Prior to 1993, the AREA Manual recommended that all pipelines carrying flammable gas and flammable liquids under the track to be encased in a larger steel pipe. This casing requirement was somewhat unique to the railroad industry. Except for the State of New York, no other state or federal regulatory agency required casings. No other professional organization such as the ASCE, ASME, or API required casings.

Naturally, the pipeline industry questioned the necessity of casings under railroads. In 1985, the Gas Research Institute solicited Cornell University to conduct a study to determine alternatives to casing pipes. Although the research was funded by the Gas Research Institute, members of AREA and American Petroleum Institute participated in the study. One of the participants is here with me today. Mr. George Fox represented the API, an organization whose members are primarily engaged in the business of transport of liquid flammable materials through pipelines.

Cornell research included comprehensive fully three dimensional finite element modeling (FEM), followed by parametric reduction into simplified design formulas and design curves. The Cornell FEM results did not compare well with the most widely used design methods developed by Spangler in 1956 and 1964. In order to verify the Cornell design methods, full-scale field tests were performed by AAR at the Transportation Test Center at Pueblo.
Tests were performed using instrumented 12 inch and 36-inch diameter pipes buried at 5.7 ft. and 5.8 ft. below base of rail. Over a two-year period, field test measurements of both circumferential and longitudinal strain were in excellent agreement with the predicted strains of the analytical FEM, thus validating the Cornell methodology. Comprehensive details and test results appear in the December 1992 A.R.E.A. Bulletin No. 738, page 383 through 403, titled “Commentary on the Design of Uncased Pipelines at Railroad Crossings”

The design procedure was then utilized to draft a revision of Chapter 1, Part 5 of the AREA Manual to reflect, as an acceptable alternative, the use of uncased pipelines under railroads provided that wall thickness and burial depth met stated conservative minimums. Those changes were printed in the 1993 manual.

However the Manual revisions of 1993 only applied to pipelines conveying flammable gas. They did not include alternatives for pipelines conveying liquid flammable materials. The casing requirements for liquid flammable materials remained unchanged. The railroad industry was concerned that a high pressure liquid leak could develop under the track. It was perceived that a casing would prevent the embankment from erosion.

I will now present Mr. George Fox III, who will tell you “the rest of the story”.

Presentation by Mr. George Fox III:

Don has asked me to come here today to provide you with information regarding revising the AREA Manual Chapter 1, Part 5 Pipelines, to allow for Specifications for Uncased Pipelines Conveying Liquid Flammable Substances. My background contains more than 40 years experience in the pipeline industry. I have been involved with the design, construction, operation and maintenance of high-pressure transmission pipelines over these years. Perhaps more importantly, I was the American Petroleum Institute’s (API) representative on the 7 year Cornell/Gas Research Institute (GRI) study of Pipelines Crossing Railroads and Highways and was co-editor with Dr. Harry Stewart from Cornell, of the API Recommended Practice 1102 Steel Pipelines Crossing Railroads and Highways 1993.

Pro’s & Con’s of Casings

Pro Casing

Historic (1880s - 1950s) perspective for the need/desire of casing around a carrier pipe.

With the discovery of crude oil and the desire to transport it quickly and economically to market, many pipelines began to be installed. These early lines were of generally small diameter, up to 8 inches, were of wrought iron or steel and were joined together by threads into collars or other mechanical couplings. Two other important considerations were that these lines were laid bare and as a regular matter pumped crude oil that contained water and sediments from the production well. With the last items fostering external
and internal corrosion, poor joint connections and the lack of environmental sensitivity that we have today, pipeline leaks were commonplace. Because of the propensity of pipelines to leak, both pipeliners and railroaders wanted casings for railroad crossings. However they had different reasons, the pipeliners felt that casings would provide an easy way to replace, at low cost, a leaky unsatisfactory crossing and the railroaders wanted protection from the leaky pipeline washing out their roadbed. Another matter of concern, was that a train would impose a load on a pipe installed underneath the roadbed and possibly crush it. A casing would prohibit this unknown load from being transferred to the pipe. I have named this a factor of ignorance, i.e. if you don’t know what it is, eliminate it or make it substantially stronger. We have better tools now and have found some cases where structures had been constructed with double-digit safety factors to account for this factor. As the years went by, pipe sizes became larger and the joining became more effective with the advent of acetylene welding. These liquid pipelines began to carry refined petroleum products as well as crude oil.

