LOCTITE® Fixmaster® Metal Rebuilding

Rebuild, Repair and Restore
Industrial Equipment Catalog and Technical Guide
When you choose the LOCTITE® brand, you receive much more than a reliable assembly, you obtain a comprehensive solutions package:

- Wide product range
- Advanced training programs
- Engineering services
- Research and development
- Agency certification and approvals
- Local application assistance
- Global availability
- Online resources at www.henkelna.com

Visit henkelna.com/mro for an all-access pass to distributors, MSDS, literature and product application assistance.
Introduction

This manual is designed to assist maintenance personnel through many common everyday repairs.

LOCTITE® Fixmaster® composites REBUILD, REPAIR and RESTORE industrial equipment and surfaces, while extending equipment life, improving efficiency, and minimizing downtime.

Providing Maintenance Solutions

LOCTITE® Fixmaster® composites offer proven maintenance solutions to the problems caused by wear, abrasion, chemical attack, erosion, vibration, corrosion, fatigue, and mechanical damage. With metal reinforcement fillers, these products are machinable and have superior adhesion. They are designed to protect and extend the service life of a wide range of plant equipment.

Creating Partnerships

LOCTITE® branded products are foremost in the business of solving and preventing customers’ problems. With Fixmaster® composites technology providing the foundation, customers get more than a product – they get a partner who will work side-by-side with them to create and implement innovative solutions.

Focusing on Customer Support

Our highly experienced Fixmaster® composite Application Engineers are committed to providing the highest level of technical support and assistance in the industry. Working closely with local industrial suppliers, our Application Engineers provide full process support, from maintenance assessment to implementation of solutions.

Surface Preparation

Refer to page 14

Mixing Tips

Refer to page 17

Application Examples

Course Grinding

Ablasive Blasting

Proper Mixing

Keyway Repairs

Shaft Repairs

Not all repair procedures are listed. However, with the techniques shown here, combined with the versatility of LOCTITE® products and the ingenuity of the user, many hundreds more are possible.
Loctite® Fixmaster® Selector Guide

- High compressive strength
- Choice of mild steel aluminum or non-metallic fillers
- Can be machined, drilled, or tapped after cure
- Excellent resistance to aggressive chemicals

**WHAT TYPE OF APPLICATION IS NEEDED?**

### PUTTY

<table>
<thead>
<tr>
<th>Steel</th>
<th>Aluminum</th>
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<tr>
<td>Loctite® Fixmaster® Steel Putty</td>
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<tr>
<td>Loctite® Fixmaster® Aluminum Putty</td>
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**Steel**

- Color: Grey
- Maximum Temperature: 200°F (93°C)
- Working Time*: 20 min.
- Cure Time*: 6 hrs.
- Compressive Strength: 11,100 psi
- Common Sizes / Part Number:
  - 1 lb. kit – 99913
  - 25 lb. kit – 99912

**Aluminum**

- Color: Light Grey
- Maximum Temperature: 200°F (93°C)
- Working Time*: 10 min.
- Cure Time*: 6 hrs.
- Compressive Strength: 10,800 psi
- Common Sizes / Part Number:
  - 4 lb. kit – 99914
  - 25 lb. kit – 97453

### Stainless Steel

<table>
<thead>
<tr>
<th>Stainless Steel</th>
<th>High Performance</th>
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<tr>
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<tr>
<td>Loctite® Fixmaster® Superior Metal</td>
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</tbody>
</table>

**Stainless Steel**

- Color: Grey
- Maximum Temperature: 225°F (107°C)
- Working Time*: 6 hrs.
- Cure Time*: 6 hrs.
- Compressive Strength: 11,100 psi
- Common Sizes / Part Number:
  - 1 lb. kit – 99913
  - 4 lb. kit – 99914

**High Performance**

- Color: Grey
- Maximum Temperature: 250°F (121°C)
- Working Time*: 20 min.
- Cure Time*: 6 hrs.
- Compressive Strength: 12,000 psi
- Common Sizes / Part Number:
  - 1 lb. kit – 97443
  - 4 lb. kit – 97440

### SPECIALTY

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<thead>
<tr>
<th>Steel</th>
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<tr>
<td>Loctite® Fixmaster® Steel Liquid</td>
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<tr>
<td>Loctite® Fixmaster® Aluminum Liquid</td>
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</tbody>
</table>

**Steel Liquid**

- Color: Light Grey
- Maximum Temperature: 25°F (–13°C)
- Working Time*: 5 min.
- Cure Time*: 8 hrs.
- Compressive Strength: 12,000 psi
- Common Sizes / Part Number:
  - 1 lb. kit – 97483
  - 1 lb. kit – 97484

**Aluminum Liquid**

- Color: Light Grey
- Maximum Temperature: 20°F (–6°C)
- Working Time*: 3 min.
- Cure Time*: 6 hrs.
- Compressive Strength: 12,000 psi
- Common Sizes / Part Number:
  - 4 oz. stick – 98853
  - 4 oz. stick – 82093

