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NTSB
National Transportation Safety Board
490 L'Enfant Plaza, SW
Washington, DC 20594-0001
www.ntsb.gov

Operations Group Factual Report **Report Date: June 6, 2008**

A.

Accident Identification

Accident Number:	DCA08-MP001
Type of System:	Hazardous Liquid Pipeline
Accident Type:	Pipe Rupture and Fire
Location:	Carmichael, Mississippi
Date:	November 1, 2007
Time:	10:35:02 a.m. CDT
Owner/Operator:	Dixie Pipeline Company
Material Released:	Propane
Operating Pressure:	Approximately 1405 psi at rupture location
Max. Op. Pressure:	1448 Psi
Component Affected:	12-inch diameter Low Frequency ERW pipe

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Operations Group Members

Cliff Zimmerman
Operations Group Chairman
National Transportation Safety Board
490 L'Enfant Plaza, S.W.
Washington, D.C. 20594
202-314-6468 office
zimmerc@ntsb.gov

Mr. Michael Schwarzkopf
Southern Region Engineer
US DOT, PHMSA
233 Peachtree Street, Suite 600
Atlanta, Georgia 30303
404-832-1158 office
Michael.A.Schwarzkopf@dot.gov

Mr. John Lee Sullivan
Western Area Manager
Dixie Pipeline Company
PO Box 544
Petal, MS 39465
601-582-4343 x26 office
jsullivan@dixiepipeline.com

Mr. Phil W. Miller
General Manager, Engineered Products
Lone Star Steel Company
515 N. Sam Houston Pkwy, Suite 400
Houston, TX 77060
281-447-8818 office
millerp@lonestarsteel.com

Accident Synopsis

On November 1, 2007, at about 10:35:02 a.m. central daylight time, a 12-inch diameter pipeline operated by Dixie Pipeline Company was transporting liquid propane at about 1405 psig when it ruptured in a rural area near Carmichael, Mississippi. Upon being released to the lower pressure of the atmosphere, the liquid propane changed to gas. The resulting gas cloud expanded over nearby homes and ignited as a large fireball, which was heard and seen from miles away. The ensuing fire resulted in the death of 2 people, 7 people with minor injuries, destruction of four homes, damage to several other homes, evacuation of 60 families, and a burned area of about 71.4 acres of mostly grassland/woodland. Approximately 10,253 barrels (430,500 gallons) of propane were ultimately released. Dixie Pipeline Company reported that the cost of the accident, including the loss of product was $3,377,247.

The Accident

About 10:35:02 a.m. CDT, Dixie Pipeline Company's (Dixie) nominal 12-inch diameter pipeline was transporting propane and ruptured approximately 2,672 feet downstream of Carmichael Station (MP 425.48). The ruptured pipe was not located in a high consequence area (HCA). The propane ignited and the ensuing fire resulted in the death of 2 people and 7 injured people were transported to a local hospital. The pipe joint that ruptured was 52' ¾" long with approximately 2 inches of the rupture extending into the downstream pipe joint. The cover on the pipe at the rupture was approximately 41 inches. The 12-inch diameter pipe starts on the west side of the Mississippi River near Erwinville, LA and continues to Opelika, AL. Yellow Creek Station is 18.27 miles upstream of Carmichael Station. Butler Station, the first downstream pump station is 19.28 miles from Carmichael. The system map showing the entire pipeline from Mont Belvieu, TX, to Apex, NC shows the pipeline facilities and various line sizes of pipe used in the system.

On November 1, 2007, the highest discharge pressure recorded at Carmichael Station was 1417 psi, which was the pressure at the time of the rupture. The calculated pressure at the rupture site was approximately 1405 psi at the time of the pipe failure. The Carmichael pressure and flow recorder was reviewed by Dixie and the clock was found to be 8:08 minutes ahead of control center network time. At the time of the rupture, the flow increased from 5952 barrels per hour (BPH) to 7354 BPH.

ATTACHMENT 1	Dixie Pipeline System Map
ATTACHMENT 2	Volume, pressure, time of rupture
ATTACHMENT 3	PHMSA Accident Report HL20070334
ATTACHMENT 4	Carmichael Station Pressure Recorder Data

PHOTOGRAPH 1	12-inch Pipe rupture looking upstream
PHOTOGRAPH 2	12-inch Pipe rupture looking downstream
PHOTOGRAPH 3	Aerial view of burned area in gray, in center ruptured area lighter
PHOTOGRAPH 4	Aerial view of the accident area before the fire

Pipeline Records

Pipe Design Specifications

The specification of the pipe in the segment that ruptured was 12.75-inch diameter, 0.250- inch wall, API[1] grade X52, electric resistance welded (ERW) steel pipe. Lone Star Steel Company manufactured 395 miles of the 12-inch diameter pipe for Dixie in 1961. The pipe was manufactured using a low frequency longitudinal seam weld process and then it was full-body normalized at over 1650 degrees Fahrenheit. The pipeline was constructed in 1961 and the pipe was field coated with coal tar enamel and felt wrap.

