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SEAL LABORATORIES

February 16, 2012

Mr. Jeffrey M. Thomas, Esq.
Gordon Tilden Thomas & Cordell, LLP
1001 Fourth Avenue, Suite 4000
Seattle, WA 98154-1007

RE: Puget Sound Energy- Ingham Fire
SEAL Job No. 21151.

Dear Mr. Thomas:

After review of the photographs of the gas pipe lines with "holes" from the following addresses in Seattle, Washington, a test protocol was proposed (Appendix I):

1. 12040 8th Avenue NE (gas line crossing oil vent line)
2. 913 NE 122nd Street (gas line crossing water service line)
3. 1020 (or 1016) NE 127th Street (gas line crossing abandoned water pipe)
4. 12312 5th Avenue NE (gas line crossing sewer service)

Metallurgical testing of all the above pipe samples was performed on 20th December, 2011 at MDE, Inc. in Seattle, WA, per the testing protocol with minor modifications agreed upon by all the experts and attorneys present during testing (Appendix II).

The testing details and results of each pipe section will be described by their address:

12040 8th Avenue NE (gas line crossing oil vent line):

This pipe section was collected by Infrasource on 9-26-11, as evidenced by the tag attached to the rapped pipe section; Figure 1. The gas service line pipe was made from steel, was 42 inches long with 1.2 inch outer diameter and wall thickness of 0.11 inch. The pipe contained a slightly oval hole with major and minor diameters as 0.3 inch and 0.22 inch; Figures 2 and 3. The surface coating on the pipe had melted. A section of the pipe was cut containing ¼ of the hole wall, as shown in Figure 4. The removed section contained the ¼ hole in a corner and is shown from the inner diameter (ID) and outer diameter (OD) side in Figure 5. The hole was clearly created from OD toward the ID, as seen by the missing material at the hole wall. The hole surface appeared smooth with no fracture features; Figure 6.

Scanning Electron Microscope (SEM) examination of the hole surface at ID transition revealed melted globules of steel, indicating melting by electrical arcing forming the hole; Figure 7. Energy dispersive X-ray (EDX) analysis of the pipe material indicated a plain carbon steel.

A metallographic mount was made with the hole wall in cross section. The mount was ground, polished and etched using standard metallographic procedures. The etched mount was examined using an optical microscope and the micrographs are presented in Figures 8-11. The surface of the hole from ID to OD revealed an altered microstructure due to melting and re-solidification of the surface; Figures 8-10. The hole surface also revealed a small void; Figure 10(a). The general microstructure of the steel indicates a low to medium carbon steel; Figure 11.

913 NE 122nd Street (Gas line crossing water service line):

This pipe section was collected by Infrasource on 9-27-11, as evidenced by the tag attached to the pipe section; Figure 12. The gas service line pipe was made from steel, was 53 inches long with 1.69 inch outer diameter and wall thickness of 0.135 inch. The pipe contained a slightly oval hole with major and minor diameters as 0.48 inch and 0.40 inch; Figure 13. A section of the pipe was cut containing ¼ of the hole wall, as shown in Figure 14. The removed section contained the ¼ hole in a corner and is shown from the ID and OD side in Figure 15. The hole was clearly created from OD toward the ID, as seen by the missing material at the hole wall. The hole surface appeared smooth with no fracture features and re-solidified surface; Figure 16.

A metallographic mount was made with the hole wall in cross section. The mount was ground, polished and etched using standard metallographic procedures. The etched mount was examined using an optical microscope and the micrographs are presented in Figures 17-20. The surface of the hole from ID to OD revealed an altered microstructure due to melting and re-solidification of the surface; Figures 17-19. The general microstructure of the steel indicates a medium carbon steel; Figure 20.

The copper water line that was allegedly in contact with the gas line is shown in Figure 21(a). The attached tag to the water line is shown in Figure 21(b). The periphery of the hole in the copper line shows melted copper balls, indicating it is caused by arcing; Figures 22 and 23. The line was clamped and pinched at a location adjacent to the hole; Figure 24.

1020 (or 1016) NE 127th Street (Gas line crossing abandoned water pipe):

This pipe section was collected by Infrasource on 9-26-11, as evidenced by the tag attached to the pipe section; Figure 25. The gas service line pipe was made from steel, coated with green epoxy Scotchkote 101, was 158 inches long with 1.15 inch outer diameter and wall thickness of 0.11 inch. The pipe contained an irregular shaped oval hole with major diameter as 1.0 inch and minor diameter as 0.6 inch; Figure 26. The green coating had melted and evaporated or flaked off around the hole. A section of the pipe was cut containing ¼ of the hole wall, as shown in Figure 27. The removed section contained the ¼ hole in a corner and is shown from the ID and OD side in Figures 28-30. The hole was clearly created from OD toward the ID, as seen by the missing material at the hole wall. The hole surface appeared smooth with no fracture features and re-solidified surface; Figure 30.

A metallographic mount was made with the hole wall in cross section. The mount was ground, polished and etched using standard metallographic procedures. The etched mount was examined using an optical microscope and the micrographs are presented in Figures 31-33. A large void (gas bubble) was present near the hole surface that was created during the arcing, melting and re-solidification process; Figure 31. The surface of the hole from ID to OD revealed an altered microstructure due to melting and re-solidification of the surface; Figure 32. The general microstructure of the steel indicates a medium carbon steel; Figure 33.

12312 5th Avenue NE (Gas line crossing sewer service):

This pipe section was collected by Michael Radcliff on 9-26-11, as evidenced by the tag attached to the pipe section; Figure 34. The gas service line pipe was made from steel, surface coated, was 225 inches long with gas meter attached to one end of the pipe. The pipe has 1.08 inch outer diameter and wall thickness of 0.11 inch. The pipe contained a round hole on the bottom of the pipe with an average diameter of 0.25 inch on the OD surface. A small section of the pipe containing the hole was sectioned; Figure 35. Another section of the pipe containing the hole was marked and cut as shown in Figure 36. The removed section was further cut to expose the hole on the ID surface as shown from the ID and OD side in Figures 37. The hole surface on the OD appeared smooth with no fracture features and re-solidified surface.

A metallographic mount was made with the entire hole in cross section. The mount was ground, polished and etched using standard metallographic procedures. The etched mount was examined using an optical microscope and the micrographs are presented in Figures 38-41. The hole was clearly created from OD toward the ID, as seen by the missing material; Figure 38. The surface of the hole from ID to OD revealed an altered microstructure due to melting and re-solidification of the surface. The general microstructure of the steel indicates a medium carbon steel; Figure 41.

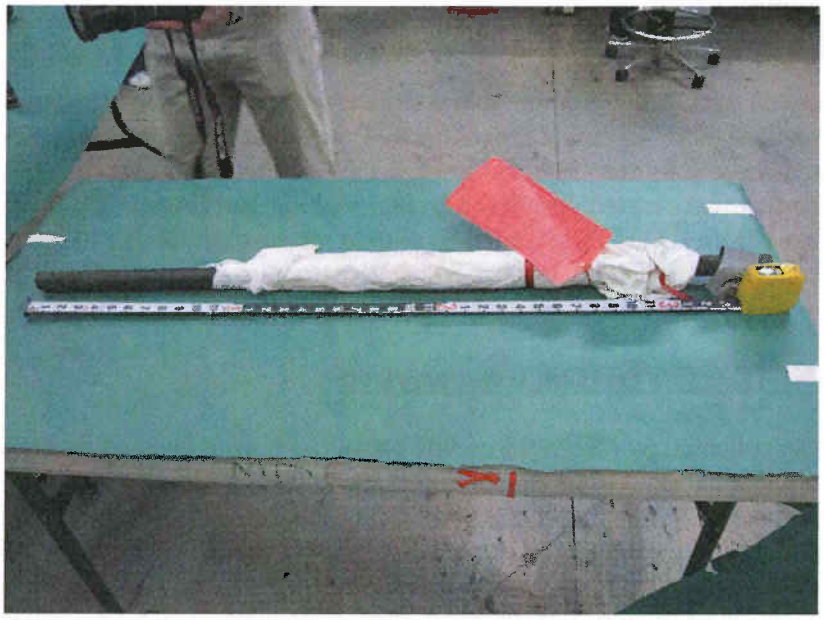
SUMMARY:

In summary, metallurgical examination and analysis of all the four (4) steel gas pipes revealed holes created by an arcing process since the hole surface revealed melted and re-solidified material with no fracture features. The holes varied in size and were created from outside to inside. The holes were not caused by a corrosion process. The pipe material revealed no metallurgical defect.

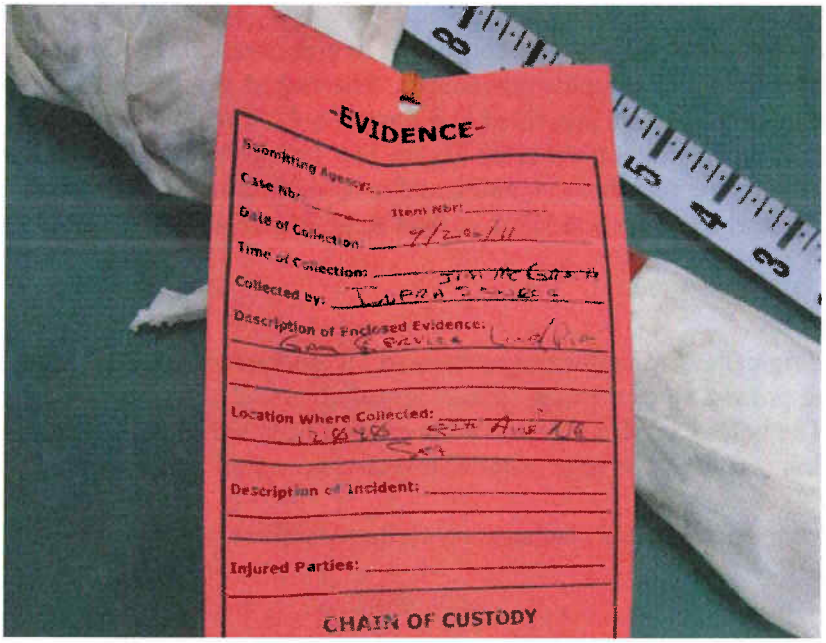
Please do not hesitate to contact me if you have any further questions regarding this report.
Sincerely,

SEAL LABORATORIES

Arun Kumar, Ph.D.
President



(a)



(b)

Figure 1. Color photographs showing the gas line from 12040 8th Avenue NE and the attached tag.

(a)

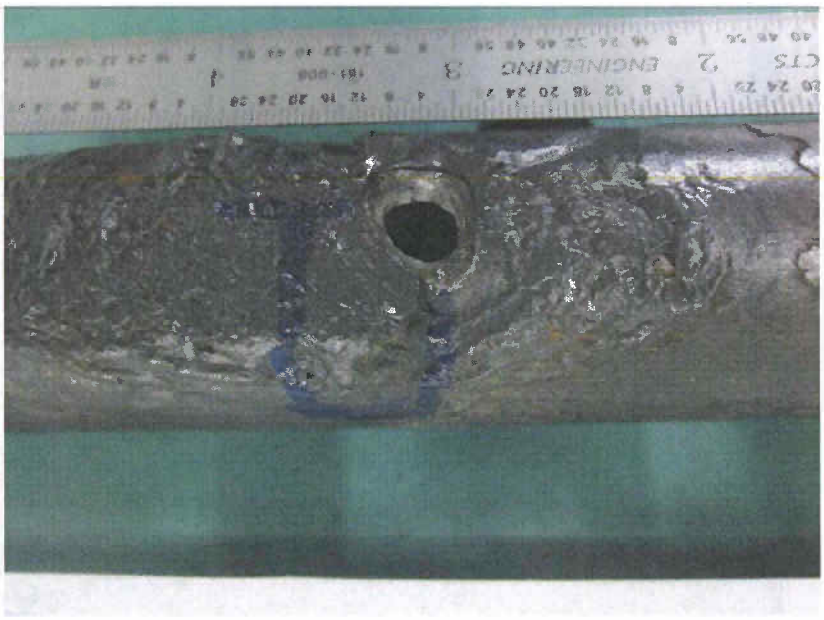
(b)

Figure 2. Detailed color photographs showing a hole in the gas line from 12040 8th Avenue NE.

(a)

(b)

Figure 3. Detailed color photographs showing the hole in the gas line from 12040 8th Avenue NE. The surface coating is melted around the hole.

