Solutions in Pipeline Safety

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Transmission Pipeline Repair Methods

Appalachian Underground Corrosion Short Course

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COURSE OUTLINE

I. Introduction – Why & What
I. Code
II. Evaluation of pipe
    A. Types of Anomalies
    B. Methods of Analysis
III. Repair Methods
    A. Split sleeve
    B. Composite sleeve
    C. Clamp
IV. Safety
V. Economics
VI. Products
VII. Questions & Closing Remarks

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WHY DO WE NEED THE ABILITY TO REPAIR A PIPELINE?

- Public safety
- Operational restriction or loss of service
- Economics

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FEDERAL CODE
WHAT DOES IT SAY AND WHERE?

- Interstate (between or among states) natural gas and hazardous liquid pipelines are governed by the 49th Code of Federal Regulations (CFR) Parts 190-199.

- Intrastate (within states) natural gas and hazardous liquid pipelines are governed by the states in which they reside, most of the time each state adopts the federal code.

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FEDERAL CODE
WHAT DOES IT SAY AND WHERE?

For Natural Gas Pipelines the applicable parts of the 49th CFR Part 192 – Subpart M (Maintenance) are as follows:

- § 192.703(a,b,c) – The Options
- § 192.709(a) – Record Keeping
- § 192.711(a,b) – Public Safety
- § 192.713(a,b) – Repair of Damage or Imperfections
- § 192.715(a,b,c) – Repair of Welds
- § 192.717(a,b,c) – Repair of Leaks

FEDERAL CODE – THE MANDATE

§ 192.703(a) – "No person may operate a segment of pipeline, unless it is maintained in accordance with this subpart."

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FEDERAL CODE – THE OPTIONS

§ 192.703(b) – "Each segment of pipeline that becomes unsafe must be replaced, repaired, or removed from service."

§ 192.703(c) – "Hazardous leaks must be repaired promptly."

FEDERAL CODE – RECORD KEEPING

§ 192.709 – Each operator shall maintain the following records for transmission lines for the periods specified:

(a) The date, location, and description of each repair made to pipe must be retained for as long as the pipe remains in service.

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FEDERAL CODE – PUBLIC SAFETY

§ 192.711(a, b)

(a) Each operator shall take immediate temporary measures to protect the public whenever:

(1) A leak, imperfection, or damage that impairs its serviceability is found in a segment of steel transmission line operating => 40% of SMYS.
(2) It is not feasible to make a permanent repair at the time of discovery.
As soon as feasible, the operator shall make permanent repairs.

(b) Except as provided in § 192.717(b)(3), no operator may use a welded patch as a means of repair.

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Federal Code – Repair of Damage or Imperfections

§ 192.713(a, b)

(a) Each imperfection or damage that impairs the serviceability of pipe in a steel transmission line operating at or above 40% SMYS must be –

(1) Removed by cutting out and replacing a cylindrical piece of pipe; or
(2) Repaired by a method that reliable engineering tests and analyses show can permanently restore the serviceability of the pipe.

(b) Operating pressure must be at a safe level during repair operations.

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Federal Code – Repair of Welds

- **§ 192.715(a, b, c) – Each weld that is unacceptable under § 192.241(c) must be repaired as follows:**
  - (a) If it is feasible to take the segment of transmission line out of service, the weld must be repaired in accordance with the applicable requirements of § 192.245.
  - (b) A weld may be repaired in accordance with § 192.245 while the segment of transmission line is in service if:
    - (1) The weld is not leaking;
    - (2) The pressure in the segment is reduced so that it does not produce a stress that is more than 20% of the SMYS of the pipe; and
    - (3) Grinding of the defective area can be limited so that at least 1/8-inch (3.2 millimeters) thickness in the pipe weld remains.
  - (c) A defective weld which cannot be repaired in accordance with paragraph (a) or (b) of this section must be repaired by installing a full encirclement welded split sleeve of appropriate design

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Federal Code – Repair of Leaks

- § 192.717(a,b,c) – Each permanent field repair of a leak on a transmission line must be made by –
  - (a) Removing the leak by cutting out and replacing a cylindrical piece of pipe; or

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Federal Code – Repair of Leaks (Continued)

(b) Repairing the leak by one of the following methods:

(1) Install a full encirclement welded split sleeve of appropriate design, unless the transmission line is joined by mechanical couplings and operates at less than 40 percent of SMYS.

