

Failure Investigation Report – Columbia Head Gasket Failure – Activity ID 130195

Principal Investigator David Hippchen WV PSC
Regional Director Byron Coy
Date of Report 03/02/2011
Subject Failure Investigation Report – Columbia Clendenin Compressor Station Head Gasket Failure

Summary:

On May 7, 2009, a head end gasket failed on Clendenin Compressor Station Unit #3, resulting in an uncontrolled gas discharge into the building. The fixed gas detectors actuated the visual alarm which caused the station operator on duty to assess and react to the situation from outside the building. After assessing the situation, the station operator notified gas control and manually initiated a station shutdown. During the emergency shutdown sequence, 3 of 6 fire gates failed in service, allowing gas to vent from the blowdown valves for about 90 minutes until the last fire gate was manually closed. The event was reported as an incident due to the volume of lost gas and associated costs. No injuries were sustained by operator personnel or the public.

Operator, Location, & Consequences

Date & Time of Failure: 5/7/2009
Commodity Released: Natural Gas
City/County & State: Clendenin, Hampshire County, WV
OpID & Operator Name 2616 Columbia Gas Transmission
Unit # & Unit Name 67791 Clendenin Compressor
SMART Activity #: 130195
Milepost / Location Latitude: 38°29'43"N
Longitude: 81°18'44"W
Type of Failure: Head Gasket Failure and non-operational shutdown valves
Fatalities: 0
Injuries 0
Description of area impacted Rural
Property damage \$726,553

System Details

Unit No. 3, Clendenin Compressor Station

Events Leading up to the Failure

On Thursday, May 7, 2009, the station was set up for a typical pumping Tennessee suction to Coco storage with overflow to TM-17. At approximately 8:42 p.m. a head-end head gasket failed on main unit #3 and the building began filling with gas. As the station operator was preparing for 9:00 p.m. rounds he heard gas blowing, donned safety gear and went to identify the source. He noted that the red strobe light was on at compressor building 3-4, indicating the presence of gas in the building. Cautiously approaching an open door he saw and heard gas blowing

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between units 3 and 4, but was unable to determine its source. He then returned to the control room to advise Gas Control of the issue and notify them he would shutdown the station.

Emergency Response

Assistance arrived as a result of telephone notification, but also due to the enormity of noise resulting from the gas blowing off - which could be heard as far as the town of Clendenin. Station Team Leaders, repairmen and an off-duty operator responded. The team was able to identify blow off at the northeast side of the station (a 6" blow off valve at fire gate TM-1711 00) a 4" unit blow down valve in the station and a 6" blow off valve at fire gate TM-LOOPII08 were blowing. It was then determined the 6" blow off valve at fire gate TM-LOOPII08 required the most immediate assistance. It was closed to eliminate noise in the immediate vicinity. By this time approximately 45 minutes had elapsed since the initiation of the Emergency shutdown. The team then began determining which valves ahead of the station could be closed to deter the blow off and isolate the station, and they began manually closing line and station valves. It came down to fire gate TM-LOOPIIIO to isolate the station, taking nearly 45 minutes to close this valve. At approximately 10:15 p.m. the last fire gate valve was closed and the station finally blew down.

Summary of initial start-up plan and return-to-service, including preliminary safety measures

While the unit was down, additional investigation and preventative maintenance was performed on the unit. In the investigation, a number of additional anomalies were noted below. After the station was back on line, gas was re-introduced to the pipeline facilities in the compressor building to determine where the leak was coming from.

1. A bent rod was found on compressor 2.
2. Evidence of elevated bearing temperature on compressor 4.
3. Significant rod packing leakage on all the compressors

Investigation Findings & Contributing Factors

A root cause analysis of this incident has not identified the exact cause of the gasket failure; however the evidence is strong in favor of fluids ingested into the compressor. When gas was re-introduced to the facilities in the building, the head-end of compressor 3 on Unit #3 was quickly identified as the leak source. Upon closer inspection of the compressor unit 3, it was determined that the gas leak was a result of the head end gasket located between the cylinder head and cylinder body being blown out. The blow out was at the six-o'clock discharge valve position on the head end of the cylinder. The blown out portion of the gasket was not recovered.

