

Wyo

Fatality Narrative

Debra Lee Zeleny
Merit Energy Company
305653305/P1128

Date & Time of the Accident:

Sunday, April 6, 2003 at approximately 11:50 a.m..

Notification:

The accident was reported to Wyoming Workers' Safety [WWS] at 2:43 p.m., Sunday 04/06/03 by the Converse County Sheriff's Department.

Merit Energy Company [Merit] employees had notified the sheriff's department at 12:35 p.m. the day of the mishap. On Monday morning, 04/07/03, Mr. Johnnie Hall, WWS Compliance Supervisor, spoke to Mr. Glenn Markgraf the Merit Operations Manager in Gillette regarding the mishap. Mr. Markgraf confirmed that Ms. Debra Lee Zeleny had been fatally injured at the scene and that Ms. Marsha Jane Iriberry was in the Campbell County Memorial Hospital with serious injuries from the mishap. Both were identified as Merit employees.

The Investigation:

On Monday 04/07/03, Mr. Hall assigned Compliance Safety & Health Officers [CSHOs] Wayne Dvorak (lead) and Ken Lantta to perform the fatality investigation. CSHO Dvorak is based at the Gillette WWS field office and CSHO Lantta is based at the Casper WWS field office. Upon being assigned as the investigators, CSHOs Dvorak and Lantta conducted a telephone conference to make preliminary investigation plans.

CSHO Dvorak contacted Mr. Markgraf. Arrangements were made for the CSHOs to meet with Mr. Markgraf and pertinent Merit employees at the mishap site in mid afternoon on Monday, 04/07/03.

CSHO Lantta contacted Deputy Jim Armstrong of the Converse County Sheriff's Department by telephone. Deputy Armstrong was the lead investigator for that department. Deputy Armstrong provided details on the location of the mishap and agreed to provide a copy of his incident report for inclusion in the casefile.

CSHO Lantta next contacted Mr. Ross Gorman, Converse County Coroner. CSHO Lantta requested a copy of the coroner's report be forwarded for inclusion in the casefile. Mr. Gorman asked that a letter of request be forwarded for his files. The letter was mailed on Monday, 04/07/03.

As agreed, CSHO's Dvorak & Lantta met in Wright approximately 1:30 p.m. on Monday 04/07/03. They then drove to the mishap location where Merit employees Mr. Markgraf, Mr. Larry Zimbelman, and Mr. Donald Stevens met them.

CSHO Dvorak conducted an opening conference with Mr. Markgraf. The CSHO's and the Merit employees then examined the mishap site. While CSHO Dvorak was discussing the mishap with the Merit employees, CSHO Lantta captured their comments on videotape. CSHO's Dvorak & Lantta also took numerous still photos of the mishap site as well as additional videotape of the scene. The CSHOs recorded distance measurements pertinent to the investigation.

The CSHOs then accompanied the Merit employees to the Powell Pressure Maintenance Unit [Powell] office approximately ¼ mile away. At this location, the CSHOs conducted recorded interviews with Mr. Markgraf (Operations Manager), Mr. Zimbelman (Production Foreman), and Mr. Stevens (North Buck Draw pumper). Merit employee, Mr. Troy Mathews, also was present at the Powell office. He was not interviewed since he was not directly involved in any aspects of the mishap. Mr. Mathews is the assistant to Mr. Markgraf at the Gillette Merit office.

Following the conclusion of the interviews, the CSHOs and Mr. Zimbelman agreed to meet the following day at noon at the North Buck Draw [North Buck] compressor station. The CSHOs departed the Powell office at 6:30 p.m.

On Tuesday, 04/08/03, the CSHOs met at the WWS Gillette field office at 8:00 a.m. Following a review of notes from the previous day, they departed for the Campbell County Emergency Services office to obtain a copy of their incident report and to meet with the Campbell County responders who had been at the scene on the day of the mishap.

At noon, the CSHOs met Mr. Zimbelman at the North Buck location. He briefed the CSHOs on the equipment at that site, its relationship to the natural gas pipeline that failed, and showed the CSHOs the equipment used for launching pipeline pigs. Mr. Zimbelman also showed the gas pipeline pressure recording devices that operate at that location.

From the North Buck location, the CSHOs and Mr. Zimbelman drove to the Spearhead Ranch pipeline valve. This was the valve that Mr. Zimbelman operated on the day of the mishap. The CSHOs took still and video photos of the site.

The CSHOs and Mr. Zimbelman then drove to the Sage Creek Gas Plant [Sage Creek]. The CSHOs looked at the computer-based controls used to operate the field and associated equipment. They also looked at and photographed the pipeline pig receiving equipment. The CSHOs were provided with copies of the computer screen prints depicting system pressures and flow rates at the time of the mishap.

On Monday 04/14/03, CSHO Lantta was contacted by Mr. Markgraf who advised that the mishap site was ready for a second evaluation. The pit where the pipeline ruptured had been excavated to permit entrance and examination of the pipe and valve. CSHO Lantta drove to the site in the mid afternoon, arriving at 3:30 p.m. He entered the excavation and photographed the pipe and valve. No Merit employees were present at the time of this visit.

On Tuesday 04/22/03, CSHO Lantta was contacted by Mr. Markgraf who reported that Ms. Iriberry's medical condition had improved such that she was ready to be interviewed. CSHO Lantta drove to Gillette and met CSHO Dvorak at the WWS Gillette field office. They then went to the Campbell County Memorial Hospital where they met and interviewed Ms. Iriberry. The recorded interview was conducted at 3:15 p.m.

CSHO Dvorak conducted a closing conference by telephone with Mr. Markgraf on 05/27/03.

Victim:

Debra Lee Zeleny

Address:

821 East 5th Street
Gillette, WY 82716

Occupation:

Pumper/Gager

Employer:

Merit Energy Company

Accident Location:

Along the Sage Creek Gas Pipeline near the Powell Pressure Maintenance Unit, on Ross Road approximately 56 miles north of Glenrock, WY. The site is located in Section 26 T40N R74W. The geographical coordinates of the mishap site are N43.41164 W105.72809.

Personnel Present at the Time of the Accident:

<u>Name</u>	<u>Company</u>	<u>Job Title</u>
Marsha Iriberry	Merit Energy Company	Pumper/Gager
Debra Zeleny	Merit Energy Company	Pumper/Gager

Company Employees Interviewed during the Investigation:

Name	Company	Job Title
Glenn Markgraf	Merit Energy Company	Operations Manager
Larry Zimbelman	Merit Energy Company	Production Foreman
Donald Stevens	Merit Energy Company	Pumper
Marsha Iriberry	Merit Energy Company	Pumper/Gager

Contractor Employees Interviewed during the Investigation:

Name	Company	Job Title
none		

Events leading up to the Accident:

The Sage Creek Gas Pipeline is approximately 37 miles long. It originates at the North Buck Draw [North Buck] compressor plant and terminates at the Sage Creek Gas Plant [Sage Creek]. The pipeline runs in an approximate north south direction with the origination point to the north. The North Buck origination point is in southern Campbell County and the Sage Creek terminus is in northern Converse County.

The pipeline is 12" diameter with a rated working capacity of 1440 p.s.i. The pipeline was commissioned in 1999 when the gas production field and equipment was owned by Devon Energy Corporation [Devon]. In July 2002, Merit acquired the gas field, equipment, and pipeline from Devon.