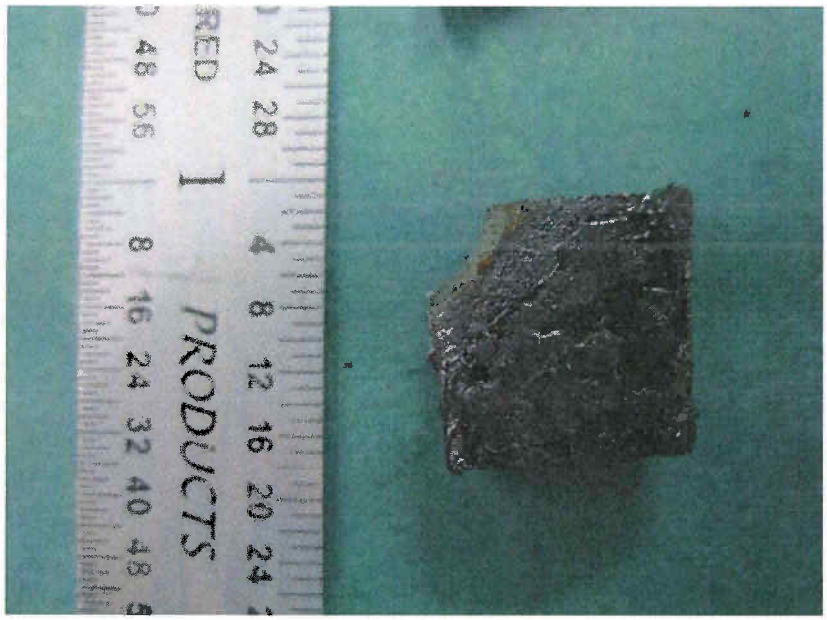


(a)

(b)

Figure 4. Detailed color photographs showing the marking at the hole and after cutting a portion of the hole from the gas line from 12040 8th Avenue NE.

(a)



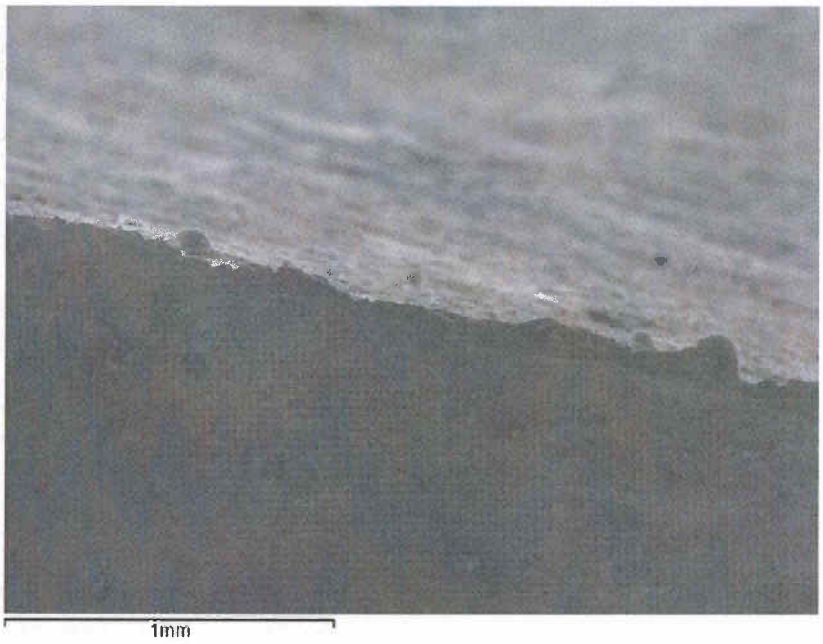
(b)

.Figure 5. Detailed color photographs showing a section of the hole removed from the gas line from 12040 8th Avenue NE. (a) ID surface; (b) OD surface.

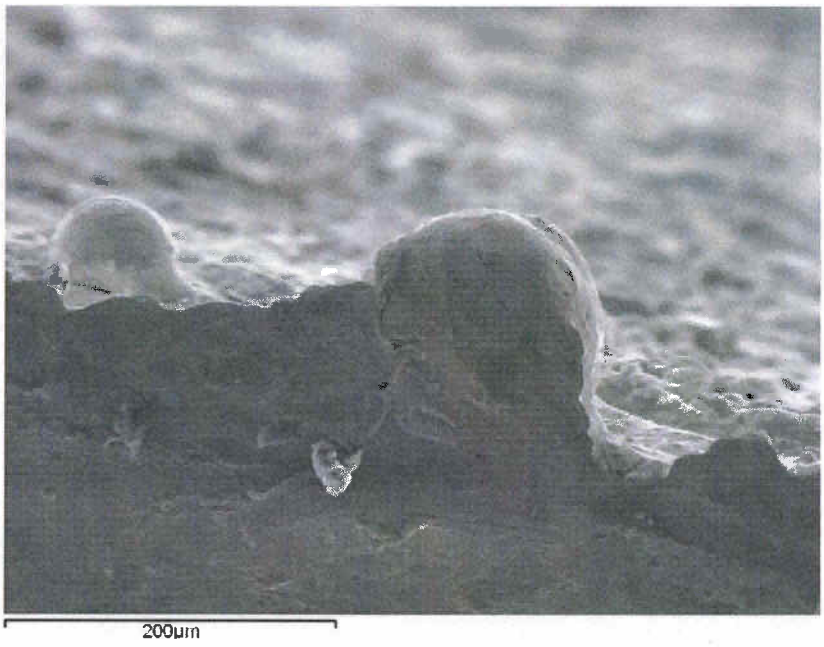
(a)

(b)

Figure 6. Detailed color photographs showing the hole surface and the hole profile of the section removed from the gas line from 12040 8th Avenue NE. (a) Hole surface, 20X; (b) Hole Profile with OD on top of photo, 20X.

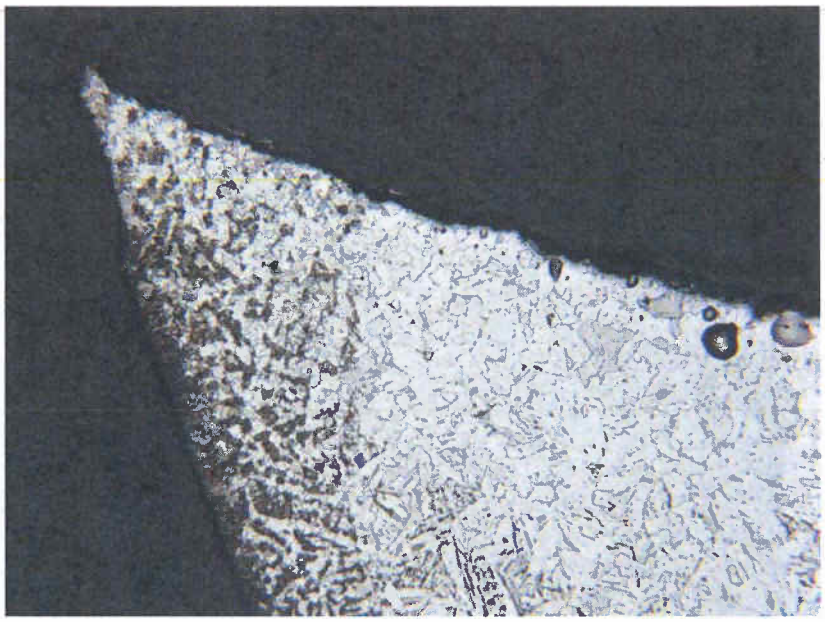


(a)

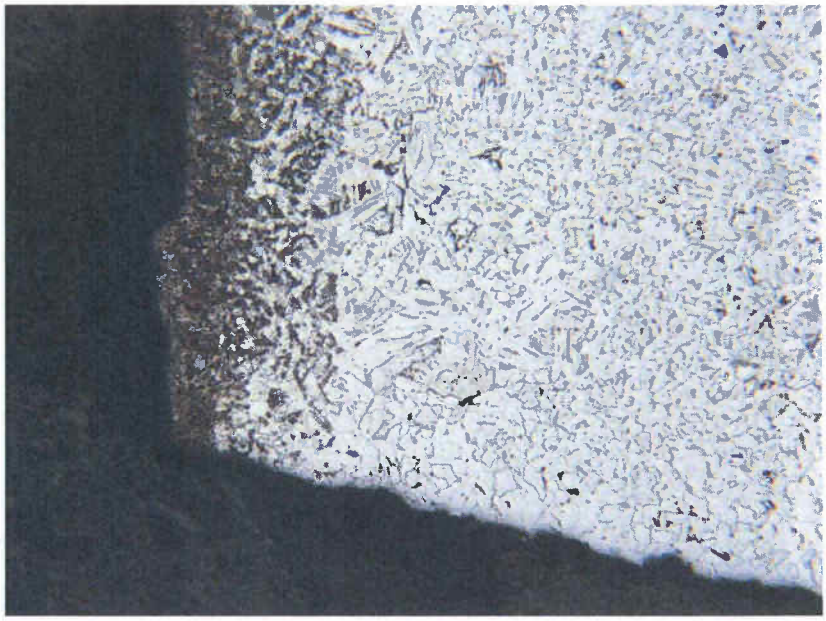


(b)

Figure 7. Detailed SEM micrographs showing the hole surface at ID transition from the section removed from the gas line from 12040 8th Avenue NE. (a) ID surface, 50X; (b) ID surface, 250X.

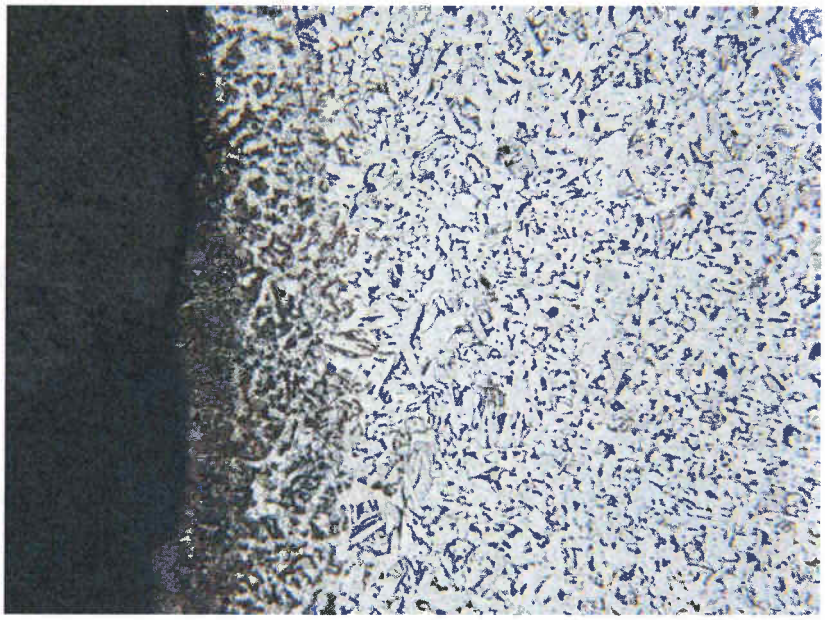


(a)

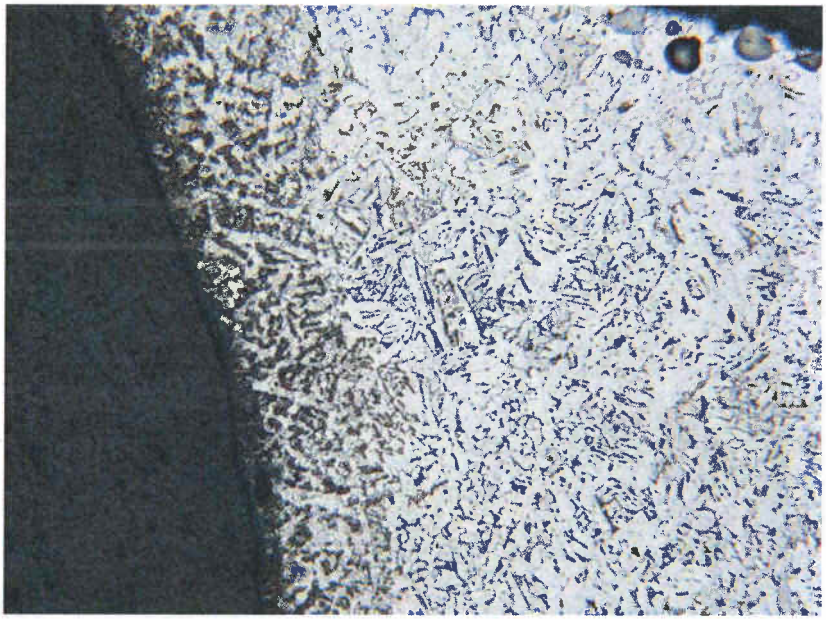


(b)

Figure 8. Detailed optical micrographs showing the hole surface in cross section of the sample removed from the gas line from 12040 8th Avenue NE. (a) ID surface, etched, 50X; (b) OD surface, etched, 50X.