Previous In-service Pipeline Failures

For the entire 12-inch diameter pipe prior to the accident, three in-service releases were reported by Dixie and all were in the located in Alabama. A failure from third party damage occurred on December 17, 1969, when a bulldozer hit the pipeline. A small pipe leak on April 3, 1976, was from an unknown cause. A leak on September 2, 1984, was from a 2-inch long crack in the longitudinal seam weld of the 12-inch pipe that occurred while the pipeline was operating at 1440 psi. . No in- service pipeline failures were reported in girth welds. None of these leaks occurred in the area of the 2007 accident.

ATTACHMENT 7 12-inch Pipeline in-service releases

Girth Weld Inspection and Failure History

The original 1961 construction specifications contain welding specifications and a welding procedure. The document details the repair or removal of defects, testing welders, testing welds, and heat-treating, and the acceptance standards for radiographic inspection for the girth welds that were subjected to radiography. When defects were located, the company required that the weld be repaired or replaced at no charge. No construction x-rays were located by Dixie.

ATTACHMENT 34 Welding Specification and Procedure

Pipeline Ownership

Dixie Pipeline Company was the operator of the pipeline at the time of the November 1, 2007 accident. Enterprise Products Operating L.P. became the Managing Partner of Dixie Pipeline Company on July 1, 2005 and subsequently changed it name to Enterprise Products Operating LLC. The following entities have a percentage ownership in Dixie Pipeline Company: Enterprise Products Operating LLC (42.9%), Enterprise NGL Pipelines LLC (31.28%) and

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[1] American Petroleum Institute

Amoco Pipeline Holding Company (BP) (25.82%). The only product this pipeline currently transports is propane.

ATTACHMENT 5	12-inch Pipe Purchase Order
ATTACHMENT 6	Pipe heat normalization
ATTACHMENT 47	Dixie Pipeline Company ownership

One Call, Aerial Patrol and Pipeline Contact Reports

Aerial patrol reports and pipeline contact reports since 2005 were reviewed, which indicate no excavation activity was reported in the area of the rupture. Dixie's Report of Visual Inspection and Repair forms show no work at the rupture location. The closest report was work done at the Hunt Oil pipeline crossing approximately 200 feet north of the rupture. On August 17, 2007, Hunt Oil replaced a segment of pipeline that was about 15 feet from 12-inch Dixie Pipeline. Dixie personnel were present to monitor the work. The one-call reports since 2005 were reviewed and showed no work was done at the location where the pipe ruptured.

ATTACHMENT 29	Aerial Patrol Reports
ATTACHMENT 30	Report of Visual Inspection and Repair
ATTACHMENT 31	One-Call Reports

Corrosion Records

Records for the 2005 and 2006 annual external corrosion control survey were reviewed. The closest upstream pipe to soil potential reading was taken at Carmichael Station. The 2005 reading was –2.091 V at station 22467+54.The 2006 reading was –2.322 V at station 22467+54. The closest downstream reading, taken at the Hunt Oil pipeline crossing, was -2.265V at station 22496+61.

ATTACHMENT 32	2005 Annual External Corrosion Control Survey
ATTACHMENT 33	2006 Annual External Corrosion Control Survey

Operating Pressure Within One Year Prior to the Rupture

Pressure charts from Carmichael Station from November 2006 to October 2007 show that the pipe experienced operating pressures in excess of 1405 psi from November 6, 2006, through February 23, 2007. As an example, on February 23, 2007, the last day the pressure was over 1405 psi before the accident, the pressure chart shows the discharge pressure ranged between 562 and 1435 psi and was between 1405 psi and 1435 psi for approximately 5 hours 18 minutes.

ATTACHMENT 43	Carm Sta press chart 11 06 2006
ATTACHMENT 44	Carm Sta press chart 02 23 2007

Pre-accident Hydrostatic Pressure Tests

In October and November 1961, the entire 12-inch diameter pipeline was hydrostatically pressure tested before it was placed in service. Thirteen pipe failures on the entire 12-inch pipeline occurred before it was tested without leakage. Ten of the pipeline failures were characterized as seam splits or ruptures in the longitudinal seam weld, one as a leak from pipe laminations, one as a leak from pinholes in the seam weld, and one as a leak of undefined extent in the seam weld. The pipeline segment containing the pipe that ruptured had been successfully tested to 1,600 psi for a minimum of 4 hours on October 13, 1961. The pressure at the pipe that ruptured in this accident could not be calculated because there is no record of the pressure recorder location.

