A Look Into:

Pipeline Inspection, Design, and Failure Analysis

White Paper | Berkeley Engineering And Research, Inc.

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AFTERMATH OF THE SAN BRUNO PIPELINE EXPLOSION. BROCKEN INAGLORY, CC BY-SA 3.0

Pipeline Design and Failure Analysis

Berkeley Engineering And Research, Inc. has extensive experience inspecting, qualifying, designing, and analyzing the failure of pipelines. Our CEO, Dr. Glen Stevick, P.E. focused his doctoral research and dissertation on the "why" of the 1985 disaster of the Mohave and Detroit Edison Power Station's main steam pipe's failure. The critical factor contributing to the failure - a mismatch in high temperature weld material properties resulted in a change in the ASME Piping Code and Dr. Stevick's recruitment to serve for 10 years on the ASME's piping code design committee.

Pipes are the most cost effective and safest method to transport most gas, liquids and slurries. Unfortunately, failures are still common. This year, there have been 573 incidents, with 30 reports of injury and nine fatalities recorded by the Pipeline and Hazardous Materials Safety Administration (PHMSA). In addition to the loss of human life, the total cost of this damage has totaled **over $240 million.**

PHMSA Pipeline Incidents: Multi-Year Averages (1999-2018)

Incident Type: All Reported **System Type:** (All Column Values) **State:** (All Column Values)

	Incident Count
3 Year Average - (2016-2018)	639
5 Year Average - (2014-2018)	667
10 Year Average - (2009-2018)	632
20 Year Average - (1999-2018)	600

	Fatalities	Injuries	Total Cost
3 Year Average	15	72	$596,564,976
5 Year Average	15	72	$492,194,869
10 Year Average	14	69	$535,743,184
20 Year Average	16	65	$418,377,790

	2019 Year-To-Date
Incidents	573
Fatalities	9
Injuries	30
Total Cost	$240,406,849

Source: phmsa.dot.gov (12/11/2019)

Source of Failures

Material/Weld/Equipment Failures

Material, weld, and equipment failures are the most common root cause of pipeline failures based on PHMSA data representing 42% of all cases reported, shown below. Corrosion and incorrect operation follow– each at 13%. BEAR has the capability to identify, differentiate and explain all of the various root causes using our state-of-the-art equipment, testing lab and engineering experience.

BEAR Engineers have identified the cause of many pipeline failures during our 27 years in business, including the Covalo (1998) and the San Bruno (2010) explosions. To help prevent future catastrophic gas pipeline failures, we provided our assistance to the California Public Utilities Commission to determine and endorse appropriate safety and hydrotest procedures.

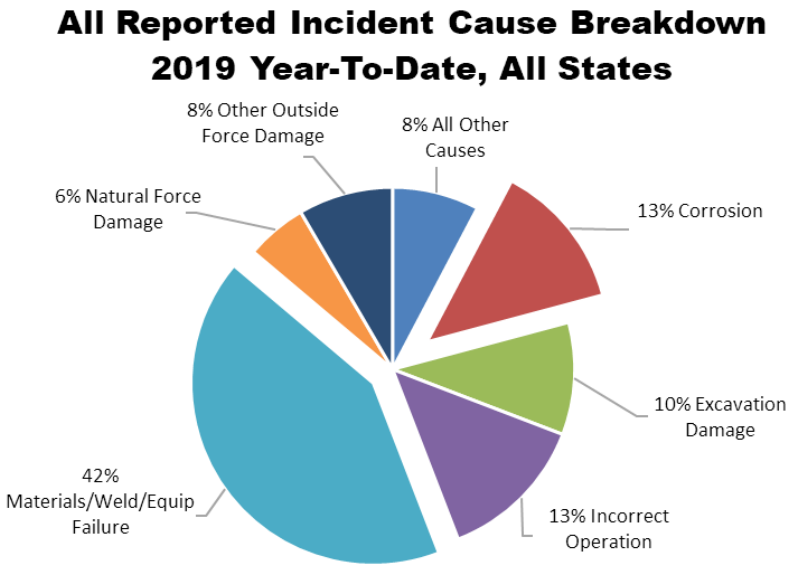

FIGURE 1 SOURCE: PHMSA.DOT.GOV (12/11/2019)

Welds and Corrosion

As the data shows above, welds and corrosion are the leading causes of pipeline failures. Welds hold the many sections of pipelines together. This is a common process used to fuse sections together using heat and a filler material, and is common in piping to securely connect different lengths together. But it is an craft as much as it is a science. An insufficient weld is all that is needed to cause a dangerous and premature failure. When poorly heated, a weld may not penetrate enough to securely connect two parts, but when heated too much, it may compromise the chemistry and the performance of the base material.

Corrosion, on the other hand, is the process by which the environment can slowly degrade a material. Certain materials are more resistant than others and there are ways to improve or restrict it when material choice is limited. For example, highly saline environments, such are those near large bodies of ocean, are especially susceptible to corrosion and diligence should be used when designing products or structures exposed to such conditions. Welds and corrosion can unfortunately go hand in hand, as the compromising effects on the chemistry from the heat could compromise corrosion resistance. With the proper inspection and testing techniques, these failure mechanisms can be identified.

Pipeline Projects

Berkeley Engineering And Research has led the investigations into a number of major pipeline incidents. Below, we highlight two of our projects. Think you might have a pipeline case we could help you on? Contact us for a consultation!

San Bruno, California

Gas Pipeline Explosion

The San Bruno pipeline disaster occurred when a natural gas pipeline owned by PG&E exploded into flames in a neighborhood just west of the San Francisco Airport. The failed section of the pipeline is shown below. The devastation was immense—almost 50 homes were destroyed, and nine fatalities resulted. The image on the first page of this brochure reveals only a portion of this damage. BEAR inspected the failure and identified its cause as defective welds in the pipeline. The intensive pressure in the line, and the increasing demand for energy from San Bruno's expanding user base lead to this failure.

New York, New York

Steam Pipe Explosion

An explosion in Manhattan shot a 40-story-high shower of steam and debris caused by the failure of an underground steam pipe. BEAR was engaged to assess maintenance procedures and provide recommendations to avoid future incidents. Engineers from BEAR's team investigated the failed parts of the pipeline and outlined the timeline of events leading up to the explosion. Ultimately, negligent maintenance practices were also revealed and identified as a major motivator in the ultimate failure of the pipeline.

Berkeley Engineering And Research, Inc. has designed and analyzed hundreds of smaller pipes and hoses for use in water, propane, natural gas and many other applications in homes, power plants, chemical plants, factories and refineries. At our laboratory, our engineers perform fatigue tests, destructive and non-destructive inspections, and computer analyses of piping systems and pipe failures for clients around the world. Based in Berkeley, CA, we have over 10,000 square feet of testing space, including a materials lab, machine shop, combustion lab, and more.

If you would like more info, or need our expertise,
contact our Case Manager, Chelsea Torgersen-Bell at 510-549-3300x107.

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