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**Gas Transmission System :
Construction & Commissioning .
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Type Of Construction Contract

- There are three types of contracts that the owner/client may enter into with a contractor for the construction of gas transmission infrastructure.
 1. Design, Build & Turnkey/Engineering, Procurement and Construction (**EPC**)
 2. Procurement & Construction (**PC**)
 3. Construction Contract (**CC**)



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Pipeline Construction Contracts

- EPC
 - Front End Engineering Design (FEED) based on the conceptual design
 - Provides the right of way (ROW) for the pipeline.
- Contractor completes (under Client supervision):
 - Detailed design
 - Procurement of materials
 - Construction, testing and commissioning of the pipeline



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PC Contracts

- Client completes
 - Engineering and Design
 - Provides ROW
- Contractor completes (under supervision of client):
 - procurement of prescribed materials
 - construct, test and commission the pipeline



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Pipeline Construction Contracts In a CC

- Client completes
 - Engineering
 - procurement of materials
 - acquire ROW
- Contractor completes
 - Construction
 - Tests and commissioning of the pipeline



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Pipeline Construction Activities

- Surveying and clearing the right-of-way
- Right of way preparation
- Hauling and stringing of the pipe
- Bending the pipe
- Welding
- Digging the trench
- Lowering the Pipe



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Pipeline Construction Activities

- Fabrication of special sections
 - road, river, waterway crossings
 - valve stations
 - scarper stations etc.
- Tie Ins.
- Swabbing, cleaning, gauging, water filling and hydrostatic testing
- Commissioning of the pipeline

Pipeline Construction Activities

Right of Way (ROW)

- **25 meter** width ROW strip is made available for a large, cross-country pipeline.
 - **15 meter** center strip is for laying the pipeline
 - **5 meter** on one side is required for temporary storage of top soil during excavation of trench for pipeline
 - **5 meter** on either side is for movement of construction equipment and hauling materials



ROW Preparation

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ROW Preparation

- Usually a backhoe, dodgers and graders are used for ROW clearing and grading.
- Extreme care is taken to protect flora and fauna of the region.
- Pipeline crew must plan for how to restore ROW to its original condition after construction work.
- Usually representatives of local community and land owners are consulted during this stage.



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Hauling & Stringing

- Pipes are moved from stockpile sites to the ROW. They are lined up along the ROW, ready for welding.
- Pipes are carefully strung along cleared and graded ROW on sandbags or wooden skids.
- Pipe trailers, prime movers, side boom pipe layers and small cranes are used for the work.



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Pipe Bending

- A pipeline may cross over hills and curve around special places such as lakes and sacred sites.
- To accomplish this, a specialized pipe-bending machine is used to bend some pipe to the shape of the land.
- The pipe retains its strength and remains rounded at bends due to the characteristics of steel and the bending techniques used.



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Welding

- Welding is a technique where another metal is melted and used to join the pipes.
- The area of the weld where the two pipes are joined is actually stronger than the pipe.
- Automatic welding machines are used where possible and some hand welding also takes place.
- A strict quality assurance and quality control program is followed to ensure the strength and quality of the welding.



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Welding and Welding Inspection



Welding Inspection :

- All welds in high pressure pipelines are radio-graphically inspected using X-ray or gamma ray isotopes.
- Modern pipeline welds are inspected by automatic ultrasonic test.
- Radiography inspection detects defects
 - Excess Penetration
 - Lack of Penetrations
 - Lack of Fusion
 - Burn Through
 - Slag inclusion
 - Gas porosity
 - Cracks
- **All defects are removed/repared following API 1104 standards.**
- Pipeline contractor submits welding and radiography procedure before work and gets these qualified. Usually third party inspectors interpret radiographs.



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Non-Destructive Testing (NDT)





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NDT Film Processing





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Pipeline Coating

- Pipelines are either pre-coated at the factory or coated at the site for an anti-corrosion protective measure
- For sour gas services, pipelines are also coated internally at the factories.
- The welded joints after radiography clearance are cleaned and coated. It can be coated using polyethylene (PE) tapes or Heat Shrink Sleeves (HSS).
- Trenching machines, backhoe excavators or manual labors are used to dig trenches
- High pressure pipelines are to be buried at least 1.5 – 2 meters below the ground.