The main causal factor for the Emergency Shutdown Failure was water in the plant Emergency Shutdown air system. The water had worked its way to the low places of the dead end piping that is inherent in the Emergency Shutdown system. The causal factor for the water in the air lines is the extended down time on the plant air dryer.

Through this investigation, the exact cause of the gasket failure was not determined. However, it is likely that the failure of the head-end gasket was the result of one or more of the following:

- Inadequate torque on one or more of either the through studs or internal studs (or both) in the cylinder, in the vicinity of the leak. No physical evidence was discovered to conclusively rule this in or out.
- Imperfection or damage to the gasket material in the area of the failure.
- Excessive discharge pressure in cylinder passages due to the clearances being consumed by fluids in the compression chamber and valve pockets.

Appendices

- 1 Root Cause Analysis - Lost Gas
- 2 Root Cause Analysis - Unit 3 Gasket
- 3 Response to Data Request
- 4 OQ Documentation
- 5 NRC Report #904943
- 6 Incident report 20090055-6145
- 7 Maps

Appendix 1 Root Cause Analysis – Lost Gas

Columbia Gas Transmission Root Cause Investigation

This document is on file at PHMSA

Appendix 2 Root Cause Analysis – Unit 3 Gasket

Columbia Gas Transmission Root Cause Investigation

This document is on file at PHMSA



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Engineer

David Hippchen
Public Service Commission of West Virginia
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July 20, 2009

RE: Clendenin CS Incident First Data Response

Dear Mr. Hippchen:

Columbia Gas Transmission (Columbia) respectfully submits the following response to your data request regarding the Emergency Shutdown System (ESD) incident that took place on May 7, 2009 at the Clendenin Compressor Station.

1) Compressor station Operator's full name and Operator Qualification records.

Bradley Williams. (OQ report attached).

2) Procedure to maintain plant 'Air System', and if any Service Bulletins were issued by the manufacturer pertaining the Air System (if applicable).

No procedure is available to maintain the Air System in Clendenin CS. No Service bulletins were issued.

3) Procedure covering the ESD of the compressor station.

Clendenin CS does not have a "site specific" plan for ESD testing, however Company personnel follow the company approved ESD test procedure.

4) When was the last ESD run performed at the CS, (Full Scale or Block Vents)?

A blocked vents test was performed on May 1, 2009.

- 5) Which valves were closed to isolate the compressor station? Please provide the location, equipment number and manufacturer.**

Please refer to the diagram in Exhibit 1 which displays the location of isolation valves involved in this event.

The following listing represents the name and location of the isolation valves. Rockwell SM-101 24", TM-7; 20", TM-7 Loop; 20", Panther Mountain; 20", Tennessee; 24" on the west end of the station, TM-17; 24" on the east end of the station.

- 6) In reference to paragraph under 'Others' found on page 4 in the Compressor Station Root Cause Analysis, provide additional explanation regarding the AC/DC isolation and how the Telemetry will function after an isolation to its bus takes place in an ESD activation?**

To be provided at a later stage.

- 7) Is the low voltage system tied-in to Clendenin's ESD system and is this typical Columbia standard installation or it applies to Clendenin only?**