### Fast Setting

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<thead>
<tr>
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<tr>
<td>Loctite® Fixmaster® Metal Magic Steel</td>
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<tr>
<td>Loctite® Fixmaster® 2000° Putty</td>
<td>Page 13</td>
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</tbody>
</table>

**Metal Magic Steel**

- Color: Dark Grey
- Maximum Temperature: 250°F (121°C)
- Working Time*: 3 min.
- Cure Time*: 6 hrs.
- Compressive Strength: 12,000 psi
- Common Sizes / Part Number:
  - 4 oz. stick – 98853

**2000° Putty**

- Color: Grey
- Maximum Temperature: 2000°F (1093°C)
- Working Time*: 5 min.
- Cure Time*: 30 min.
- Compressive Strength: 2,600 psi
- Common Sizes / Part Number:
  - 50 ml cart. – 96604

### Pourable

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**Steel Putty**

- Color: Grey
- Maximum Temperature: 225°F (107°C)
- Working Time*: 6 hrs.
- Cure Time*: 6 hrs.
- Compressive Strength: 12,000 psi
- Common Sizes / Part Number:
  - 1 lb. kit – 99913
  - 25 lb. kit – 97463

**Aluminum Putty**

- Color: Grey
- Maximum Temperature: 200°F (93°C)
- Working Time*: 20 min.
- Cure Time*: 6 hrs.
- Compressive Strength: 11,300 psi
- Common Sizes / Part Number:
  - 1 lb. kit – 97463
  - 25 lb. kit – 97453

### Kneadable Stick

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<tr>
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<tr>
<td>Loctite® Fixmaster® Underwater Repair Epoxy</td>
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</table>

**Underwater Repair Epoxy**

- Color: White
- Maximum Temperature: 30°F (–1°C)
- Working Time*: 15 min.
- Cure Time*: 4 hrs.
- Compressive Strength: 6,000 psi
- Common Sizes / Part Number:
  - 4 oz. stick – 82093
  - 8 oz. can – 95724
Repair, Rebuild and Restore Damaged Parts

Different fillers provide a range of performance characteristics, making LOCTITE® Fixmaster® composites suitable for specific applications. Putty, liquid and stick forms give you the flexibility to fix equipment throughout the plant.

**FIXMASTER® PUTTIES**

**LOCTITE® Fixmaster® Steel Putty**
Versatile Repair Compound for Steel
Non-slumping, two-part, steel-filled putty. Recommended for repairing and rebuilding worn steel components, such as bearing and fan housings. Can be machined when cured. ABS Approved. Sets in 30 minutes.

- 1 lb. kit – 99913
- 4 lb. kit – 99914
- 25 lb. kit – 99912

**LOCTITE® Fixmaster® Fast Set Steel Putty**
Faster Version of LOCTITE® Fixmaster® Steel Putty
Faster setting version of the LOCTITE® Fixmaster® Steel Putty. Recommended for repairing pipes and other emergency repairs. ABS Approved. Sets in 3 minutes.

- 1 lb. kit – 39917

**LOCTITE® Fixmaster® Superior Metal**
Non-Rusting, Ferro-Silicone-Filled Composite
Extremely high compressive strength and wear resistance. Ideal for rebuilding worn surfaces exposed to harsh environments. Recommended for use on all metals. Can be machined, drilled and tapped in 6 to 8 hours. For final finish cuts, let the product cure for 24 hours and use carbide tooling. Spreadable putty. Sets in 20 minutes.

- 1 lb. kit – 97473
- 4 kg kit – 40900

**LOCTITE® Fixmaster® Aluminum Putty**
Aluminum Repairs
Similar to LOCTITE® Fixmaster® Steel Putty, but aluminum filled to better match the coefficient of thermal expansion of aluminum. General purpose putty for repair of all aluminum alloy components. ABS Approved. Sets in 20 minutes.

- 1 lb. kit – 97463

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<tr>
<td>Loctite® Fixmaster® Steel Putty</td>
<td>30 minutes @ 77°F (25°C)</td>
<td>6 hours @ 77°F (25°C)</td>
<td>225°F (107°C)</td>
</tr>
<tr>
<td>Loctite® Fixmaster® Fast Set Steel Putty</td>
<td>3 minutes @ 77°F (25°C)</td>
<td>10 minutes @ 77°F (25°C)</td>
<td>200°F (93°C)</td>
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<td>Loctite® Fixmaster® Superior Metal</td>
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<td>250°F (121°C)</td>
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Repair, Rebuild and Restore Damaged Parts

**Loctite® Fixmaster® Curing Times**

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To speed the cure of composites at low temperature:
- Store composite at room temperature
- Pre-heat repair surface until warm to the touch

To slow the cure of composites at high temperature:
- Mix composites in small masses to prevent rapid curing
- Cool resin/hardener components

**TIPS & TRICKS**

- The higher the temperature, the faster the cure
- The larger the mass of material mixed, the faster the cure

**FIXMASTER® POURABLE LIQUIDS**

**Loctite® Fixmaster® Steel Liquid**

Steel Casting or Molding
Pourable and self-leveling, steel-filled epoxy. Ideal for casting or making molds. Works well to fill hard-to-reach areas. Can be machined when cured. ABS Approved. Sets in 25 minutes.