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Preparation of Pipe Laying “Holiday Detection”





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Trenching





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Trenching and Backfilling

- Top soil must be carefully preserved on one side of the excavated trench and used during backfilling.
- Welded line pipe strings are lowered in the trench carefully after carrying out holiday testing for coating integrity of the line pipes.
- Side boom pipe layers, small cranes, backhoe excavators are often used for pipe laying in a stress-free manner.



Backfilling

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- Tie Ins
- Pipeline sections buried underground are tied in the pit using external clamps, radio graphically tested, coated and buried.
- Special sections like road crossings, rail crossings and river crossings have a special crew.
- Valve stations and Scraper stations are prefabricated and tied.



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Special Section Construction

- Special section construction:
 - River crossings, waterway crossings, road crossings, rail crossings, water logged area crossings, line valves, scrapper stations
- Pipes of a higher thickness and a special coating are used.
- Sections laid under rivers, roads and railway tracks are fabricated above ground and pretested.



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River Crossing

- Small rivers and waterways can be crossed by traditional open cut method utilizing the following methods:
 - Surface Pull
 - Submerged Pull
 - Bottom Pull
- The crossing section is dammed and drained of water. Trench is excavated either by long arm backhoes or draglines.



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River Crossing : HDD

- Large, tidal rivers are crossed by Horizontal Directional Drilling method (HDD).
- A pipeline spanning a large river (up to 2000m wide) can be laid about 15-20m below the river bed without affecting river traffic or causing any damage to river banks.
- First a pilot hole is drilled across a pre-designed drill profile using similar directional drilling procedure as used in drilling of gas or water wells.



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River Crossing : HDD

- First an approximate size pilot hole is drilled from the rig side to the pipe side along the predesigned drill profile.
- Pilot hole is enlarged, “rimmed,” several times depending on the size of the product pipe.
- Drilling tunnel walls are stabilized using bentonite based mud.
- The product pipe is fabricated on the other side of the river, pretested and dragged back through drilled tunnel



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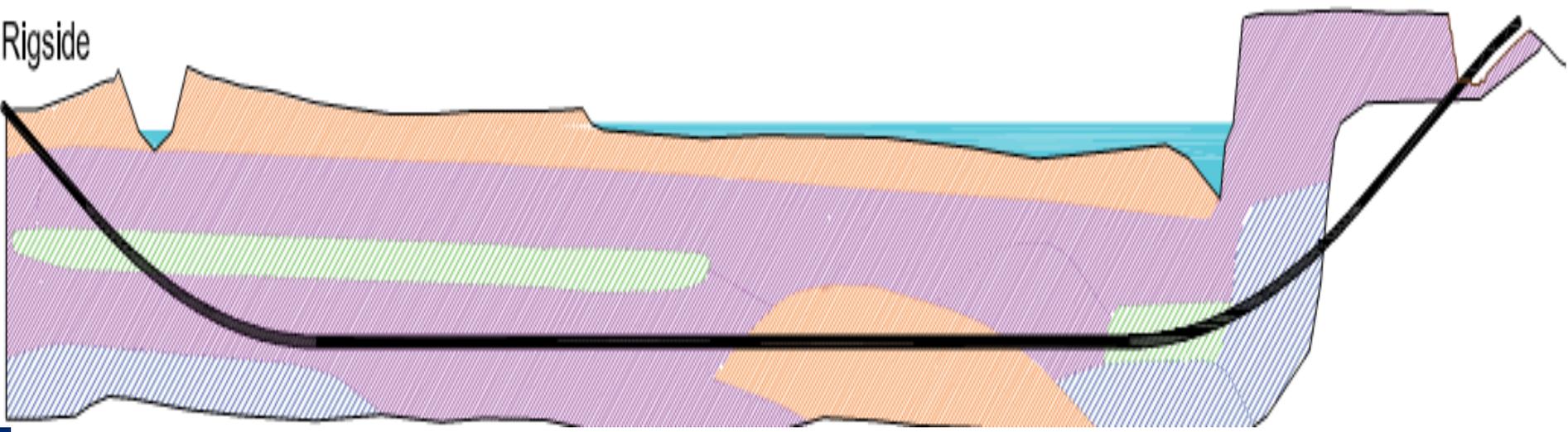
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Typical HDD Layout of Amu Darya

