Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

REASSESSMENT OF THE RESPONSE TO
PIPELINE SAFETY RECOMMENDATION P95-01 – P94H0003

Background

On 15 February 1994, a rupture and a fire occurred on the Foothills Pipe Lines (Sask.) Ltd. (FPL) 1067-millimetre (42-inch) natural gas pipeline at Kilometre Post (kmp) 66 + 041 near Maple Creek, Saskatchewan. The rupture initiated at the mid-wall of the pipe wall under or adjacent to a "sulphurcrete" saddle weight. There were no injuries.

The Transportation Safety Board of Canada (the Board) determined that the rupture was caused by the ductile fracture of a delamination in the mid-wall of the pipe. The delamination was produced by the diffusion of atomic hydrogen at inclusions in the pipe steel during normal pipeline operations. This mechanism is known as hydrogen induced cracking (HIC) and requires both a source of atomic hydrogen and a mechanism to drive or permit the hydrogen atoms to enter the steel.

The susceptibility of line pipe steels to HIC depends on several metallurgical and environmental factors which must occur concurrently to cause a HIC flaw to initiate and propagate to failure. All these factors were present in the vicinity of the rupture at kmp 66 + 041.

The Board concluded its investigation and released report P94H0003 on 23 August 1995.

Board Recommendation P95-01

Historically, HIC has been associated with the transmission of sour gas. It would appear as if the difference between the manufacturing standards for steel pipe intended for sour service versus sweet service was based on the assumption that HIC was mainly a function of the chemical characteristics of the commodity carried in the pipe. However, following this occurrence it is apparent that certain subsurface environmental conditions are also conducive to corrosive reactions on the surface of the pipe, allowing atomic hydrogen to be absorbed through the exterior walls of the pipe if the protective coating of the pipe has been breached.

Given that steel pipe may still be manufactured in Canada to a standard that does not provide adequate resistance to HIC, the Board recommends that:

> The National Energy Board, in conjunction with the Canadian Standards Association, re-evaluate the standards for steel pipe manufacturing with respect to the prevention of hydrogen entrapment within the pipe wall.
>
> P95-01

Response to P95-01 (30 November 1995)

The National Energy Board (NEB) accepted the recommendation and indicated its intent to review, with the Canadian Standards Association, the standards for steel pipe manufacturing with respect to the prevention of hydrogen entrapment within the pipe wall.

Board Assessment of Response to P95-01 (30 January 1996)

Since the intended review could identify changes which, if implemented, could result in pipe that is more resistant to hydrogen-induced cracking, the response to Recommendation P95-01 was assessed as **Satisfactory Intent**.

Board Reassessment of Response to P95-01 (February 2006)

The standards for the manufacturing of steel pipe were subsequently changed to ensure that pipe used in sour natural gas service is more resistant to hydrogen induced cracking. However, since the changes to the standards did not address steel pipe used in sweet gas service, the Board maintained the assessment of the response to this recommendation as "*Satisfactory Intent"*.

Additional Response to P95-01 (January 2011)

The NEB indicated that pursuant to CSA Z662, pipeline companies now have in place integrity management programs to identify threats to their systems, such as hydrogen entrapment within the pipe wall, as well as plans and procedures to mitigate those threats. In addition, the NEB conducts compliance monitoring programs, comprising inspections, audits and incident investigations, to verify that the integrity management programs are functioning as intended. Recent changes to the Z245 standard address the issue of hydrogen entrapment within the pipe wall of pipe used in both sour and sweet gas service. In conjunction, pipeline companies closely monitor the levels of Cathodic Protection (CP) applied to buried pipeline systems to ensure these levels do not exceed the upper design range permitted by the Z662, thus preventing CP overcharging and associated hydrogen production.

Board Reassessment of Response to P95-01 (February 2011)

The Board considers that implementation of these programs should ensure that companies have identified hydrogen entrapment as a possible threat in sweet gas service. The recent changes to the Z245 standard address the issue of hydrogen entrapment within the pipe wall of pipe used in both sour and sweet gas service. Therefore, the Board has reassessed the response to this recommendation as "***Fully Satisfactory".***

Next TSB Action

This deficiency file is assigned an "***Inactive"*** status.