Hose-in-Hose Transfer Line Technology

US Department of Energy Hanford Nuclear Site

C Farm/AN Farm Retrieval

River Bend Transfer Systems, LLC

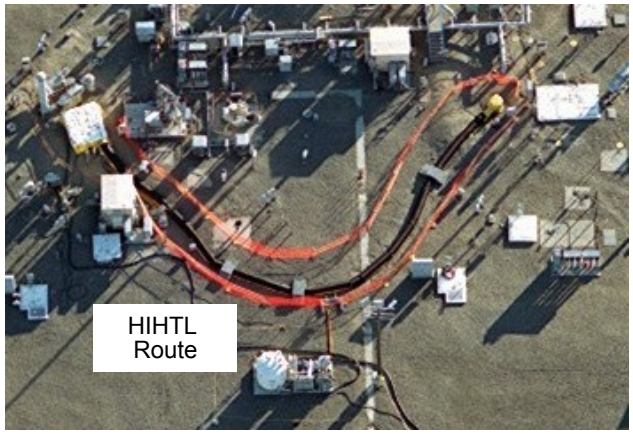
Compliant, Contained, Cost Effective

Origins of Hose In Hose Transfer Line (HIHTL)

- *In 1998 Department of Energy (DOE)Hanford Radioactive Waste Tank SY-101 Level began an unexplained rise. A team was formed to emergency pump the tank.*
- *DOE authorizes Emergency equipment design and installation.*
- *HIHTL design is approved for transfer of radioactive waste.*
- *Project review demonstrates significant schedule and cost benefits of HIHTL design.*
- *Numerous DOE projects adopt HIHTL to meet critical needs.*

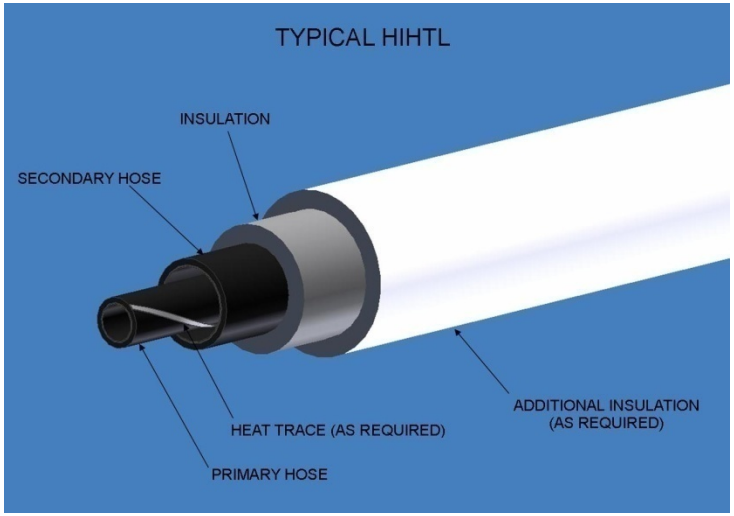
Tank SY-101 Waste

Pump Pit Installation



Hanford's Tank SY-101
Aerial View

HIHTL Description



- ***What are Hose-in-Hose Transfer Lines?***
  - ***Double encased hose systems qualified for conveying liquids and slurries.***
  - ***Main components are a primary hose(s) for waste transfer, an encasement hose to contain potential leakage, and patented connections to interconnect assemblies and process equipment.***
  - ***Additional capabilities include heat trace, leak detection, and customized inner liner to accommodate the chemical properties of the transferred fluid.***