(2) If the leak is due to a corrosion pit, install a properly designed bolt-on-leak clamp.

(3) If the leak is due to a corrosion pit and on pipe of not more than 40,000 psi (267 MPa) SMYS, fillet weld over the pitted area a steel plate patch with rounded corners, of the same or greater thickness than the pipe, and not more than one-half of the diameter of the pipe in size.

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Federal Code – Repair of Leaks (Continued)

(4) If the leak is on a submerged offshore pipeline or submerged pipeline in inland navigable waters, mechanically apply a full encirclement split sleeve of appropriate design.

(5) Apply a method that reliable engineering tests and analyses show can permanently restore the serviceability of the pipe.

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Evaluation of Pipe

§ 192.485(a,b,c)

(a) *General Corrosion*. Each segment of transmission line with general corrosion and with a remaining wall thickness less than that required for the MAOP of the pipeline must be replaced or the operating pressure reduced commensurate with the strength of the pipe based on actual remaining wall thickness. However, corroded pipe may be repaired by a method that reliable engineering tests and analyses show can permanently restore the serviceability of the pipe. Corrosion pitting so closely grouped as to affect the overall strength of the pipe is considered general corrosion for the purpose of this paragraph.

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EVALUATION OF PIPE

§ 192.485 (a,b,c)

(b) *Localized corrosion pitting*. Each segment of transmission line pipe with localized corrosion pitting to a degree where leakage might result must be replaced or repaired, or the operating pressure must be reduced commensurate with the strength of the pipe, based on the actual remaining wall thickness in the pits.

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EVALUATION OF PIPE

§ 192.485(a,b,c)

(c) Under paragraphs (a) and (b) of this section, the strength of pipe based on actual remaining wall thickness may be determined by the procedure in ASME/ANSI B31G or the procedure in AGA Pipeline Research Committee Project PR 3-805 (with RSTRENG disk). Both procedures apply to corroded regions that do not penetrate the pipe wall, subject to the limitations prescribed in the procedures.

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Repair Methods

A. Split sleeve

B. Composite sleeve

C. Clamps

Do a pro/con list of each (split sleeve that is a Class A and isn't welded up can have water migrate in and out).

CAUTION: Not all repair methods are compatible with all anomalies (i.e. composites with cracks).

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Acceptable Threat Prevention and Repair Methods

Table 4 Acceptable Threat Prevention and Repair Methods (Cont'd)

Prevention, Detection, and Repair Methods	Third-Party Damage			Corrosion Related		Equipment				Incorrect Operation	Weather Related			Manufacture		Construction				O-Force	Environment
	TPD(IF)	PDP	Vand	Ext	Int	Gask/ Oring	Strip/ BP	Cont/ Rel	Seal/ Pack	IO	CW	L	HR/F	Pipe Seam	Pipe	Gweld	Fab Weld	Coup	WB/B	EM	SCC
Repairs																					
Pressure reduction	...	X	...	X	X	..	...	...	...	...	...	...	...	X	X	X	X	X	...	...	X
Replacement	...	X	X	X	X	X	X	X	X	...	X	X	X	X	X	X	X	X	X	X	X
ECA, recoat	...	...	...	X	X	...	...	...	...	...	...	...	...	...	...	X	...	...	...	...	...
Grind repair/ECA	...	X	X	...	...	...	...	...	...	...	...	...	...	X	X	X	X	...	...	...	X
Direct deposition weld	...	...	X	X	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Type B, pressurized sleeve	...	X	X	X	X	...	...	..	...	...	...	..	...	X	X	...	X	X	...	...	X
Type A, reinforcing sleeve	...	X	X	X	...	...	...	...	...	...	...	...	...	X	X	..	...	..	...	...	X
Composite sleeve	...	...	...	X	...	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...
Epoxy filled sleeve	...	X	X	X	...	...	...	...	...	...	...	...	...	X	X	X	X	X	X	...	...
Mechanical leak clamp	...	...	...	X	...	...	...	...	...	...	...	...	...	...	..	...	...	...	...	...	...

