



CLOCK SPRING®

Application Note Sample Operating and Maintenance Language

This document is intended to assist Company's in drafting language for their Operating and Maintenance Manuals. This is suggested wording only. Each Company will have to assess and modify both the wording and detail to suit their particular needs and procedures.

Operating and Maintenance Manual Language for the Use of Clock Spring® Composite Repair Sleeves

1. SCOPE

This specification covers the use and installation of the Clock Spring® composite sleeve repair system.

2. INTRODUCTION

"Clock Spring®" refers to a family of related fiber glass-and-resin matrix products used to repair blunt defects in pipes and reinforce dents or other mechanical defects. Clock Spring® provides permanent structural reinforcement for corroded pipe having a minimum of 20% remaining wall thickness in pipe sizes from 4 to 56-inch (102 – 1422 mm) diameter. The system is designed to repair carbon steel pipe (API 5L). Proper installation will restore full strength in the repair zone.

The system operates by restricting bulging in the pipe at the defect location. The hoop stress is transferred through high compressive strength filler, to the composite sleeve (Clock Spring®) wrapped around, and bonded to, the pipe.

Clock Spring® technology is suitable for various applications including the repair of corrosion defects (80% maximum through-wall defect), blunt mechanical defects, girth weld zone corrosion and defects associated with bends and elbows. A separate embodiment of the technology can be used to arrest ductile fractures in low-toughness pipe.

In addition to providing a permanent repair for external defects, Clock Spring® technology may also be used to provide temporary reinforcement for internal corrosion defects. Clock Spring® will not arrest the corrosion mechanism associated with internal corrosion and the durability of the repair will therefore be related to the growth rate of the defect.

To ensure the effectiveness of the Clock Spring® technology, the product must be properly installed and the technology correctly applied. Clock Spring® installation is a covered task for the purpose of the Operator Qualification Rule in the United States (Task 40.3). It is required that Clock Spring® installers be trained and certified by an authorized Clock Spring® trainer.

3.0 REGULATORY REFERENCE

- 3.1 Title 49 CFR Part 192 Transportation of Natural and Other Gases by Pipelines
- 3.2 Title 49 CFR Part 195 Transportation of Hazardous Liquids by Pipelines

These codes were changed to allow the use of alternative repair methods that were validated by reliable engineering testing and analyses. Clock Spring® was the impetus for this change and is named directly in the Federal Registry that outlined the new wording.

3.3 ASME B31.4 PIPELINE TRANSPORTATION SYSTEMS FOR LIQUID HYDROCARBONS AND OTHER LIQUIDS

Mechanically applied composite material wrap may be used to reinforce the pipeline provided that design and installation methods are proven for the intended service prior to application. The user is cautioned that a qualified written procedure performed by trained personnel is a requirement and records shall be retained in accordance with para. 455.

4.0 **PRECAUTIONARY NOTES AND RECOMMENDATIONS**

Although all steps and procedures of the Clock Spring® installation are important, the following items are of key concern and are therefore highlighted.

4.1 ADVISORY NOTES

- 4.1.1 Although the Clock Spring® System may be customized for use as a ductile pipe “crack arrestor”, the system is not a “CRACK REPAIR” system. The application will serve to stop a “free running” crack.
- 4.1.2 The Clock Spring® System may be applied in diverse weather conditions (cold weather, high humidity, etc.) but the installation area is to be protected (tented) from inclement conditions whenever possible.
- 4.1.3 An anchor pattern is required on the pipe surface prior to a Clock Spring® installation. Cleanliness required shall meet the standard of NACE #3 finish or equivalent.
- 4.1.4 All sharp edges are to be removed from “gouge” type defects (ground out as required). Sharp edges represent potential “stress risers”. Clock Spring® shall be applied only to “blunt” defects.
- 4.1.5 All pipe coatings containing “coal tar” or “zinc” must be completely removed from the repair area. Coal tar residue and the presence of zinc inhibit the curing and bonding properties of the adhesive. Coal tar may be used as a pipe coating after the Clock Spring® Adhesive has attained full cure.
- 4.1.6 The Clock Spring® adhesive must attain a minimum hardness of 40 durometer on the Shore “A” Hardness Scale prior to applying any pipe coating material. The Clock Spring® must be removed if the minimum hardness is not attained.
- 4.1.7 Pipe coatings for aboveground pipe must be opaque. The Clock Spring® is UV sensitive.
- 4.1.8 Wire brushing the surface is not a recommended method for final surface preparation.
- 4.1.9 The completed Clock Spring® assembly is to be treated as a standard pipe repair requiring an external barrier coating.