**Modern Era Liquid Pipelines (post 1950s)**

While I don’t have the precise dates, the following have substantially reduced the likelihood and/or minimize pipeline leaks:

- Invention of insulating protective coatings & cathodic protection systems
- Improved pipemaking and non-destructive testing methods
- Electric welding and radiographic inspection of pipe joints
- Advent of corrosion inhibitors to eliminate internal corrosion
• Required hydrotesting of pipelines to 125% of their maximum operating pressure
• Internal inspection devices (smart pigs)
• Computerized leak detection systems
• Ability to determine stresses effecting a pipeline in railroad crossing situations
• The extreme cost of a leak and its subsequent cleanup

Probably the single most important factor in the safety of modern pipelines is the use of coatings and cathodic protection systems on steel pipes. Without protection steel pipe will eventually go to a lower potential state by corroding to iron oxide, rust. The first step in a protection scheme is to insulate the pipe from the ground with a protective coating. If you could be certain that the coating is and will remain perfect, you don’t have to do any more. However in the real world nothing is perfect and the coating has or will develop small imperfections. To combat the coating imperfections, a direct current electrical charge or voltage is put on the pipe making it the cathode and the surrounding ground an anode. This is done so that the direction of electron flow is to the pipe instead of away from it. This potential difference between the pipe and the ground is constantly maintained by a series of anodes or rectifiers and is regularly tested along the pipeline.

**Con’s of Casing**

In the Modern Era of high pressure transmission pipelines the industry has found casings to be the cause of many problems and not the solution once
thought. A large percentage of pipeline maintenance budgets are spent each year repairing pipelines at casings.

Problems attendant with casings:

- Natural earth movements caused by freeze/thaw, heating/cooling and wetting/drying, settlement due to construction of the crossing along with liquid temperature cycles within the pipeline and superimposed load cycles from trains, cause the pipe and casing to move differentially. These movements over time, despite the best efforts to insulate them from each other, often cause the pipe and casing to touch one another causing a short. This short grounds the cathodic protection system and eliminates the protection, allowing the pipe to corrode. In extreme cases this differential movement can cause significant stress on the carrier pipe at the casing end. While it would seem easy to say; when it shorts fix it, the problem is that some shorts are intermittent, may be in the middle of a crossing, are difficult to excavate and combined with the fact that there are hundreds of thousands of pipeline casings you begin to understand the problem.

- In many cases a pipeline casing is sealed at each ends to prevent groundwater infiltration or flow. When equipped with required vents, the casing will contain water after a period of time because the pipeline will be relatively cold and will condense moisture from the air. This presents a problem of atmospheric corrosion which the cathodic protection will not contend with.

- The reason that the cathodic protection system is ineffective within a casing is that the metal casing pipe shields the carrier pipe from the protecting cathodic protection current. Also because of the casing, determining what the status of the pipeline within the casing is difficult to
conclude without running a smart pig, which may or may not be possible due to the pipeline’s design.

**Change - What’s In It For Me?**

1. On modern pipelines, casings cause problems without solving any. If a pipeline has a railroad casing problem, you, the railroad, will be effected.
2. Simplify the AREMA manual to allow for uncased liquid steel pipelines crossings; thereby reducing your engineering time, expense and complexity.
3. Avoid expensive and time consuming litigation.
4. Eliminate Factors of Ignorance - utilize the 7 years and millions of dollars of effort invested by the pipeline industry and Cornell working along with AREMA members to accurately generate design criterion for steel pipelines crossing railroads. They apply to everyone both gas and liquid.
5. Join other Professional Societies such as American Society of Civil Engineers (ASCE), American Society of Mechanical Engineers (ASME), American Petroleum Institute (API) and Governmental Agencies such as the U.S.D.O.T Office of Pipeline Safety allowing uncased crossings of railroads by liquid petroleum pipelines.
Presentation by Mr. Don Lozano:

Thank you Mr. Fox.


According to the report, the leading cause of pipeline incidents is “third-party” damage, (i.e. incidents where excavation results in a leak or rupture of a buried pipeline) which accounted for 19.9 percent of all incidents. The next most common cause is “external corrosion” which accounts for a nearly identical 19.4% of all incidents. Thus, elimination of these two categories should reduce incidents by nearly 40%.

While a casing will provide some mechanical protection against third party damage, the degree of protection is marginal considering the ripping force of excavators. There are more practical ways of achieving this protection without the problems inherent to casings. In many soil conditions, deeper burial is a practical method to reduce the risk of third party damage. Modern directional drilling techniques can economically achieve greater installation depths without interruption to railroad traffic.

The second leading cause of pipeline incidents is external corrosion. As Mr. Fox has explained, a casing pipe increases the risk of corrosion by defeating cathodic protection and exposing the carrier pipe to atmospheric corrosion.
Therefore elimination of the casing pipe will actually reduce the potential development of a leak caused by external corrosion.

The evidence is convincing. The perceived added factor of safety provided by a casing pipe does not outweigh the negative effects that a casing has on the overall reliability of the carrier pipe. In addition to modern cathodic protection systems and deeper burial, the pipeline industry has been successful in reduction of incidents through public awareness programs, underground utility “One Call” programs and more frequent markings for pipelines.

Thank you for your attention. I will now volunteer Mr. George Fox to answer questions from the audience.