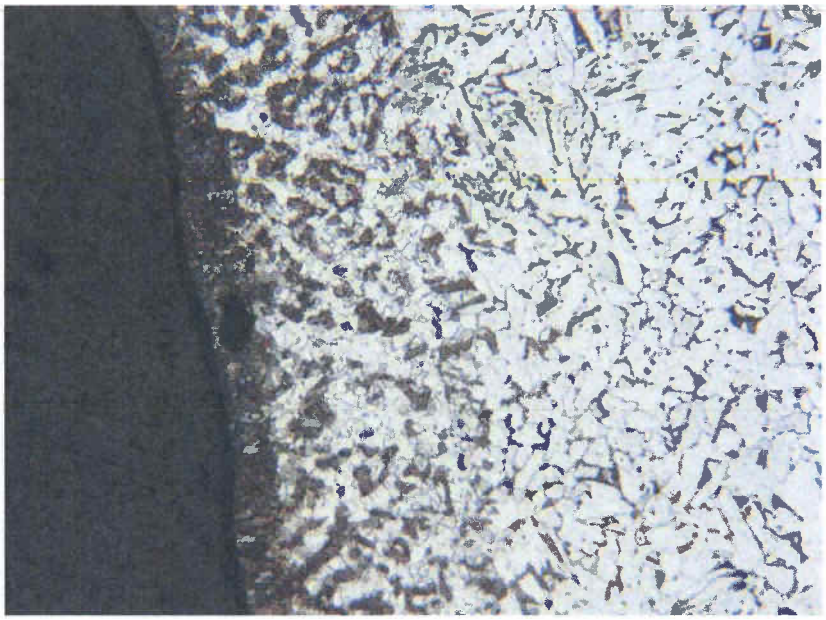


(a)

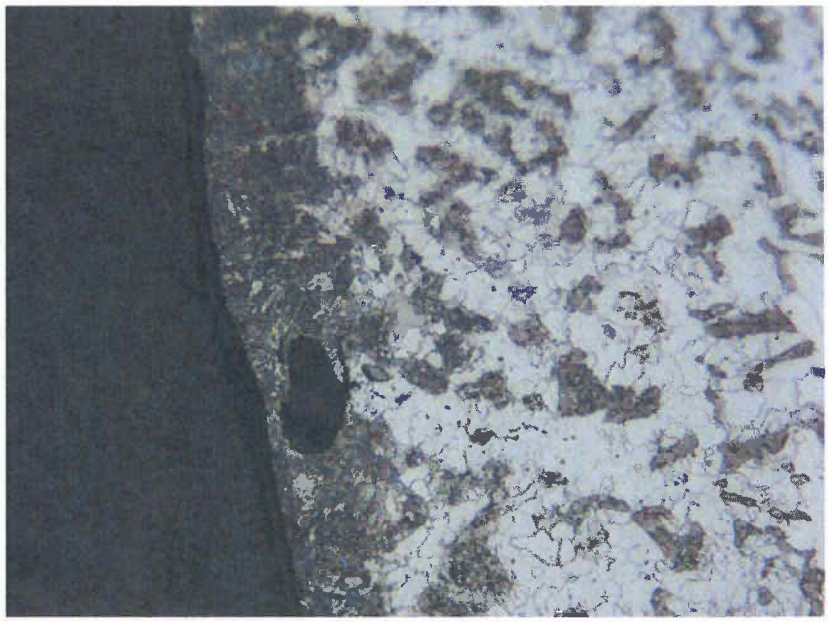


(b)

Figure 9. Detailed optical micrographs showing the hole surface in cross section of the sample removed from the gas line from 12040 8th Avenue NE. (a) Near OD surface, etched, 50X; (b) Away from OD surface, etched, 50X.

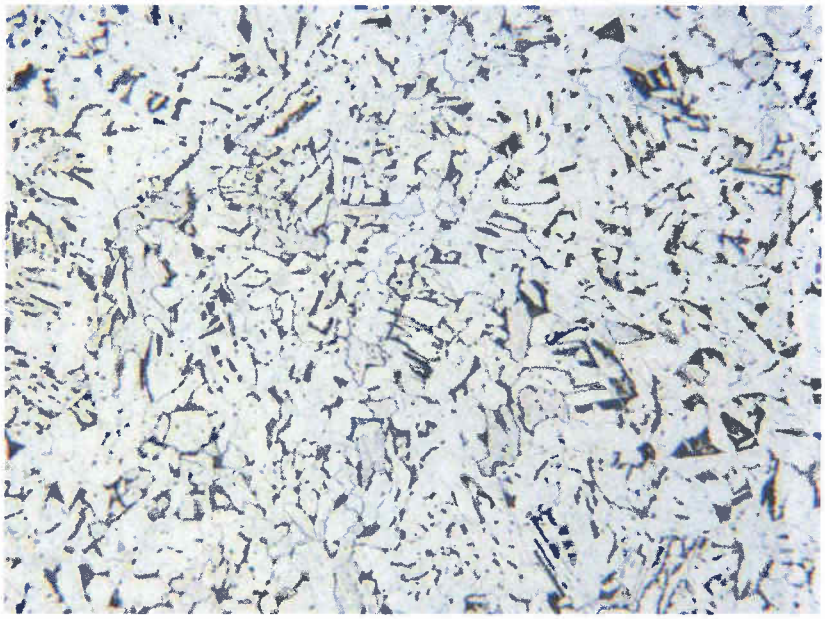


(a)

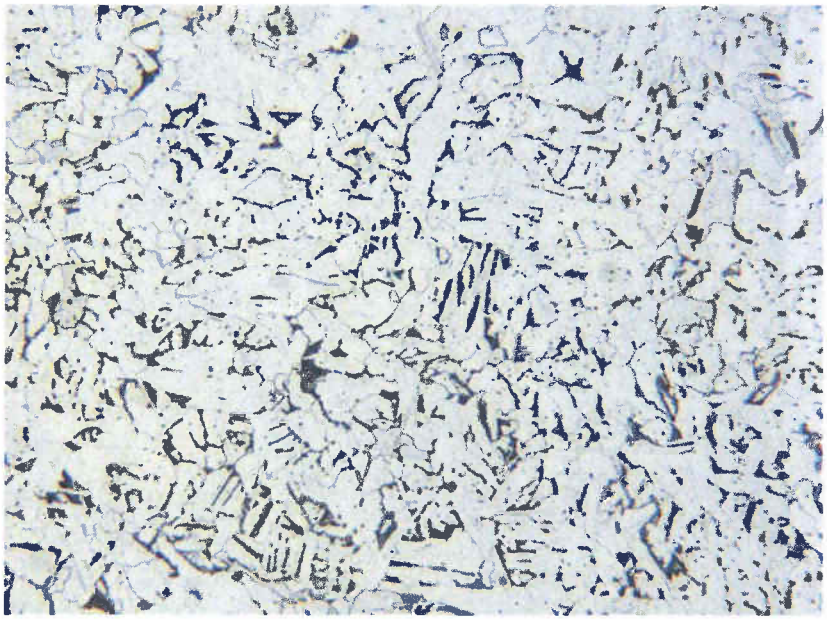


(b)

Figure 10. Detailed optical micrographs showing the hole surface in cross section of the sample removed from the gas line from 12040 8th Avenue NE. (a) Midway between OD and ID, etched, 100X; (b) Midway between OD and ID surface at void, etched, 200X.



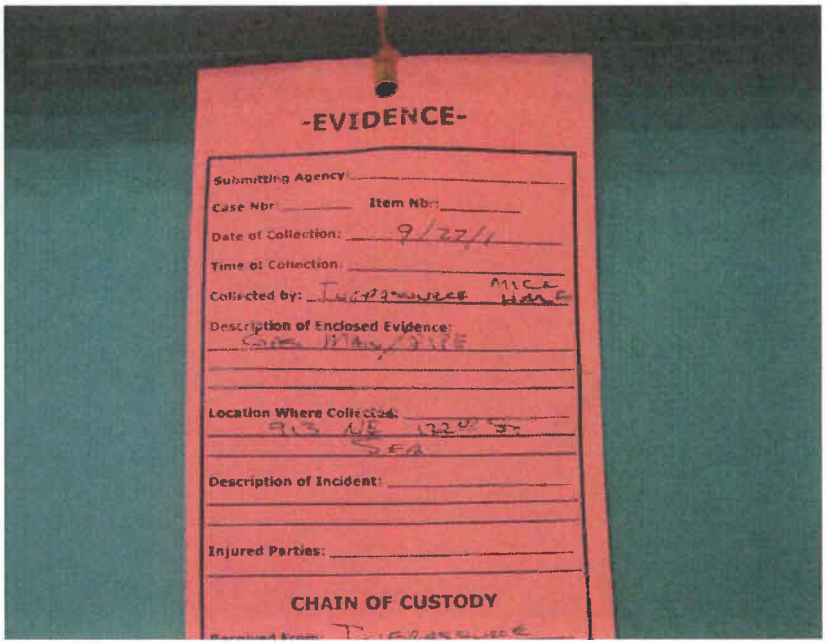
(a)



(b)

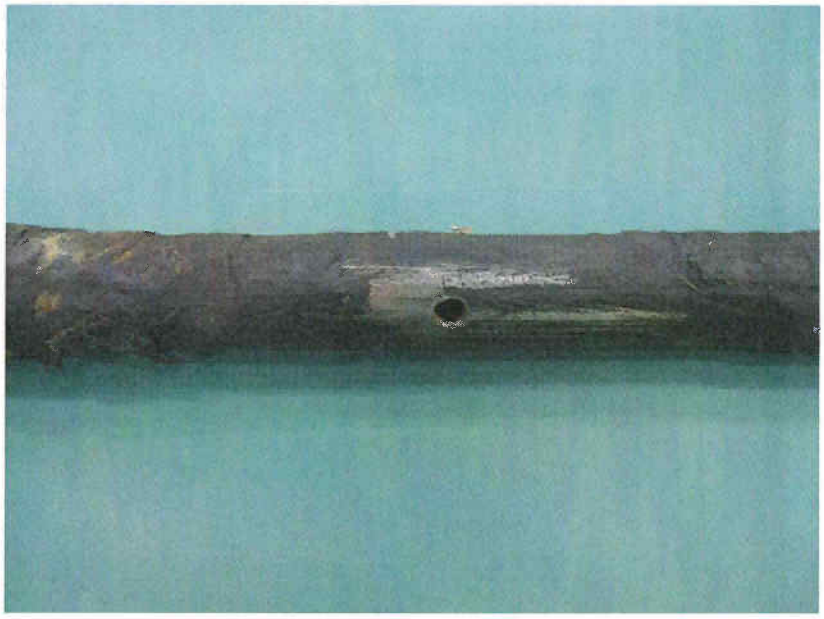
Figure 11. Detailed optical micrographs showing the metallurgical microstructure of steel section removed from the gas line from 12040 8th Avenue NE. (a) Etched, 100X; (b) Etched, 100X.

(a)

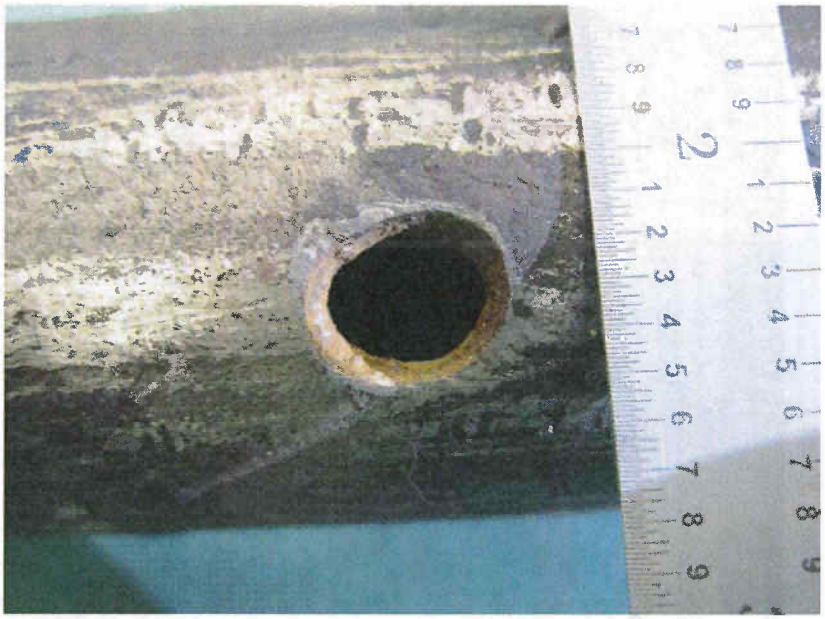


(b)

Figure 12. Color photographs showing the gas line from 913 NE 122nd Street and the attached tag.