GENERAL NOTE: The abbreviations found in Table 4 relate to the 21 threats discussed in para. 5. Explanations of the abbreviations are as follows:

Cont/Rel = Control/Relief Equipment Malfunction
Coup = Coupling Failure
CW = Cold Weather
EM = Earth Movement
Ext = External Corrosion
Fab Weld = Defective Fabrication Weld
Gask/Oring = Gasket or O-Ring
Gweld = Defective Pipe Girth Weld
HR/F = Heavy Rains or Floods
Int = Internal Corrosion
IO = Incorrect Operations Company Procedure
L = Lightning
PDP = Previously Damaged Pipe (delayed failure mode)
Pipe = Defective Pipe
Pipe Seam = Defective Pipe Seam
SCC = Stress Corrosion Cracking
Seal/Pack = Seal/Pump Packing Failure
Strip/BP = Stripped Thread/Broken Pipe
TPD(IF) = Damage Inflicted by First, Second, or Third Parties
Vand = Vandalism
WB/B = Wrinkle Bend or Buckle

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EVALUATE THE SITUATION

- Is the line in service?
- Can the line be taken out of service?
- Does the line need to be taken out of service?
- Does the pressure need to be reduced?
- What temperatures exist on the pipeline?
- Are ambient temperatures hot or cold?
- Is it wet or dry?
- How quickly does the repair need to be made?
- What are the resources available?
- Are there cracks?
- Is there a leak?
- Does your O&M manual cover pipeline repairs?
- Long term can you certify people on a product?

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METHODS OF ANALYSIS

ASME B31G

RSTRENG

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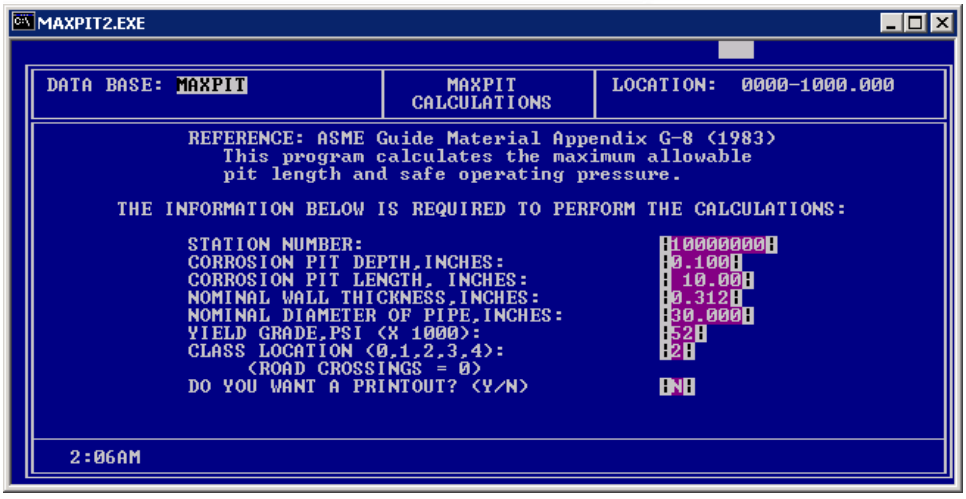

