NATIONAL TRANSPORTATION SAFETY BOARD
Office of Railroad, Pipeline and Hazardous Materials Investigations
Washington, D.C. 20594

August 23, 2001

RELIEF VALVE GROUP FACTUAL REPORT

A. Accident Identification

Accident:	Pipeline fire and rupture
Location:	Bellingham, Washington
Date:	June 10, 1999
Time:	4:43 p.m. Pacific Daylight Time
Operator:	Olympic Pipe Line Co.
Product:	Gasoline
Number:	DCA-99-MP-008

B. Group Members/Participants

Mr. Robert H. Trainor
National Transportation Safety Board
490 L'Enfant Plaza East, SW
Washington, DC 20594
202-314-6467

C. Accident Summary

About 3:30 p.m. on June 10, 1999, a 16-inch diameter steel pipeline owned by Olympic Pipe Line Company ruptured and released about one-quarter million gallons of gasoline into a creek that flowed through Whatcom Falls Park in Bellingham, Washington. The gasoline was ignited about 1½ hours after the rupture with the fire traveling approximately 1½ miles downstream. Two young boys, both 10 years old, and a young man 18 years old were killed as a result of the accident. Eight additional injuries were documented. A single family residence and the City of Bellingham's water treatment plant were severely damaged.

D. Relief Valve Information

General.—RV 1919 was located at the Bayview Products Terminal in an 8-inch pipeline branching off the 16-inch "Ferndale inlet" pipeline into the terminal. RV 1919 was installed to protect the piping at the Bayview terminal from pressures surges from the 16-inch Ferndale inlet pipeline that could potentially exceed the maximum allowable operating pressure of 740 psig of

the terminal piping.[1] Under normal operating conditions RV 1919 was closed; however, RV 1919 was designed to open when the operating pressure exceeded the "set point" of the pilot valve for RV 1919. The pilot valve would then open, and cause the main piston of RV 1919 to open, and thereby divert the product from the terminal piping into fixed storage tank 209.

(Appendices A and B.)

Design.—RV 1919 was an 8-inch Brooks model 760 control valve[2] manufactured by Fisher-Rosemount Petroleum.[3] According to the manufacturer's specifications, the model 760 control valve is designed to regulate inlet pressure within ± 2 psi regardless of variations in flow rate or downstream pressure. The model 760 valve contains a piston and main valve control spring. The inlet pressure to the valve works to push the piston up and thereby open the valve for flow. As the inlet pressure on the piston head pushes the piston up, the compression of the main valve control spring exerts a downward counterforce against the piston to close the valve. The inlet pressure is reduced by flow through the open valve. When the counterforce exerted by control spring exceeds that from the inlet pressure, the piston reseats and the valve closes.

A relief valve with a pilot valve such RV 1919 monitor the inlet pressure on the main relief valve and provide controlled throttling (opening and closing) of the relief valve such that the relief valve opens at a predetermined maximum inlet pressure and dissipates excess pressure. Such a pilot-control system also provides pressure relief protection without an external power source to open and close relief valve.

The main component of the pilot-control system is the pilot valve, which, like the relief valve, is a spring-loaded valve. The pilot valve, through the use of a specific spring, valve cover, piston, and o-ring, will be rated to operate [open] within a specific pressure range. The rated pressure range for a pilot valve can be altered to another designated pressure range only if the pilot valve has the correct spring, valve cover, piston, and o-ring required for the new pressure range. As manufactured, the pilot valve and the relief valve are interconnected by a series of product/sensing tube lines. A line extends from the inlet of the relief valve and splits into two branches with one branch to the inlet of the pilot valve and the second branch to the backside (spring-side) of the relief valve piston. A combination needle valve/strainer is located in the branch line to the spring-side of the relief valve piston. The needle valve is to control the closing speed of the relief valve. A tube line connects the sense port on the pilot valve to the inlet of the main valve. The pressure inputs through this sensing tube line acts against the bottom of the piston in the pilot valve.[4] Compression of the pilot valve spring creates a counteracting and

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[1] The 8-inch piping at the Bayview terminal was rated as ANSI 300 pound pipe, and by definition had a maximum allowable working pressure of 740 psi. The 16-inch Ferndale inlet pipeline was rated as ANSI 600 pound pipe with a maximum allowable working pressure of 1480 psi.

[2] "Control valve" is the terminology used in the Brooks literature. RV 1919 functioned as a pressure relief valve and will be described as such in this report.