In May 1984, a successful hydrostatic pressure test at 1912 psi was completed on the pipeline segment between Carmichael and Demopolis. Although Dixie has no records that confirm the reason for the test, this pressure re-test was apparently done to maintain the current operating pressure while complying with revised hydrostatic pressure test regulations. During the 1984 testing, eight seam splits occurred between 1,802 psi and 1,949 psi at the failure location and a seeping leak occurred at a welded fitting on the pipe. (See Chart 1) Based on the successful 1984 hydrostatic pressure test and the liquid properties, Dixie calculated the maximum operating pressure (MOP) for the segment of pipe from Carmichael to Butler Station to be 1448 psi. The September 2006 system operating pressures chart listed the winter season engineering approved maximum discharge control set point for Carmichael station at 1435 psi. The summer season engineering approved maximum discharge control set point for Carmichael station was listed as 1292 psi in that chart. The pressure at the location where the pipe ruptured in this accident was calculated to be 1816 psi during the 1984 hydrostatic test pressure.

The 1984 hydrostatic test failures from Hattiesburg to Carmichael Station included 6 seam splits occurring between 1,698 psi and 1,832 psi, a seeping leak at a seam at 1,799 psi, and a seeping leak at a field weld (which Dixie indicated was likely a girth weld at MP 367.42) at 1,842 psi at the failure location.

Hydrostatic pressure re-tests were performed on other segments of the 12-inch pipeline in 1983, 2001, 2002, 2004, 2006, and 2007. The pressure range of the seam leaks for these tests was between 1,670 psi and 2,006 psi at the pressure recorder location.

During hydrostatic pressure tests before the accident, the 12-inch pipeline had experienced a total of 59 longitudinal seam ruptures before successful tests were completed.

ATTACHMENT 8	Highway 45- Demopolis Hydrotest 1961
ATTACHMENT 9	12-inch Dixie Hydrotest Leak Data
ATTACHMENT 10	Sulphur- Grangeville- Hattiesburg Hydrotests
ATTACHMENT 11	Hattiesburg - Carmichael Hydrotest 1984
ATTACHMENT 12	Carmichael - Demopolis Hydrotest 1984
ATTACHMENT 13	Demopolis – Milner Hydrotest
ATTACHMENT 14	Operating Pressures – Dixie Pipeline

Chart 1

Dixie 12-inch Propane Pipeline

Hydrostatic Pressure Re-test Failure History before 2007 Accident

Test Year	Segment	Seam Split Failure Pressure Range (psi)	Location of failure in the pipe
1983	Demopolis-Opelika	1702-1980	12 seam splits
1984	Hattiesburg-Carmichael	1698-1832	6 seam splits, 1 weeping seam, 1 field (girth) weld @ 1842 psi
1984	Carmichael-Demopolis	1802-1949	8 seam splits, 1 welded fitting @1505 psi
2001	Mississippi River Trap-Grangeville	1920	1 seam split
2002	Amite River-Grangeville-Hattiesburg	1670-1926	16 seam splits, 1 seep leak in pipe, 1 weld +end fitting
2004	Demopolis-Opelika (2nd re-test)	1900-2006	8 seam splits
2006	Mississippi River Trap-Grangeville (2nd re-test)	No Failures	None
2007	Amite River-Grangeville-Hattiesburg (2nd re-test)	1895-1960	7 seam splits

Dixie Pipeline Integrity Management Program History

The then managing partner, Phillips Pipe Line Company, developed the initial Integrity Management Program (IMP) for Dixie on March 28, 2002. For the Hattiesburg to Demopolis baseline assessment in 2004, the plan's flow chart was used to assess the longitudinal seam. The assessment included evaluation of in-service failures and pressure reversal[2] failures during prior hydrostatic pressure testing. Six pressure reversals resulting in longitudinal seam weld ruptures had occurred on the Hattiesburg to Demopolis segment during the 1984 Hydrostatic pressure test. The magnitude of the pressure reversals for the segment varied between 11- 92 psi. The IMP flow chart for baseline assessment of longitudinal seam weld integrity led to performing a special ERW seam integrity assessment. A special assessment was defined as doing a Transverse (transaxial) Magnetic Flux Leakage (MFL) in-line inspection, an ultrasonic shear wave in-line inspection, or a hydrostatic pressure test.

As a result of Dixie Pipeline's Integrity Management Program (IMP) in effect in 2005, an in-line inspection using the GE Ultra Scan Crack Detection (USCD) in-line inspection (ILI) tool was chosen over hydrostatic testing for the special assessment method. Dixie's procedure did not require any additional analysis or documentation of the assessment selection process for longitudinal seam weld integrity. The ultrasonic tool was selected because it had the capability to detect anomalies in the axial direction (such as crack features in the longitudinal seam) and this tool was compatible with being run in propane. In 2006, a Magpie MFL/ DEF[3] inspection was run to find corrosion and geometric anomalies in the 12-inch pipeline from Hattiesburg to Demopolis. Even though the rupture was not in an HCA, the requirements in the Dixie Pipeline's IMP were the principles used to evaluate the entire pipeline regardless of location.

