PIPELINE INCIDENTS CAUSED BY MECHANICAL DAMAGE

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HOW MECHANICAL DAMAGE CAN AFFECT A PIPELINE

Mechanical equipment hits and punctures the wall of the pipe resulting in an immediate release

(IMMEDIATE FAILURE)

IMMEDIATE FAILURE

HOW MECHANICAL DAMAGE CAN AFFECT A PIPELINE

Mechanical equipment hits the pipe but no immediate release occurs

- **Damage is discovered immediately and repaired**
- **Damage is not discovered but is not severe enough to cause a failure at any time in the future**
- **Damage is not discovered immediately but is discovered later by inspection before it can cause a failure**
- **Damage is not discovered but fails at a later time**

(DELAYED FAILURE)

DELAYED FAILURE

DAMAGE DISCOVERED BEFORE FAILURE

HOW SIGNIFICANT IS MECHANICAL DAMAGE TO PIPELINE SAFETY?

An appropriate yardstick is the number of pipeline accidents caused by damage that are reported to DOT

WHAT IS A REPORTABLE INCIDENT? (gas pipeline-Part 191)

- Release of gas and:
- Death or injury necessitating in-patient hospitalization
- Property damage of $50,000 or more
- Otherwise judged by operator to be significant

WHAT IS A REPORTABLE INCIDENT? (liquid pipeline-Part 195)

- Release of hazardous liquid resulting in any of the following:
- Explosion or fire not intentionally set by operator
- Release of 5 gallons or more
- Death of any person
- Personally injury necessitating hospitalization
- Property damage of $50,000 or more

HOW MANY PIPELINE INCIDENTS RESULT FROM MECHANICAL DAMAGE?

	Total number of reportable incidents from all causes 1985 through 2003	Number of immediate incidents from mechanical damage	Number of delayed incidents from mechanical damage	Ratio of immediate to delayed
300,000 miles of natural gas transmission and gathering pipelines	1583	440 (28% of total)	49 (4% of total)	9 to 1
160,000 miles of liquid petroleum pipelines	3366	724 (21% of total)	153 (5% of total)	5 to 1

PREVENTATIVE MEASURES FOR IMMEDIATE FAILURES FROM MECHANICAL DAMAGE

- **ONE-CALL programs**
- **Permanent marking and right-of-way maintenance**
- **Public education**
- **Surveillance and patrolling the right-of-way**
- **Physical barriers**

In the future?

- **Real-time monitoring**

PREVENTATIVE MEASURES FOR DELAYED FAILURES FROM MECHANICAL DAMAGE

- **All of the measures used to prevent immediate failures plus periodic integrity assessment**
- **Integrity assessment is not a panacea because damage can occur at random times and places.**
- **Every pipeline has a unique exposure to damage based on its age, geometry, location, and operational parameters.**
- **The operator should consider each situation and emphasize the preventive alternatives most appropriate to that situation.**