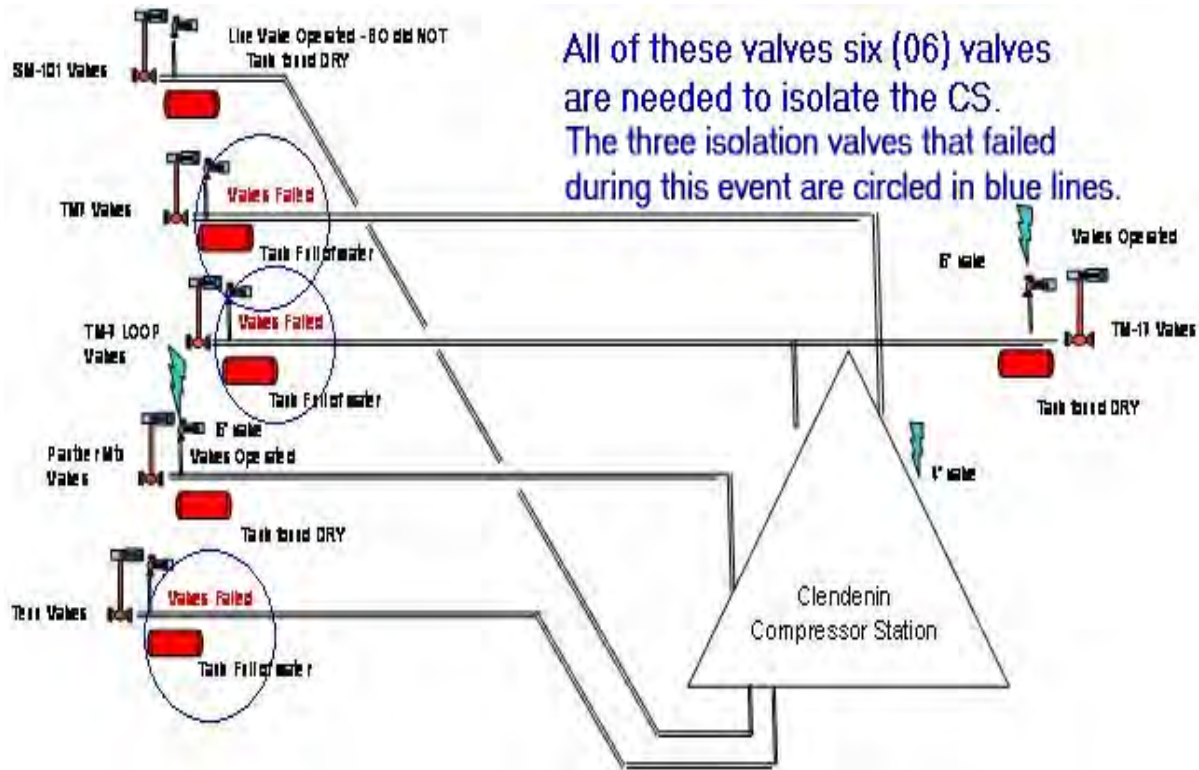
To be provided at a later stage.

- 8) When was the failed gasket replaced and due to what? Who is the manufacturer? Was it subject to a similar failure, or a different reason (routine PM, an Advisory Bulletin, SB, etc.)? If it failed due to same gasket as in May 2009 incident, was there any RCA generated for the previous gasket?**

The failed gasket was replaced after the investigation was completed. A similar failure occurred in 2007. No Service Bulletins were issued by the manufacturer in reference to this type of gasket failures. (The RCA for the gasket is attached.)

Exhibit 1

Schematic drawing (last page in Clendenin Compressor Station ESD Failure/Lost Gas Issue, May 209 Root Cause Analysis) showing the location of the isolation valves that are used in the ESD system at Clendenin CS.





OPQUALE- OpQual by Team Leader and Employee

Employee: BAWILLIAMS
Employee Name: Williams,Bradley
Team Leader: SNELSON

<u>Qualification</u>	<u>Description</u>	<u>Date Issued</u>	<u>ExpirationDate</u>	<u>Team Leader</u>
PLOQ.0015	Isolate & Purge Compressor Units	4/11/07	4/9/12	SNELSON
PLOQ.0019	Perform Manual Start/Operate/Stop Compressor Unit	4/11/07	4/9/12	SNELSON
PLOQ.0020	Perform Automatic Start/Operate/Stop Compressor Unit	4/11/07	4/9/12	SNELSON
PLOQ.0024	Operate Valve	3/6/07	3/4/12	SNELSON
PLOQ.0025	Inspect Valve	3/6/07	3/4/12	SNELSON
PLOQ.0029	Patrol Pipeline Facilities	3/14/02	3/13/07	SNELSON
PLOQ.0030	Operate Portable Gas Detectors - Presence of Gas	3/6/07	3/4/12	SNELSON
PLOQ.0031	Operate Portable Gas Detector - % of Gas	3/6/07	3/4/12	SNELSON
PLOQ.0034	Purge Gas Facility of Air Using Gas	3/6/07	3/4/12	SNELSON
PLOQ.0035	Blowdown Gas Facilities (for Pressure Removal Only)	3/6/07	3/4/12	SNELSON
PLOQ.0036	Evacuate Gas from Facilities (for Construction Activities)	3/6/07	3/4/12	SNELSON