[3] Purchase orders and invoices for RV 1919 denote Brooks model valves offered through Fisher-Rosemount Petroleum, a division of Emerson Electric Company. Fisher-Rosemount Petroleum is now Daniel Measurement and Control Division, a division of Emerson. For this report, Fisher-Rosemount will be used to designate the company/facility that sold RV 1919 and other relief valves used by Olympic Pipe Line Company.

[4] Fisher-Rosemount representatives noted during the examination of RV 1919 at Stress Engineering Services in September 2000 that the pilot control tube lines on RV 1919 had been modified and manual valves added.

opposing force against the top of the pilot valve piston. If the pressure inputs are great enough, the piston moves upward and the pilot valve opens. The upward movement of the piston also causes further compression of the spring and increases the counteracting spring force. The main relief valve will open only when the pilot valve is open. As the inlet pressure is relieved, the spring force eventually exceeds the pressure inputs and causes the pilot valve, and in turn the main relief valve to close. In order for the pilot valve to open, the piston for the pilot valve must be able to physically move upward and compress the spring.

Fisher Rosemount Petroleum offers pilot valves that are designed to operate over a variety of pressure ranges. Fisher Rosemount Petroleum attaches a metal plate or tag to each pilot valve indicating the pressure range for the pilot valve. Fisher Rosemount Petroleum also calibrates the "set point"[5] of each pilot valve and attaches a tag to the pilot valve certifying the set point of the pilot valve before the valve is shipped from the manufacturing facility. The set point of the pilot valve can be increased by manually compressing the pilot valve spring by tightening the adjustment screw on the top of the valve, and likewise decreased by loosening the adjustment screw.

RV 1919 was equipped with a model 1760 pilot control valve with a rated pressure range of 70 to 180 psi.[6] The available pilot spring pressure ranges for this model pilot valve were:

- 0 to 20 psig;
- 0 to 40 psig;
- 30 to 80 psig;
- 70 to 180 psig;
- 150 to 350 psig; and
- 350 to 650 psig.

A Brooks (Fisher-Rosemount Petroleum) technical bulletin for control valves pilot springs (number V-9500-11 dated September 1984) notes that the proper spring and piston are needed to establish the desired set point range for the pilot valve. A Brooks part list (number PL-V7560-20 dated April 1992) also sets forth the various parts required to establish the desired rated pressure range for the pilot valve.

(Appendix C.)

Operating Parameters for RV 1919.—According to a contingency analysis dated July 18, 1997, and prepared by the Jacobs Engineering Group, Inc. (a design contractor for Olympic Pipe Line), the set pressure [point] for RV 1919 and three other relief valves intended to protect the ANSI 300 # piping from pressure surges was to be 740 psig, the equivalent of the maximum allowable working pressure for this class of ANSI-rated pipe.

Olympic provided the National Transportation Safety Board a copy of a Jacobs Engineering instrument specification sheet for RV 1919 dated December 17, 1997, and stamped

[5] The pressure within the pilot valve's rated pressure range at which it opens.
[6] *Testing of Pressure Relief Valve "RV 1919"*, Stress Engineering Services, Inc., Houston, Texas, December 2000.

with the number 0001546. The following operating parameters/specifications for RV 1919 were indicated:

Line 2:	Manufacturer/Model	Brooks / 8" 300 # RFF Model 760
Line 4.	Service	Full flow relief
Line 14:	Inlet Size/Rating	8 in / 300# RF Flange
Line 15:	Outlet Size/Rating	8 in / 300# RF Flange
Line 28:	Fluid	Diesel
Line 29:	Flow Units	US gal/min
Line 30:	Flow @ Relieving Conditions	8400
Line 33:	Pressure psig – Operating	blank
Line 34:	Press. psig – Process set/Spring set	740 / blank
Line 35:	Temp. ^{o}F – Operating/Design/Relief	blank/ blank/ 100

Fisher Rosemount Petroleum provided the Safety Board with a copy of the Olympic Pipe Line purchase order dated January 6, 1998, for full flow relief valves. RV 1919 was one of four Brooks 8-inch 300# RFF Model 760 full flow relief valves included under this purchase order.[7] (The purchase order also included an order for 7 150# Model 760 relief valves.) The purchase order referenced the instrument data [specification] sheet for each of the eleven valves. A copy of the Jacobs Engineering instrument specification sheet for each of the eleven valves was also attached to the purchase order.