River Amu Darya

Pipeside

Rigside





Drilling of Pilot Hole at Rig Site

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Fig. 4: Reaming a 72" borehole with two drilling rigs (bit with HK 250T and HK 750PT in foreground)



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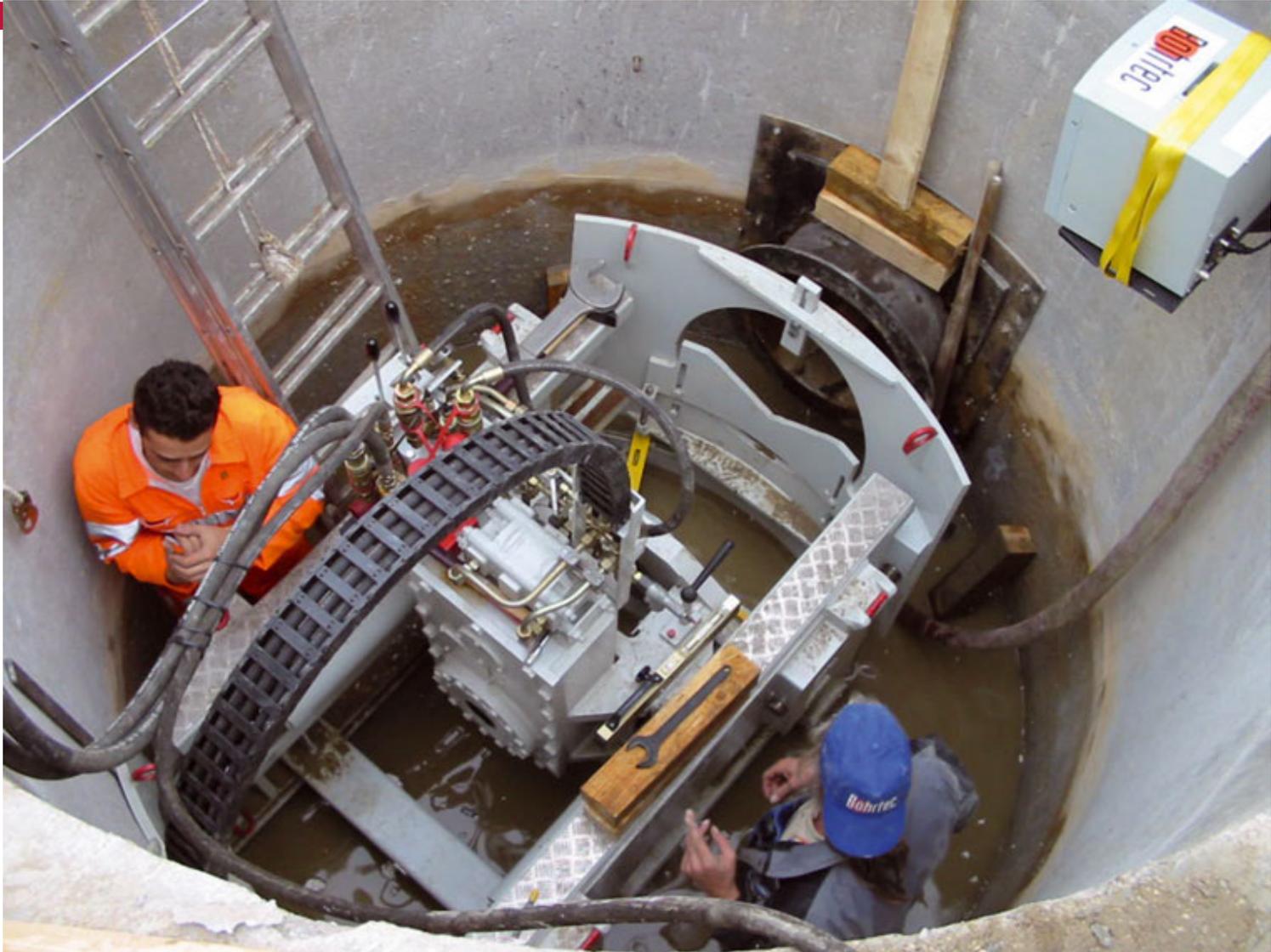
- **Road and railway Track Crossings**
- Major roads and rivers are crossed by thrust - boring method.
- Bore pit is made on one side of the road and at the recommended depth below the road surface and rail track.
- A higher diameter casing string is thrust through by auger boring.
- The product pipe is then pushed through the casing.
- Thinsulators are placed on product pipe to insulate it from casing
- End seals are used at either end to stop water penetration.



