Low Pressure Systems
Risks and Replacement Challenges

AGA

May 1, 2019

Agenda

- LP System Origins
- LP System Risks and Incidents
- Replacement Challenges
- NTSB Recommendations
- AGA Best Practices
- Risk Mitigation Approach

Low Pressure System Origins

Natural Gas utilized the Manufactured
Gas Low Pressure Delivery Systems

Low Pressure Systems Risks

Typically Older Systems (1800's - early 1900's)

- Integrity Management Issues
  - Leaks and difficulty in repairing leaks
  - Cast Iron, Wrought Iron, Bare Steel
    - Bell and Spigot, Bell/Bell Chill ring
    - Steel services off CI mains.
  - Antiquated Equipment - Valves
  - Poor Meter set locations. i.e. curb meters, basement meter sets
  - Leak Migration - Wall to wall pavement

Multiple Inlet Sources

- Increase susceptibility to risk of failed open regulation

No Pressure Regulation between the distribution system and Customer Equipment.

Low Pressure System Recent Incidents

Recent Incidents involving Over-Pressurization

Recent Incidents involving Cast Iron Pipeline Failure

Incidents Involving Over-Pressurization

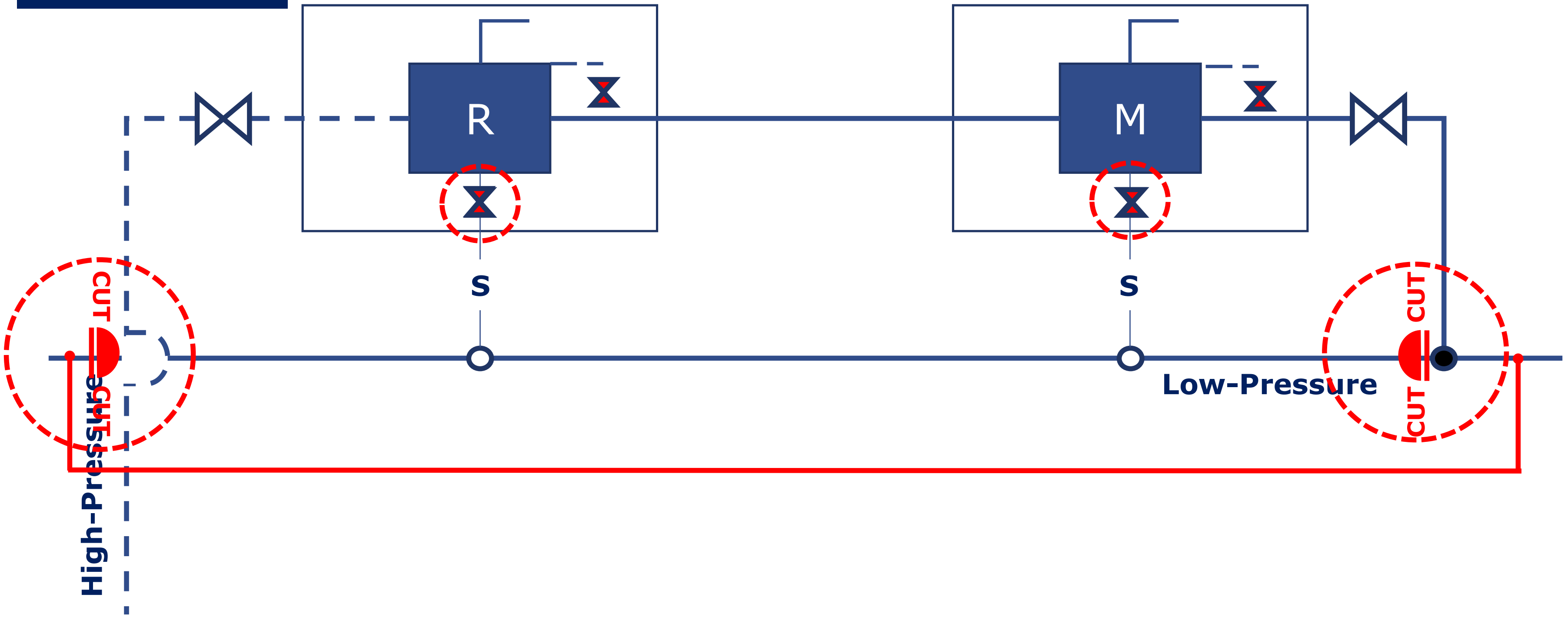
Scenario 2: Alameda, CA

September 14, 2018

- Damaged 131 Structures
- 5 Homes Destroyed
- 1 Fatality
- 21 Injuries

Key

R: Regulator
M: Monitor
S: Sensing Line



Recent Incidents Involving Cast Iron Pipeline Failure

January 20, 2018 - Brooklyn, NY
Gas Fire. Injured four. 6-inch CI installed 1927. Apparent cause - frost heave.