1 lb. kit – 97483
4 lb. kit – 97484

**Loctite® Fixmaster® Aluminum Liquid**

Aluminum Casting or Molding
Self-leveling aluminum liquid. Can be poured into molds and cavities. Recommended for casting aluminum replacement parts and for making molds. ABS Approved. Sets in 20 minutes.

1 lb. kit – 97453

**FIXMASTER® PUTTIES**

**Loctite® Fixmaster® Stainless Steel Putty**

Stainless Steel Repairs
Similar to Loctite® Fixmaster® Steel Putty, but stainless steel filled to better match the coefficient of thermal expansion of stainless steel. Sets in 20 minutes.

1 lb. kit – 97443

**Loctite® Fixmaster® Stainless Steel Putty**

- 20 minutes @ 77°F (25°C)
- 6 hours @ 77°F (25°C)
- 225°F (107°C)

**Loctite® Fixmaster® Aluminum Liquid**

- 20 minutes @ 77°F (25°C)
- 6 hours @ 77°F (25°C)
- 200°F (93°C)

**Loctite® Fixmaster® Steel Liquid**

- 25 minutes @ 77°F (25°C)
- 6 hours @ 77°F (25°C)
- 225°F (107°C)

**Loctite® Fixmaster® Aluminum Liquid**

- 20 minutes @ 77°F (25°C)
- 6 hours @ 77°F (25°C)
- 200°F (93°C)
**Wet or Underwater Repair in Stick Form**

This putty-like material is ideal for plumbing, irrigation and marine applications because it is unaffected by chlorinated or salt water. Will stick to wet surfaces. Ideally suited for underwater repairs. Sets in 15 minutes.

4 oz. stick – 98853

**FIXMASTER® KNEADABLE STICKS**

**LOCTITE® Fixmaster® Metal Magic Steel™**

Steel Epoxy in Stick Form

Kneadable, two-part paste. Working time is 3 minutes – sets in 10 minutes. Adheres to damp surfaces. Can be drilled, filed, and painted. Ideal for emergency sealing of leaking tanks and pipes. Smooths welds, repairs small cracks in castings, and fills oversized bolt holes.

4 oz. stick – 98853

**LOCTITE® Fixmaster® Underwater Repair Epoxy**

Wet or Underwater Repair in Stick Form

This putty-like material is ideal for plumbing, irrigation and marine applications because it is unaffected by chlorinated or salt water. Will stick to wet surfaces. Ideally suited for underwater repairs. Sets in 15 minutes.

4 oz. stick – 82093

**FIXMASTER® SPECIALTY PRODUCTS**

**LOCTITE® Fixmaster® Fast Set Steel Epoxy**

Cartridge-Based, Steel-Filled Epoxy

Cartridge-based, steel-filled epoxy. Makes fast, cost-effective repairs. Easy-to-use and easy-to-apply. Ideal for metal parts that must be back in service quickly. Can be machined when cured. Requires the handheld dispenser (P/N 98472). One mix nozzle comes included with the cartridge. Sets in 3 minutes.

50 ml cartridge – 96604

**LOCTITE® Fixmaster® 2000° Putty**

Extreme Temperature Repair

Single component putty designed to fill and restore damaged metal and fill cracks in environments that will see 2000°F. Water-based and non-toxic. Typical applications include header, manifold and cast iron repair.

8 oz. can – 95724

**DID YOU KNOW?**

**100% SOLIDS**

LOCTITE® Fixmaster® composites are formulated with 100% solids. This means that unlike solvent-based systems, LOCTITE® Fixmaster® composites will not shrink when cured.

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<td>250°F (121°C)</td>
</tr>
<tr>
<td>Loctite® Fixmaster® Underwater Repair Epoxy</td>
<td>15 minutes @ 77°F (25°C)</td>
<td>30 minutes @ 77°F (25°C)</td>
<td>300°F (149°C)</td>
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The successful application of any LOCTITE® Fixmaster® polymer composite product is largely dependent on correct surface preparation. For this reason, it is critical that all applications begin with a thorough preparation of the repair surface in keeping with the instructions in this section.

General Surface Preparation

Ensure that the surface is dry and stop all liquid leakage. Remove all dirt, paint, rust, and other contaminants by abrasive blasting or other suitable mechanical techniques.

Degrease thoroughly using LOCTITE® ODC-Free Cleaner & Degreaser or LOCTITE® Natural Blue® Biodegradable Cleaner and Degreaser.

Provide a profile by abrasive blasting or other mechanical means.

To bond a composite to a badly degraded surface or to fill large voids, first tack weld wire mesh over the damaged area, then fill the prepared area with the composite.