4.2 NOTES

- 4.2.1 To test for the presence of coal tar or zinc, apply a small sample of “mixed” adhesive to the area in question. If coal tar or zinc is present, the adhesive will turn from the color blue to green.
- 4.2.2 Do not use tools having a galvanized coating. The galvanized coating will inhibit the proper curing characteristics of the adhesive.
- 4.2.3 Do not use solvents other than Acetone or Methyl Ethyl Ketone (MEK) during pipe surface preparation or ancillary cleaning of the Clock Spring®.
- 4.2.4 Acetone and MEK are highly flammable liquids. Careful handling is required. Be sure to read and be guided by the material safety data sheets.
- 4.2.5 Clock Spring® must not be installed over any type of elastomeric (soft) material. Elastomeric materials (rubber based, mastic, urethane, etc.) interfere with the instantaneous load transfer to the bonded Clock Spring® product.

4.3 RECOMMENDATIONS:

- 4.3.1 In addition to Governmental and Company Regulation the ditch preparation for installations should be an inverted “bell-shape” with approximately 48-inches (1219 mm) of working area on both sides of the pipe and deep enough to provide “belt-buckle” working height (if possible - provide approximately 24-inches (610 mm) of clearance beneath pipe). Follow applicable codes.
- 4.3.2 After measuring ambient and pipe temperatures, mix the adhesive with the activator quantity (refer to chart on adhesive container) for the maximum temperature to be encountered.
- 4.3.3 In the event that the repair zone of the pipe cannot be sandblasted, a hand grinder with a disk (24 to 80 grit) may be used to create a clean anchor patterned surface. Solvent wipe surface as applicable.

5.0 ALLOWABLE REPAIRS

- 5.1 Clock Spring® composite repairs can be used as a permanent repair for the following defects.
 - 5.1.1 External corrosion in the body of the pipe that is less than 80% wall in depth. The defect should be assessed using GRIWrap™ or equivalent. If the defect is too long to be repaired by a single Clock Spring®, multiple units can be used. The gap between units should not exceed 0.25-inches (6.4 mm).
 - 5.1.2 External corrosion affecting the girth weld zone. Corrosion should not exceed 50% wall thickness in depth nor extend more than 30% around the circumference of the pipe. Special installation techniques are required for girth weld repairs. Contact the appropriate engineering group for detailed instructions and approval. The defect should be assessed using GRIWrap™ or equivalent.
 - 5.1.3 Gouges and grooves in the body of the pipe. The gouge or groove must be removed from the pipe by grinding. The defect must be ground to a smooth contour taking care to ensure that the root of the gouge/groove has been removed. Grinding should not exceed the depth or length specified in the appropriate Company procedure for grinding defects. The ground area should be

inspected for cracks, hardness and other imperfections by an appropriate NDE technique. The defect should be assessed using GRIWrap™ or equivalent.

- 5.1.4 Corrosion in bends. Corrosion in a bend requires special considerations. Contact the appropriate engineering group to get detailed instructions and approval for repair of defects in bends. The defect should be assessed using GRIWrap™ or equivalent.
- 5.1.5 Reinforcement of dents in the body of the pipe. The dent must be assessed according to the applicable code. The dent must not contain stress concentrators. The dent must be filled with the high-compressive strength filler material supplied by Clock Spring. Contact the appropriate engineering group to get detailed instructions and approval for the reinforcement of dents.
- 5.1.6 Cracks cannot be repaired with Clock Spring®. If a crack is ground from the pipe, it may be repaired in the same manner as a gouge or groove (5.1.3). Contact the appropriate engineering group for detailed instruction and approval for this repair.
- 5.1.7 Manufacturing anomalies in the body of the pipe. Contact the appropriate engineering group for detailed instruction and approval.
- 5.2 Clock Spring® can be used as a temporary repair for the following defects. Engineering must approve all temporary repair applications.
 - 5.2.1 Internal corrosion in the body of the pipe not exceeding 80% of the wall thickness in depth. . The Clock Spring® repair will not arrest the corrosion. The effective durability of the repair will depend on the corrosion growth rate.
 - 5.2.2 Defects exceeding 80% wall thickness. There may be times when it is necessary to reinforce defects that exceed the 80% wall thickness depth requirement established by code. This might be done to allow product displacement prior to cutting the pipe. Special procedures are required to ensure that the repair procedure does not exacerbate the defect. Contact the appropriate engineering group for detailed instruction and approval.

6.0 DEFECT ASSESSMENT

To ensure the effectiveness of the Clock Spring® technology, the product must be properly installed and the technology correctly applied. Each defect to be repaired by Clock Spring® must be assessed to determine the effectiveness of the repair. This assessment is based on ASME B31G, "Manual for Determining the Remaining Strength of Corroded Pipelines", and the mechanical properties of the Clock Spring® system. Repair is allowed when the reinforced failure pressure of the pipe exceeds the pristine yield pressure of the pipe. An Excel™ spreadsheet to assist with this analysis is available from Clock Spring Company and can be downloaded at www.clockspring.com.