January 9, 2012 - Austin, TX
Home explosion. 1 fatality and 1 injury. 4-inch CI installed in 1950. Apparent cause – ground movement rainfall that followed extended drought conditions.

July 31, 2016 - Shreveport, LA
Gas Fire. 1 fatality and 1 injury. 4-inch CI installed in 1911. Apparent cause - erosion.

February 9, 2011 - Allentown, PA
House Fire. 5 fatalities 3 injured 8 homes destroyed 12-inch CI installed in 1928. Apparent cause – break.

March 5, 2015 - Detroit, MI
Gas Leak. 1 fatality, 1 injury, 6-inch CI installed 1923. Apparent cause - Circumferential crack.

January 18, 2011 - Philadelphia, PA
Explosion and fire. 1 fatality several injuries 12-inch CI installed in 1942. Apparent cause – break.

January 27, 2015 - Cordova, AL
Home explosion. 1 fatality and 3 injuries. CI installed in 1952. Apparent cause - Earth movement.

Why not just replace it?

Because it's Hard!

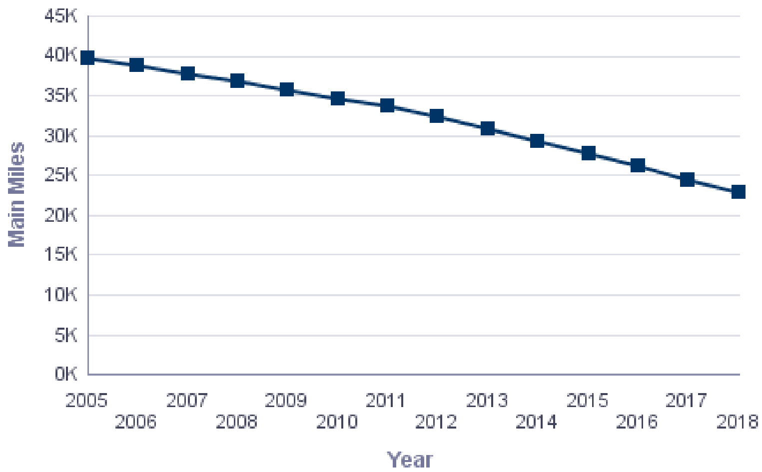
We have been trying for a long time!

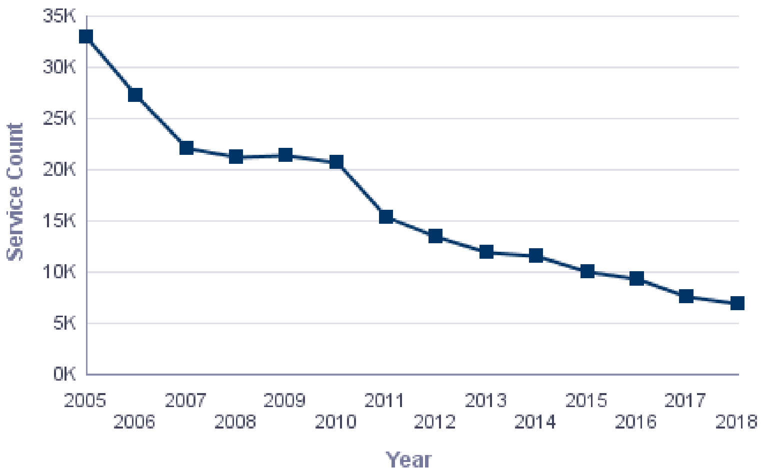
In 1983 Operators reported 61,536 miles of CI/WI main

Cast/Wrought Iron Main Miles and Service Count by Year

State: (All Column Values)

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Main Miles	39,645	38,704	37,720	36,813	35,623	34,592	33,669	32,406	30,904	29,359	27,770	26,224	24,493	22,861
Service Count	32,862	27,232	22,050	21,216	21,323	20,728	15,408	13,511	11,991	11,618	10,028	9,345	7,652	6,985