To prevent adhesion to a surface, as when casting parts or in tooling preparations, coat the surface with LOCTITE® Silicone Lubricant (Product No. 51360) or other release agent.

Cleaning the Surface

Clean the surface with LOCTITE® ODC-Free Cleaner & Degreaser or LOCTITE® Natural Blue® Biodegradable Cleaner & Degreaser.

Areas immersed in oil must be cleaned repeatedly to draw the oil out of the surface. Use a heat gun to force oil out of the pores. Allow the surface to cool, then degrease again.

After cleaning, roughen the surface to produce a good profile. The following methods may be used, but in all cases the objective is to obtain an anchor profile of 0.003 to 0.005 inches (75 to 125 microns).

Abrasive blast using an angular grit such as aluminum oxide, silicon carbide, or coal slag 1240 medium grade. Round abrasive grit should not be used. High velocity water blasting with an abrasive medium is also recommended. (See Figure 1)

If grit blasting is not possible, roughen the surface using a coarse grinding wheel (60 grit or coarser) or a needle gun to achieve the desired profile. (See Figure 2)

Using coarse sandpaper or a file is acceptable only if the first two methods cannot be utilized.

After roughening, the surface must again be thoroughly cleaned with LOCTITE® ODC-Free Cleaner & Degreaser or LOCTITE® Natural Blue® Biodegradable Cleaner and Degreaser. Repairs should be made as soon as possible to avoid rusting.

Wet surfaces

Exceptions to having a dry surface are when using LOCTITE® Fixmaster® Wet Surface Repair Putty, Fixmaster® Underwater Repair Epoxy, or Fixmaster® Metal Magic Steel™. These products will cure in the presence of water.

Stop all leakage or seepage by:

• Turning off the water flow.
• Fitting a wooden peg or sheet metal screw.
• Stuffing with cork, wax, rags, or any other suitable material. (See Figure 3)

If the leak is caused by corrosion, the side wall may be weak. Open the hole to a point where the wall is close to its original thickness. Then plug the opening using a suitable material. All surface condensation, wetness, or dampness must be wiped clean and dried off using a hot air gun or similar device. Continue surface preparation in accordance with the preceding section on Surface Cleaning.

Surface Profile

Chemical contaminants that are not readily visible, such as chlorides and sulphates, attract moisture through coating systems, resulting in premature failure. Therefore it is fundamentally important to chemically clean all substrates with an industrial strength cleaner and degreaser such as LOCTITE® Natural Blue®.

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Surface Preparation Grades of Blast

**Rust Grade**
- A: Steel with mill scale layer intact and very minor, or no rusting
- B: Steel with spreading surface rust and the mill scale commenced flaking
- C: Rusty steel with mill scale layer flaked and loose or lost but only minor occurrence of pitting
- D: Very rusty steel with mill scale layer all rusted and extensive occurrence of pitting

**Blast Class**
- 1 (SP-7/N4): Very light over clean with removal of loose surface contaminants
- 2 (SP-6/N3): Substantial blast clean with widespread, visible contaminate removal and base metal color appearing
- 2.5 (SP-10/N2): Intensive blast clean leaving shading grey metal with only contaminates
- 3 (SP-5/N1): Complete blast clean with consistent metal color all over and no visible contaminates

Mixing Tips

The following tips are designed to facilitate the process of working with LOCTITE® polymer composite products under a variety of conditions.

**Mixing**

Thorough mixing, in proper ratio, is critical to the performance of the material. Whenever possible, the complete container should be mixed at one time. If the material is to be mixed in separate batches, the user must be careful to adhere to the mix ratios that appear on the product label.

The material is mixed by adding hardener to resin. The mixing process is complete when the product is free from streaks or other variances. Failure to thoroughly mix the material will cause soft spots or overall failure of the product. Mixing should take 3 to 5 minutes.

Large masses (over one pound) can be mixed more easily by turning out the resin and hardener onto a clean, disposable surface. Mix and knead material with a putty knife or other flat tool until the product is thoroughly mixed. Do not fold material into the mix as this process can cause air entrapment that will weaken the cured product.

**Cure**

Polymer composite compounds begin to cure, or harden, when the hardener is added to the resin. Curing is by a chemical reaction that causes exotherming, or the process of giving off heat. There are some basic principles of working with composite compounds that every user should understand.

**Cure Times are Mass Dependent.** The larger the mass mixed, the faster it will cure. If the mixed material cannot be applied during the working time specified on the product label, mix it in smaller batches.

**Cure Times are Temperature Dependent.** The higher the temperature, the faster the product will cure. Ideal mixing temperature is between 55°F and 80°F.

If the application is to occur at higher temperatures, the product should be stored at room temperature or slightly below to slow down the chemical reaction between resin and hardener.

At lower temperatures, the epoxy will cure very slowly or may fail to cure at all. To speed up the cure at low temperatures, store product at room temperature and heat parts to be repaired prior to application. The repaired area can also be heated with a heat gun upon completion of the application.