Approximately 12 miles south of the North Buck compressor plant is an intersection in the pipeline where gas from the Powell Pressure Maintenance Unit [Powell] compressor plant can be added. At this intersection, a ball valve was located in the main 12" line as well as a valve for the smaller pipeline entering from the Powell unit. The 12" ball valve was located approximately seven feet underground and was in line with the pipeline. A hand wheel above the surface of the ground on the valve stem pedestal operated the valve. (See **Photos #1 thru #3.**)

Approximately 12 miles further down the line from Powell is a valve named Spearhead Ranch. At this location, an identical ball valve is located underground in the 12" gas pipeline. A smaller feeder gas line also intersects the 12" line at this location to add more gas to the pipeline. This site is surrounded by a chain link fence; much like what had been located at the Powell valve site. (See **Photo #4.**)

The output from the compressor stations feeding into the Sage Creek pipeline is controlled from the Sage Creek plant. An operator is on duty around the clock monitoring gas pressure and pipeline flow rates in the system. The system information is displayed to the operator on computer screens and he controls the system via computer keyboard inputs. The operator also monitors and controls the various processes occurring within the Sage Creek plant. The Merit pipeline system is interconnected

with other pipeline systems, which allows the operator to divert the output from an individual Merit compressor station away from the Sage Creek pipeline and into other pipeline systems (e.g. Western Gas Resources system) if required.

The Sage Creek operator sets the interval at which spherical devices called pigs are automatically released from the North Buck plant into the Sage Creek pipeline (see **Photo #5**). The release interval is seasonally adjusted (more frequent releases in cold months) and is based on volume of gas flowing in the pipeline. The pigs travel through the pipeline pushing condensates down the line to Sage Creek. The pigs are hollow and made of a dense rubber like material. They are filled with a glycol solution. In the cold weather months, the pigs are released automatically into the system approximately every six hours. At any given time, a number of pigs will be present at intervals within the 37 mile long pipeline.

The launching equipment at the North Buck plant is self-contained and only requires reloading of the pig magazine every two or three days – see **Photo #6**. The pigs are then automatically released into the 12" Sage Creek pipeline based on the preset gas flow rate. When the pigs arrive at the end of the pipeline, automatic receiver equipment at Sage Creek captures the pig – see **Photo #7**. The receiver is then manually emptied and the pigs are cleaned and made ready for transport back to the magazine at the North Buck plant where they are again introduced into the pipeline.

The 12" Sage Creek Pipeline has a rated carrying capacity of 1440 p.s.i. The leased compressors at the North Buck compressor plant have an 800 p.s.i. contractual limitation on the maximum output pressure. The normal output pressure was in the range of 550 p.s.i. to maintain system balance and required gas flow rates.

On Sunday 04/06/03 at about 6:00 a.m., the Sage Creek plant operator began observing a gradual decrease in the gas flow rate from the Sage Creek pipeline into the Sage Creek plant. At about 7:30 a.m., the operator observed the North Buck plant output pressure into the pipeline was gradually increasing. The operator was also able to observe that there was not a concurrent pressure rise in the feeder line from the Powell unit.

This increasing differential pressure in the 12 mile section of pipeline between North Buck and Powell indicated to the operator that there was likely a pig stuck somewhere in that section. The operator notified the North Buck and Powell stations of the situation and advised that he planned to continue to increase the differential pressure in an attempt to free the stuck pig. This could be accomplished by continuing to increase the output pressure of the North Buck compressor plant while concurrently drawing additional gas from the pipeline into the Sage Creek plant to lower that plant's inlet pipeline pressure.

At approximately 8:30 a.m., the Sage Creek operator (Mr. Steve Hockaday) telephoned the production foreman (Mr. Larry Zimbelman) to apprise him of the situation and the plan to increase the differential pressure across the stuck pig. The plan included increasing the North Buck output to 740 p.s.i. This target was reached about 10:00 a.m. At this point, Mr. Hockaday diverted all North Buck plant output to a Western Gas Resources pipeline. This isolated the northern section of the Sage Creek pipeline with approximately 740 p.s.i. pressure between the North Buck plant and the stuck pig.

Mr. Zimbelman left his home approximately 10:00 a.m. to drive to the Powell unit (a distance of about 56 miles, part of which is gravel road). Enroute to the Powell plant, Mr. Zimbelman received a cell phone call from the North Buck plant operator (Mr. Donald Stevens). Mr. Stevens advised that all output gas from the North Buck plant had been diverted to the Western Gas Resources pipeline. Mr. Zimbelman and Mr. Stevens agreed to close the 12" ball valve on the Sage Creek pipeline at the Powell location. They also reviewed the locations of valves and blow down points along the Sage Creek line and how best to maneuver differential pressure to free the stuck pig. Mr. Zimbelman telephoned the Powell field employees (Ms. Zeleny and Ms. Iriberry) to close the Powell 12" ball valve.

When Mr. Zimbelman arrived at the Powell 12" ball valve location, he met with Ms. Zeleny and Ms. Iriberry. They had closed the valve as requested. The pressure was checked on the 12" line and it read 310 p.s.i. Mr. Zimbelman then had Ms. Zeleny and Ms. Iriberry close the valve on the smaller line from the Powell Pressure Maintenance Unit plant. This prevented any gas from the Powell unit from entering the 12" line just downstream from the 12" ball valve.

Mr. Zimbelman telephoned Mr. Hockaday to apprise him of the plan. Mr. Hockaday in turn diverted the output gas from the Powell plant to another pipeline.

At this point, the Sage Creek 12" pipeline was closed at the North Buck origination point. The gas trapped in the pipeline between North Buck and the stuck pig was over 700 p.s.i. The 12" ball valve in the pipeline was closed at the Powell location. The gas in the pipeline between the stuck pig and the closed Powell valve was approximately 300 p.s.i. The valve on the feeder line from the Powell plant was closed which prevented any additional gas from being introduced into the pipeline immediately downstream from the Powell 12" ball valve.

Mr. Zimbelman asked Ms. Zeleny and Ms. Iriberry to remain at the Powell 12" valve site while he drove to the Spearhead Ranch valve site. This location is approximately 12 miles further downstream along the Sage Creek pipeline. When Mr. Zimbelman arrived at the Spearhead Ranch valve site, he shut the 12" ball valve and began to blow down the upstream line pressure. When this was done, the pipeline between the closed Powell valve and the closed Spearhead Ranch valve was at zero pressure. The blow down port (see **Photo #8**) was left open.

The Accident:

At the time of the mishap, Mr. Zimbelman was at the Spearhead Ranch valve site. Ms. Zeleny and Ms. Iriberry were at the Powell valve site. The employees at these two locations were in contact via pickup truck mounted cell phone.

There was zero pipeline pressure downstream from the Powell 12" ball valve. There was approximately 400 p.s.i. of differential pressure across the stuck pig. The plan was to quickly open the Powell 12" valve, which would increase the differential pressure across the stuck pig and get it moving. Mr. Zimbelman was stationed at the Spearhead Ranch valve location to observe a gas release from the

open blow down port. This would indicate the pig was unstuck and moving down the line along with the gas.

Mr. Zimbelman telephoned Ms. Zeleny at about 11:50 a.m. and asked that she and Ms. Iriberry very quickly open the Powell 12" ball valve to a full open position. Very shortly thereafter, Mr. Zimbelman observed a small puff of gas but not a continuous stream of venting gas from the blow down port as expected. At this point, he was not sure if Ms. Zeleny and Ms. Iriberry had opened the Powell 12" valve as requested. Mr. Zimbelman tried to call Ms. Zeleny's cell phone but did not get a response. On this first call, he left a voice mail message asking for a call back with a status update. Mr. Zimbelman did not receive a return call and then made several more calls to Ms. Zeleny's cell phone – but there was not an answer.

At 11:50 a.m., Mr. Hockaday was at the Sage Creek control panel and observed the pipeline pressure at North Buck begin to fall. Thinking the pig was free; Mr. Hockaday restored the North Buck compressor output from the Western Gas Resources pipeline to the Sage Creek pipeline.

Within the next few minutes, Mr. Zimbelman tried several more times to reach Ms. Zeleny by cell phone – all unsuccessful. Mr. Zimbelman contacted Mr. Stevens at the North Buck plant and let him know that he could not reach the two employees at the Powell valve site. Mr. Zimbelman asked Mr. Stevens to drive to the Powell location to check on the situation.