After Enterprise Products Operating, LP became the Dixie operating partner on July 1, 2005, a process was started to revise Dixie's IMP plan. In IMP Section 5-01 " Risk Analysis Procedure", dated August 4, 2006, which was in effect at the time of the accident, sixteen factors related to defects are taken into account to evaluate pipeline threat factors. Dixie indicated that thirteen of the pipeline defect threat factors are related to the evaluation of longitudinal seam or girth weld defects. The factor for pipe type was specific for the type of longitudinal weld seam and rated pre-1970 ERW pipe as the highest risk factor.

IMP-SEC2-01, subsection 2.2 "Integrity Assessment Method Selection Procedure" in effect at the time of the accident, specifically provided for an evaluation of the pipeline's susceptibility to a longitudinal weld seam failure. The baseline assessment method for longitudinal seam integrity had been updated to use the flow chart contained in a paper developed by John Kiefner titled "Dealing with Low Frequency- Welded ERW Pipe and Flash-Welded Pipe with respect to HCA- Integrity Management Assessment" (paper # ETCE 2002/Pipe-29029). In subsection 2.2.13 it states " failures of original longitudinal weld seams

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[2] "A pressure reversal is defined as the occurrence of a failure of a defect at a pressure level that is below the previous level that the defect previously survived due to defect growth produced by the previous higher pressurization and possible subsequent damage upon depressurization." *The benefits and Limitations of Hydrostatic Testing*, John Kiefner and William A. Maxey
[3] Magnetic Flux Leakage / Deformation

during the original construction hydrostatic test are classified as manufacturing defects and are not fatigue related failures." Additional pipeline history items were included in the flow chart used to evaluate the longitudinal seam threats and included among others: in-service failures, hydrostatic pressure test failures, whether there was a pressure reversal failure (failure at lower test pressure than the previous test pressure), existence of aggressive pressure cycles, and any known effects of corrosion or fatigue. On a scale of 1 to 5, with 5 being the most aggressive defect score for pressure cycles in a segment, all 9 HCA segments from Hattiesburg to Demopolis had scores of 4 or 5. The Assessment Options in the Assessment Method Selection Spreadsheet (3 pages) shows the acceptable options for low frequency ERW seam assessments include TFI (Trans Flux Inspection), AFD (Axial Flaw Detection), UT (Ultrasonic Testing), or Hydro (Hydrostatic Test). The Grangeville to Hattiesburg segment was the only Dixie 12-inch pipeline segment assessed for 2007 and hydrostatic pressure test was chosen as the inspection method for that segment.

ATTACHMENT 15	Dixie Engineering Critical Assessment
ATTACHMENT 16	IMP SEC 5 Risk Analysis Proc 08 04 2006
ATTACHMENT 17	IMP Section 6 BAP 6-28-2002
ATTACHMENT 18	IMP-SEC2-01, subsection 2.2
ATTACHMENT 19	IMP Risk Model- Questions & Select Options for Defects
ATTACHMENT 20	Kiefner ERW Pipe HCA-Related Integrity Assessments-
ATTACHMENT 21	Assessment Method Selection Spreadsheet
ATTACHMENT 22	Dixie IMP Plan Changes

Inspection and Repairs Resulting from In-Line Inspection

After the 2005 inspection was completed, GE performed an Engineering Critical Analysis (ECA) of the features found to determine which seam defects were significant to pipeline integrity. Dixie used this report and inspection data to establish a remediation program for those found to be sub-critical. In late 2005, Dixie identified 43 pipe joints to be excavated at 41 sites and field inspections were performed. In 2006, twenty-one pipe cut-outs were made in the Hattiesburg to Demopolis segment with the entire pipe joint being removed regardless of the minimum cut-out required to remove defect features the in-line inspection had identified. Six of the cut-out joints had been exposed and inspected in the field during 2005 by NDE inspectors. A total of 58 pipe joints were inspected, repaired, or replaced subsequent to the GE USCD tool inspection.

The GE USCD tool reported two features in the joint that ruptured. The features reported were a 4.6-inch long, less than 12.5 % wall thickness notch-like feature adjoining[4] the seam weld and a geometric anomaly 2.8 inches long terminating 1.36 inches from center of the downstream girth weld. Both features were reported in the pipe base metal in close proximity to the longitudinal weld seam.

[4] An adjoining feature is defined as being 0.787 inches (20 mm) on either side of the seam weld

No defect features were reported in the area of the rupture from the 2006 Magpie MFL/DEF inspection or from the prior 1998 Tuboscope Linalog (MFL) inspection. In 2006 as a result of running the Magpie MFL/ DEF tool, field inspections and repairs were completed and one cut-out was done in the remaining Hattiesburg to Demopolis segment.