Most polymer composite compounds are skin and eye irritants, and many hardeners are corrosive. Always wear appropriate gloves and goggles or face shield during mixing and handling. Observe good industrial safety practices, and review product Material Safety Data Sheet (MSDS) prior to use for complete precautionary information.

Composite is turned out onto a disposable surface to ensure proper mixing.
Application Tips and Case Histories

For Maximum Bond
Pre-coat the application surface by rubbing the mixed composite into the substrate. This technique, called “wetting out the surface,” helps the repair material fill all the crevices in the application surface, creating a superior bond between the composite and substrate. The rest of the mixed product can then be applied over the pre-coat to finish the application.

Eliminating Air Entrapment
Use a heat gun (do not use an open flame) to pull air bubbles out of cast composite. Heat will cause bubbles to rise to the top and dissipate.

Creating a Smooth Finish
Smooth out the uncured product with a warm trowel for a smooth, glossy finish. A heat gun can also be used to create a smooth finish.

Pouring Liquid Composites
Avoid air entrapment in cured composite by pouring close to the mold in a steady, even stream.

Application Case Histories

**PROBLEM:** Leaking flange
**EQUIPMENT:** Flange face on a chemical pump
**SOLUTION:** LOCTITE® Fixmaster® Aluminum Putty

Flange faces, eroded by chemical exposure, were previously repaired by welding and machining. Loctite® Fixmaster® Aluminum Putty repairs aluminum faces at a lower cost and with far less downtime than conventional methods.

**PROBLEM:** Severely damaged pipe
**EQUIPMENT:** Slurry transport pipe
**SOLUTION:** Fixmaster® Metal Magic Steel™

Damage to this pipe was so severe that expanded mesh was welded over the opening to provide reinforcement for the epoxy application. Fixmaster® Metal Magic Steel™ was pressed over the mesh to fill and seal the application area. The pipe was ready for service in just minutes.

Typical Repair Applications

**PIPE AND DUCTING REPAIRS:**

Pipes are used for transporting all compositions of fluids, slurries, gases and solids. Wear, corrosion, abrasion and chemical attack can lead to progressive damage to pipe walls, leading to eventual piping failure.

Industries such as coal-fired power plants, sewage treatment plants, pulp and paper processors, and aggregate sites are particularly vulnerable to pipe abrasion due to caustic and abrasive media carried in the piping system.

The areas of piping most subject to wear and damage are elbows, t-junctions, reduction fittings and weld spots in both seams and joints. Flange faces can also suffer erosion, preventing effective gasket sealing. The problem of pipe damage can be as simple as a leaky pipe or as severe as a total plant shutdown, service contamination, or fire damage; but good plant maintenance depends on keeping equipment, such as piping systems, running smoothly and efficiently. The following information is intended to identify possible problem areas that can be successfully protected or repaired with LOCTITE® epoxies in order to reduce downtime and equipment failure.

**NOTE:** Before starting any pipe repair, the line pressure must be removed.

**Exterior Repair – Fractures and Pinholes**

**1. EXTERIOR REPAIR – FRATURES AND PINHOLES**

- Prepare the application, plug the hole or fracture with LOCTITE® Fixmaster® Metal Magic Steel™, an epoxy in stick form that hardens in just 10 minutes. Or use a wooden dowel, putty or plasticine. If the wall thickness is insufficient to support a mechanical plug, use a rubber patch and an adhesive such as LOCTITE® Fixmaster® 4-Minute Epoxy.
- Abraive blast, grind, or file off all deposits, paint, rust, and mill scale. The area must be prepared with an extension border of 3” (7.6 cm) around the damaged area. Degrease the application area completely with LOCTITE® ODC-Free Cleaner & Degreaser.
- The repair area must be prepared with an extension border of 3” (7.6 cm) around the damaged area. Degrease the application area completely with LOCTITE® ODC-Free Cleaner & Degreaser.
- Apply the epoxy to the prepared area, forcing the product into the crack. Also apply epoxy to the inside radius of the backing plate. P
deep the backing plate firmly over the repair area. Use ties, clamps, or wire to hold the repair firmly in place. After the epoxy has cured, the clamps may be removed and the patch coated with more product for reinforcement of the repair.

- (See Figures 4 & 5) Force out any air, and remove excess epoxy. A half section of pipe with a slightly larger diameter than the pipe to be repaired. A curved aluminum or steel backing plate that extends 2” (5 cm) radially and axially beyond the damaged area will also work to reinforce the repair.

- (See Figure 6) Force epoxy into damaged area.
Typical Repair Applications

PIPE AND DUCTING REPAIRS (Continued):

4. REPAIRS TO HIGH-PRESSURE PIPES
   (> 100 PSI OR 0.70 MPA):

Prepare the pipe as above. Wrap the repair firmly with reinforcing mesh and impregnated with epoxy. Before the epoxy hardens, over-spray and shape the repair with a final application of epoxy. (See Figure 7)

5. REPAIRS TO LOW PRESSURE, SMALL DIAMETER PIPES
   (<100 PSI OR 0.70 MPA AND < 3” OR 7.6 CM DIAMETER):

Prepare as in Step 1 above. Apply 1/8” or 3 mm layer of epoxy, working it well into the anchor pattern and into the hole. Wrap reinforcement mesh treated with repair compound at least twice around the pipe. Remove excess product. As epoxy starts to cure, over-coat the repair with a final application of epoxy.