About 12:30 p.m., Mr. Stevens reached the Powell valve site. He observed Ms. Zeleny and Ms. Iriberry lying in the pasture some distance from the valve pedestal. Ms. Iriberry called out to Mr. Stevens. Mr. Stevens found that Ms. Zeleny did not have a pulse, had lost color, and would not respond. Mr. Stevens called Mr. Zimbelman and reported that he needed help for the two downed employees. Mr. Stevens then returned to try to get a response from Ms. Zeleny. He was not successful since she had sustained fatal injuries. In the next few minutes, Mr. Zimbelman contacted Mr. Hockaday to call for ambulance or life flight assistance. Mr. Zimbelman contacted the Operations Manager (Mr. Glenn Markgraf) in Gillette and reported the mishap to him. Mr. Zimbelman also drove back to the Powell valve site from the Spearhead Ranch site.

When Mr. Zimbelman arrived at the mishap location, he and Mr. Stevens attended to Ms. Iriberry while waiting for emergency personnel to arrive. Responding units included an ambulance from Glenrock, Converse County Sheriff's Department personnel, an ambulance from Wright, and Campbell County Fire Department responders. The Casper based life flight helicopter could not respond due to an isolated heavy snowstorm in Natrona County. Due the remote location of the mishap, emergency responders did not begin arriving on scene for about an hour. It was another half hour or more before Ms. Iriberry was transported by ambulance to the Campbell County Memorial Hospital.

When Ms. Iriberry was interviewed, she could not recall anything beyond her and Ms. Zeleny preparing to quickly open the 12" ball valve per the plan for freeing the stuck pig. They planned to turn the valve wheel together to open it more quickly. They were side by side within the chain link fenced enclosure surrounding the valve.

The next several seconds were extremely catastrophic and occurred suddenly without warning. Within an instant, Ms. Zeleny was hurled approximately 54' from the valve pedestal and Ms. Iriberry was hurled approximately 64'. These are the locations where Mr. Stevens found them with no indication that they moved that distance on their own. As shown in **Photos #9 & #10**, a crater was formed near the ruptured gas pipeline. Escaping gas from the ruptured pipeline formed this crater.

Of particular note: There was no fire or incendiary explosion associated with this incident. The crater was formed and the damage was done by the kinetic energy of compressed gas escaping from the ruptured 12" pipeline.

When Mr. Stevens arrived at the scene (some 30 minutes after the pipeline pressure began dropping), he did not encounter any escaping gas from the ruptured line. He reported that only slight fumes and vapors were present. The pipeline pressure upstream from the rupture was close to zero at this time.

When Mr. Hockaday was advised of the mishap (as Mr. Stevens arrived on scene), he made the control room keyboard entries to divert the North Buck plant output from the Sage Creek pipeline to the Western Gas Resources pipeline. Other information gathered indicated that the system is programmed to stop sending gas down a pipeline when the pressure drops precipitously. Mr. Stevens' observation that gas was no longer escaping from the ruptured line when he arrived on scene supports the premise that the automatic system had activated.

The stored energy of a 12-mile long 12" diameter pipeline full of compressed gas was suddenly released as the pipeline ruptured. The kinetic energy of this escaping gas almost instantaneously hurled the two employees away from the valve pedestal as the ground rose beneath their feet. The gate for the chain link fence was broken loose and came to rest about 57' feet from the valve and in the same general westward direction as the two employees. The valve wheel that the employees were turning was broken from the pedestal and came to rest about 46' westward of the valve. The chain link enclosure fencing had steel posts set in concrete. The fence was some six feet tall. The fence material and posts were rolled, wadded and came to rest about 47' south of the valve pedestal (downwind in the blast of escaping gas) – see **Photo #11**.

As the gas was escaping from the ruptured pipeline, the open end of the pipe was somewhat like a jet nozzle. The kinetic energy directed through this nozzle caused the crater to extend to the south as soil was pushed out and blown southward. For several hundred feet south of the crater, the prairie grass was bent and full of drifted soil.

There were three pigs located in the vicinity of the mishap. One was found about 60' from the ruptured pipeline, the second about 552' from the rupture, and the third about 735' from the rupture. All were somewhat south of the scene, in the direction of the escaping gas. (See **Photos #12, #13, & #14**.)

The 12" ball valve at the Powell location was only slightly cracked open when the pipeline ruptured as seen in **Photos #15 & #16**. The valve ball has a mark that appeared to have been made by an object impacting the ball.

The pipeline rupture occurred about 74" upstream of the center of the 12" ball valve (see Photo #17). Additional views of the ruptured section of pipe can be seen in Photos #18 thru #22.

Findings:

- Jo-Max Construction Company, Inc. constructed the Sage Creek Pipeline in 1999 for Devon. Merit acquired the pipeline in July 2002 as part of a purchase of Devon assets.
- Devon, or companies providing field contract services to Devon, formerly employed most current Merit employees.
- The Sage Creek Pipeline system is operated from the Sage Creek operations center. State of the art computer displays and associated control systems are available to the plant operator. The operator can monitor and control the output of the various compressor plants that feed into the Sage Creek Pipeline. He also controls the Sage Creek plant equipment.
- The Sage Creek Pipeline has a rated capacity of 1440 p.s.i. Current operations do not require this pressure since the quantity of gas available for pipeline transmission is well below the maximum capacity of the pipeline. The pipeline was "overbuilt" in anticipation of future growth.
- The leased compressor systems at North Buck are contractually restricted to no more than 800 p.s.i. output.
- Normal operations of the Sage Creek Pipeline utilized pressure in the 550 p.s.i. range.
- The Sage Creek Pipeline is approximately 37 miles long. It begins to the north at the North Buck plant and ends to the south at the Sage Creek facility.
- Additional gas is introduced into the Sage Creek Pipeline from the Powell Pressure Maintenance Unit. This site is approximately 12 miles south of the North Buck plant.
- There are pipeline valves at the point where the Powell gas pipeline intersects with the Sage Creek Pipeline.
- Similar valves are located approximately 12 miles further south along the Sage Creek Pipeline where additional gas is introduced. This location is named Spearhead Ranch.
- The Powell and Spearhead valve locations include inline 12" ball valves in the Sage Creek Pipeline.
- Pigging is an industry wide operation to clear condensate from gas pipelines.
- The smaller 4" and 6" gas lines within the gas field have manual pig launchers and receivers. These systems are utilized on a routine, scheduled basis to clean those gas pipelines.
- Ms. Zeleny and Ms. Iriberry each had worked for approximately two years in the Powell field (Ms. Zeleny slightly longer than Ms. Iriberry). They initially worked for a company contracted by Devon to operate the field. When Merit acquired the field, both employees continued their same jobs, but with Merit as the employer.
- Ms. Zeleny and Ms. Iriberry were employed as pumper/gagers. They maintained the gas well equipment and the compressor equipment in the Powell field. They also recorded the readings from the various pieces of gas flow measuring devices within the field.
- Ms. Zeleny and Ms. Iriberry routinely conducted manual pigging operations on the smaller lines in the vicinity of the Powell Pressure Maintenance Unit as part of their normal duties.
- Having pigs become stuck in the smaller 4" and 6" Powell lines was not uncommon. Ms. Zeleny and Ms. Iriberry had experience in freeing these stuck pigs using differential pressure.