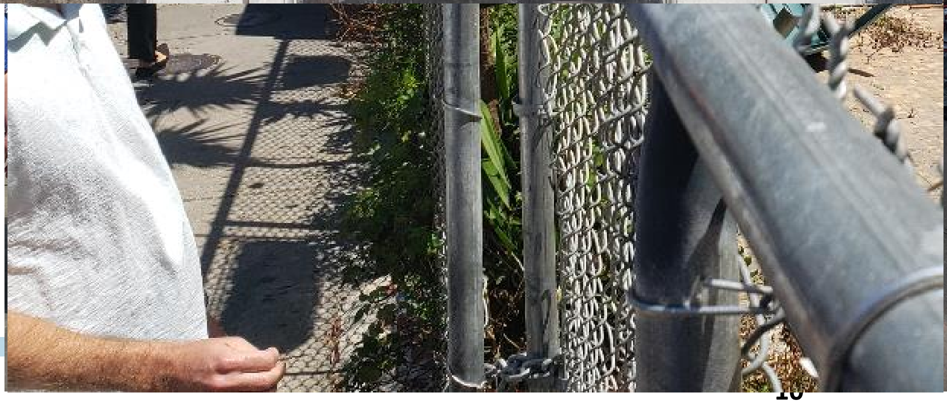
At this rate we still have 20 years to go.

- 1983 - **61,536** miles of CI/WI in operation
- 2005 – **39,645** miles in operation
- 2018 – **22,861** miles in operation

Data Source: US DOT Pipeline and Hazardous Materials Safety Administration
Portal - Data as of **4/4/2019**

Replacement Challenges

- Maintaining Gas Service During Replacement
- Cast iron systems
  - Replacement and shut-off is difficult
    - Can't weld on it or cut it
- Congested Utilities
  - Abandoned facilities present
  - No place to install
  - Thick street cross sections
  - Limited Work Hours - Traffic Control Requirements
- Poor Meter Locations
  - Customer fuel gas line requires modification
- Etc.



NTSB Recommendations

1. Require a professional engineer's seal
2. Engineering and constructability review processes
3. Records Review - traceable, reliable and complete
4. Apply management of change process identify system threats that could result in a common mode failure
5. Job Procedures and Monitoring – Clearances, Shut Down and Tie In. Hang Gauges etc.

AGA Leading Practices

AGA Leading Practices to Reduce the Possibility of a Natural Gas Over-Pressurization Event:

- Design Practices for all Pressure Classifications — **18**
- Standard Operations and Maintenance Practices — **11**
- Construction, Tie-Ins, Tapping, Uprates, and Abandonments Practices — **4**
- Damage Prevention Practices — **5**
- Records Practices — **6**

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Human Factors:
- Management of Change - **4**
- Training for Recognition and Prevention of AOC's - **4**
- Filed Oversight Practices - **5**
- Management of Risk of an Overpressure Event
  - General - **2**
  - DIMP - **4**

