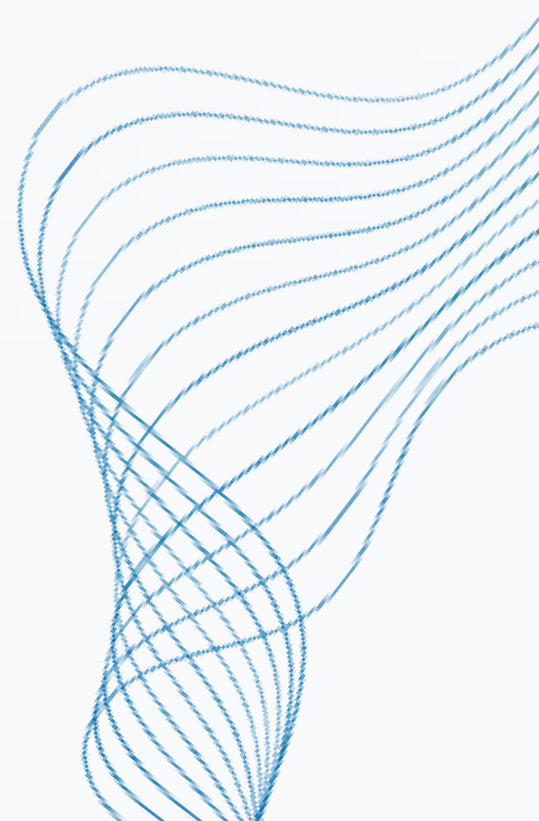




TANK CLEANING SOLUTION

ST GLOBAL RESOURCES

ST Global Resources Ltd

is an Alberta-formed oil and gas industry service/consulting provider engaged in the development and implementation of new technologies since 2005. ST Global Resources has developed a method for cleaning tanks and preventing the formation of bottom sediments online using a coiled tubing system (Patent Pending US 63/148.976, PCT International 17/484.013). This method allows not only prevents the formation of bottom sediments but also destroys the already formed sludge online, which can significantly reduce the time for the final cleaning of the tank.

The use of the coiled tubing system allows cleaning of the tanks without the presence of personnel inside until the moment of complete degassing and the elimination of the source of the formation of harmful gases and vapor.





Partner: ARKOIL Technologies

ARKOIL Technologies Netherland's developed its exclusive system for all types of storage tank cleaning and hydrocarbon recovery. ARKOIL was founded with the aim of supplying non-man entry crude tank cleaning services. Technology is based on the transformation of steam energy and the application of special tank cleaning nozzles. The size of tanks can reach up to 200.000 m³, with fixed or floating roofs. The total amount of accumulated sludge is unlimited. More than 1750 crude and storage tanks have been cleaned by the ARKOIL system.