- The Sage Creek Pipeline has an automatic pigging system. The spherical pigs are introduced into the pipeline automatically per a preset schedule from the North Buck plant. Automatic retrieving equipment captures the pigs from the pipeline at the Sage Creek plant.
- Pigs are launched based on gas flow rates. The frequency of release is increased in cold weather months and decreased in warm weather months. At the time of the mishap, pigs were being introduced into the pipeline about every 6 hours.
- At any given time, there are a number of pigs in the 37 mile long pipeline. The exact number is not recorded or of particular importance as it varies with changes in gas flow rates and pressure.
- Since commissioning of the pipeline in 1999, there was only one other instance where a pig became stuck in the Sage Creek Pipeline as far as any of the long-term employees could remember.
- This prior stuck pig event occurred approximately two weeks prior to the mishap when the area experienced a significant blizzard and snowfall.
- Merit does not have written procedures regarding freeing stuck pigs in the Sage Creek Pipeline.
- The fully accepted approach by Merit employees and management is to increase the differential pressure across the stuck pig to get it moving again. Either increasing the upstream pressure, decreasing the downstream pressure, or a combination of both, does this.
- This technique was successfully utilized on the prior stuck pig events in both the 12" line and the smaller 4" & 6" field lines.
- Pressure in the section of 12" line downstream of a stuck pig can be lowered by either pulling more gas into the Sage Creek plant or by closing an inline valve and bleeding off the gas pressure. Feeder lines into the Sage Creek pipeline can be closed off with valves as needed.
- On the day of the mishap, the Sage Creek operator noted pressure rising in the pipeline at the North Buck plant. He also observed reduced gas flow into the Sage Creek plant. There was not a pressure increase at the pipeline from the Powell Pressure Maintenance Unit.
- This combination of pressure and flow changes indicated a stuck pig somewhere in the 12 miles of pipeline between the North Buck plant and the Powell plant intersection.
- Pressure was increased to about 740 p.s.i. on the upstream side of the stuck pig. The pressure on the downstream side of the stuck pig had decreased to about 310 p.s.i. by pulling more gas into the Sage Creek plant.
- Mr. Zimbelman arrived at the Powell valve location and met with Ms. Zeleny and Ms. Iriberry.
- Sunday, 04/06/03, was a normal rotational workday for Ms. Zeleny and Ms. Iriberry.
- A plan was formulated to close off the gas flowing into the Sage Creek Pipeline from the Powell plant. The 12" inline ball valve in the Sage Creek Pipeline was closed at the Powell location. Mr. Zimbelman then drove to the next inline 12" valve downstream at the Spearhead Ranch. At this location he could bleed off the remaining pressure in the section of line between Powell and Spearhead. With this done, the plan was to rapidly open the Powell 12" valve. This would have lowered the pressure downstream of the stuck pig – effectively raising the differential pressure across the stuck pig.
- When the Powell valve was only slightly opened, the Sage Creek Pipeline ruptured adjacent to the valve.
- The pipeline separated approximately 74" upstream from the center of the 12" valve ball. There was about 7' of soil above the pipeline and valve at this location.

- The sudden release of compressed gas from the ruptured pipeline caused the soil to erupt and hurl Ms. Zeleny and Ms. Iriberry away from the valve pedestal.
- Ms. Zeleny was fatally injured from having been hurled through the air. Ms. Iriberry sustained serious injuries from the event.
- The escaping gas from the pipeline created a crater around the pipeline and valve as it blew the soil to the south.
- Three pigs were located in the pasture downstream of the ruptured pipeline. One was broken open and was closer to the rupture. The other two were considerably farther away and had far less damage.
- The ball of the 12" valve had a mark indicating an object impacted it.
- The sections of the pipeline at the rupture are laterally offset by more than one pipe diameter as seen in **Photo #23**.
- A check with other gas pipeline companies in the region revealed that they utilize differential pressure to free up pigs that become stuck in their pipelines.
- None of the companies in the region have written procedures for freeing stuck pipeline pigs.
- A search of numerous Internet websites did not reveal information on freeing stuck pigs or precautions to observe during those operations.

Analysis & Conclusions:

Only Ms. Zeleny and Ms. Iriberry were at the scene at the time of the mishap. Due the violent nature of the pipeline rupture and the significant injuries received, Ms. Iriberry cannot remember anything after moving to the valve with Ms. Zeleny to begin opening it. Post mishap observations show the 12" ball valve in the pipeline was only "cracked" open. (Their intention was to very quickly fully open the valve.) The ball of the valve also appears to have a mark that could have been made by an object impacting the valve.

Three pigs were located in the pasture near the mishap scene. These pigs were expelled from the 12" pipeline following the rupture. The pig nearest the scene was significantly damaged. It was likely the first one expelled from the line. It may have impacted the ball of the 12" valve before being expelled in the conflagration as the line ruptured. The second and third pigs were a considerable distance from the scene and likely were not expelled from the open pipeline until sufficient gas had escaped to elongate the crater to the south. The escaping gas impinging on the soil created somewhat of a ramp at the south end of the crater.

Pigging of natural gas pipelines is a routine procedure, done industry wide. The procedure is required to remove condensate from the pipeline to prevent freezing and corrosion. Pigging operations are conducted more frequently in the cold weather months than in the warm weather months. Ms. Zeleny and Ms. Iriberry had conducted pigging operations on the 4" and 6" lines within the Powell field during most of their time of employment – approximately two years each.

Dealing with stuck pigs in the smaller 4" and 6" gas pipelines in the field is a common maintenance task that had been performed by Ms. Zeleny and Ms. Iriberry. The procedure involves increasing the differential pressure across the stuck pig. This procedure in effect pushes harder on the backside of the

pig, which gets it moving again down the pipeline. The differential pressure is manipulated by a combination of increasing compressor output pressure (upstream of the pig), increasing downstream gas flow to pull added gas from the pipeline, thus reducing downstream pressure, or utilizing bleed ports and valves to drain gas from the downstream portion of the pipeline. The exact combination of procedures is dependent on the location of the stuck pig relative to the compressors, gas plants, and various valves or bleed ports.

The Sage Creek Pipeline had only had one prior event where a pig became stuck in the 12" pipeline. This event occurred about two weeks prior to the mishap. At that time, the differential pressure was increased across the stuck pig and it began moving again.

By applying differential pressure across a stuck pig, the total force applied to the pig can be readily calculated. Of note here is that as the size of the pig increases, the forces increase exponentially. This is due the factor of "radius squared" that is utilized in the calculation. The same differential pressure across a four inch diameter pig and a 12" diameter pig produces nine times the total force on the larger pig compared to the smaller pig. Once a stuck pig breaks free, the force on that pig is translated into acceleration and velocity as the pig begins moving down the pipeline.

On Sunday morning 04/06/03, the Sage Creek operator observed system pressure and flow readings that indicated a pig was stuck in the Sage Creek Pipeline between the North Buck compressor plant and the Powell field valve location. The production foreman, Mr. Zimbelman, was notified and he drove in to work to oversee the effort to free the stuck pig. He devised a plan to increase the differential pressure across the stuck pig. He would execute a portion of the plan from the Spearhead Ranch valve location, and Ms. Zeleny and Ms. Iriberry would execute a portion of the plan from the Powell valve location.

Since Mr. Zimbelman was some 12 miles farther down the pipeline from where Ms. Zeleny and Ms. Iriberry were located, he utilized cell phones for communication. He could not see or hear anything from the Powell valve location. Similarly, Mr. Zimbelman used his cell phone to contact Mr. Hockaday at the Sage Creek plant and Mr. Stevens at the North Buck plant.

As Ms. Zeleny and Ms. Iriberry began opening their valve, the ground erupted adjacent to the valve and hurled them each more than 50 feet away from the valve. Ms. Zeleny was fatally injured and Ms. Iriberry was seriously injured by this event.

Exactly what occurred at the instant they opened the valve is not known. However, it appears that the stuck pig began moving down the pipeline and impacted the ball of the 12" valve these two employees were attempting to open. Simultaneously, the pipeline ruptured beneath the ground about 74" upstream of the valve. The sudden release of compressed gas led to the conflagration at the site. With a section of 12" pipeline some 12 miles long at approximately 700 p.s.i., the kinetic energy of the gas escaping from the ruptured pipeline was phenomenal.

It is not known where the pig was stuck within the 12-mile section of pipeline between the North Buck plant and the Powell valve location.

The question that remains unanswered: Why did the pipeline rupture at the moment the valve was beginning to be opened?