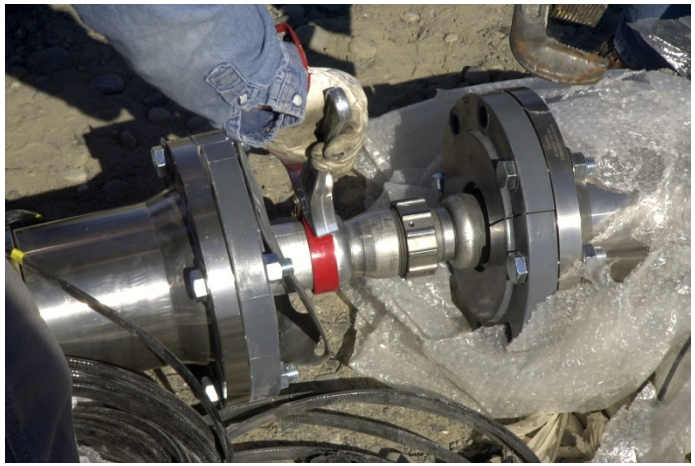
HIHTL Benefits

- ***Hose In Hose designs offer unique benefits in Safety, Risk Reduction, Cost, and Schedule.***
  - ***Portability, ease of routing, and quick deployment for normal or emergency use. No special tools or equipment required for installation.***
  - ***Assemblies can be procured and installed in weeks not months or years.***
  - ***Flexible hose provides inherent survivability from seismic events.***
  - ***High resistance to chemical attack, radiation exposure, UV light, and physical damage.***
  - ***Materials, engineering, schedule, and construction costs are fractions of equivalent piped systems.***
  - ***Each assembly is custom designed and fabricated, yet can be deployed or adapted for use in multiple configurations.***

HIHTL Design Specifications

- ***Typical HIHTL Specifications****
  - ***Static pressures from full vacuum to 425 psig (2" primary) and 250 psig (4" encasement).***
  - ***Process and flush water temperatures to 180 deg F.***
  - ***Process fluids with bulk density up to 1.4 g/cc, solids content to 30%, viscosity to 30 cP, pH to 13, including organics content.***
  - ***Lengths to 390' for single-joint assemblies, unlimited for assemblies using multiple joints.***
  - ***Low coefficient of friction reduces pump power requirements.***
  - ***Resistant to effects of cumulative radiation dose of 10^7 rads.***
  - ***Easily flushable after use to remove residual solids and contaminants.***

***** ***Specific design attributes can be supported.***



"Zero-clearance" fitting* for joining hose segments.

* US Patent #'s 6682102B1 & 6913291B1

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HIHTL Fabrication

- ***How are Hose-in-Hose Transfer Lines constructed?***
  - ***Custom length flexible hose specifically engineered for chemical processing and/or hazardous waste service.***
  - ***Multi-ply design of each hose segment includes inner and outer tubes of synthetic rubber encasing steel wire and fabric reinforcement.***
  - ***Ethylene propylene diene monomer (EPR or EPDM) is the synthetic rubber typically used – it resists the effects of chemicals, radiation, heat, pressure, and aging. Other specialty hose materials are available depending on liquid properties.***
  - ***Stainless steel connections are installed using patented fittings and processes.***

Shear strength testing

Primary hose fitting

HIHTL Qualification/Testing

- *Hose In Hose Qualification and Testing*
  - *Materials are qualified for pressure, temperature, radiation, effects of aging, and mechanical damage, by a combination of tests and analyses.*
  - *Each production lot is tested to conform to national and industry standards including:*
    - *Burst pressure at a minimum of 4 times maximum working pressure*
    - *Heat soak and thermal cycling*
    - *Tensile and shear strength*
  - *Individual acceptance tests for each hose assembly produced, including proof pressure test at twice maximum working pressure.*
  - *Qualified under terms of ASME B31.3 and RMA IP-2*
  - *RBTS Quality Assurance procedures and processes for manufacture and design comply with ASME NQA-1.*

Testing for resistance to mechanical damage included 3300lb steel plate dropped from 6 ft for 25 repetitions with assembly required to pass all new assembly burst test.