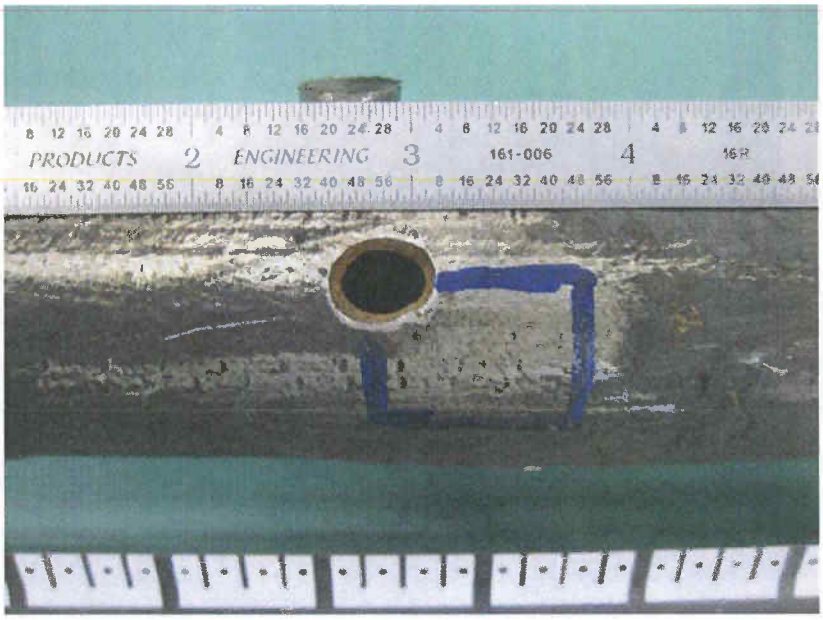


(a)

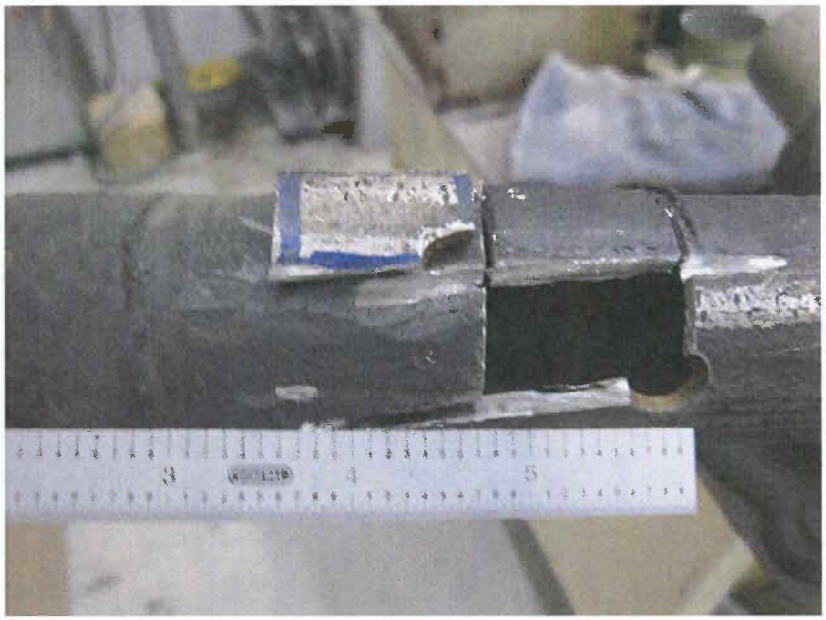


(b)

Figure 13. Detailed color photographs showing a hole in the gas line from 913 NE 122nd Street.

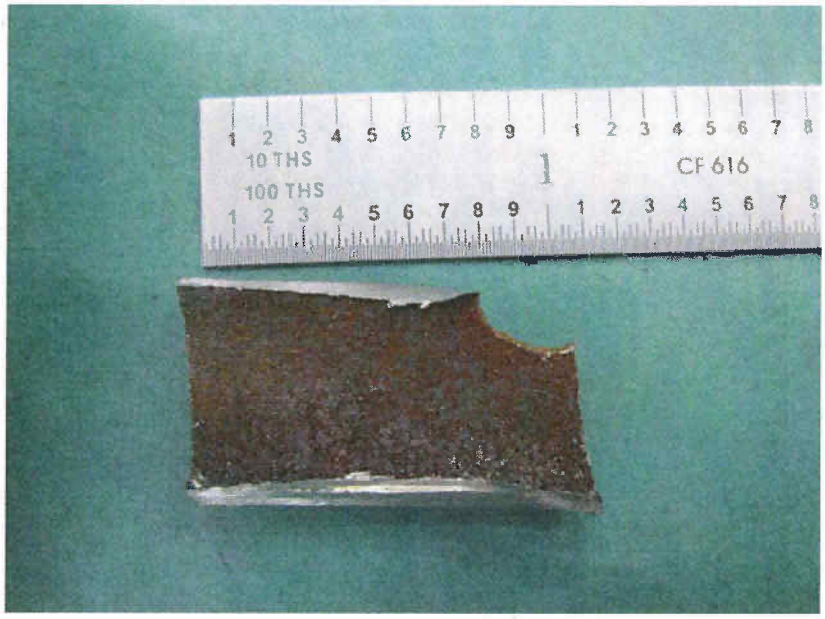


(a)

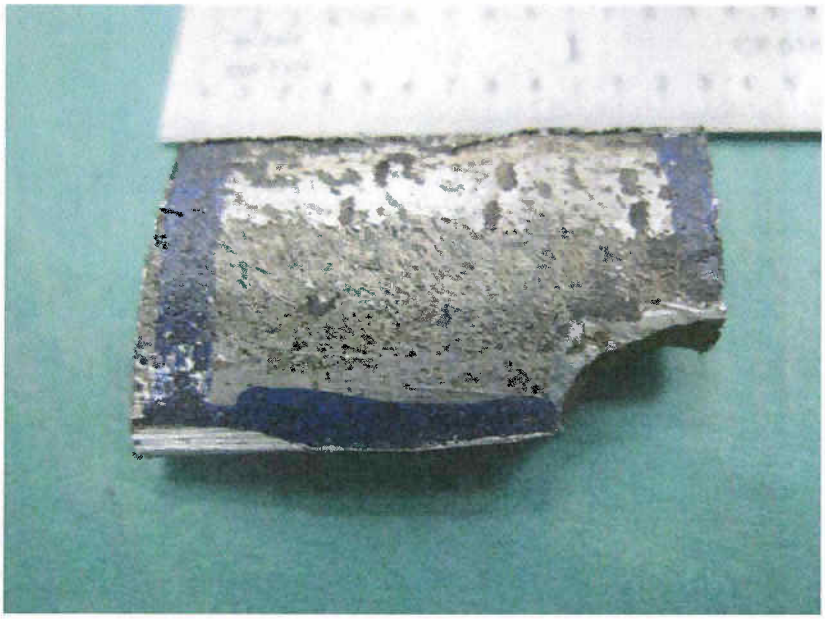


(b)

Figure 14. Detailed color photographs showing the marking at the hole and after cutting a portion of the hole from the gas line from 913 NE 122nd Street.

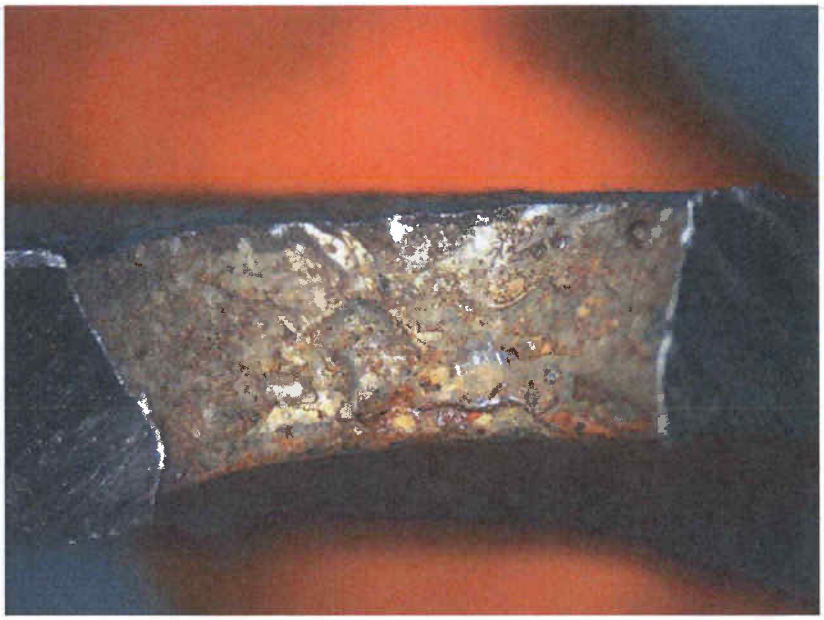


(a)

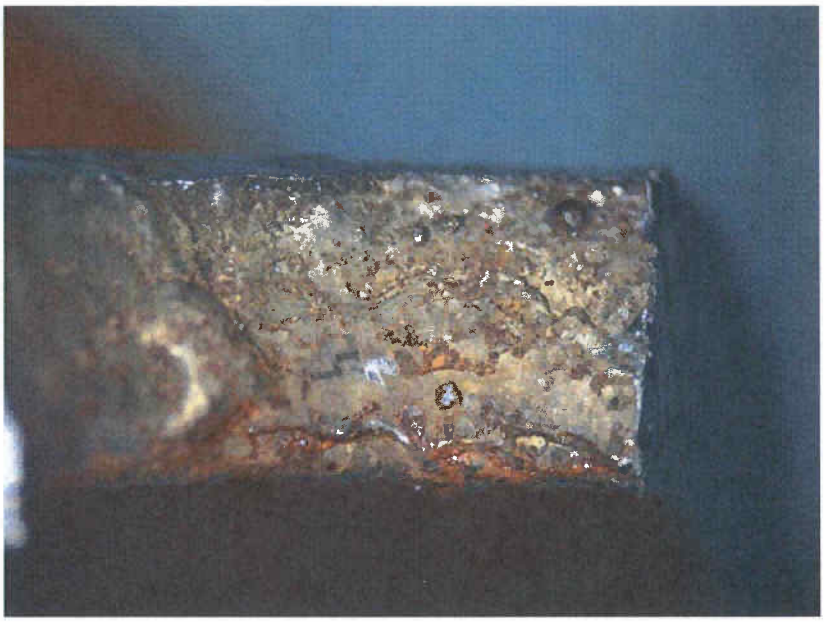


(b)

Figure 15. Detailed color photographs showing a section of the hole removed from the gas line from 913 NE 122nd Street. (a) ID surface; (b) OD surface.

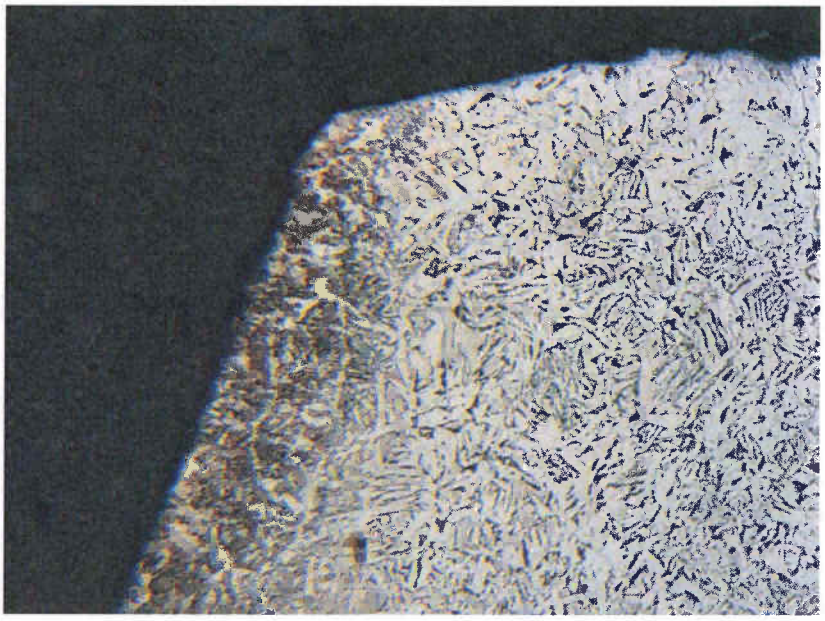


(a)

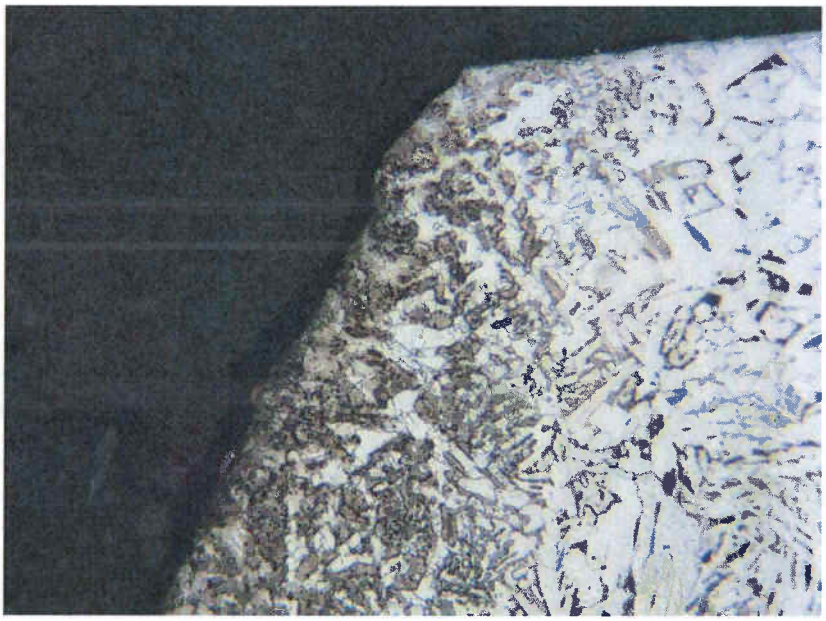


(b)

Figure 16. Detailed color photographs showing the hole surface of the section removed from the gas line from 913 NE 122nd Street. (a) Hole surface, 15X; (b) Hole Surface, 20X.