Possible answers include:

- 1) The pig was stuck only a very short distance upstream from the Powell valve. Thus as the valve was just slightly opened, all pressure between the stuck pig and the valve was relieved. This rapidly increased the differential pressure across the pig and got it moving – possibly accelerating rapidly.
- 2) The force of the pig impacting the slightly opened ball valve was sufficient to fracture the pipeline material or the weld at the joint that parted.
- 3) The pipeline and/or the weld at the rupture point were already weakened from manufacturing or installation flaws. The added shock loading from the pig impacting the valve was sufficient to cause a rupture at the flaw.
- 4) The pipeline and/or weld were weak and the sudden rise in pressure as the pig passed by was sufficient to initiate the failure sequence.
- 5) The pipeline was misaligned laterally at the point of rupture, which had induced stress related weakening in the weld or pipe material over the time since installation.
- 6) A combination of the above.

Of note in the above analysis is that the pipeline was rated for carrying 1440 p.s.i. with the pressure at the time of the mishap being significantly lower (no more than 750 p.s.i. upstream of the pig).

The Sage Creek operator restored North Buck compressor output gas flow to the pipeline as he observed the pipeline pressure drop upstream of the stuck pig. This was done based on a false assumption that the stuck pig had been freed up and the pipeline was back to normal operation. In fact, when the gas flow was restored to the pipeline, it had already ruptured. An automated system diverted the gas flow out of the pipeline shortly thereafter as the pressure continued to fall. Having restored the gas flow to the Sage Creek pipeline did not precipitate the mishap nor did it compound the consequences in this instance.

Recommendations:

- All company employees should review the findings of this investigation.
- Conduct “smart pigging” or other testing and evaluation of the pipeline in the vicinity of the rupture to check the integrity of the pipeline and associated welded joints.
- Written procedures should be developed for freeing stuck pipeline pigs, with emphasis on
 - o Communication plan among those involved in the evolution.
 - o Analysis of potential locations where the pig could be stuck in relationship to pipeline components such as valves, blow down ports, etc. Of primary focus would be minimizing the potential of a suddenly moving and accelerating pig from impacting pipeline components – sometimes referred to as “slamming” within the industry.
 - o Identification of all points along the affected pipeline where gauges or instrumentation are available to closely monitor pipeline pressures during the evolution to free the stuck pig.

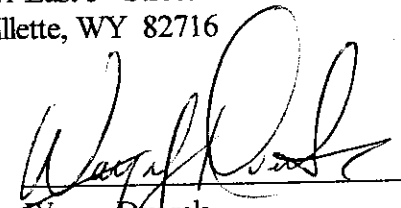
- Recognition of the increased total force being applied to a "large" diameter pig through the application of differential pressure compared to the total force the same differential pressure applies to a "small" diameter pig. These vast differences are the result of the "radius squared" factor utilized in the calculations.
 - Evaluation of the consequences of a freed pig rapidly accelerating down the pipeline.
 - Evaluation of applying differential pressure such that the downstream pressure would be greater than the upstream pressure across a stuck pig. This "back pressure" might force the pig backward in the pipe for some distance. Once normal pressure was restored, the pig may again begin moving forward down the line and continue beyond the section of pipeline where it was originally stuck.
 - Evaluation of the availability of emergency responders.
- Consideration should be given to utilizing two way radios vice cell phones for communication during out of the ordinary evolutions. Radios would provide for all participants to simultaneously hear broadcast communications.
 - The coordinator of the evolution to free up a stuck pig should make the determination when normal gas flow can be restored to the pipeline. The coordinator must first be sure the operation to free the stuck pig was successful and that all valves and blow down ports are restored to normal operating conditions.
 - Review testing and installation records retained from when the Sage Creek pipeline was installed to determine if any other pipeline sections warrant structural integrity analysis at this time.

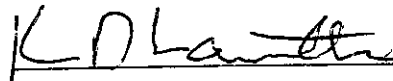
All information gathered concerning this investigation is on file at the Wyoming Workers' Safety office in Cheyenne, WY.

This report of investigation and findings are regarding the fatal accident involving:

Debra Lee Zeleny
821 East 5th Street
Gillette, WY 82716

Signed:


Wayne Dvorak
Wyoming Workers' Safety


Ken Lantta
Wyoming Workers' Safety

Date:

5-29-03

5/27/03

OSHA Photo Evidence

Casefile No.: 305653305
Date of Mishap: 04/06/03

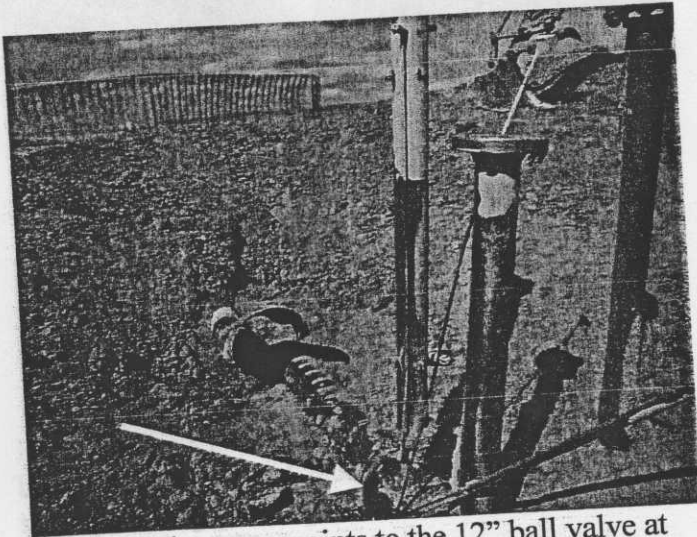


Photo #1 The arrow points to the 12" ball valve at the Powell site. It was beneath about 7' of soil prior to the mishap. The valve stem extended to the surface where a wheel was located to operate the valve. The capped off line to the front of the photo was the smaller connecting line from the Powell unit.

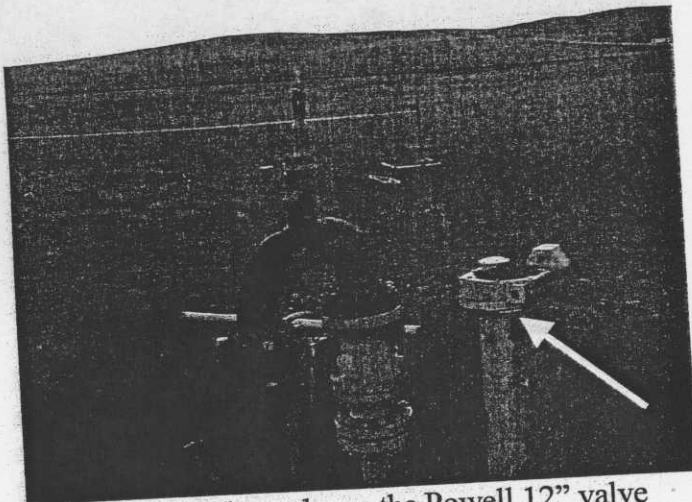


Photo #3 This photo shows the Powell 12" valve pedestal (arrow) with the wheel broken off. The intersecting Powell unit feeder gas pipeline and valve are located to the left of the pedestal.

Employer: Merit Energy Company
Location: Sage Creek Pipeline



Photo #2 This is an identical 12" valve pedestal and wheel at the Spearhead Ranch location along the Sage Creek pipeline.

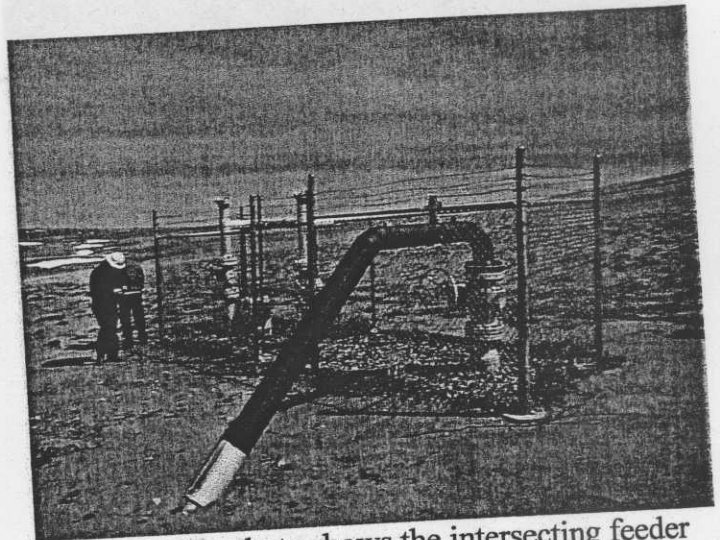


Photo #4 This photo shows the intersecting feeder gas pipeline at the Spearhead Ranch location. The chain link fence surrounding the valves is very similar to what had been in place at the Powell valve location.