HIHTL Deployments

HIHTL INSTALLATION HISTORY:

Project	Fluid	Hose Diameters	Average Flow Rate	Number of Transfer Routes	Distances
SY-101 Emergency Pumping and Cross Site – Hanford, WA (1999 – 2000)	Liquid High-Level Mixed Waste with entrained solids	2" (50mm) primary hose, 4" (100mm) encasement hose	90 gpm (20 m^3/hr), 3.6 Mgal (13700 m^3) total	3	165' (50m)
Interim Stabilization – Hanford, WA (2000 – 2004)	Interstitial Liquid	2" (50mm) primary hose, 4" (100mm) encasement hose	9 gpm (2 m^3/hr), with flush flows to 90 gpm (20 m^3/hr) 2.6 Mgal (8500 m^3) total	17	106' to 790' (30m to 240m)
Single-Shell Tank Retrieval – Hanford, WA (2002 – Present)	Liquid High-Level Mixed Waste with entrained solids	2" (50mm), 3" (75mm), and 4" (100mm) primary hose, 4" (100mm) and 8" (200mm) encasement hoses	9 gpm (2 m^3/hr) to 97 gpm (22 m^3/hr) 4.6 Mgal (17,400 m^3) to date	55	30' to 1800' (10m to 540m)
K-Basin Sludge Transfer (Oct 2006)	Slurry with solids content to 30% by volume	1 ¼" (32mm) primary hose, 4" (00mm) encasement hose	70 gpm (16 m^3/hr) of slurry 9000 gal (35 m^3)total sludge volume	1	2460' (740m)
F Farm Retrieval - Savannah River, NC (Sept to Dec 2008)	3-phase slurry with solids content to 50% by volume	1 ½" (40mm) primary hose, 4" (100mm) encasement hose	10-30 gpm (2 to 7 m^3/hr) 10,000 gal (38 m^3) total sludge volume	2	1100' (330m)
K-Basin Sludge Treatment Project (May 2009 to present)	Slurry with solids content to 25% by volume	1 ½" (40mm) primary hose, 4" (100mm) encasement hose	70 gpm (16 m^3/hr) of slurry 35 cubic yards (27 m^3) total sludge volume	3	150' (45m)
Fukushima Dai-ichi Recovery Project – Unit 1, Japan (June to Aug 2011)	Contaminated sea water, sludge, and oil mixture	4" (100mm) primary hose, 6" (150mm) encasement hose	150 gpm (35 m^3/hr)	2	1530' (460m)
Fukushima Dai-ichi Recovery Project – Unit 4, Japan (June to Aug 2011)	Unit 4 reactor sludge	2" (50mm) primary hose, 4" (100mm) encasement hose	40 gpm (10 m^3/hr)	1	950' (285m)
Silo 130 waste transfer - AREVA La Hague, France (Nov 2011 – May 2012)	UNGG waste – water, powdered graphite, corrosion products, Mg+ and U	2" (50mm) primary hose, 4" (100mm) encasement hose	45 gpm (10 m^3/hr)	1	4760' (1430m)

- ***Total volume transferred: Over 10 Mgal/30M litres of High-Level Waste***
- ***Total number of transfer routes installed to date: 85***
- ***Combined length of transfer routes installed: Over 11 Miles/17Km***

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Continuing HIHTL Development

- ***Intelligent Hose with integrated leak/abrasion detection. iHose™ detects leaks of any conductive fluid in the inner tube of the hose before the outer tube is breached.***

Sample of iHose™

* US Patent 8,087,430 B1

HIHTL Deployments

- ***Hose In Hose installations***

Multiple HIHTLs in DOE Hanford S & SY Tank Farms

HIHTLs being installed at Fukushima nuclear plant

HIHTL Dry Run Installation at AREVA facility in La Hague, France.

HIHTLs at DOE Savannah River Site

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HIHTL Deployments

- ***Hose In Hose installations***

1800’ HIHTL from Hanford U Tank Farm to SY Tank Farm.
Route was established in 5 days.

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HIHTL Deployments

- Several design options are available for hose protection or radioactive shielding.

HIHTL in shallow trench covered by steel plate

Steel structures for connection points

HIHTLs at grade level, shielded by concrete hose “barns”

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