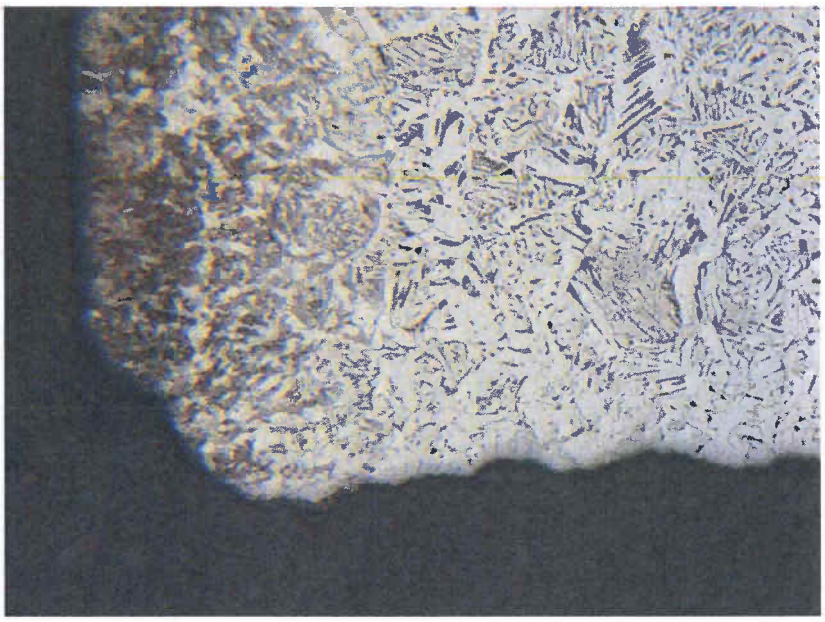


(a)

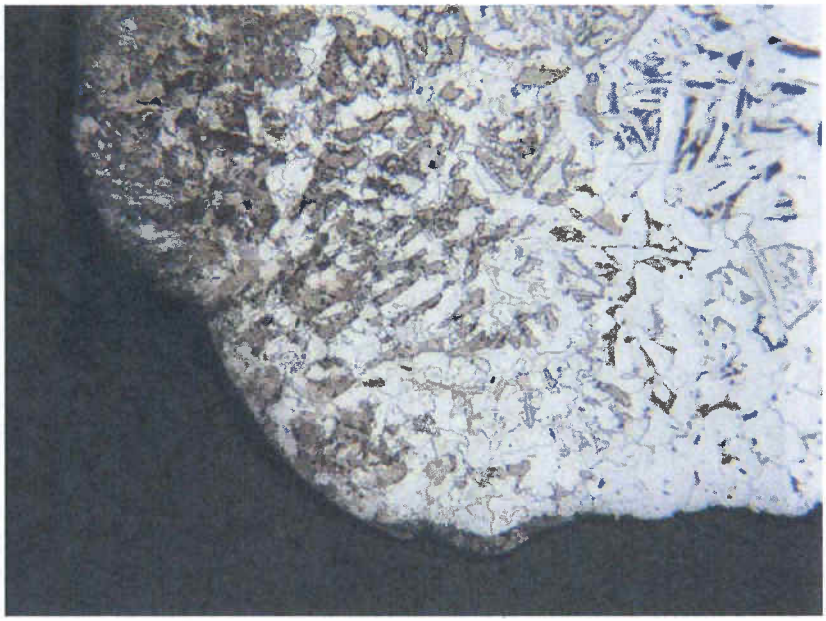


(b)

Figure 17. Detailed optical micrographs showing the hole surface in cross section of the sample removed from the gas line from 913 NE 122nd Street. (a) OD surface, etched, 50X; (b) OD surface, etched, 100X.

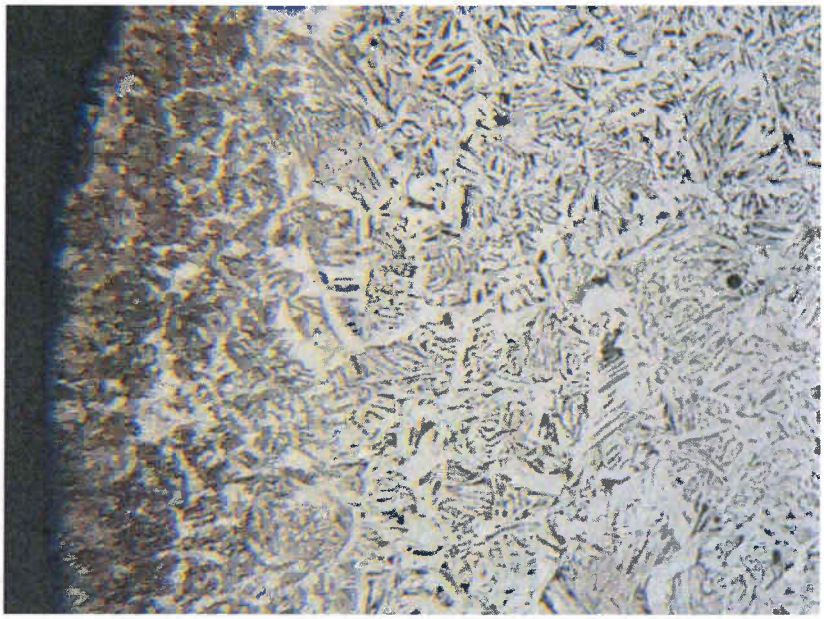


(a)

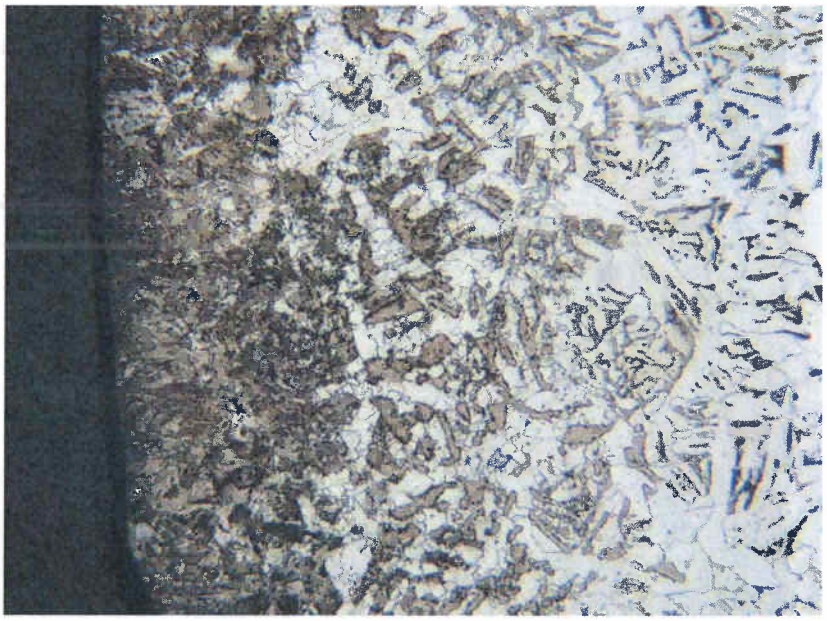


(b)

Figure 18. Detailed optical micrographs showing the hole surface in cross section of the sample removed from the gas line from 913 NE 122nd Street. (a) ID surface, etched, 50X; (b) ID surface, etched, 100X.

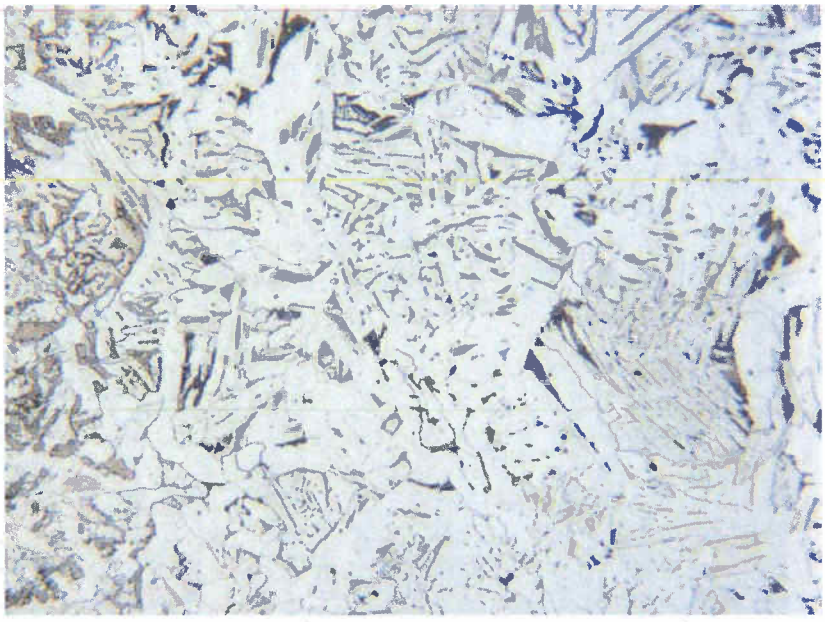


(a)

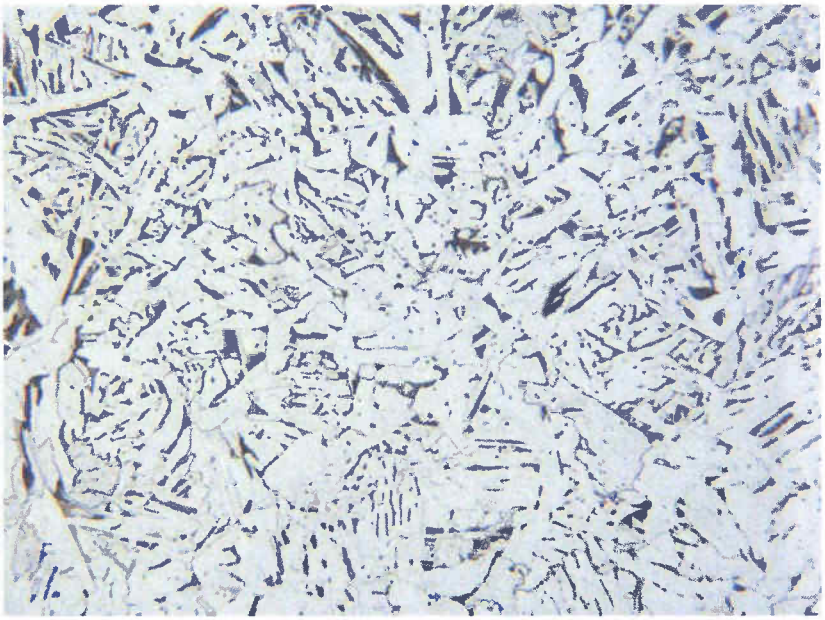


(b)

Figure 19. Detailed optical micrographs showing the hole surface in cross section of the sample removed from the gas line from 913 NE 122nd Street. (a) Near ID surface, etched, 50X; (b) Near ID surface, etched, 100X.



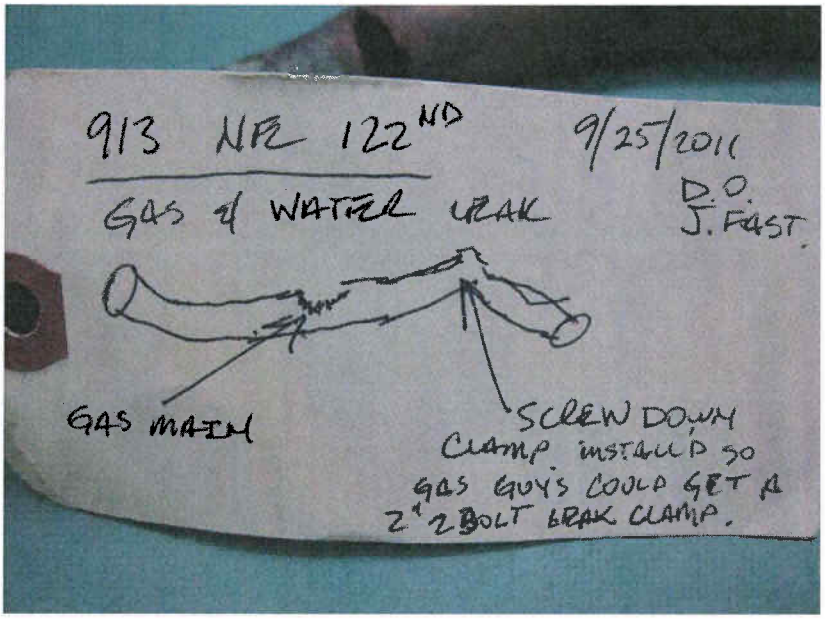
(a)



(b)

Figure 20. Detailed optical micrographs showing the metallurgical microstructure of steel section removed from the gas line from 913 NE 122nd Street E. (a) Etched, 100X; (b) Etched, 100X.

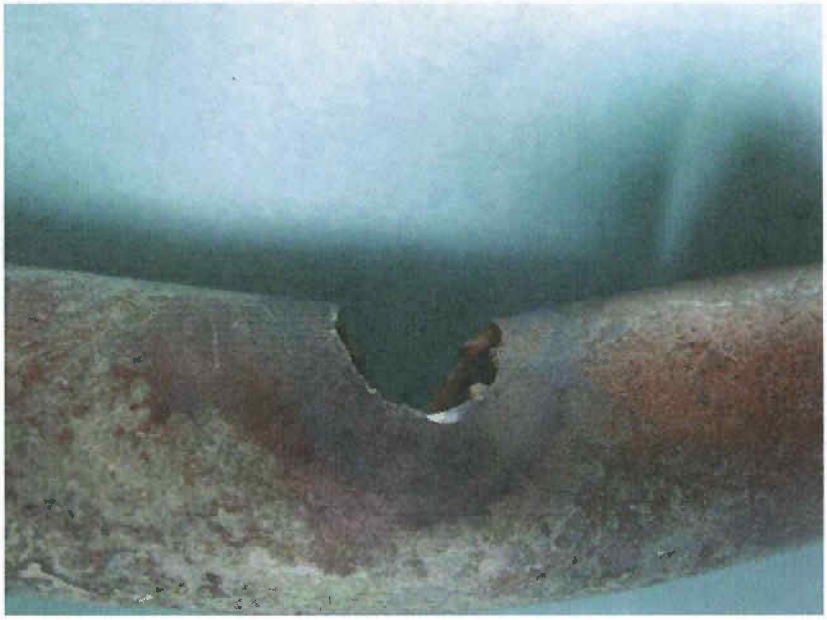
(a)



(b)

Figure 21. Color photographs showing the copper water line from 913 NE 122nd Street and the attached tag.