TOTAL **63**

Tools and Systems Required

Accurate Records

Operating Diagrams
Locate sensing lines locations

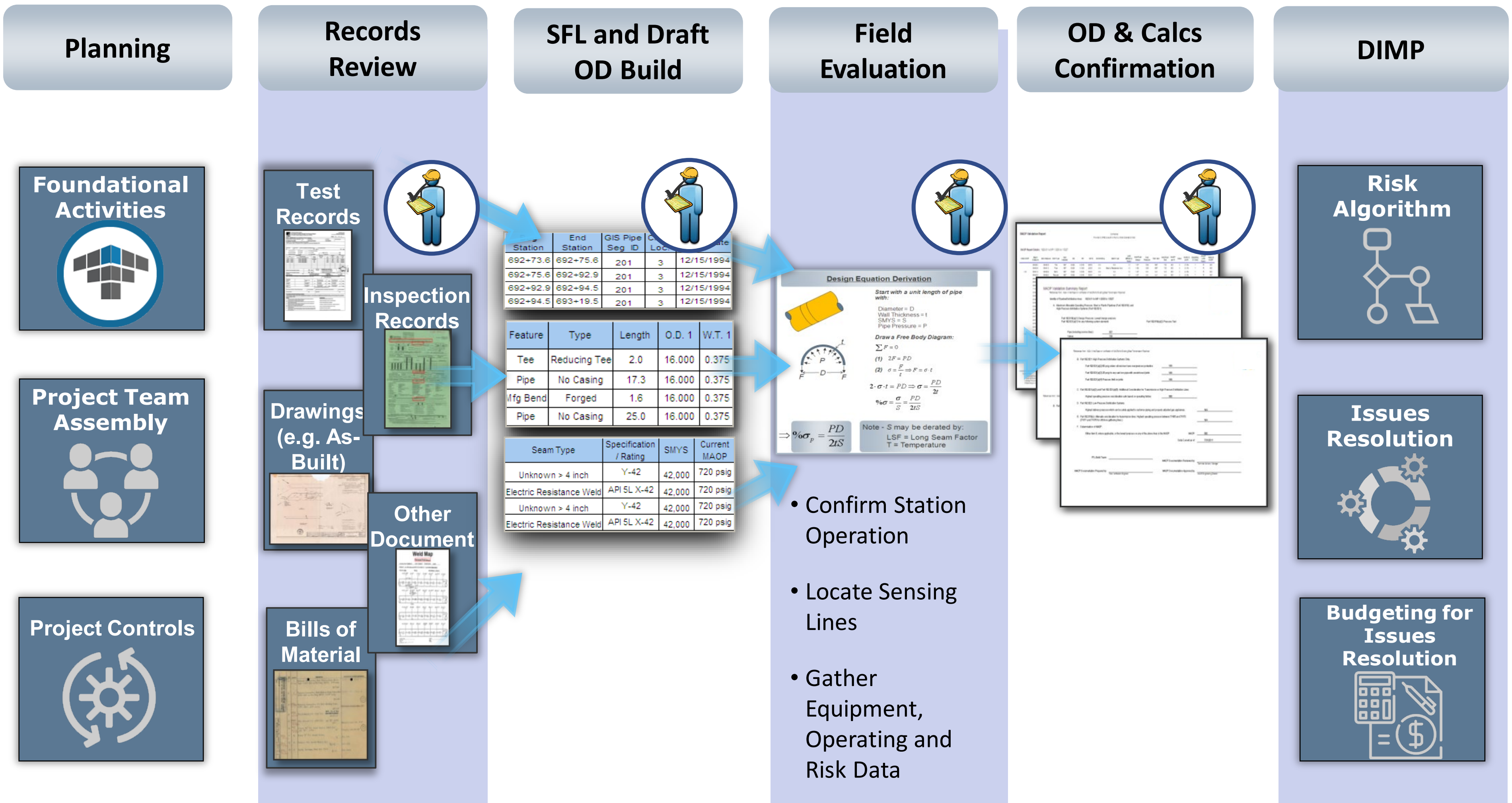
Equipment Records and Maintenance Management Systems

Confirmation that records match what's installed.

"Health" Score card.

Stations Included in DIMP

GTS Station Evaluation and Risk Mitigation™



Station	End Station	GIS Pipe Seg ID	Loc.	
692+73.6	692+75.6	201	3	12/15/1994
692+75.6	692+92.9	201	3	12/15/1994
692+92.9	692+94.5	201	3	12/15/1994
692+94.5	693+19.5	201	3	12/15/1994

Feature	Type	Length	O.D. 1	W.T. 1
Tee	Reducing Tee	2.0	16.000	0.375
Pipe	No Casing	17.3	16.000	0.375
Mfg Bend	Forged	1.6	16.000	0.375
Pipe	No Casing	25.0	16.000	0.375

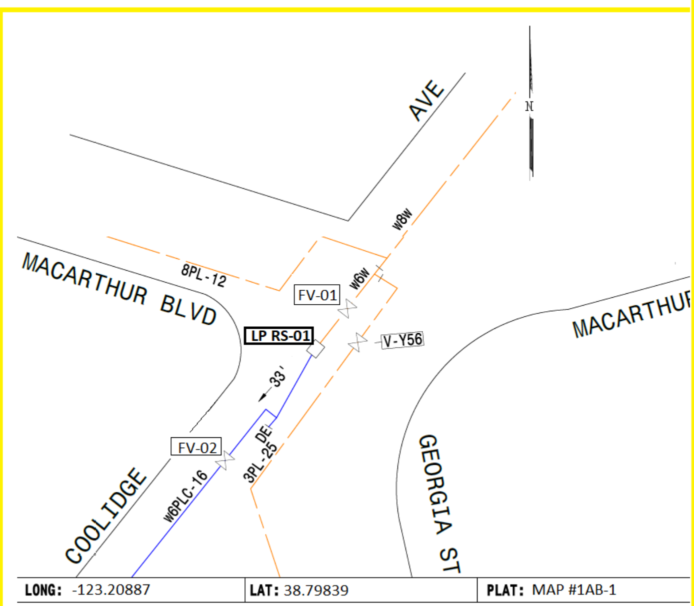
Seam Type	Specification / Rating	SMYS	Current MAOP
Unknown > 4 inch	Y-42	42,000	720 psig
Electric Resistance Weld	API 5L X-42	42,000	720 psig
Unknown > 4 inch	Y-42	42,000	720 psig
Electric Resistance Weld	API 5L X-42	42,000	720 psig