7.0 INSTALLATION PROCEDURE FOR CLOCK SPRING® COIL

The pressure in the pipeline being repaired should be at, or below, the level established by Company procedure. Determine the operating pressure of the pipe and contact the appropriate engineering group to ensure that proper pressure restrictions are in place.

- 7.1 This procedure is to be used as a guideline by certified Installers and Trainers for standard Clock Spring® installations. If questions or concerns arise, that are not clearly answered in this guide the appropriate engineering group for detailed information and instruction.

- 7.2 Characterize the defect to determine if Clock Spring® is a suitable repair using GRIWrap™ or an equivalent method. Record defect information. The length of the defect will determine the number of Clock Spring® units needed for the repair. Clock Spring® units are nominally 11.5-inches (292 mm) wide and must overlap the defect by 2-inches (51 mm) on each side. Multiple units can be used side-by-side to repair longer defects.
- 7.3 Table 1 outlines items provided in the Clock Spring® kit and items to be provided by the Installer. Verify that all necessary items are available.

| Clock Spring® Kit | Installer Supplied Tools |
|-------------------------------|----------------------------------|
| Clock Spring® Sleeve | Safety Glasses |
| Starter Pad | Thermometer |
| Filler and Activator | Tarp or Covering (as necessary) |
| Adhesive and Activator | Thermal Pipe Wrap (as Necessary) |
| 3-inch (76 mm) Putty Knife | Marker |
| Jiffy Mixer | Measuring Tape |
| Roller Handle and Sleeve | Electric Drill (Battery) |
| 2-inch (51 mm) Brush (Qty. 2) | 1-Pound (.45 kg) Rubber Mallet |
| Razor Knife | Shore A Hardness Tester |
| Adhesive Tray | MEK or Acetone Solvent |
| Wooden Alignment Blocks | Rags |
| Adhesive Spatula | 3M Adhesive |
| Dual Lock Tight Pad | |
| Trash Bag | |
| 1-inch (25 mm) Filament Tape | |

Table 1.

- 7.4 Prepare pipe surface for repair by removing any pipe coating, corrosion residue, primer or adhesive, allowing 4 – 6-inches (102 – 152 mm) of prepared pipe on each side of the area to be sleeved. The pipe surface should conform to NACE # 3 standards or equivalent. Wipe the repair area with MEK or Acetone.
- 7.5 Dry apply 2 – 3 wraps of Clock Spring® sleeve around the defect area for “marking” purposes. An alternative is to use any item (i.e. pipe wrap, plastic strip, etc.), which will conform to the pipe.) Center the Clock Spring® over the repair ensuring a 2-inch (51 mm) overlap on each side of the defect. Mark the edge of the Clock Spring®. This reference mark will be used later in the procedure.
- 7.6 Remove the Clock Spring® dry wrap and attach the starter pad. Center the starter pad within the “marked” repair area about 4 – 6-inches (102 – 152 mm) from the primary defect area with the “easy peel” side towards the ground.
- 7.7 Obtain and record the ambient and pipe surface temperatures. If the pipe temperature is less than 32°F (0°C) or greater than 100°F (33°C), contact the appropriate engineering group for special instructions. Use the highest temperature obtained to determine appropriate ratio of activator needed for filler and adhesive. Refer to the chart on the Adhesive container or Filler tube for the proper mix ratio. Tables 2 and 3 are provided here for reference only. If the information in these tables is at variance with the mix ratio charts on the Adhesive container or Filler tube, this table will take precedent. Thoroughly mix the adhesive with the blue colored activator and the filler with the orange colored activator until both mixtures are uniform in color and without streaks. Mix for

approximately 2 – 3 minutes. Note that the working time has begun once the activator is mixed.

| Installation Temperature | | Activator Quantity (grams) | | | | | Approximate | |
|--------------------------|-----|----------------------------|------|------|------|------|----------------------|-----------------|
| | | Adhesive Quantity (grams) | | | | | Working Time Minutes | Cure Time Hours |
| °C | °F | 650 | 1200 | 1700 | 2400 | 3000 | | |
| 0 | 32 | 80 | 150 | 215 | 300 | 380 | 45 | 2.5 – 3 |
| 10 | 50 | 70 | 130 | 180 | 250 | 320 | 45 | 2.5 – 3 |
| 21 | 70 | 60 | 110 | 160 | 220 | 280 | 45 | 2.5 – 3 |
| 27 | 80 | 40 | 75 | 105 | 145 | 190 | 45 | 2.5 – 3 |
| 32 | 90 | 40 | 75 | 100 | 145 | 175 | 35 | 2 – 2.5 |
| 38 | 100 | 40 | 75 | 100 | 145 | 175 | 22 | 1.5 – 2 |
| 43 | 110 | 40 | 75 | 100 | 145 | 175 | 21 | 1.5 – 2 |
| 49 | 120 | 40 | 75 | 100 | 145 | 175 | 20 | 1.5 - 2 |