ATTACHMENT 23 Pipe Rehabilitation from GE USCD ILI
ATTACHMENT 24 ILI Analysis Kiefner 2/1/2008
ATTACHMENT 25 GE USCD Feature List-Fine Evaluation at Ruptured Joint

Laboratory Examination of Hydrostatic Pressure Test Failures

On February 17, 2006, Kiefner and Associates completed an analysis of the 2004 hydrostatic pressure test failures from Demopolis to Milner that included 8 failures on 12-inch diameter ERW low-frequency pipe that ends at Opelika. All of the 12-inch ruptures were evaluated to be manufacturing seam defects including stitching[5], low ductility of the weld bond line, hook cracks,[6] and cold welds[7]. Seven of the failures examined had no obvious point of origin, and none showed any evidence of pressure-cycle induced fatigue crack growth. The failure pressures on the 12-inch diameter pipe were between 1825 psi and 1966 psi and all failures occurred at stress levels exceeding 89.5 % of the specified minimum stress (SMYS[8]).

On September 17, 2007, Stork Metallurgical Consultants prepared an analysis of the May 2007 hydrostatic pressure test from the Louisiana/Mississippi state line to Hattiesburg Station that included 7 ruptures in Lone Star ERW 12-inch pipe. The 12-inch pipe failure pressures occurred from 1895 psi to 1960 psi. There were no definitive features on the fracture surface to confirm the apparent fracture origins. Three ruptures were attributed to hook cracks, three ruptures showed stitching, and one rupture was at a weak and brittle weld that appeared to be a cold weld. Stitching was also evident in two of the ruptures with hook cracks.

ATTACHMENT 26 Kiefner 12 inch DM-ML Dixie Report 06-3R
ATTACHMENT 27 Stork Laboratory Report- LA-MS state line to HA

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[5] API Standard 5T, 10th Edition defines stitching as a variation in the properties of the weld due to repetitive variation in welding heat. The variation in properties gives rise to a regular pattern of light and dark areas visible only when the weld is broken in the weld line.
[6] API Standard 5T, 10th Edition defines hook cracks as metal separations, resulting from imperfections at the edge of the plate or skelp, parallel to t he surface, which turned to the inside diameter or outside diameter pipe surface when the edges are upset during welding.
[7] API Standard 5T, 10th Edition defines a cold weld as a metallurgically inexact tern generally indicating a lack of adequate bonding strength of the abutting edges, due to insufficient heat of pressure. A cold weld may or may not have a separation in the weld line.
[8] The internal pipe pressure corresponding to the pipe's specified minimum yield strength specification is 2,039 psi.

Laboratory Examination of Pipe Removed following 2005 GE USCD Crack Tool Inspection (Draft Report)

On March 31 2007, Stork Metallurgical Consultants, Inc. prepared a draft report titled "Testing and Examination of Pipe from Dixie Pipeline Company's 12-inch Hattiesburg, MS to Demopolis, AL Pipeline." After the GE Ultrasonic Crack Detection (USCD) tool had inspected the pipeline from Hattiesburg to Demopolis in 2005, 21 joints of 12-inch diameter pipe removed from service as part of the pipeline integrity repair program were subjected to a number of tests that included hydrostatic pressure burst and fatigue testing. The failure pressures of the 21 joints ranged from 2,055 psi to 3,250 psi[9] during the burst tests. The average failure pressure of the burst tests was 2,784 psi. All of the pipe ruptures occurred above the specified minimum yield strength of the pipe in the weld seam. No indications of fatigue crack growth were observed on the burst test fracture surfaces.

During the laboratory examination of the fracture surfaces, one fracture (test 16) had a chevron pattern that pointed to the general area of the fracture origin, however no defect was found to determine an initiation site. Two fracture surfaces (test 5 and 10) had multiple flaws near the fracture origin but no hook cracks were found near the origin. The fracture origin of test # 3 was at a hook crack with chevrons found on each side pointing to the crack. The apparent origin of eleven fracture initiation sites was determined to be at hook cracks where no definable fracture characteristic was found pointing to the origin. An apparent fracture origin was not identifiable for 6 fractures (test 2, 4, 7, 11, 14, and 21), but hook cracks were present in the fracture area of each joint.

Scale was found on fracture surfaces of hook cracks on 3 pipe joints (test 7, test 16, and the fatigue rupture joint #10737). The report noted that scale from the heat of welding can sometimes be found on the surface of hook cracks, which shows they formed during manufacture. On the remainder, no scale was apparent during the examination and the report indicated that it was not clear whether the hook cracks formed during manufacture or subsequently due to stress across weak fiber lines.