The copy of the Jacobs Engineering instrument specification sheet for RV 1919 had the following hand-written notations - the printed number "100" for the relief temperature at line 35 was circled, and "70-180" was handwritten above the circle. The other instrument specification sheets did not have any hand-written notations. Representatives for Fisher-Rosemount Petroleum (now Daniel Measurement and Control) confirmed in a June 4, 2001, letter that the handwritten notation "in all likelihood" refers to the spring range used for a 100 psi setting for the model 1760 pilot control valve on the model 760 pressure relief valve. The letter also notes that the notation was made by an employee in the order entry group at the Statesboro manufacturing facility. The letter also confirms that RV 1919 was shipped with a pilot control pressure set point of 100 psi, and that this set point was indicated on the "27803" order acknowledgement dated March 19, 1998, and on the certified print "760.234-1-K" dated February 2, 1998. The letter concludes:

> "With respect to RV 1919, as discussed above, the instrument data sheet from Olympic/Jacobs Engineering indicates on Line 35, third box in the right hand column, a pressure relief setting of 100 psi. This 100 psi pressure set point was confirmed in subsequent documentation to Olympic/Jacobs Engineering."

Various Fisher Rosemount Petroleum invoices and acknowledgements for the purchase order identify pilot valve for RV 1919 and the three other 300 # valves as a model 760 relief valves and equipped with model 1760 pilot control valves set at 100 psig. These invoices and

[7] The three other relief valves were RV 1923, RV 1932, and RV 1941.

acknowledgements also indicate that the relief valves were sold to Jacobs Engineering Group, Inc. and were to be shipped to Olympic Pipe Line to meet a delivery date of April 17, 1998.

(Appendices B, D, E, F, and G.)

Purchase of Replacement Parts.—On December 17, 1998, Fisher Rosemount Petroleum received and processed a rush order on behalf of Olympic for four springs (part number 460024) for a pilot control valve. (This particular spring can be used in a pilot control valve with a set point range of 70 to 180 psig or 350 to 650 psig depending on the piston, cover, and o-ring selected.) The four springs were shipped to Olympic about December 22, 1998.

(Appendix H.)

E. Federal Regulations

U.S. Department of Transportation (DOT) regulations for pipelines transporting hazardous liquids[8] are found in 49 CFR 195, including testing requirements for overpressure safety devices and overfill protection systems in 49 CFR 195.428. According to 49 CFR 195.428(a):

> Each operator shall, at intervals not exceeding 15 months, but at least once each calendar year, or in the case of pipelines used to carry highly volatile liquids, at intervals not to exceed 7½ months, but at least twice each calendar year, inspect and test each pressure limiting device, relief valve, pressure regulator, or other item of pressure control equipment to determine that it is functioning properly, is in good mechanical condition, and is adequate from the standpoint of capacity and reliability of operation for the service in which it is used.

49 CFR 195 does not otherwise address testing methods or performance standards for relief valves or other pressure control equipment.

Robert H. Trainor
Relief Valve Group Chairman

[8] Under 49 CFR 195.8, a *hazardous liquid* means petroleum, petroleum products, or anhydrous ammonia. A *highly volatile liquid* means a hazardous liquid which will form a vapor cloud when released to the atmosphere and which has a vapor pressure exceeding 40 psia at 100 ^{o}F. The vapor pressure of gasoline, the product released in the Bellingham accident, at 100 ^{o}F is about 7.5 psia.

Appendices

A. Olympic Pipe Line system map and piping and instrumentation diagram for the Bay view product terminal.
B. Jacobs Engineering Group contingency analysis dated July 18, 1997.
C. Manufacturer's technical bulletins and design specifications for model 760 control valve and model 1760 pilot valve.
D. Instrument specification sheet for RV 1919 dated 12/17/97, marked "0001546", and submitted by Olympic Pipe Line.
E. Olympic Pipe Line purchase order dated January 6, 1998, and instrument specification sheet for RV 1919, submitted by Fisher Rosemount Petroleum.
F. Fisher Rosemount Petroleum invoices and acknowledgements for Olympic purchase order of RV 1919 and other relief valves.
G. Attorney letter dated June 4, 2001, re handwritten notations on RV 1919 instrument sheet.
H. Fisher Rosemount Petroleum invoices and acknowledgements for Olympic purchase order of pressure spring (part number 460024).