OPQUALE- This report pulls all Operator Qualifications for the selected Team Leader (or all) and Employee (or all).



Pipeline & Hazardous Materials Safety Administration

(Version 3.4.05 PROD)

HMIS->INCIDENTS->TELEPHONICS

Rules of Behavior

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Rescinded Comments (max 250 characters)

NRC Number: 904943
Call Date: 05/07/2009
Call Time: 22:24:58

Caller Information

First Name:
Last Name:
Company Name:
Address:
City:
State:
Country:
Zip:
Phone 1:
Phone 2:
Organization Type:
Is caller the spiller? Yes No No Response
Confidential: Yes No No Response

Discharger Information

First Name:
Last Name:
Company Name:
Address:
City:
State:
Country:
Zip:
Phone 1:
Phone 2:
Organization Type:

Spill Information

State:
County:
Nearest City:
Zip Code:
Location

Spill Date: (mm/dd/yyyy)
Spill Time: (24hh:mm:ss)
DTG Type: DISCOVERED
Incident Type: FIXED FACILITY
Reported Incident Type
Description

130195 Appendix 5 - NRC Report 904943

Materials Involved

Material / Chris Name	Chris Code	Total Qty.	Water Qty.
NATURAL GAS	ONG	0 UNKNOWN AMOUNT	

Medium Type: AIR
 Additional Medium Information:

Injuries:				Fatalities:	
Evacuations:	Yes	No	Unknown	No. of Evacuations:	
Damages:	Yes	No	Unknown	Damage Amount:	
Federal Agency Notified:	Yes	No	Unknown	State Agency Notified:	Yes No Unknown
Other Agency Notified:	Yes	No	Unknown		

Remedial Actions

Additional Info

Latitude
 Degrees: Minutes: Seconds: Quadrant:
Longitude
 Degrees: Minutes: Seconds: Quadrant:
 Distance from City: Direction:
 Section: Township:
 Range: Milepost:

130195 Appendix 6 - Incident report 20090055-6145

NOTICE: This report is required by 49 CFR Part 191. Failure to report can result in a civil penalty not to exceed \$25,000 for each violation for each day that such violation persists except that the maximum civil penalty shall not exceed \$500,000 as provided in 49 USC 1678. Form Approved OMB No. 2137-0522



INCIDENT REPORT - GAS TRANSMISSION AND GATHERING SYSTEMS

Report Date _____
 No. _____
 (DOT Use Only)

INSTRUCTIONS

Important: Please read the separate instructions for completing this form before you begin. They clarify the information requested and provide specific examples. If you do not have a copy of the instructions, you can obtain one from the Office Of Pipeline Safety Web Page at <http://ops.dot.gov>.

PART A – GENERAL REPORT INFORMATION

Check one or more boxes as appropriate:

Operator Name and Address	Original Report	Supplemental Report	Final Report
a. Operator's 5-digit Identification Number (when known) / _____ /			
b. If Operator does not own the pipeline, enter Owner's 5-digit Identification Number (when known) / _____ /			
c. Name of Operator _____			
d. Operator street address _____			
e. Operator address _____ City, County or Parrish, State and Zip Code			