As a result of the pressure testing, the report stated that a rupture initiated where an inspection indication was recorded during the in-line inspection at 3 of the 21 fracture sites (test 3, 8 and 15). (See Chart 2) At those locations where inspection indications were reported, the failure pressures were 3190 psi, 2250 psi, and 2650 psi. Five additional fracture sites (test 1, 2, 4, 7, 9) were identified in the report as having in-line inspection indications along the length of the fracture. [In addition, Dixie's comparison of the GE USCD inspection results and the fracture location data (this summary follows the Stork Draft report in the attachment) confirmed 4 fractures (test 5, 13, 17, and 19) were identified where an inspection indication was reported along the length of the fracture surface.] For 5 of the fractures (test 6, 10, 16, 20 and 21), the report identified that no ILI inspection indications were reported along the length of the rupture. [The comparison of GE USCD inspection results to the fracture location data confirmed that no

[9] The internal pipe pressure corresponding to the pipe's (average measured) ultimate strength of the material is 3,333 psi.

ILI inspection indications were reported along the length of the rupture on 4 additional fractures (test 11, 12, 14 and 18).]

The fatigue tests were performed on sections of the pipe that had not ruptured in the burst tests. The fatigue test sections were from joint #6418 after being tested to 3025 psi and joint #10737 after being tested to 2250 psi. The two fatigue tests were conducted with pressure-cycles between 300 psi and 1440 psi on un-fractured pipe sections remaining from the hydrostatic pressure burst tests. The first fatigue test on a section of joint #6418 had inspection indications of 3 cracks with the longest being 54 inches and 36.8% wall thickness depth. The test was unsuccessful in rupturing the pipe after 92,636 cycles when the test was terminated. A specimen was prepared for examination from the area with the heaviest inspection indications and no evidence of fatigue crack extension was found. The second test was performed on a section of joint #10737 and a rupture occurred after 1,768 cycles. The section contained 3 regions with lack of fusion signatures that were from 6.75 inches to 24 inches long and 34.4% to 38% wall thickness depth. The rupture was 3 feet 8 inches long and was a location where no inspection indications had been reported. The appearance of the fracture surface indicated that the failure started at a large hook crack with some bright fracture marks present that indicated likely fatigue crack propagation. Scale was found along the surface of the hook crack indicating it originated during manufacture of the pipe. Smaller hook cracks were also present on the fracture surface.

ATTACHMENT 28 Stork Draft HA-DM 12” Joints Exam plus Inspection Data

Chart 2
Stork Report - Hattiesburg to Demopolis Laboratory Examination of Burst Tests

Burst Test #	Failure Pressure (psi)	Fracture Initiation	Initiated at Recorded In-line Inspection Defect
1	2,880	Hook Crack	No (see Note 1)
2	2,797	Not identified	No (see Note 1)
3	3,190	Hook crack with chevron pattern on each side	Yes
4	2,515	Not identified	No (see Note 1)
5	3,200	Two small flaws near bulge	No (see Note 2)
6	2,700	Hook crack	No
7	2,700	Not identified (scale on fracture surface of hook cracks)	No (see Note 1)
8	2,250	Hook crack	Yes
9	2,790	Hook crack	No (see Note 1)
10	3,025	Multiple flaws at apparent origin	No
11	2,250	Not identified	No
12	2,775	Hook crack	No
13	2,775	Hook crack	No (see Note 2)
14	2,055	Not identified	No
15	2,650	Hook crack	Yes
16	3,250	Chevron pattern points to initiation area, but no identifiable defect (scale on fracture surface of hook cracks)	No
17	2,900	Hook crack	No (see Note 2)
18	3,100	Hook crack	No
19	3,050	Hook crack	No (see Note 2)
20	2,770	Hook crack	No
21	2,850	Not identified	No

Note 1 - GE USCD In-line inspection indications reported along length of fracture noted in report.

Note 2 - In-line inspection indications reported along length of fracture confirmed subsequently with a comparison of GE USCD report data.

PHMSA Corrective Action Order

The PHMSA Corrective Action Order issued after the accident required Dixie Pipeline Company and Enterprise Products Partners, LP to immediately take the following corrective actions among other requirements with respect to the pipeline:

- Do not operate the pipeline segment until authorized to do so by the Director, Southern Region
- Develop a return to service plan for PHMSA.
- Maintain a 20% pressure reduction along the entire12-inch pipeline segment from Erwinville, LA to Opelika, AL.
- Commission a consultant to examine the In-line inspection surveys and tabulate the results.
- Submit a written plan, with schedule, to verify the integrity of the entire pipeline segment. The plan must provide integrity testing that addresses all factors known or suspected in the failure, which may include, but not be limited to:
    a. In-line inspection tool surveys and remedial action. The type of in-line inspection tools used shall be technologically appropriate for assessing the system based on the type of failure that occurred on November 1,2007, with emphasis on identifying and evaluating the following: 1) anomalies associated with dents, grooves, and gouges; 2) metal loss due to corrosion; 3) the orientation of the longitudinal pipe seam; 4) pipe deformation; and, 5) longitudinal cracks, mill defects, and stress corrosion cracking.
    b. A detailed description of the inspection and repair criteria to be used in the field evaluation of the anomalies that are excavated. This includes a description of how many defects are to be graded and the schedule for repairs or replacement.
- Respondents may request approval from the Director, Southern Region to increase the operating pressure above the interim maximum pressure based on a showing that the hazard has been abated or that a higher pressure is justified based on an analysis that all known defects, anomalies, and operating parameters of the pipeline segment.