(a)



(b)

Figure 22. Color photographs showing the hole in the copper water line from 913 NE 122nd Street.

Figure 23. A detailed color photograph showing the hole in the copper water line from 913 NE 122nd Street.

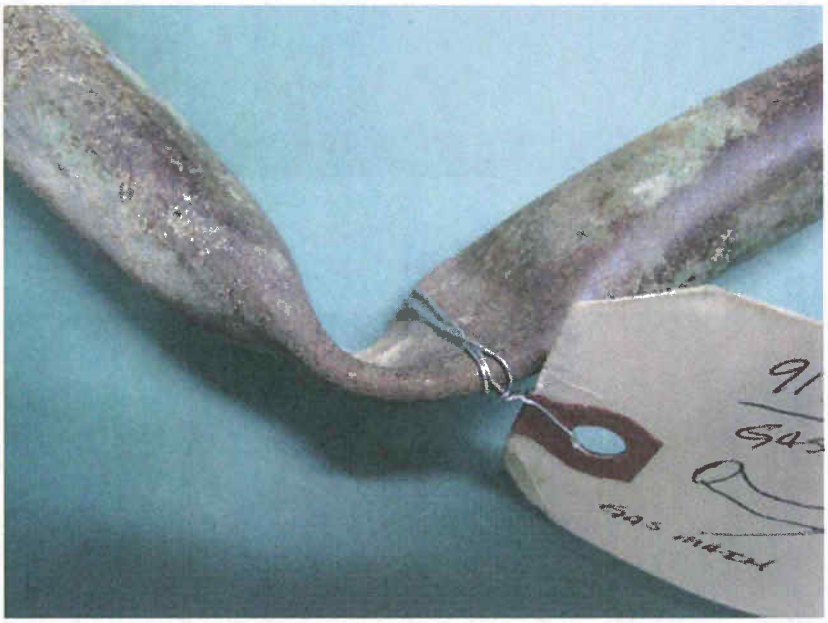
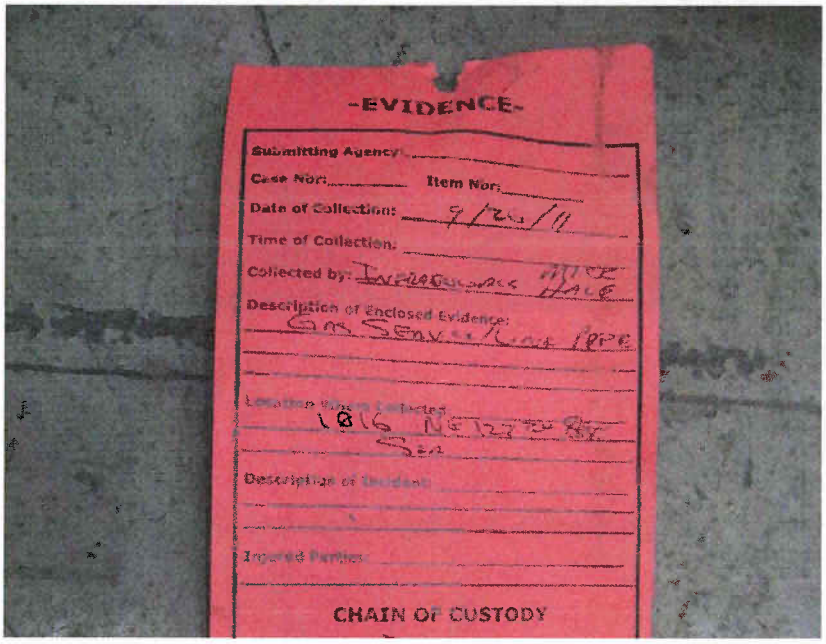


Figure 24. A detailed color photograph showing the pinched area in the copper water line from 913 NE 122nd Street.

(a)



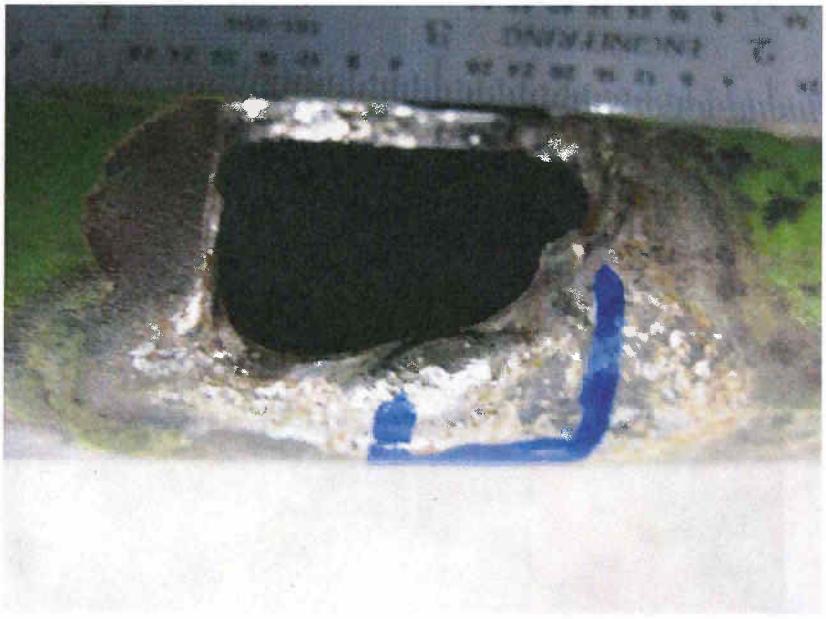
(b)

Figure 25. Color photographs showing the gas line from 1016 NE 127th Street and the attached tag.

(a)

(b)

Figure 26. Detailed color photographs showing a hole in the gas line from 1016 NE 127th Street.



(a)

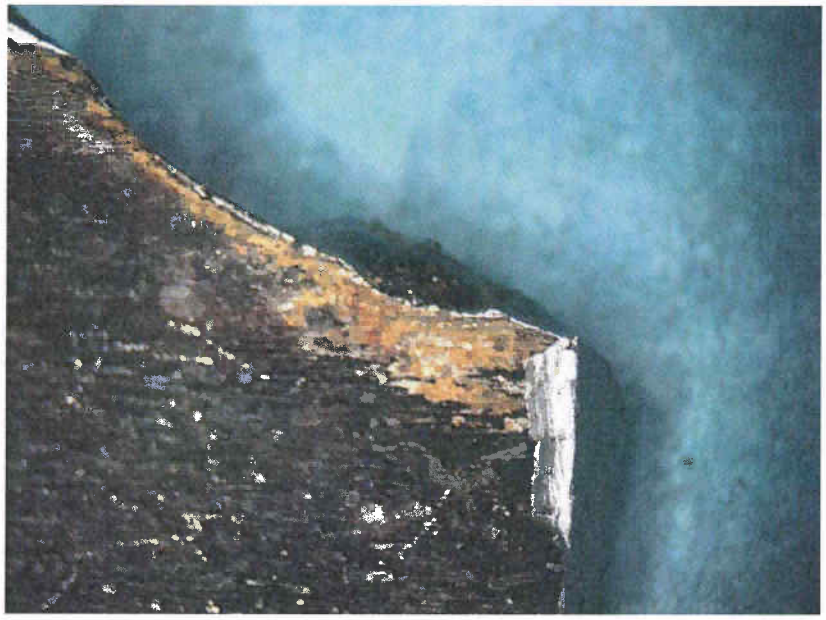
(b)

Figure 27. Detailed color photographs showing the marking at the hole and after cutting a portion of the hole from the gas line from 1016 NE 127th Street.

(a)

(b)

Figure 28. Detailed color photographs showing a section of the hole removed from the gas line from 1016 NE 127th Street. (a) ID surface; (b) OD surface.

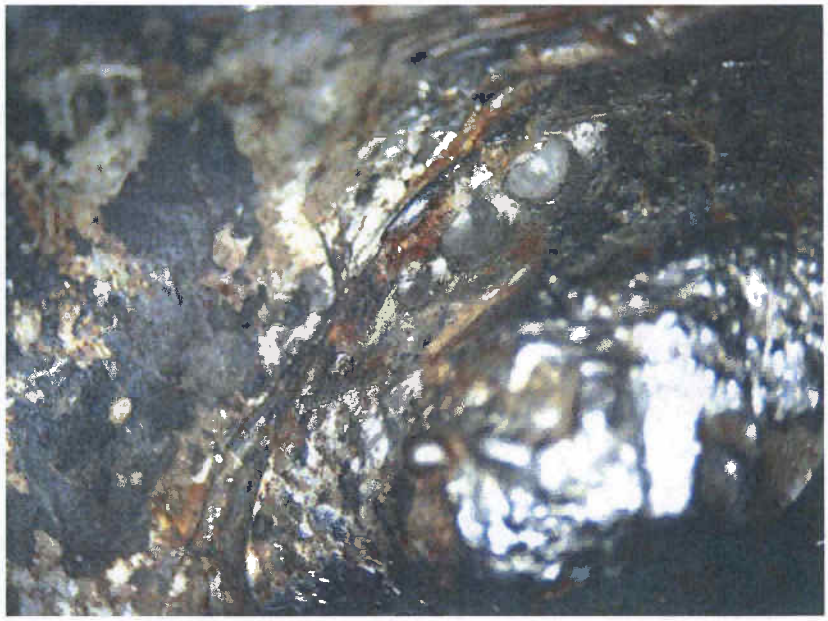


(a)

(b)

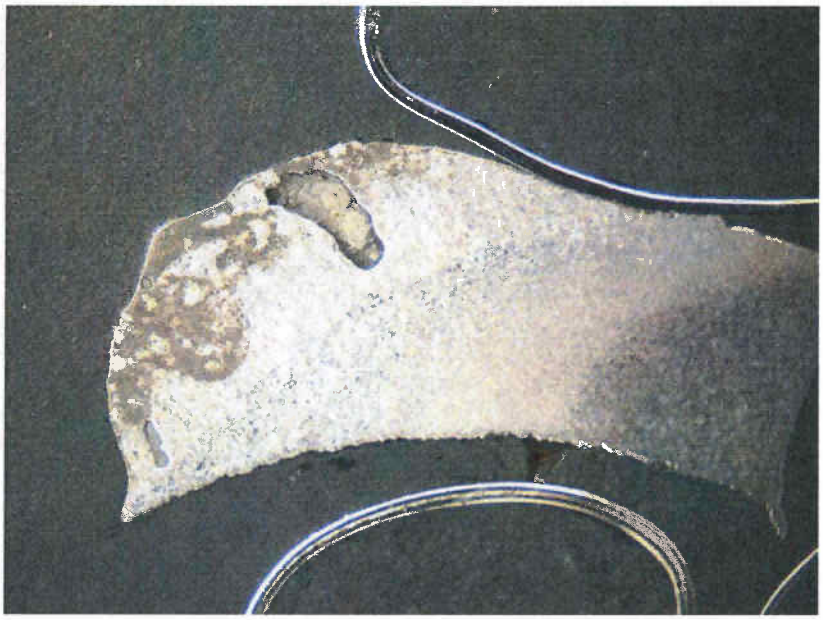
Figure 29. Detailed color photographs showing the ID surface near the hole of the section removed from the gas line from 1016 NE 127th Street. (a) ID surface, 10X; (b) ID Surface, 20X.

(a)

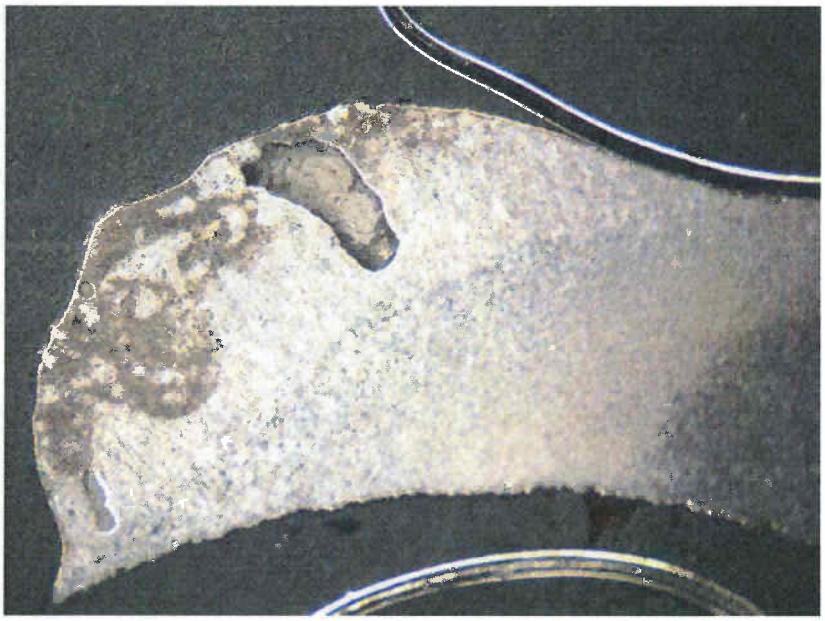


(b)

Figure 30. Detailed color photographs showing the OD surface near the hole of the section removed from the gas line from 1016 NE 127th Street. (a) OD surface, 10X; (b) OD Surface, 20X.