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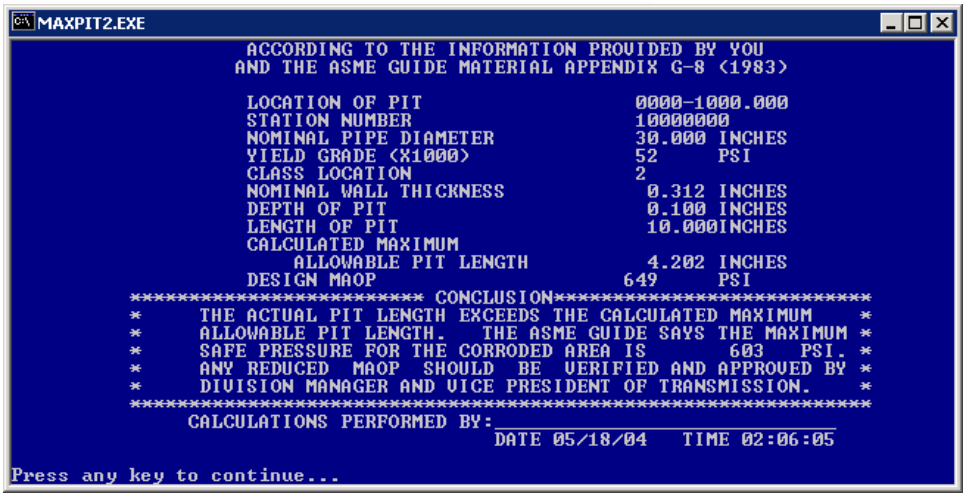

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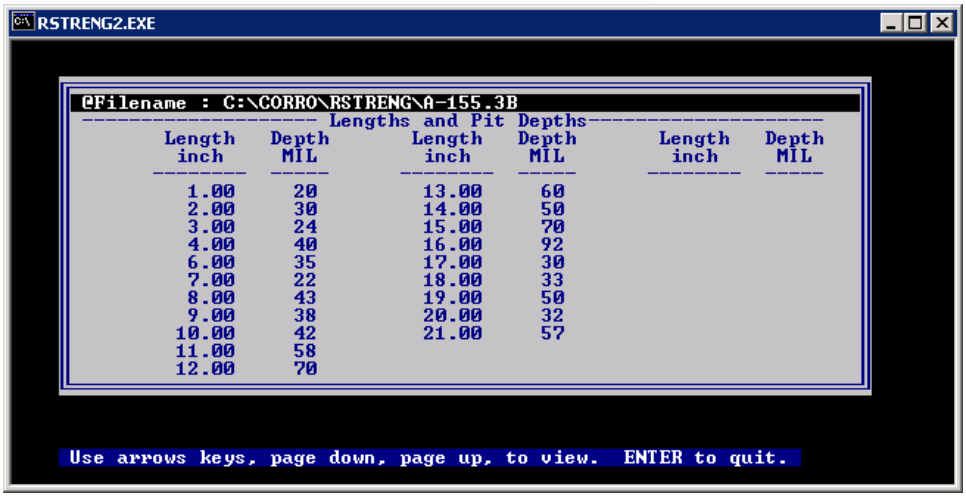

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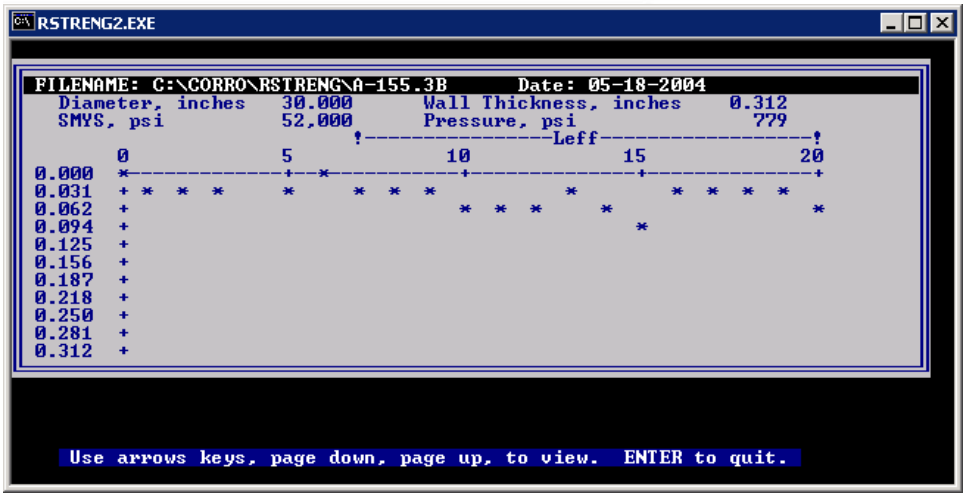