2. Time and date of the incident _____ / _____ / _____ / _____ hr. month day year	5. Consequences (check and complete all that apply)
3. Location of incident	a. Fatality Total number of people: _____ / Employees: _____ / General Public: _____ / Non-employee Contractors: _____ /
a. _____ Nearest street or road	b. Injury requiring inpatient hospitalization Total number of people: _____ / Employees: _____ / General Public: _____ / Non-employee Contractors: _____ /
b. _____ City and County or Parrish	c. Property damage/loss (estimated) Total \$ _____ Gas loss \$ _____ Operator damage \$ _____ Public/private property damage \$ _____
c. _____ State and Zip Code	d. Release Occurred in a 'High Consequence Area'
d. Mile Post/Valve Station _____	e. Gas ignited – No explosion f. Explosion
e. Survey Station No. _____	g. Evacuation (general public only) _____ / people Reason for Evacuation: Emergency worker or public official ordered, precautionary Threat to the public Company policy
f. Latitude: _____ Longitude: _____ (if not available, see instructions for how to provide specific location)	6. Elapsed time until area was made safe: _____ / hr. _____ / min.
g. Class location description Onshore: Class 1 Class 2 Class 3 Class 4 Offshore: Class 1 (complete rest of this item) Area _____ Block # _____ State _____ / or Outer Continental Shelf	7. Telephone Report _____ / _____ / _____ / _____ NRC Report Number month day year
h. Incident on Federal Land other than Outer Continental Shelf Yes No	8. a. Estimated pressure at point and time of incident: _____ PSIG b. Max. allowable operating pressure (MAOP): _____ PSIG c. MAOP established by 49 CFR section: 192.619 (a)(1) 192.619 (a)(2) 192.619 (a)(3) 192.619 (a)(4) 192.619 (c)
i. Is pipeline Interstate Yes No	d. Did an overpressurization occur relating to the incident? Yes No
4. Type of leak or rupture Leak: Pinhole Connection Failure (complete sec. F5) Puncture, diameter (inches) _____ Rupture: Circumferential – Separation Longitudinal – Tear/Crack, length (inches) _____ Propagation Length, total, both sides (feet) _____ N/A Other: _____	

PART B – PREPARER AND AUTHORIZED SIGNATURE

_____ (type or print) Preparer's Name and Title	_____ Area Code and Telephone Number
_____ Preparer's E-mail Address	_____ Area Code and Facsimile Number
_____ Authorized Signature	_____ Date
_____ (type or print) Name and Title	_____ Area Code and Telephone Number

PART C - ORIGIN OF THE INCIDENT

- | | |
|---|--|
| <p>1. Incident occurred on
Transmission System
Gathering System
Transmission Line of Distribution System</p> <p>2. Failure occurred on
Body of pipe Pipe Seam
Joint
Component
Other: _____</p> | <p>3. Material involved (<i>pipe, fitting, or other component</i>)
Steel
Plastic (If plastic, complete all items that apply in a-c)
Plastic failure was: a.ductile b.brittle c.joint failure
Material other than plastic or steel: _____</p> <p>4. Part of system involved in incident
Pipeline Regulator/Metering System
Compressor Station Other: _____</p> <p>5. Year the pipe or component which failed was installed: / ____ /</p> |
|---|--|

PART D - MATERIAL SPECIFICATION (if applicable)

1. Nominal pipe size (NPS) / ____ / in.
 2. Wall thickness / ____ / in.
 3. Specification SMYS / ____ /
 4. Seam type _____
 5. Valve type _____
 6. Pipe or valve manufactured by _____ in year / ____ /

PART E - ENVIRONMENT

1. Area of incident In open ditch
Under pavement Above ground
Under ground Under water
Inside/under building Other: _____
 2. Depth of cover: _____ inches

PART F - APPARENT CAUSE

Important: There are 25 numbered causes in this section. Check the box to the left of the **primary** cause of the incident. Check one circle in each of the supplemental items to the right of or below the cause you indicate. See the instructions for this form for guidance.

F1 - CORROSION

If either F1 (1) External Corrosion, or F1 (2) Internal Corrosion is checked, complete all subparts a - e.