Photo Evidence (cont.)



Photo #5 This photo shows the spherical pigs used by Merit in the Sage Creek pipeline. The pigs clean the pipeline by pushing condensates down the line as the pig travels with the gas.

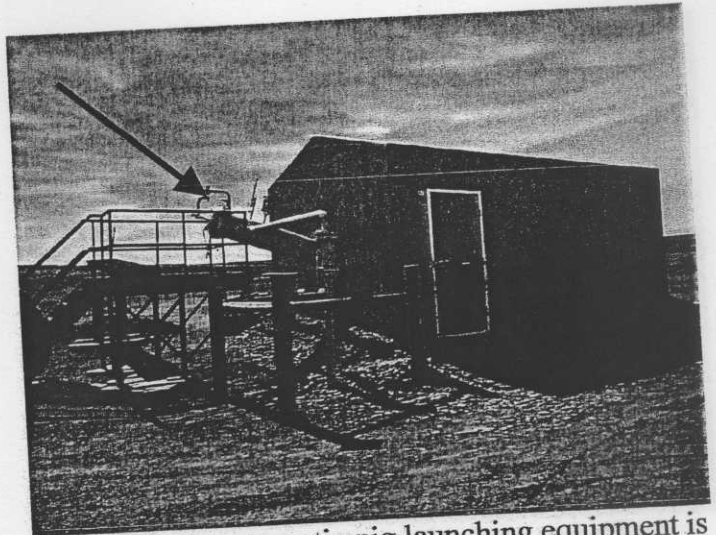
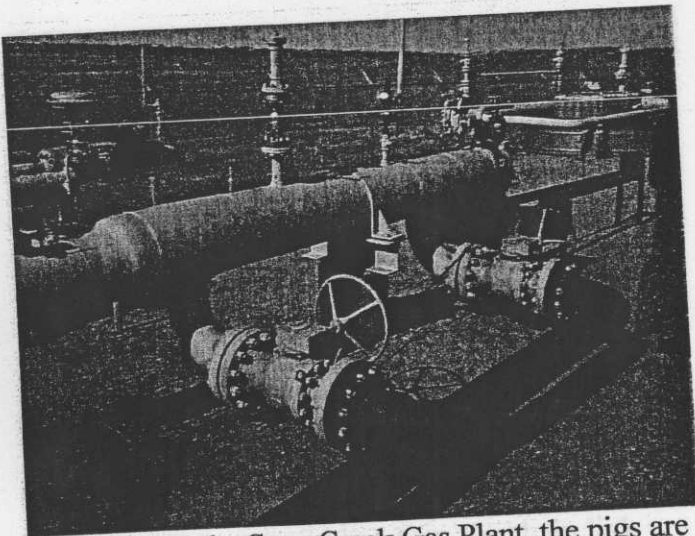


Photo #6 The automatic pig launching equipment is housed in this outlying building at the North Buck Draw plant. The magazine (arrow) is manually loaded with enough pigs for several day's worth of releases.



Photos #7 At the Sage Creek Gas Plant, the pigs are automatically routed to this receiver. From here they are manually removed, cleaned, and made ready for transport back to North Buck Draw and reuse.

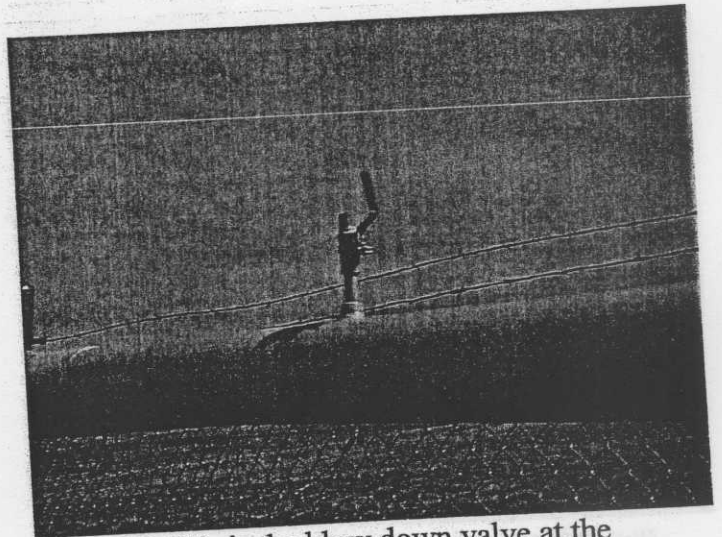


Photo #8 This is the blow down valve at the Spearhead Ranch valve site. This valve was used to bleed the pressure to zero in the Sage Creek 12" pipeline between the Powell valve and the Spearhead Ranch valve.

Photo Evidence (cont.)

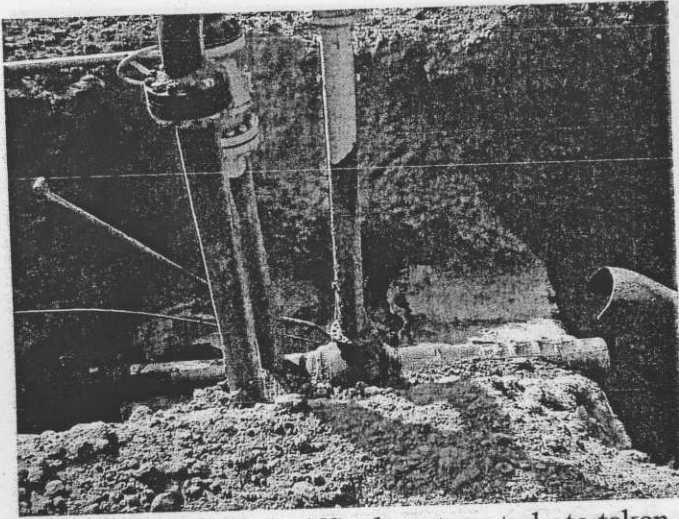


Photo #9 This is a sheriff's department photo taken within three hours of the mishap. The 12" pipeline is ruptured at the right of the photo. The 12" ball valve is in the center of the photo. Escaping gas from the ruptured pipeline formed the crater.

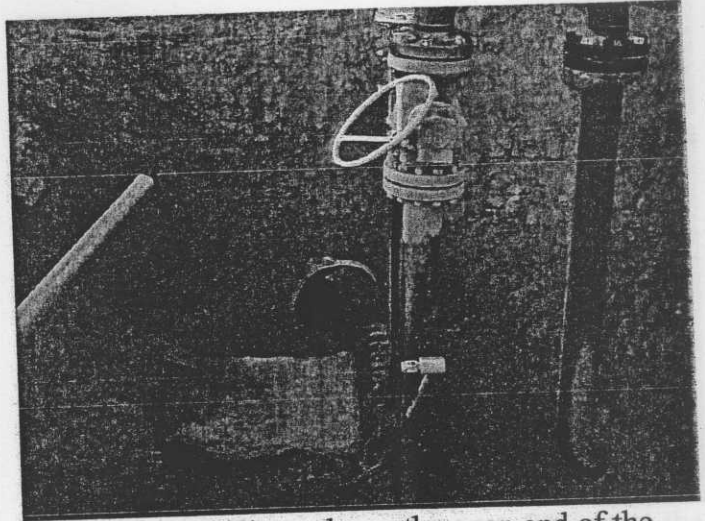


Photo #10 This photo shows the open end of the ruptured pipeline. The shiny pipe at the left of the photo is a post from the chain link fence that had surrounded the valve site. The rapidly escaping gas from the open pipe formed the crater.