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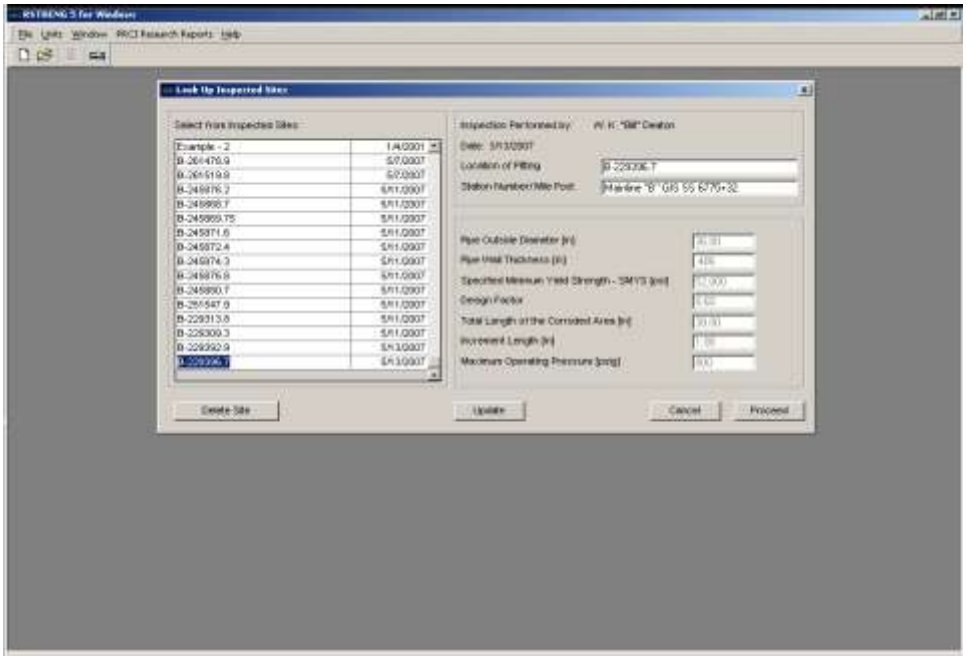
RSTRENG2.EXE