On February 19, 2008, PHMSA issued a Notice of Probable Violation and Proposed Compliance Order to Dixie Pipeline Company regarding not following procedures subject to Part 195.402, Procedure manual for operations, maintenance, and emergencies. The probable violation was for exceeding the design pressure for a component related to Parts 195.406, Maximum Operating Pressure. The compliance order required Dixie to review the data presented in the manual and then to follow their procedures and establish the maximum operating pressures meeting all requirements of Part 195.406. Changes were made to the manual and Dixie provided an additional response on exceeding the design pressure for a component on May 1, 2008.

ATTACHMENT 35 PHMSA Corrective Action Order

Dixie Post-accident Actions

On November 8, 2007, a 12-inch diameter pipe rupture occurred during the hydrostatic pressure test of a 12-mile segment of pipeline downstream of Carmichael Station. The pressure test was required by PHMSA before PHMSA allowed the pipeline to return to service at the reduced operating pressure. During the spike[10] portion of the pressure test, the pipe was pressured to 1979 psi at the hydrotest pressure recorder location. The spike test portion of the pressure test at that location was approximately1.38 times the winter discharge set point (1435 psi) for Carmichael Station. At a location 6.71 miles downstream of Carmichael Station, a 10' 4" long pipe rupture occurred in a longitudinal seam weld at a calculated pressure of 1915 psi. The pressure test rupture was not in an HCA. A review of the Magpie MFL/DEF inspection data after the accident confirmed no features were reported or that any features had been detected that were under the reporting level. The GE USCD tool feature list showed a crack-like feature, 3.5 inches long and 25-40 % of wall thickness depth was reported adjoining the seam weld at 13.57 feet downstream of the upstream girth weld.

As a result of the PHMSA Corrective Action Order, Dixie decided to run the Rosen AFD inspection tool on the 12-inch pipeline to acquire data from a different axial inspection tool technology to compare data from both axial tools in an effort to gain additional insight into pipeline integrity. Since the accident Dixie has run an AFD tool in the entire 12-inch pipeline from the Mississippi River to Opelika. Starting at the Mississippi River, the first run was completed about February 1, 2008 and subsequent runs were completed within one month. Each of the three tool runs had some sensor failure and the data is being evaluated to determine if the runs can be accepted. From preliminary review of the runs, no immediate pipe cut-outs were indicated. On April 8, 2008, Dixie has made a decision to hydrostatically pressure test the 12-inch pipeline segment from Hattiesburg to Demopolis and on May 6, 2008, confirmed that a spike test will be included.

ATTACHMENT 36 Carmichael – MP 437.43 Hydrotest – Nov. 8, 2007
ATTACHMENT 37 GE USCD Feature List at 11/8/2007 Hydrotest Rupture

PHMSA ERW Pipe Reports

In August 1989, the DOT Office of Pipeline Safety completed Technical Report OPS 89-11on electric resistance pipe failures. The two principal causes identified when a metallurgical analysis has been performed on hazardous liquid pipe failures were manufacturing defects or environmental attack on the manufacturing defect. Lack of fusion defects accounted for 52% of the failures between 1977 and 1988. Selective corrosion failures accounted for 10% of the failures and fatigue cracks for another 10%. Hook cracks accounted for 6% of the failures. For all of the in-service failures between 1968-1988 approximately 26% of the failures occurred on pipelines that had been hydrostatically tested. The average time interval between the in-service failure and the most recent hydrostatic test was about 16 years.

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[10] The spike portion of the test is an additional requirement for testing at a pressure above the minimum regulatory requirement of 1.25 times the maximum operating pressure (MOP) that PHMSA mandated as part of the return to service plan.

Based on the 2006 Hazardous Liquid Annual reports to PHMSA there were 48,256 miles of low frequency ERW pipe in liquid pipeline service, including 13,348 miles that transport HVL liquids. For high frequency ERW pipe, 62,132 miles were in liquid pipeline service, including 29,729 miles that transport HVL liquids. A total of 166,133 miles of hazardous liquid pipelines were in service in 2006.

From the PHMSA database for 2002 –2007, there were 22 significant[11] hazardous liquid accidents in low frequency ERW pipe excluding the accident at Carmichael, Mississippi. A significant accident is defined as involving: a fatality or an injury, a fire/explosion not intentionally set, a loss of 50 or more barrels, an HVL release of 5 or more barrels, or costing $50,000 or more. Without including Carmichael, Mississippi, there were no deaths reported and 2 injuries reported in accidents involving low frequency ERW pipe. The pipe failure was at the longitudinal weld seam in nine of the releases from low frequency ERW pipe and one of those releases occurred in Lone Star Steel Company pipe. One of the longitudinal weld seam failures was due to corrosion while the other 8 were classified as material/weld failures.