INTERNAL REPAIR

Internal repair of pipes, elbows, and fittings is sometimes possible and necessary. This procedure should include exterior patching according to Step 3 above.

1. PREPARE SURFACE:

   To prepare the surface, flush the interior of the pipe liberally with high pressure water, if available. Abrasive blast to achieve 0.003 - 0.005” (75 - 125 microns) profile. Blast inside and outside, as well as the backing plate, for the exterior patching. Degrease thoroughly.

2. EXTERIOR PATCHING:

   Exterior patching must be done prior to internal lining. If backing plate is not suitable, tack weld a heavy metal mesh and apply 1/8 to 1/4” (3 - 6 mm) of epoxy.

3. COAT INTERIOR:

   Coat the interior by applying a series of thin coats of epoxy pressed into the abraded profile. Continue to build up the original profile. As the epoxy begins to cure, apply a 1/4” (6 mm) over-coat of epoxy to the repair area.

CAUTION: PRESSURIZED LINES SHOULD BE REPLACED WHEN TIME AND MANPOWER PERMITS.

METAL SURFACE REPAIRS:

The following procedures are developed for surface repairs that call for filling or rebuilding a damaged metal surface. Damage caused by metal fatigue or stress cracks should be replaced.

LOCTITE® Repair Epoxies are recommended for making surface repairs to restore the integrity of cracked or damaged metal. In general, epoxies are not recommended for heavy load bearing applications or for making structural repairs; however, experience has shown that successful temporary or emergency repairs can be made to seriously damaged equipment using skillful and imaginative techniques.

Non-stress cracking problems are common to pump casings, bearing housings, valve bodies, tanks and gearboxes.

NOTE: WHEN THE EQUIPMENT TO BE REPAIRED MAY HAVE CONTAINED FLAMMABLE OR EXPLOSIVE MATERIAL, PROPER SAFEGUARDS MUST BE TAKEN TO CLEAN THE AREA OR BLOW OUT THE CRACKED AREA TO REMOVE ALL FLAMMABLE MATERIAL. IF IN DOUBT, CONTACT A LOCTITE® BRAND PRODUCTS REPRESENTATIVE.

1. PREPARE SURFACE:

   To prepare the surface of the damaged metal, refer to the Surface Preparation Section in this manual.

2. DRILL HOLES:

   Drill holes 1/8” (3 mm) larger than the crack at either end of the crack. Use detecting dye if necessary to determine the actual area of the crack. If the crack is over 5” (12.5 cm) long, drill multiple holes along the length of the crack. (See Figure 9)

3. CREATE BETTER BOND:

   To create a better bond drill, or edge grind the cracked area with an abrasive wheel to “V” out the cracked area. After the area has been opened up, clean the area of any residue using LOCTITE® ODC-Free Cleaner & Degreaser. (See Figure 10)

4. APPLY EPOXY:

   Apply the epoxy with a putty knife, forcing the epoxy material into the crack. Fill the “V” thoroughly and overlap approximately 1” on each side of the application area. (See Figure 11)
5. **REINFORCING MESH:** Use a reinforcing mesh, such as fiberglass or wire screening, to lay a strip of the reinforcement material over the application and imbed the tape into the epoxy. (See Figure 12)

6. **APPLY EPOXY:** Apply another 1/16” to 1/4” (1.5 – 6 mm) of epoxy over the reinforced mesh and smooth out the epoxy. To prevent lifting of the repair, be sure to feather the edges in keeping with the contour of the repaired equipment. (See Figure 13)

7. **SPEED CURE:** To speed the cure, heat the area with a heat gun or heat lamp. Never expose epoxy to open flame.

**Figure 13. Over-coat the epoxy/tape application with another coating of epoxy.**

**SHAFT REPAIRS:**

LOCTITE® epoxies can often be used to repair damaged or scored shafts. In some cases, however, the repair may not provide long-term service and should not be made.

Repairs are not recommended to the following shafts:

- Any repair on an area subject to frictional heat such as on a shaft worn by mechanical packing.
- The worn area under a bearing, bushing or mechanical seal that exceeds its width.
- Shafts under 1/2” (13 mm).

**The Shaft**

Since the area to be repaired needs to be machined, the standard preparation procedures are not used. (See Figure 14)

**Figure 14.** Undercut the worn area according to the following guidelines:

<table>
<thead>
<tr>
<th>Shaft Diameter</th>
<th>Desired Undercut</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 to 1” (13 – 25 mm)</td>
<td>1/16” (1.5 mm)</td>
</tr>
<tr>
<td>1 to 3” (25 – 75 mm)</td>
<td>1/8” (3 mm)</td>
</tr>
</tbody>
</table>

1. **UNDERCUT:** Using a lathe, undercut to the desired depth. If the shaft is already worn to the recommended depth, go to the next step.