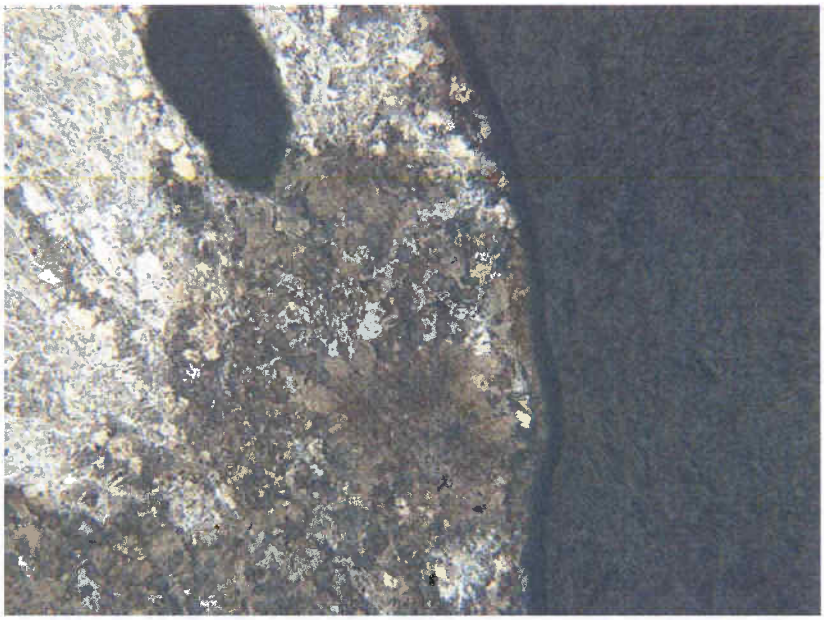


(a)

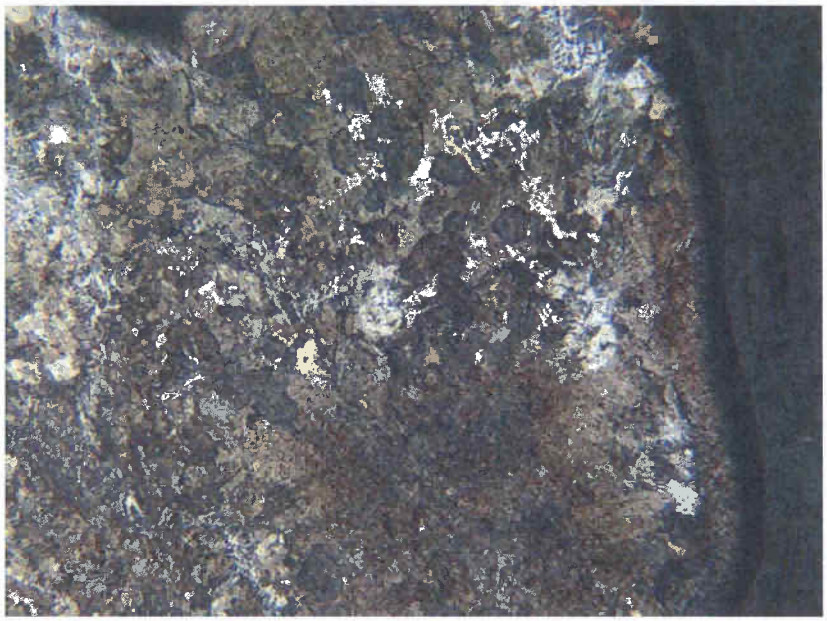


(b)

Figure 31. Optical micrographs showing the hole surface in cross section of the sample removed from the gas line from 1016 NE 127th Street. (a) Overall, etched, 15X; (b) Overall, etched, 20X.



(a)



(b)

Figure 32. Detailed optical micrographs showing the hole surface in cross section of the sample removed from the gas line from 1016 NE 127th Street. (a) ID surface, etched, 50X; (b) ID surface, etched, 100X.

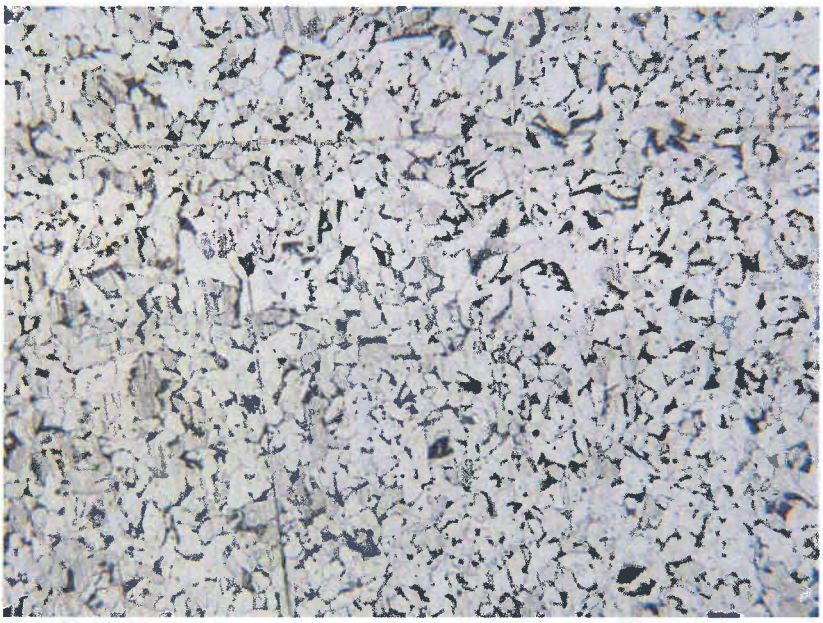
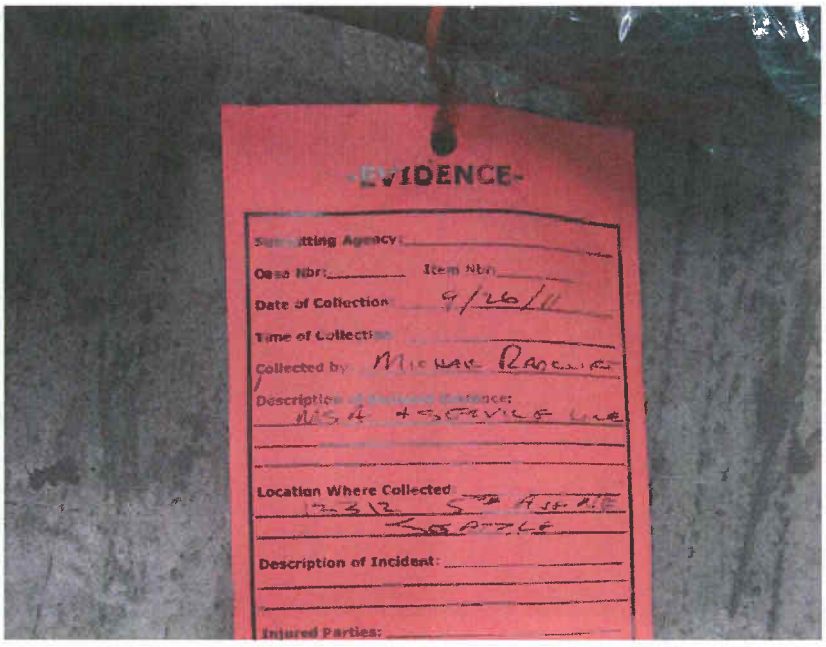


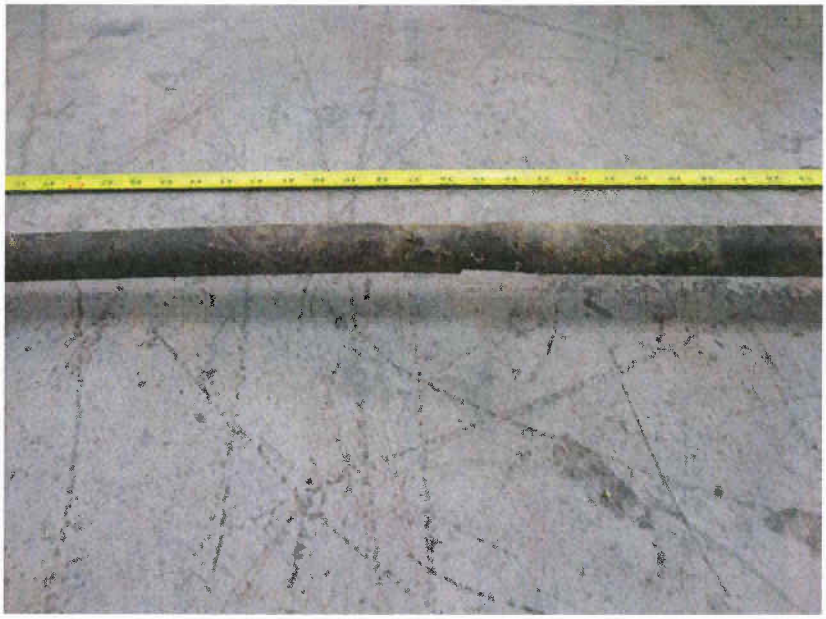
Figure 33. A detailed optical micrograph showing the metallurgical microstructure of steel section removed from the gas line from 1016 NE 127th Street. Etched, 100X.

(a)



(b)

Figure 34. Color photographs showing the gas line from 12312 5th Avenue NE and the attached tag.



(a)

(b)

Figure 35. Detailed color photographs showing a hole in the gas line from 12312 5th Avenue NE.

(a)

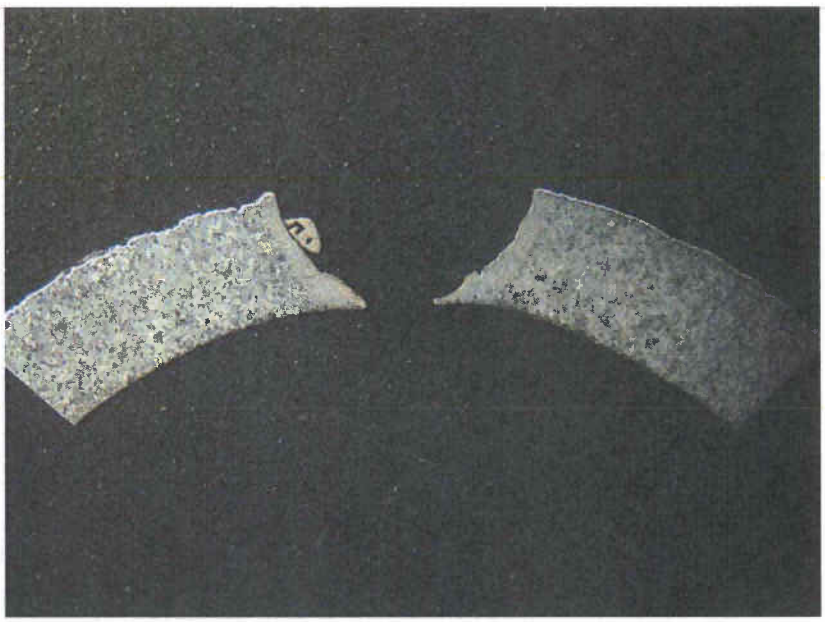
(b)

Figure 36. Detailed color photographs showing the marking around the hole and after cutting a portion of the pipe with the hole from the gas line from 12312 5th Avenue NE.

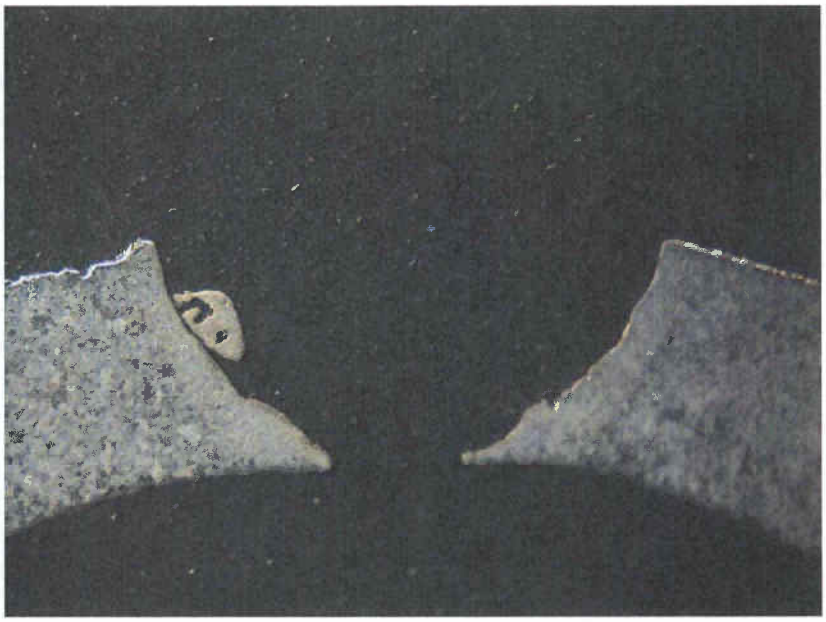
(a)

(b)

Figure 37. Detailed color photographs showing the hole removed from the gas line from 12312 5th Avenue NE. (a) ID surface; (b) OD surface.