- | | |
|------------------------------|---|
| <p>1. External Corrosion</p> | <p>a. Pipe Coating b. Visual Examination c. Cause of Corrosion</p> <p>Bare Localized Pitting Galvanic Stray Current</p> <p>Coated General Corrosion Improper Cathodic Protection</p> <p>Other: _____ Microbiological</p> <p>Other: _____</p> <p>Stress Corrosion Cracking</p> <p>Other: _____</p> |
| <p>2. Internal Corrosion</p> | <p>d. Was corroded part of pipeline considered to be under cathodic protection prior to discovering incident?
No Yes, Year Protection Started: / ____ /</p> <p>e. Was pipe previously damaged in the area of corrosion?
No Yes, How long prior to incident: / ____ / years / ____ / months</p> |

F2 - NATURAL FORCES

3. Earth Movement => Earthquake Subsidence Landslide Other: _____
 4. Lightning
 5. Heavy Rains/Floods => Washouts Flotation Mudslide Scouring Other: _____
 6. Temperature => Thermal stress Frost heave Frozen components Other: _____
 7. High Winds

F3 - EXCAVATION

8. Operator Excavation Damage (*including their contractors*) / Not Third Party
9. Third Party Excavation Damage (*complete a-d*)
- a. Excavator group
General Public Government Excavator other than Operator/subcontractor
- b. Type: Road Work Pipeline Water Electric Sewer Phone/Cable Landowner Railroad
Other: _____
- c. Did operator get prior notification of excavation activity?
No Yes: Date received: / ____ / mo. / ____ / day / ____ / yr.
Notification received from: One Call System Excavator Contractor Landowner
- d. Was pipeline marked?
No Yes (*If Yes, check applicable items i - iv*)
i. Temporary markings: Flags Stakes Paint
ii. Permanent markings: Yes No
iii. Marks were (*check one*) Accurate Not Accurate
iv. Were marks made within required time? Yes No

F4 - OTHER OUTSIDE FORCE DAMAGE

10. Fire/Explosion as primary cause of failure => Fire/Explosion cause: Man made Natural
 11. Car, truck or other vehicle not relating to excavation activity damaging pipe
 12. Rupture of Previously Damaged Pipe
 13. Vandalism

F5 – MATERIAL AND WELDS

Material

- 14. Body of Pipe => Dent Gouge Wrinkle Bend Arc Burn Other: _____
- 15. Component => Valve Fitting Vessel Extruded Outlet Other: _____
- 16. Joint => Gasket O-Ring Threads Other: _____

Weld

- 17. Butt => Pipe Fabrication Other: _____
- 18. Fillet => Branch Hot Tap Fitting Repair Sleeve Other: _____
- 19. Pipe Seam => LF ERW DSAW Seamless Flash Weld Other: _____
 HF ERW SAW Spiral Other: _____

Complete a-g if you indicate **any** cause in part F5.



a. Type of failure:

- Construction Defect => Poor Workmanship Procedure not followed Poor Construction Procedures
- Material Defect

b. Was failure due to pipe damage sustained in transportation to the construction or fabrication site? Yes No

c. Was part which leaked pressure tested before incident occurred? Yes, complete d-g No

d. Date of test: / / mo. / / day / / yr.

e. Test medium: Water Natural Gas Inert Gas Other: _____

f. Time held at test pressure: / / hr.

g. Estimated test pressure at point of incident: _____ PSIG

F6 – EQUIPMENT AND OPERATIONS

- 20. Malfunction of Control/Relief Equipment => Valve Instrumentation Pressure Regulator Other: _____
- 21. Threads Stripped, Broken Pipe Coupling => Nipples Valve Threads Mechanical Couplings Other: _____
- 22. Ruptured or Leaking Seal/Pump Packing

23. Incorrect Operation

a. Type: Inadequate Procedures Inadequate Safety Practices Failure to Follow Procedures Other: _____

b. Number of employees involved who failed post-incident drug test: / / Alcohol test: / /

c. Were most senior employee(s) involved qualified? Yes No d. Hours on duty: / /

F7 – OTHER

- 24. Miscellaneous, describe: _____
- 25. Unknown
 Investigation Complete Still Under Investigation (submit a supplemental report when investigation is complete)

PART G – NARRATIVE DESCRIPTION OF FACTORS CONTRIBUTING TO THE EVENT

(Attach additional sheets as necessary)