- Confirm Station Operation
- Locate Sensing Lines
- Gather Equipment, Operating and Risk Data

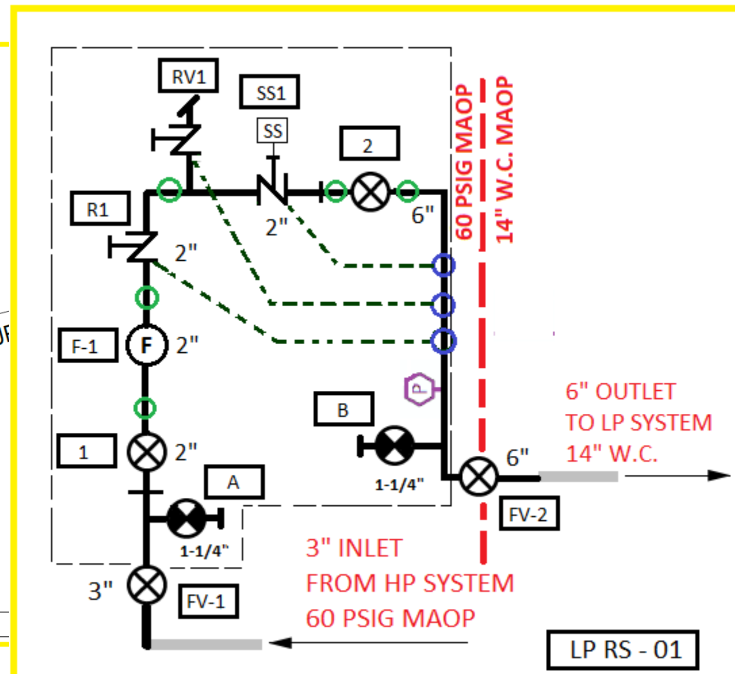
Operating Diagram Standard

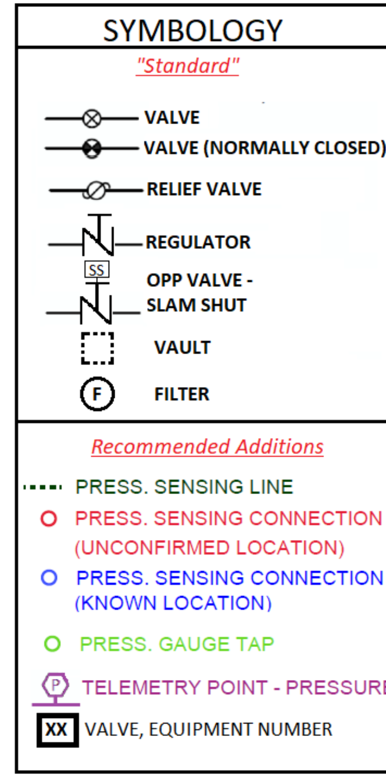
- <u>Potential Changes/Additions</u>
  - Operations: Valve tagging conventions
  - AGA Leading Practices: sensing tap locations, telemetry points
  - Ex: Single feed, bypass valves and connection, slamshut

<u>Vicinity Map</u>



<u>Operating Diagram</u>





Station Health Field Checklist

Checklist items based on:

- Code Compliance, PHMSA Gas Dist. IA Question Set
- Company Standards
- AGA Leading Practices, Risk Algorithm, Experience

Station Health - Review Checklist

Complete During Site Visits

Station:	
Service Center:	
Form Completed By:	
Date Completed:	