Table 2
Activator Quantity for Adhesive

| Temperature | | Activator Qty. Grams | Working Time Minutes |
|-------------|---------|----------------------|----------------------|
| °F | °C | | |
| 10 – 30 | -12 – 0 | 40 | 60 |
| 30 – 50 | 0 – 10 | 30 | 60 |
| 50 – 64 | 10 – 17 | 20 | 45 |
| 64 – 74 | 18 – 23 | 15 | 45 |
| 75 – 89 | 24 – 31 | 10 | 35 |
| 90 – 120 | 32 – 49 | 10 | 20 |

Table 3
Activator Quantity for Filler

- 7.8 Using the 3-inch (76 mm) putty knife, apply filler to all voids, both edges of the longitudinal weld and on one edge of the starter pad (for the leading edge placement of the Clock Spring®). Ensure sufficient filler is applied to provide intimate contact between the prepared pipe surface and the Clock Spring® sleeve to be installed.
- 7.9 Pour mixed adhesive into the application tray and, using the roller handle and roller sleeve, apply the adhesive to the entire pipe surface to be repaired, including the starter pad and filler material.
- 7.10 Remove the parting film (backing) from the starter pad and secure the leading edge of the Clock Spring® sleeve to the pad. Tap the composite sleeve onto the starter pad and ensure that it is anchored firmly to the pipe. Check that the sides of the Clock Spring® are 90° to the pipe axis and aligned with the reference mark created in Section 7.5.
- 7.11 Ensure sufficient filler material is applied to the area where the leading edge of the Clock Spring® will be positioned. Filler is required to ensure intimate contact at the point where the first layer of the clock Spring® overlays the second layer.
- 7.12 Apply Adhesive to the Clock Spring® outer-surface while wrapping the unit around the pipe.
- 7.13 Continue applying adhesive and wrapping the Clock Spring® around the pipe until the “second black identifying line” appears. There are two identifying lines “marked” on the final wraps of the Clock Spring® sleeve. The first line is to alert the Installer that the

application of the adhesive is nearing completion. The second line indicates the stopping point of the adhesive application. Apply adhesive 1-inch (25 mm) beyond this point.

- 7.14 Carefully position the remaining portion of the Clock Spring® around the pipe and assist the “memory matrix” to tighten the sleeve onto the pipe. Align the edges of the installed sleeve using the wooden blocks and a hammer.
- 7.15 Prepare to tighten the Clock Spring® sleeve by centering the dual lock pad 6 – 12-inches (152 – 305 mm) from the trailing edge of the Clock Spring®.
- 7.16 Secure the cinch bar strap to the dual lock. Position the cinch bar and apply steady pressure (approximately 80 – 100 ft. lbs. (11 – 14 Kg m)). Hold for about one minute until excess material extrudes from the edges of the Clock Spring®.
- 7.17 While maintaining steady pressure, secure the Clock Spring® in position by wrapping filament tape around the sleeve at least three times, approximately 1-inch (25 mm) from each edge.
- 7.18 Perform final alignment of the Clock Spring® sleeve with the wooden blocks.
- 7.19 Remove the extruded filler material from both edges of the sleeve using the 3-inch (76 mm) putty knife. Visually inspect the installation to ensure all wraps are tight and fit snugly to the pipe around the entire circumference. Voids or spaces between the wraps, or between the Clock Spring® and the pipe, will render the repair ineffective.
- 7.20 Seal both edges and trailing edge of the sleeve with the remaining adhesive using the paintbrushes.
- 7.21 Ensure that all edges and seams have been sufficiently coated with adhesive. Full cure should occur in approximately 2 hours. To verify that the adhesive is cured, check for a minimum hardness of 40 on the Shore A scale. The completed Clock Spring® assembly is to be treated as a standard pipe repair requiring an external coating. The Clock Spring® is U-V sensitive. Pipe coatings for aboveground pipe must be opaque.
- 7.22 It is valuable for a pipeline operator to be able to detect prior repairs on subsequent in-line-inspections so that time is not spent determining the disposition of a defect detected and repaired during a previous program. The older more traditional repairs are identifiable in the magnetic flux leakage inspection tool data but the Clock Spring® composite repairs are invisible to this technology. The Clock Spring® repair can be fitted with a metallic band to allow detection by Magnetic Flux Leakage inspection tools.
- 7.23 Clock Spring® will not affect the defect signals recorded by an MFL inspection tool. Defects repaired with Clock Spring® and identified in the inspection tool data by the banding method (6.22) can be used on subsequent inspections to calibrate the tool or qualify the inspection.
- 7.24 Fully document the repair for record keeping

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