IN-LINE INSPECTION (ILI) AND DELAYED FAILURES

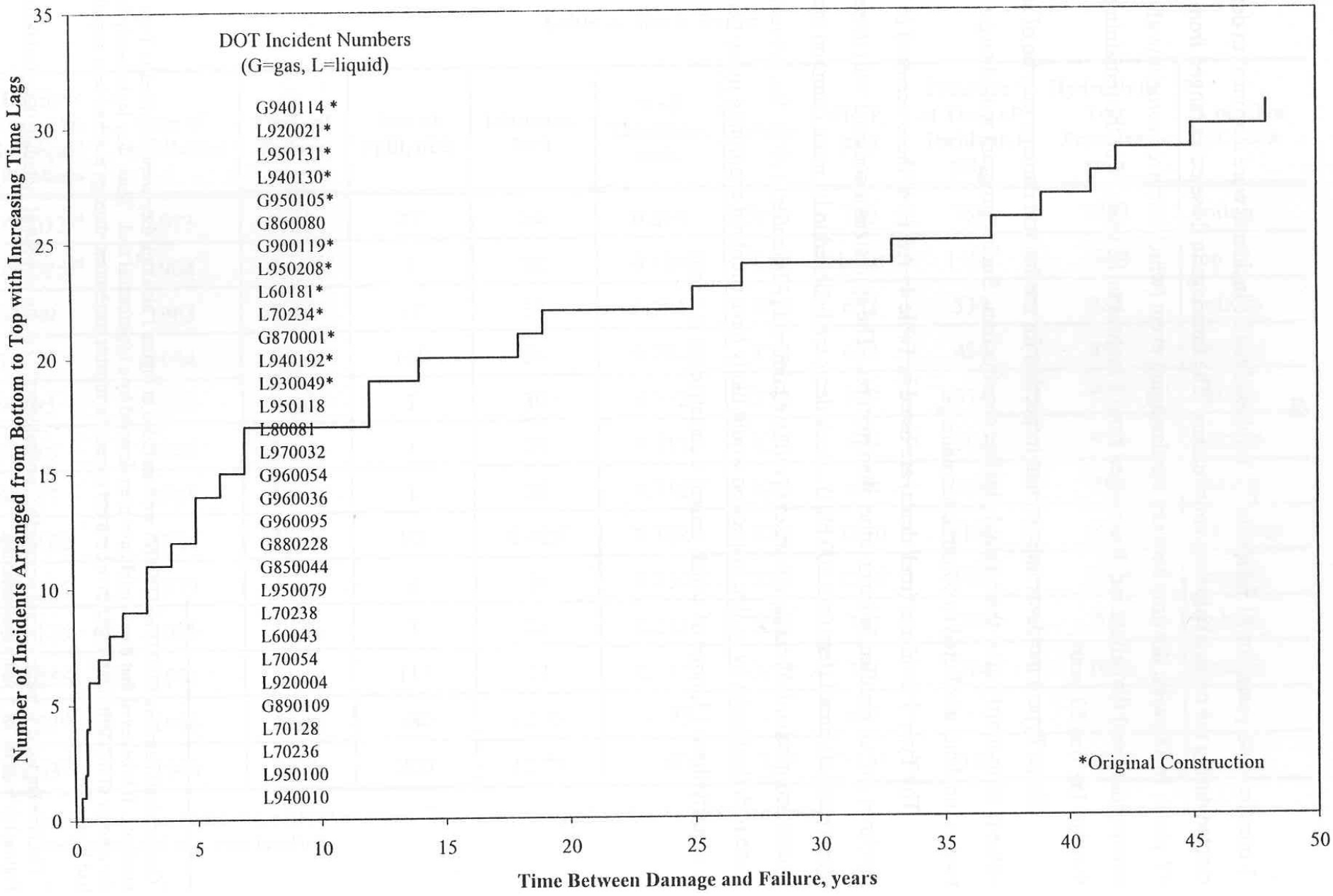
To expand on the viability of preventing delayed failures from mechanical damage, work was carried out several years ago for the Gas Research Institute (GRI-99/0050).

Reportable incident data were used in an attempt to establish how many incidents might have been prevented by ILI.

For the time period reviewed (1985-1997), 183 delayed failure incidents had been reported. Of those 68 provided useful information for further analysis.

Classification of Delayed Failure Incidents

Type of Incident	Number of Incidents (both gas and liquid, 1985-1997)
Type 1 – short time to failure (hours to days)	4
Type 2 – occurred after ≥ 10 % pressure increase	5
Type 3 – suspected corrosion, fatigue, or SCC at old damage	17
Type 4 – old damage, age documented	29
Type 5 – rock dents	13


DOT Incident Numbers
(G=gas, L=liquid)
G940114 *
L920021*
L950131*
L940130*
G950105*
G860080
G900119*
L950208*
L60181*
L70234*
G870001*
L940192*
L930049*
L950118
L80081
L970032
G960054
G960036
G960095
G880228
G850044
L950079
L70238
L60043
L70054
L920004
G890109
L70128
L70236
L950100
L940010
*Original Construction
Number of Incidents Arranged from Bottom to Top with Increasing Time Lags
Time Between Damage and Failure, years
0
5
10
15
20
25
30
35
40
45
50

ANALYSIS OF DELAYED FAILURE INCIDENTS

- **ILI is of no value in preventing Type 1 incidents.**
- **If the history and operating conditions of the pipeline justifies it, ILI before an intentional increase in Maximum Operating Pressure could prevent a Type 2 failure.**
- **Type 3 failures likely can be prevented by the types and schedules of ILI used by operators already.**
- **An arbitrary schedule for ILI would prevent some, but certainly not all, Type 4 incidents.**
- **ILI for rock dents (Type 5) is not justified. ILI for other purposes will eliminate some.**