In two low frequency ERW pipe accident reports, the failures initiated at the girth weld. The first failure cause of the failure was corrosion and the second was determined to be a "burnthrough" defect, which is a cavity in the root pass of the girth weld created during the welding process. Both of these failures occurred in Lone Star Steel Company pipe.

Twenty-Four significant hazardous liquid accidents in high frequency ERW pipe occurred from the PHMSA database for 2002 –2007. In seven of the releases from high frequency ERW pipe, the pipe failure was listed at the longitudinal weld seam. One of the longitudinal weld seam failures was due to other outside force damage while the remaining 6 were classified as material/weld failures. In two high frequency ERW pipe accident reports, the failures initiated at the girth weld with both failure causes classified as material/weld failures.

According to the PHMSA database for 2002 –2007, there were 210 additional failures in ERW pipe where low or high frequency seam data was not reported. A low or high frequency seam weld was not identified in 8 accident reports where the failure was reported at the longitudinal weld seam. Another fifteen reports indicated that the failure was in the body of the pipe, but the summary also contained information that a longitudinal tear or crack was associated with the failure.

During the same time period from 2002-2007, 23 additional significant accidents were reported at girth welds in pipe other than Low-frequency ERW. The cause of eighteen of those accidents was attributed to material/weld failures in the girth weld.

In January 2004, PHMSA instituted a check of accident reports in their Online Data Entry System (ODES) and provided training to region engineers. When an operator submits an accident report in to ODES (on-line or entered in at OPS HQ) the report goes into the Regional Review System (RRS) [liquid reports are filtered to exclude < 5 bbl spills where cost < $50K, no fire - injuries - deaths - water contamination] where it is reviewed by a region engineer for

[11] A significant accident is defined as involving: a fatality or an injury, a fire/explosion not intentionally set, a loss of 50 or more barrels, an HVL release of 5 or more barrels, or costing $50,000 or more.

completeness and accuracy. The report is tracked until complete and then closed by a region engineer.

ATTACHMENT 38	Technical Report OPS 89-11
ATTACHMENT 39	PHMSA ERW Pipe Mileage Data – FY 2006
ATTACHMENT 40	ERW-LF & HF significant Haz Liquid accidents- PHMSA 2002-2007
ATTACHMENT 41	Girth Weld significant Haz Liquid accidents- PHMSA 2002-2007
ATTACHMENT 42	PHMSA Selected Accident Forms for LF ERW

PHMSA IMP Inspection

PHMSA conducted an Integrity Management inspection of Dixie between August 28 and September 12, 2006. On August 2, 2007, PHMSA issued a Notice of Amendment to Dixie to address 8 items in Dixie's Integrity Management Program. The issues identified included:

1. Listing idle lines that affect an HCA;
2. Modify treatment for HCA buffer distances;
3. Must include integrity assessment and all available pipeline information in data for decision-making and also consider tool tolerances in the integration process;
4. More detail of steps taken after receipt of an ILI report to declare discovery of a condition;
5. Include evaluation of station piping within a facility to determine integrity;
6. Require a reduced length of time to complete an information analysis process following the initiation of an integrity assessment evaluation for those segments that have not yet been evaluated;
7. Identify specific triggers for initiation of periodic evaluation including Information Analysis within 3 years following the completion of an integrity assessment;
8. Include specific inputs used in the reassessment interval determination process.

Dixie responded by revising the IMP and submitted amended procedures dated December 18, 2006, and September 6 and 20, 2007. PHMSA reviewed the material and deemed the modifications adequate. On December 12, 2007, PHMSA sent notification to Dixie that the changes had been accepted and the Notice of Amendment had been closed.

ATTACHMENT 45	PHMSA Notice of Amendment, August 4, 2007
ATTACHMENT 46	Closure Letter for Notice of Amendment

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ATTACHMENT 1	Dixie Pipeline System Map
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ATTACHMENT 3	PHMSA Accident Report HL20070334
ATTACHMENT 4	Carmichael Station Pressure Recorder Data
ATTACHMENT 5	12-inch Pipe Purchase Order
ATTACHMENT 6	Pipe heat normalization
ATTACHMENT 7	12-inch Pipeline in-service releases
ATTACHMENT 8	Highway 45- Demopolis Hydrotest 1961
ATTACHMENT 9	12-inch Dixie Hydrotest Leak Data
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ATTACHMENT 17	IMP Section 6 BAP 6-28-2002
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ATTACHMENT 19	IMP Risk Model- Questions & Select Options for Defects
ATTACHMENT 20	Kiefner ERW Pipe HCA-Related Integrity Assessments-
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ATTACHMENT 24	ILI Analysis Kiefner 2/1/2008
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