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Auger Boring of Railway





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Valve Stations and Scrapper Outlet

- Transmission pipelines usually have line valves at 10-15 km intervals and scrapper stations at 100km intervals.
- Line valves must bear the full bore of the pipe and may have a side entry or top entry.
- Valve stations may be above ground or underground but scraper stations/scraper manifolds are above ground.
- Valve stations and scraper stations use special fabrication crews and need to be welded with low hydrogen electrode welders.



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Hot Tapping

- Branching from live lines (lines transporting gas at high pressure) are usually made by hot tapings.
- A split tee is first welded on the pipe sections to be tapped by special welders.
- After welding, magnetic particle inspection (MPI) and NDT are carried out.
- Hot tapping machine taps through sandwich valves mounted on top of the split tee



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Pipeline Compressor Station

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- **Pipeline Compressor Stations**
- Pipelines are designed to operate at or near Maximum Allowable Operating Pressure (MAOP) as far as practicable.
- The pressure is depleted as the pipeline reaches its design capacity without compression.
- Pipeline compressor stations are installed at the start of the pipeline or at regular intervals of a higher diameter long distance pipeline to boost the pressure/retrieve the original capacity.



Compressor Station

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Integrity Testing of Pipeline

- Pipeline is swabbed, cleaned and gauged by running cleaning and gauging scrappers driven by compressed air.
- Scrappers are usually made of polyurethane rubber cups. Cleaning scrappers have metal brass.
- All undesirable materials from inside the pipeline are cleaned.
- Gauging plates covering about 95% of the inside diameter of the pipeline are fitted on the gauging scrappers and run through the pipeline to detect any denting during construction.
- Cleaned fabrication of special sections (road, river, waterways, valve stations, scarper stations etc.) are pretested before tie ins.
- Tie Ins.



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TPW Scrappers

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Commissioning of Pipeline

- Cleaned and gauged pipeline is filled with water having pH value of 7.0 and free of corrosive materials.
- Compact filling is done to remove air and pipe is pressurized to about 1.44 times of the maximum allowable operating pressure.
- During this process, the tightness test is carried out to detect leaks.
- For strength tests, the pressure is held in line for 24 hours and monitored through installation of three-pen chart recorder.
- Once the pipeline passes the test, it is drained of water using swabbing (foam) scrappers and dried with methanol swabbing.

- **Commissioning :**
- Tested pipeline is commissioned by running a series of 3 scrapers are run slowly at scraper speed not exceeding 5km/hr. :
 1. Three cup rubber scrapers driven by slugs of nitrogen
 2. Foam pig driven by nitrogen
 3. Foam pig driven by natural gas Air trapped and residual water is carefully vented.
- Once the scrapers are received at the scraper receivers, the pipeline is gradually pressurized to maximum allowable operating pressure.



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- Rehabilitation
- After testing and commissioning of the pipeline, the entire pipeline ROW is graded reseeded and restored as before.
- The buried pipeline is usually covered with imported sand and the original top soil, that was carefully preserved earlier, is reused to ensure original fertility of the land.



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Marker Post

- Buried pipeline ROW is marked at regular entire by suitable marker posts with owner's address and telephone numbers.
- These marker posts must also be visible for areal surveys by the pipeline operators.
- Pipeline markers secure the ownership of the pipeline operator's assets bellow the ground.
- Pipelines also have test posts and bond box to monitor cathodic protection.



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Conclusion

- Strict quality control and quality assurance must be ensured at every stage of pipeline construction.
- A poorly constructed pipeline will create nightmare for the pipeline operator.
- All as-built documentations must be properly recorded and made readily available for operator to make required operation and maintenance plans.