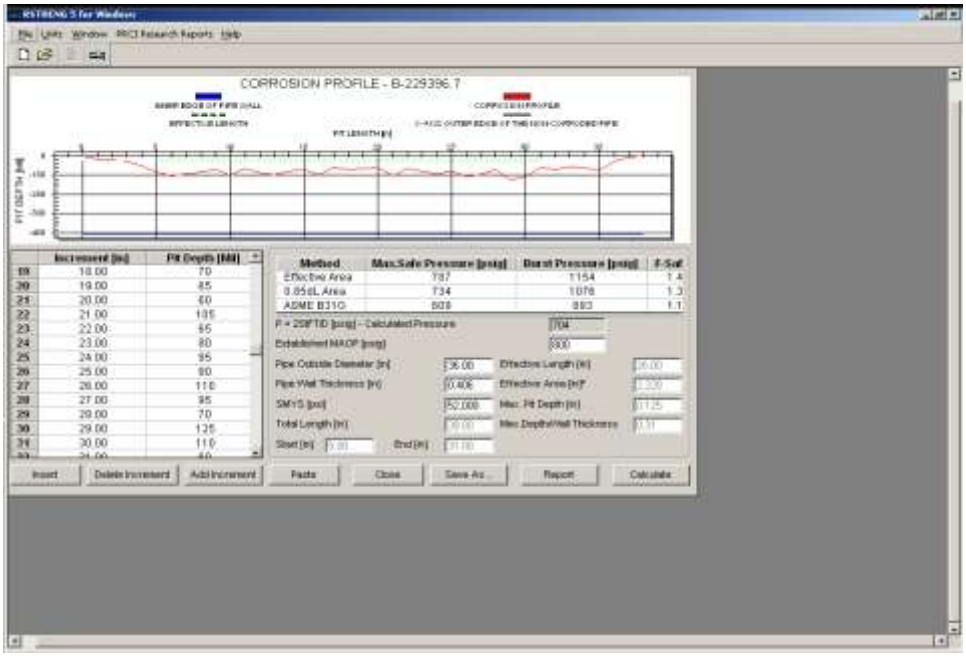
```
FILENAME : C:\CORRO\RSTRENG\A-155.3B
          Pressure, psi =    779
                          Safe          Predicted
                       Maximum          Burst
                      Pressure       Pressure          Factor
                      psi (*)            psi          of Safety
                      --------       --------         --------
CASE 1 - Effective Area    779          1,131            1.45
CASE 2 - 0.85 dL Area      736          1,021            1.31
CASE 3 - B31G              604            839            1.08

  Diameter, inches =  30.000     Wall Thickness, inch =   0.312
        SMYS , psi =  52,000     Max. Pit Depth, inch =   0.092
Total Length, inch =  20.00      Max. Depth/Thickness =   0.29
 Eff. Length, inch =  13.00         Eff. Area, inch^2 =   0.675
       Start, inch =   8.00               Stop, inch  =  21.00

(*) If the calculated safe maximum pressure for the criteria that
    the user follows (CASE 1, CASE 2, or CASE 3) is less than
    the established pressure, remedial action must be taken.

        F7 Printer          F8 File          F10 Quit
```


RSTRENG 5 for Windows
File Units Window PRCI Research Reports Help
CORROSION PROFILE - B-229396.7
Method
Max.Safe Pressure [psig]
Burst Pressure [psig]
Effective Area
0.85dL Area
ASME B31G
Insert
Delete Increment
Add Increment
Paste
Close
Save As...
Report
Calculate


RSTRENG

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SAFETY

•Excavation safety – trenching and shoring - follow 29th CFR Part 1926 Subpart P

•Personnel safety – dig under pressure or not?

•Air permits, environmental permits, city land permits, Corps of Engineers permits, County permits, State permits

•Notifications to DOT, FERC, EPA, Local Emergency Response Committees, NTSB, NRC, State and Local Officials, etc.

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ECONOMICS

•Each case must be individually evaluated to choose the best choice. Of course, if throughput is adversely affected the quickest and safest option is the best.

•Due to the amount of DOT approved choices today there are many different possibilities that weren't there just 5-10 years ago.

WEBSITES…(DO SOME RESEARCH!)

Search on Pipeline Repair:
Aquawrap http://www.corrodefense.com/
Armor Plate http://www.armorplateonline.com/documents/Brochure3_7.pdf
Black Diamond by TDW www.tdwilliamson.com
http://www.wutc.wa.gov/webimage.nsf/web+objects/pipeline/$file/Clockspring.pdf
Clockspring
m-tec http://www.pipelineintervention.com/repair.htm#
Mid-States http://www.mid-states-pipe-repair.com/
PermaWrap by WrapMaster http://www.wrapmaster.us/
PETROSleeve http://www.petrosleeve.com/faqs.html PLIDCO
http://www.drshannonco.com/plidco%20index.htm
Steel Works http://www.steelworks.ca/pipelinerep.html
TDWilliams Steel Repair Sleeves
http://www.allanedwards.com/steel_pipeline_sleeves.php
Tecnomarine http://www.pr67.dial.pipex.com/clamp.htm
Tekmar http://www.tekmar.co.uk/equipment_prc.shtml

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QUESTIONS AND ANSWERS

- What was left out that you would like to see contained in this presentation?
- What questions do you have that were not answered?
- Suggestions for improvement?

Recommend a course by Keiffner or Rosenfeld on ASME B31.8.


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Thank You
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