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#			Compliance	REFERENCES
Section 1 - Alarming, Abnormal Operating Conditions				
1	Are there mechanisms in place to generate an alarm on abnormal operating conditions? E.g. failed control valve, overpressure, excessive flow. Examples: alarm relief ("whistle", "tattle-tale", "token"), full relief valves, pressure recording devices, pressure signals to Gas Control, etc. Enter Yes or No	Comments: Ask Tech or note from observations; take photos of all taps/lines coming off of main piping.	B, C	AGA LP DP #1, p.6 AGLR ENG-303 p.3 Southern OPM DIII-S6-P1, S6.8.2 (for mon. regulators)
2	Availability of Mechanisms in Place on Reg Runs? Enter: None, Some, All		B, C	AGA LP DP #1, p.6 AGLR ENG-303 p.3
	Is SCADA available at the site, and pressures, flowrates, and other data points are transmitted to Gas Control? Enter Yes or No	Take photos of cabinets and/or instrument buildings if possible. Note locations of where pressure is measured (tapped off of pipe, going to SCADA or other pressure recorded)	C	AGA LP DP #9, p.8 Southern OPM DII-S12-P9, S12.4
3	If no SCADA Available, is pressure recorded locally (e.g. ERX) and can be transmitted/downloaded via other means? Enter Yes or No If NA for ERX or SCADA, is there a pressure recording chart box on-site?	Ask Tech or Local Service Center if possible.	B, C	AGA System Mon., p.10 Southern OPM DII-S12-P9, S12.4
4	Does the station include any remotely controlled valves? E.g. for isolation, regulator valves, etc. Enter Yes or No		B, C	AGA LP DP #9, p.8
Section 2 - Equipment Issues				
	Isolation Valves	Comments:		
5	Are any of the valve(s) inoperable, have severe blow by or leak to atmosphere? Enter Yes or No	Ask Tech or Local Service Center if possible.	B	
6	Are any of the valve(s) hard to operate or cannot get positive shutoff? Enter Yes or No	Ask Tech or Local Service Center if possible.	B	
7	Are any of the valve(s) somewhat hard to operate or have some issues? Enter Yes or No	Ask Tech or Local Service Center if possible.	A	49 CFR 192.745

Incorporation Into DIMP

Algorithm Development	
Assemble SME Panel	Include Engineers, Technicians, Gas Control etc.
Determine Risk and Consequence Categories	Consider incident history, maintenance records, Material failure reports etc.
Determine Risk and Consequence Drivers & Impact Level	Ballot Process Assign an Impact Level – High Medium or Low
Algorithm Scrubbing	Review ballot results for redundancy and to eliminate insignificant drives.
Algorithm Vetting	Apply the algorithm to a sample set of stations and consider the outcomes

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Example Reg Station Risk Algorithm

Probability of Failure X Consequence of Failure = Total Risk

$$[AP_{eq} + BP_{dd} + CP_{plc} + DP_{nc} + EP_{3p}] \times [FC_{lp} + GC_{env} + HC_{bus}] = \text{Total Station Risk}$$

This algorithm is being offered as an example strictly for this presentation. Operating conditions, incident history, environment etc. vary from operator to operator. A unique risk algorithm needs to be developed for each operator and therefore GTS does not endorse its use

P_{3p}	=	Probability of Damage by Third Party

And,

C_{lp}	=	Consequence to life or property
C_{env}	=	Consequence to the environment
C_{bus}	=	Consequence to business

Example Station Risk Algorithm

POF CATEGORIES

POF Category	Risk Rating
Req = Equipment	27
Rdd = Design Deficiency	23
Rpc = Pipeline Contaminants	17
Rnc = Natural Causes	15
Rtp = Damage by Third party	18
Total	100

POF SUB-CATEGORIES

Equipment	Enter Rating
Regs Monitors	41
Ancillary Equipment	20
Control Loop Assemblies	24
Block Valves	6
Vaults	9

POF Risk Driver Impacts

Control Loop Assemblies		
1.0	High	Location of sensing lines unknown and/or equipment is obsolete, no spare parts available, prone to failure
0.8	Medium	Equipment is obsolete, no spare parts available, prone to failure
0.6	Low	Equipment is antiquated and does not perform to modern expectations.

Results

- Records Review Performed and Confirmed with Field Assessments
- Comprehensive Equipment List and Maintenance Management system updated.
- Health Issues identified and included in management tracking mechanism.
- Relief Valve and Reg Station Capacity Calcs current and repeatable
- Accurate Operating Diagrams to facilitate Station Clearance Procedures
- Stations will be Included into the DIMP program
  - Benefit from a cross prioritization with pipeline mitigations
  - Supports rate case submittals

Questions?

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APPENDIX