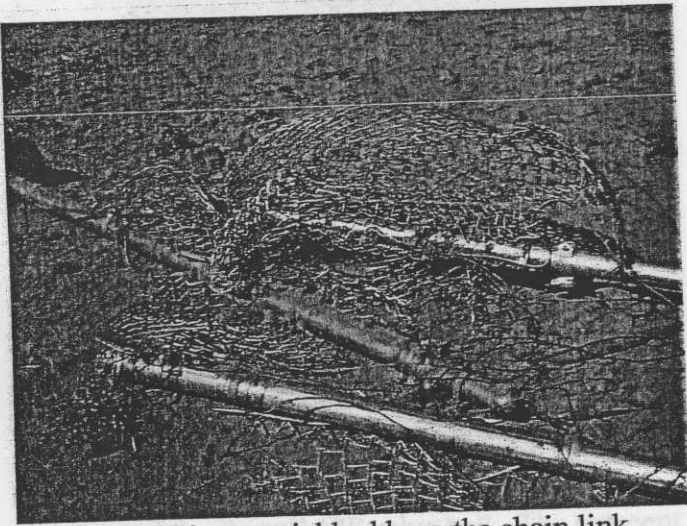


Photo #11 This material had been the chain link fence enclosure around the valve site. It was rolled and wadded and came to rest about 47' from the valve pedestal. *the ball appears to be from an impact.*

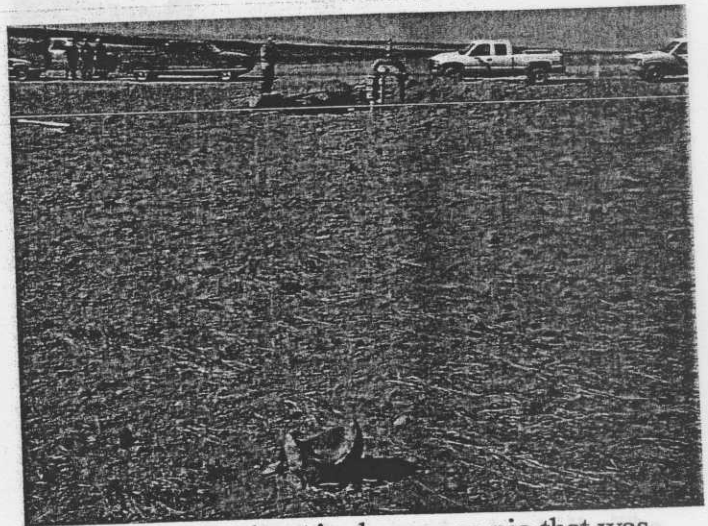


Photo #12 This photo shows one pig that was expelled from the pipeline following the rupture. This pig was significantly damaged. This pig was located SSE of the ruptured pipeline.

Photo Evidence (cont.)

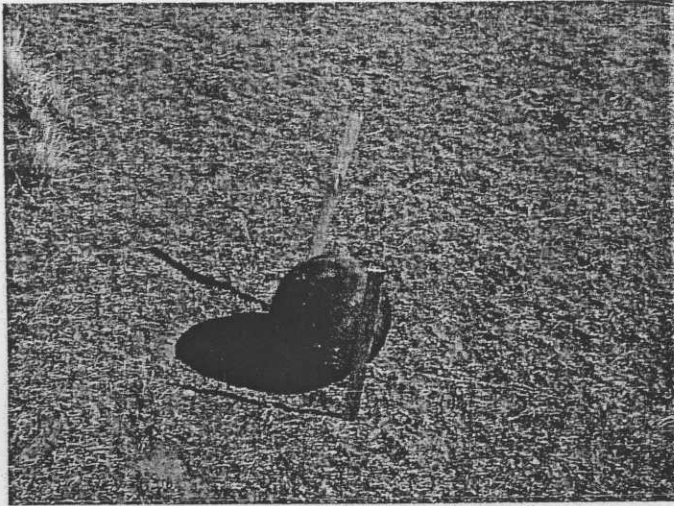


Photo #13 This pig was located some 552' from the ruptured pipeline in a southerly direction.

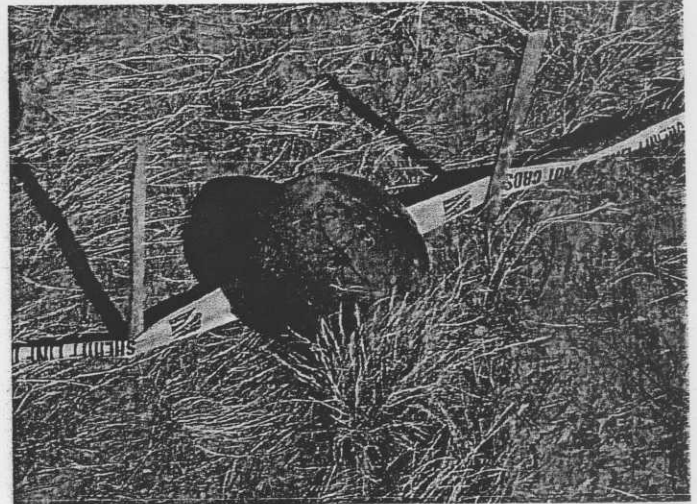


Photo #14 This pig was located some 735' from the ruptured pipeline. The glycol fill port was damaged on this pig. It was somewhat east and a bit further south of the pig in Photo #13.

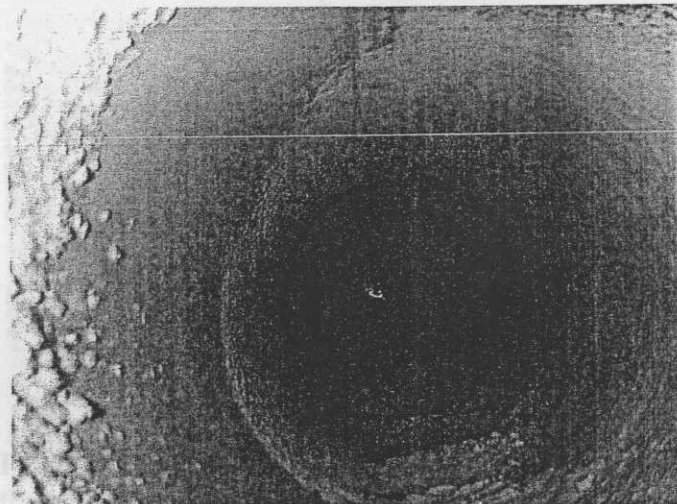


Photo #15 This photo is looking down the stub of pipe toward the Powell 12" valve ball. The crescent at the left of the ball is the slight opening as the ball had just begun to rotate to the open position. The shiny mark on the ball appears to be from an impact.

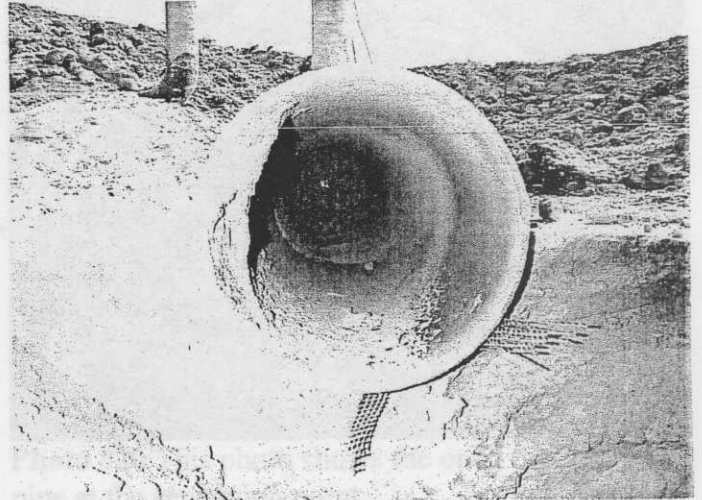


Photo #16 This photo shows the open end of the pipe stub and the slightly opened valve ball. The shiny impact mark is also visible.