   Dovetail the ends of the worn area to lock the application into place and to serve as a guide when repairing. (See Figure 15)

2. **FINISH UNDERCUTTING:** Finish undercutting by machining a rough cut surface or gramophone pattern; the larger the shaft diameter, the deeper the threads. Degrease thoroughly. (See Figure 16)

**Figure 15. Dovetailing provides mechanical lock for epoxy.**

**Figure 16. Roughen shaft for better adhesion.**

3. **APPLY EPOXY:** Apply a very thin layer of the recommended repair epoxy and force into the bottom of the threads. Turn the shaft at a very low speed and continue to apply more material by using a tool, such as a putty knife, that can be bent. (See Figure 17)

**Figure 17. Fill repair area with epoxy.**

4. **MACHINE REPAIR:** Machine repair to required dimensions using the guidelines below. (See Figure 18)

   **Table:**
   - **Lathe Speed:** 150 ft./min. 46 m/min.
   - **Feed Rate:**
     - Roughing: 0.025 in./rev 0.64 mm/rev
     - Finishing: 0.010 in./rev 0.25 mm/rev
   - **Top Rake:** 3°
   - **Side Clearance:** 3°
   - **Front Clearance:** 3°
   - **Comments:** Cut dry; use carbide or high speed steel bits. If polishing is required, use only wet 400 to 600 grit emery paper. (See Figure 19)

**Figure 18. Machine epoxy to the original dimensions of the shaft.**

**Figure 19. If necessary, polish repair with emery paper.**

**METAL SURFACE REPAIRS (Continued):**

**Figure 12.** Reinforce the repair by applying tape over the epoxy.

**Figure 11.** Overcoat the epoxy/tape application with another coating of epoxy.

**Figure 10.** Dovetailing provides mechanical lock for epoxy.

**Figure 9.** If necessary, polish repair with emery paper.

**Figure 8.** Machine epoxy to the original dimensions of the shaft.

**Figure 7.** Roughen shaft for better adhesion.

**Figure 6.** Finish undercutting by machining a rough cut surface or gramophone pattern; the larger the shaft diameter, the deeper the threads. Degrease thoroughly.

**Figure 5.** Undercut the worn area according to the following guidelines:

<table>
<thead>
<tr>
<th>Shaft Diameter</th>
<th>Desired Undercut</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2 to 1” (13 – 25 mm)</td>
<td>1/16” (1.5 mm)</td>
</tr>
<tr>
<td>1 to 3” (25 – 75 mm)</td>
<td>1/8” (3 mm)</td>
</tr>
</tbody>
</table>

**Typical Repair Applications**
KEYWAYS:
A keyway becomes worn through constant pressure from starting and stopping.

1. **PREPARE SURFACE**: To prepare the surface, follow the Surface Preparation Section. Roughen the surface with a file or rotary cutting/grinding tool and degrease again. (See Figure 20)
2. **APPLY RELEASING AGENT**: Apply a thin layer of LOCTITE® Silicone Lubricant release agent to the key and to any area where you do not want the product to stick. (See Figure 21)
3. **APPLY EPOXY**: Apply the recommended epoxy using a spatula or putty knife. Use a thin coat on the bottom and a thicker layer on the side walls to ensure the key will not be raised and also to ensure a close tolerance fit. (See Figure 22)
4. **SCRAPE**: Scrape away excess epoxy from the side of the keyway. (See Figure 23)
5. **IMMEDIATELY REPOSITION**: Immediately reposition the shaft on the hub to properly align the key, shaft and hub. Leave assembled. (See Figure 24)

SPLINES:
1. **REMOVE SPLINE**: Remove spline shaft from the socket and chamfer the edges of the sockets to a 45° angle using a file. (See Figure 25)
2. **PREPARE SURFACE**: Prepare the application surface by degreasing surface thoroughly. Check the spline shaft for evenness and remove any high spots or rough areas by filing or sanding. Degrease again.
3. **APPLY RELEASE AGENT**: Apply a thin layer of LOCTITE® Silicone Lubricant release agent to the spline shaft, ensuring that the entire surface is coated.
4. **MIX AND APPLY REPAIR COMPOUND**: Mix and apply the recommended repair compound to the spline shaft. Do not apply product into the socket. Immediately push the spline shaft into the socket and remove excess material. (See Figure 26)

Allow the epoxy to cure according to the application instructions before putting the equipment back into service.

