



# BP and Hydrogen Pipelines

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# BP Environmental Commitment

- Green corporate philosophy and senior management commitment
- Reduced greenhouse gas emissions nine years ahead of target
- Alternatives to oil are a big part of BP's portfolio, including natural gas, LNG, solar and hydrogen
- Hydrogen Bus Project won Australia's most prestigious environmental award
- UK partnership opened the first hydrogen demonstration refueling station
- Two hydrogen pipelines in Houston area



# BP's Hydrogen Pipelines

- Two lines, only a brand new 12" line is active
- Connect Houston area chemical plant with a refinery
- Lines come off a plant process and deliver to a plant process
- 12" was commissioned as a result of increased H<sub>2</sub> production capacity following chemical plant modifications
- 8" currently idled with nitrogen blanket



# 8" Hydrogen Line History

- Originally installed in 1974-75 as an ethylene line
- ANSI 900# System
- Standard wall (~0.322), API 5L X-52 line pipe, 21.7 miles long
- Crossings and aboveground piping for valves were 0.500" wall (design philosophy)
- Converted to hydrogen service in 1977-78 when ethylene market grew and more capacity was needed.



# 8" Conversion Issues

- Development of a hydrogen “market” at the refinery
- With increase in demand, a larger ethylene line was needed; 8" became available for alternate use
- Converted to hydrogen service in 1977-78
- 8" changeover to hydrogen was very simple, no special efforts were undertaken
- Conversion took place during a period of less regulation on pipeline activity



# Hydrogen Related “Problems”

- Valve stem packing
  - Floating bushing packing design requires some lubrication, but H<sub>2</sub> is dry
  - Ethylene had already dried out some of the grease-based packing in valves, allowing molecular H<sub>2</sub> to slip by
- Heightened sense of care with operations
  - Concern about H<sub>2</sub> auto-ignition/nearly invisible flame in proximity to other chemical lines
  - Stay to conservative side of allowable time frame for DOT valve checks (6 months rather than 7 ½ months)



# 8" Reuse Issues

- Due to recent ILI work on adjacent lines, the 8" has been exposed and inspected in various locations
- No external indications of problems, either with pipe or coating relating to hydrogen service
- Nothing to preclude putting line back in service
- Valve rebuilds would be necessary
- As part of integrity management program, BP would evaluate additional testing/inspection of the line



# New Construction

- New 12” line designed as an ANSI 600# system, but operated much lower
- Primarily classes 1 and 3 location
- Some special requirements for line pipe chemistry, primarily to enhance toughness
- Welding procedures/testing also focused on producing acceptable toughness and microstructure weld quality
- API 5L X-42 and X-52 material (triple stamped)
- Normal stick welding E6010/E8010
- Hydrogen “Bake Out” for connection to existing facilities



# 12" Line Operation

- Line pressure is around 320 to 350 psi
- Pressure limitations come from the process units (no additional compression)
- Current flow rates vary from 3000 – 17,000 lbs./hr.
- Typical pressure drop of 70-100 psi in the 12" line, delivering to process at around 280 psi
- Hydrogen purity is 92-93% in this system. There have been no contamination concerns expressed
- Line was built to accept pigs for periodic inspection.
- BP also evaluating maintenance pigging operations on several line segments, including this one



# General Pipeline Operations

- BP pipelines are inspected from the air at least once each week
- Standard 6 month DOT valve inspections
- Numerous visual inspections as a result of ILI work on adjacent lines
- Integrity management program requires internal line inspection every 5 years
- No real “flaw detection” methods beyond ILI, but proactive CP and pressure relief design to minimize factors contributing to failures



# How Do Flaws Form?

- In a phrase...3<sup>rd</sup> Party Damage
- Design emphasis, project management and inspection procedures in place to minimize risk of flaws from handling, corrosion, manufacturing or welding
- Close proximity of lines in pipeline corridors complicates maintenance efforts
- Unreported strikes result in coating damage, corrosion hot spots, introduction of stress risers that compromise integrity