Photo Evidence (cont.)

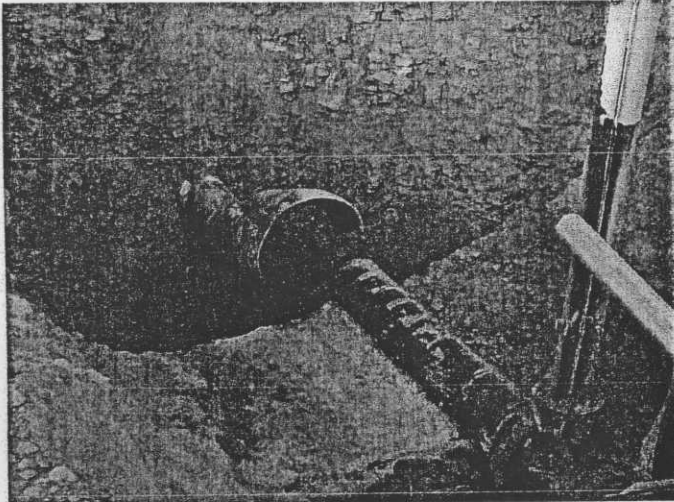


Photo #17 The pipeline rupture occurred about 74" upstream of the center of the ball valve.

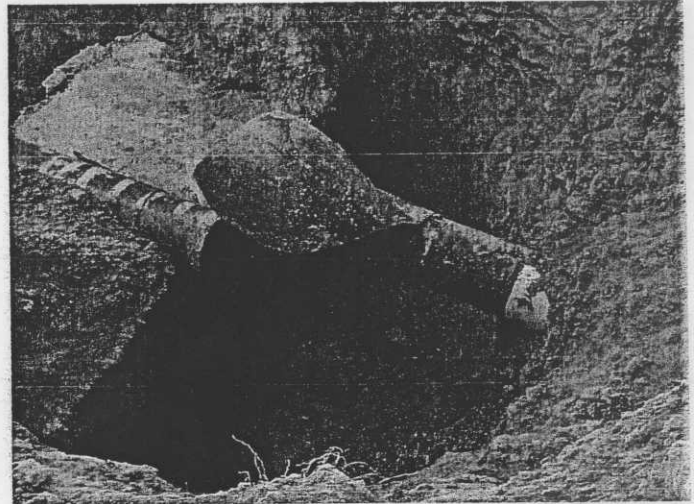


Photo #18 This photo shows the ruptured section of the pipeline from a secondary angle.

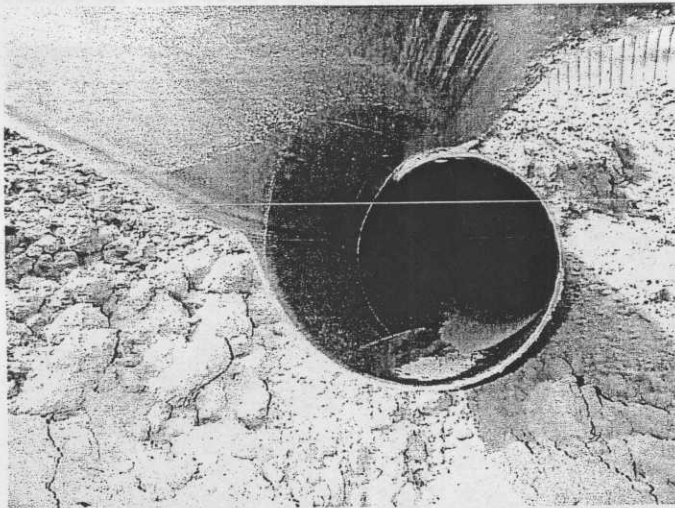


Photo #19 This photo is a close up of the interior of the open end of the ruptured pipeline.

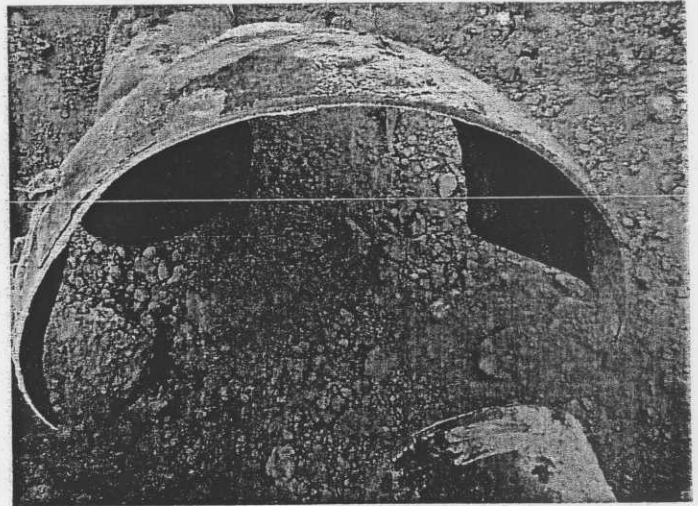


Photo #20 This photo shows the open portion of pipe at the separation point.

Photo Evidence (cont.)

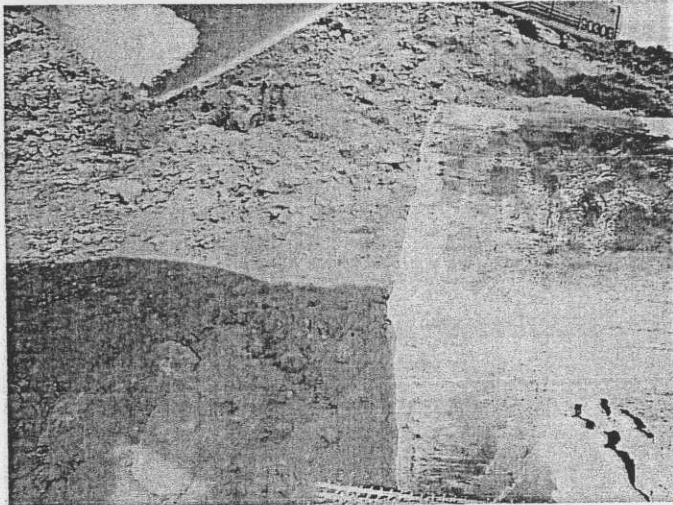


Photo #21 This photo shows the end of the stub of pipe attached to the ball valve. The weld bead is visible on this section of pipe.

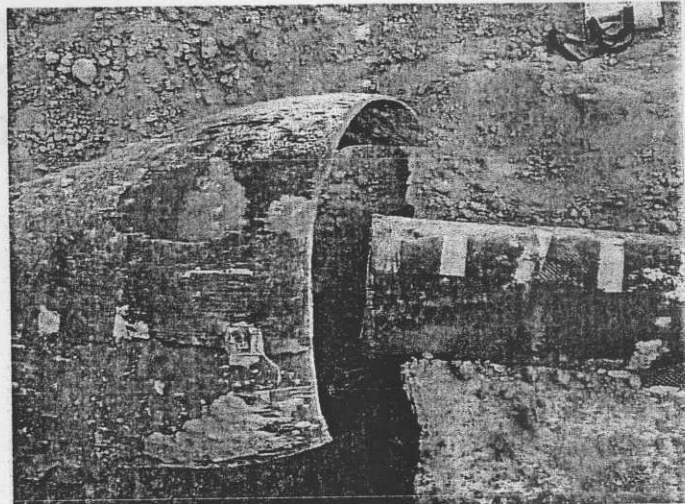


Photo #22 This photo shows the two sections of pipe at the rupture.



Photo #23 This photo shows the lateral misalignment of the ruptured pipe following the mishap. The sections of the 12" pipeline are offset by more than one pipe diameter.