If it will be necessary to dismantle the assembly in the future, mark the position of the spline and socket in order to be able to reposition the assembly in exactly the same position. (See Figure 27)

Typical Repair Applications

Figure 20. Roughen the damaged surface.
Figure 21. Coat with release agent.
Figure 22. Fill keyway with epoxy and install coated key.
Figure 23. Immediately scrape excess epoxy away from repair area.
Figure 24. Immediately align key, shaft and hub.
Figure 25. File socket to 45° angle.
Figure 26. Install coated spline into shaft and remove excess epoxy.
Figure 27. Mark the position of the spline in the socket for future assembly.
**Metal Rebuilding Composites Properties Chart**

**Application Selector Guide**

### LOCTITE® FIXMASTER® COMPOSITES PROPERTIES CHARTS

<table>
<thead>
<tr>
<th>PRODUCT</th>
<th>Item Number</th>
<th>Package Type &amp; Size</th>
<th>CO. to PACKAGE</th>
<th>COMPRESSIVE STRENGTH</th>
<th>TENSILE SHEAR STRENGTH</th>
<th>FUNCTIONAL CURE TIME</th>
<th>FULL CURE TIME</th>
<th>AGENT APPROVALS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixmaster® Metal Magic Steel™</td>
<td>98853</td>
<td>4 oz. stick</td>
<td>Grey</td>
<td>14 in.²</td>
<td>210</td>
<td>12,000</td>
<td>2,500</td>
<td>80</td>
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<tr>
<td>Fixmaster® Underwater Repair Epoxy §</td>
<td>82093</td>
<td>4 oz. stick</td>
<td>White</td>
<td>16 ft.</td>
<td>300</td>
<td>12,000</td>
<td>300</td>
<td>70</td>
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<td>Fixmaster® Steel Liquid*</td>
<td>97483</td>
<td>1 lb. kit</td>
<td>Grey</td>
<td>13 in.</td>
<td>225</td>
<td>13,500</td>
<td>6,000</td>
<td>80</td>
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<td>Fixmaster® Aluminum Liquid*</td>
<td>97484</td>
<td>1 lb. kit</td>
<td>Aluminium</td>
<td>17 ft.</td>
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<td>Fixmaster® Superior Metal</td>
<td>97473</td>
<td>1 lb. kit</td>
<td>Dark Grey</td>
<td>0.38</td>
<td>250</td>
<td>18,000</td>
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<td>Fixmaster® Stainless Steel Putty*</td>
<td>97443</td>
<td>1 lb. kit</td>
<td>Grey</td>
<td>0.25</td>
<td>225</td>
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<td>Fixmaster® Fast Set Steel Epoxy*</td>
<td>96604</td>
<td>50 ml cartridge</td>
<td>Grey</td>
<td>270</td>
<td>2,200</td>
<td>60</td>
<td>3 minutes</td>
<td>8 to 8 minutes</td>
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<tr>
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<td>96724</td>
<td>8 oz. can</td>
<td>Grey</td>
<td>2000</td>
<td>675</td>
<td>30 minutes</td>
<td>1 hour</td>
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### LOCTITE® FIXMASTER® COMPOSITES APPLICATION CHART

- **Fixmaster® Metal Magic Steel™**: Preferred Choice
- **Fixmaster® Underwater Repair Epoxy**: Good Choice
- **Fixmaster® Steel Liquid**: Acceptable Choice
- **Fixmaster® Aluminum Liquid**: Acceptable Choice
- **Fixmaster® Superior Metal**: Preferred Choice
- **Fixmaster® Stainless Steel Putty**: Good Choice
- **Fixmaster® Fast Set Steel Epoxy**: Acceptable Choice

### LOCTITE® FIXMASTER® COMPOSITES BONDING CHARACTERISTICS

- **GAP FILLING**: All products
- **FAST CURE TIME**: All products
- **FERROUS METAL REPAIR**: All products
- **NON-FERROUS METAL REPAIR**: All products
- **REPAIRING THREADED PARTS**: All products
- **FIXTURES AND PROTOTYPES**: All products
- **REPAIRING ENGINE BLOCKS**: All products
- **PUMP REPAIR**: All products
- **REPAIRING STAINLESS STEEL**: All products
- **EMERGENCY METAL REPAIR**: All products
- **REBUILDING SHAFTS, KEYWAYS AND BEARINGS**: All products
- **CORROSION PROTECTION**: All products
- **REPAIRING PIPES AND TANKS**: All products
- **SPECIALTY**: All products

### SPECIALTY

- **Fixmaster® Fast Set Steel Epoxy**: Preferred Choice
- **Fixmaster® 2000° Putty**: Good Choice

- **Preferred Choice**: [ ]
- **Good Choice**: [ ]
- **Acceptable Choice**: [ ]
<table>
<thead>
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<th>Chemical Name</th>
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<td>Aniline</td>
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<td>Anodizing Bath</td>
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**NOTE:** The above information does not constitute a recommendation of product use. It is intended only as a guide for consideration by the purchaser with the expectation of favorable confirming test results. It is impossible to test product reaction with the multitude of chemicals in existence. Therefore, compatibility has been estimated based on a wide variety of factors.

**Important:** Some chemicals may be hazardous or toxic when mixed. This database is not intended to address all aspects of chemical compatibility and should not be used in lieu of professional advice.

**Disclaimer:** The information provided is for general guidance only and should not be relied upon without verification by a qualified expert.