(a)



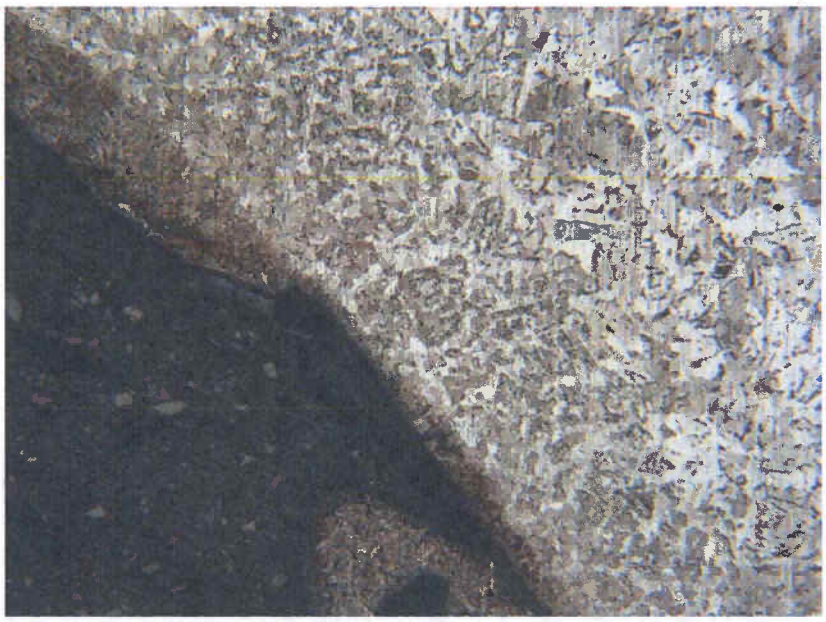
(b)

Figure 38. Optical micrographs showing the hole in cross section of the sample removed from the gas line from 12312 5th Avenue NE. (a) Overall, etched, 10X; (b) Overall, etched, 20X.

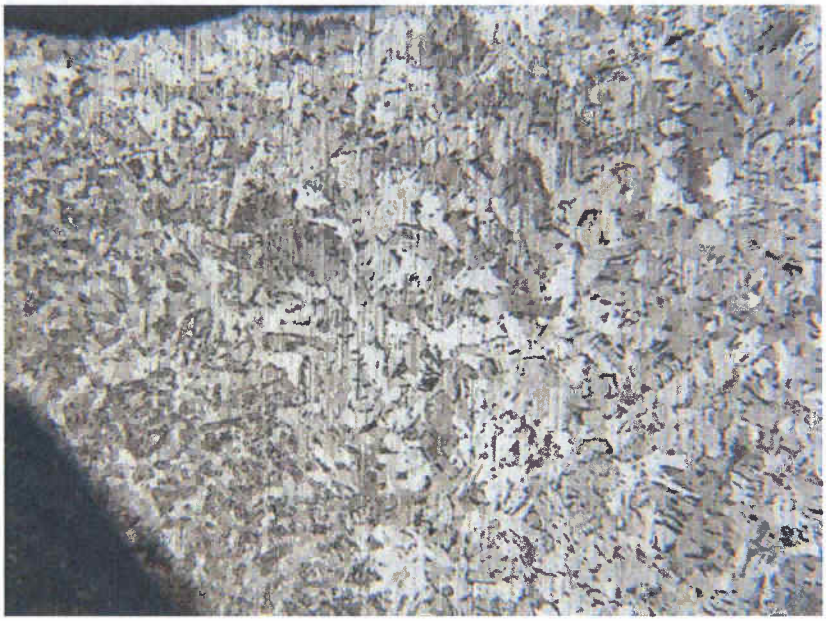
(a)

(b)

Figure 39. Detailed optical micrographs showing the hole surface in cross section of the sample removed from the gas line from 12312 5th Avenue NE. (a) ID surface, etched, 50X; (b) OD surface, etched, 50X.



(a)



(b)

Figure 40. Detailed optical micrographs showing the metallurgical microstructure of steel section removed from the gas line from 12312 5th Avenue NE. (a) At the hole surface, Etched, 50X; (b) At the hole surface, Etched, 50X.

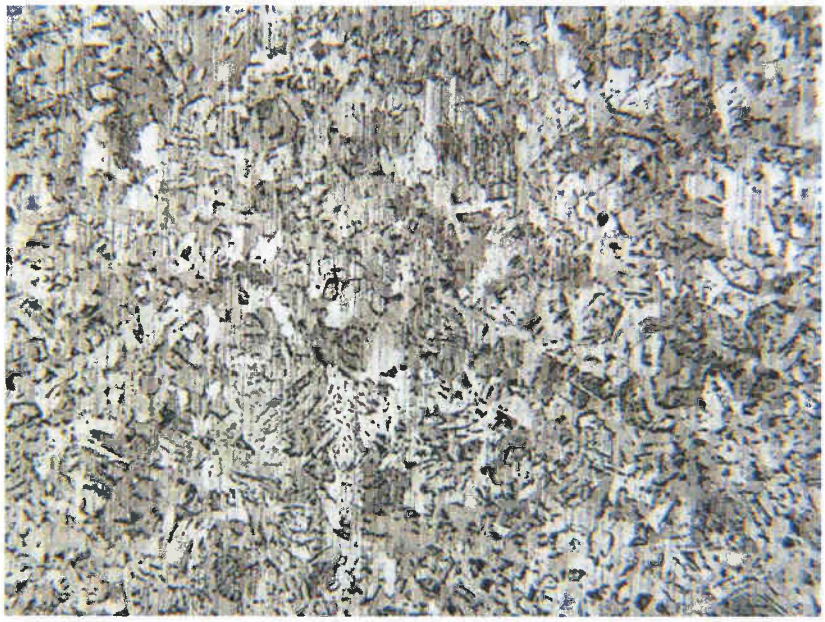


Figure 41. A detailed optical micrograph showing the metallurgical microstructure of steel section removed from the gas line from 12312 5th Avenue NE. Etched, 50X.

Appendix I

250 NORTH NASH STREET, EL SEGUNDO, CA 90245-4529 • (310) 322-2011 • FAX (310) 322-2243

SEAL LABORATORIES

November 21, 2011

Mr. Jeffrey M. Thomas, Esq.
Gordon Tilden Thomas & Cordell, LLP
1001 Fourth Avenue, Suite 4000
Seattle, WA 98154-1007

RE: Puget Sound Energy- Ingham Fire
SEAL Job No. 21151.

Dear Mr. Thomas:

I have reviewed the photographs of the gas pipe lines with "holes" from the following addresses in Seattle, Washington:

1. 12040 Avenue NE (gas line crossing oil vent line); Figure 1
2. 913 NE Street (gas line crossing water service line); Figure 2
3. 1020 NE Street (gas line crossing abandoned water pipe); Figure 3
4. 12312 Avenue NE (gas line crossing sewer service); Figure 4.

In order to determine the nature of the "hole" and the cause of its formation in the above four (4) gas line sections (whether formed due to electrical arcing, corrosion, or some other means), the following metallurgical testing protocol is proposed:

1. Color photographs of the pipe sections and detailed photographs of the "hole".
2. Measurements of the inner and outer diameter of the pipes and the dimensions of the "hole".
3. Transversely cut the "hole" from the pipe sections at approximately 1 inch on both sides of the "hole" and remove the nearly 2" long section of the pipe containing the "hole".
4. Cut and split the pipe section containing the "hole" longitudinally at 90 degrees to the hole.
5. Examine and photograph the "hole" from the inside surface of the pipe.
6. Section the pipe piece containing the "hole" in a transverse direction through the center of the hole using a thin blade diamond saw or an equivalent cutting device using a coolant. Mount one of the sections in a metallurgical mount as a transverse cross section through the center of the "hole".
7. Prepare the metallographic mount by standard polishing procedure. Document the edge of the hole and the base alloy of the pipe in the as-polished condition and after etching with 2% Nital solution, using optical microscope.
8. Perform microhardness measurements on the metallurgical mounts at the edge of the "hole" and compare with the base alloy hardness, using a Knoop indenter and a 100 or 500 gram load (as necessary).

Please do not hesitate to contact me if you have any further questions regarding this protocol.

Sincerely,

SEAL LABORATORIES

Arun Kumar, Ph.D.
President

(a)

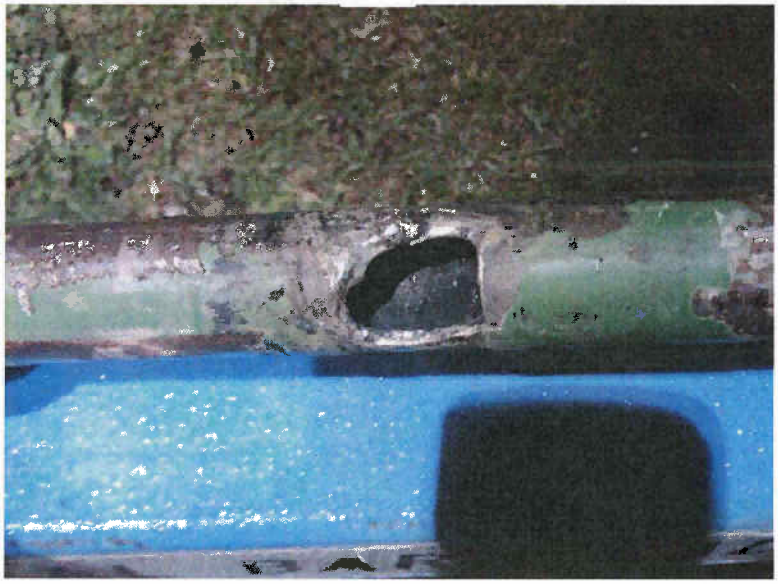
(b)

Figure 1. Color photographs showing the "hole" in the gas pipe line from 12040 Ave NE.

(a)

Figure 2. A color photograph showing the wrapped gas pipe line (right) from 913 NE Street containing a "hole".

(a)



(b)

Figure 3. Color photographs showing the "hole" in the gas pipe line from 1020 NE Street.

(a)

(b)

Figure 4. Color photographs showing the "hole" in the gas pipe line from 12312 Ave NE.

Appendix II

MDE Inc.

700 South Industrial Way
Seattle, WA 98108

VISITOR'S LOG

Inspection
PSE

ATTN: ***Persons who enter or depart this facility may be subject to an inspection of their personal effects.***
- MDE Inc.

DATE	TIME IN	TIME OUT	FULL NAME (Please Print)	COMPANY	PHONE #	PURPOSE OF VISIT	MDE CONTACT	MDE JOB #
12/20/11	8:40AM		ARUN KUMAR	SEAL Labs	310-322-2011	Test		
12/20/11	840	11:45	Glenn Johnson	Q. Global	509 539-4119	PSE		
12/20/11	8:40		John Biskey	Biskey's Forensic Exp	503 675-3864	"		
12/20/11	8:40	11:45	Gwen Johnson	Q-Global	509-539-9316	"		
12/20/11	8:45		Jeremy Hasley	NW Corrosion	360 286 4570	"		
12/20/11	8:45		VICTORIA LIEM	INVESTIGATIVE SCIENCES	425 883 8365	Testing		
12/20/11	8:50		Ed Iskra	Unified Investigations	360-275-8392	PSE Pipe testing		
12/20/11	8:55		Kuang Chu	WUTC	360-870-4830	PSE		
12-20-11	8:55		A. Jones	WUTC	360-664-1321	PSE		
12/20/2011	8:55		Bryan Templeton	CASE Forensics	425-775-5550	PSE		
12/20/2011	9:00		Doug Barovsky	MDE	2066222007	SCL		
12/20	900		Keith Clune	MDE	2066222007			
12/20	900		Matt Pierce	Gordon Tilden	206-467-6477	PSE		
12/20	9:07		Stephanie Silva	PSE	425-754-2237	Investigation.		
12/20	9:10		Jace mcmaster	PSE	425-457-1237	Investigation.		

Unified Investigations & Sciences, Inc.
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Bremerton, WA
360-275-8392

Edward Iskra, CFEI
Special Investigator

Rev. 9/2008

MDE Inc.

700 South Industrial Way
Seattle, WA 98108

VISITOR'S LOG

Inspection
PSE

ATTN: ***Persons who enter or depart this facility may be subject to an inspection of their personal effects.***
- MDE Inc.

DATE	TIME IN	TIME OUT	FULL NAME (Please Print)	COMPANY	PHONE #	PURPOSE OF VISIT	MDE CONTACT	MDE JOB #
12/20/11	0930		JACK PRESTRUD	CITY LIGHT	206 551-1530	OBSERVE	BARONSKY	
✓	2:50		Craig EVEZICH	EVEZICH	206 576-6900	✓	BISSELL	

Rev. 9/2008