosphere. The brake assembly must always be protected from direct exposure to the elements, unless specifically treated at the factory for use in that environment. Covering with plastic sheeting is not acceptable, unless provision is made to prevent condensation under the plastic.

During storage, rust may form on the surface of the brake wheel. This is not usually a problem with ductile iron wheels, nor is it necessary to clean the wheel before placing in service. The first few brake applications will polish the wheel.

Steel wheels may form scale when corroded, and the braking surface may have to be re-machined to remove the scale. See Table 4 on page 20 for machining limits. Dynamic balance may be affected by machining.

Do not paint over or remove data plates and labels. Before painting a brake, protect all pivot points, pushrod threads, the brake wheel, and friction linings. Take special care to protect the magnet core and armature face from paint.