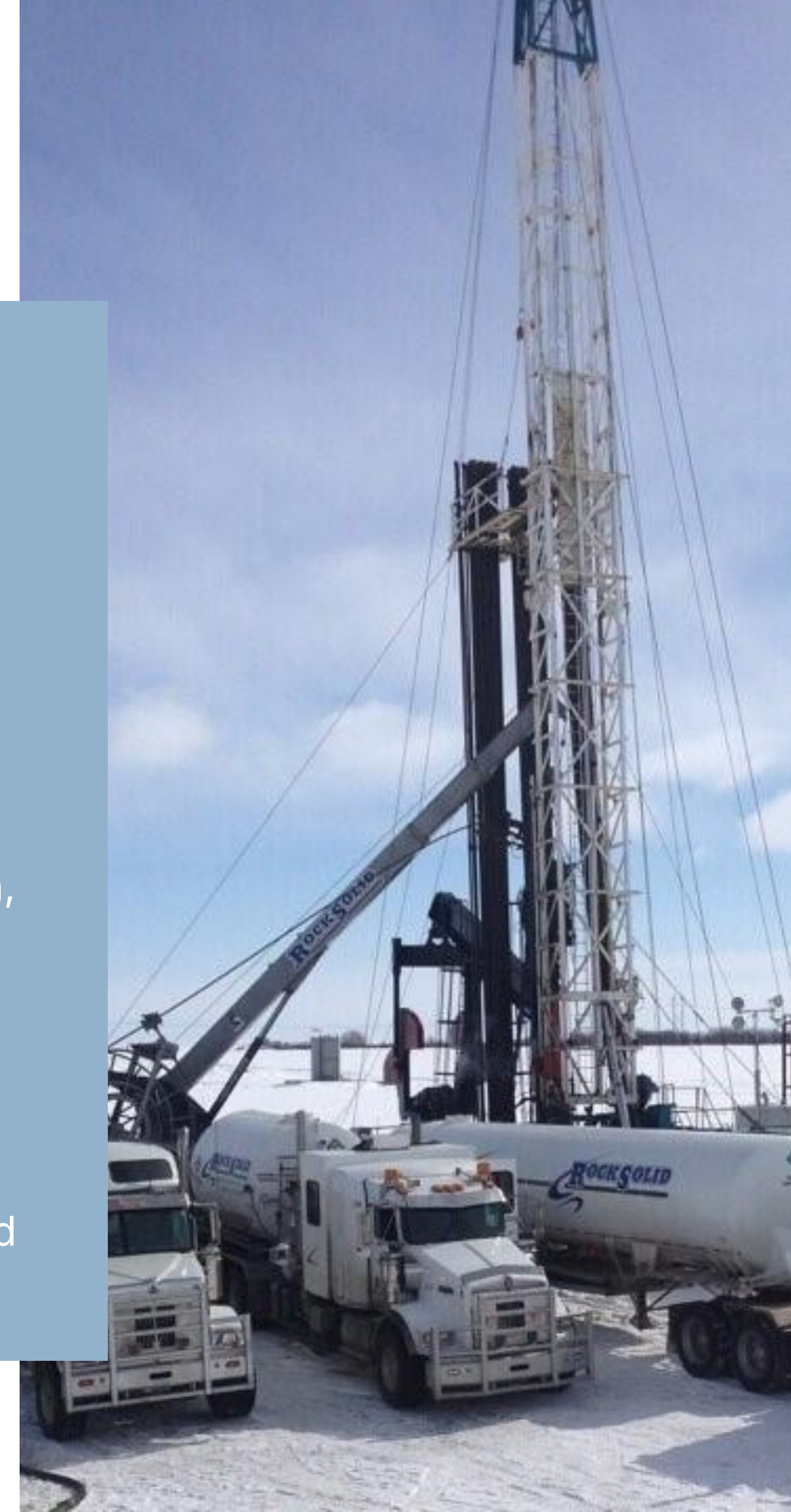


Service Provider: Rocksolid

Rock Solid Group of Companies, established in 1999, has provided services to all major E&P companies in Canada. Main Service Lines: Coiled Tubing Units; Abandonment Trailer and Tools; Nitrogen Pumping and Facility TA's; Fluid and Acid Pumping. The Rock-Solid Group of Companies is dedicated to the innovative delivery of oil and gas services. The Corporate Operations Head Office is in Vermilion AB with satellite offices in Creelman SK, Bonneville AB, Calgary AB, Northern AB, and BC, supplying strategic operations throughout Canada - Western, Eastern, and Northwest Territories.

Rock Solid Group of Companies is COR certified and on ISNetworld & Comply Works.

Rock Solid Group of Companies is an experienced service provider for ST Global Resources Ltd technology for oil storage tank cleaning.



Conventional Cleaning Disadvantages

- Potential damage to shell, roof, and coating
- Low level of Quality, Health, Safety, Environmental standards
- High risk of fatality accidents
- Financial losses due to non-recovered oil
- Logistic costs
- Oil sludge utilization costs
- Unreasonably expended time terms
- Low quality of a final result
- This method is not suitable to be used for damaged tank cleaning



Industry standards, methods, and technology

*documents and references

We did not Invent a new technology - we found the best use for existing technology.

The Society for Protective Coatings

Surface Preparation Standard Nº 1(SSPC-SP 1, Solvent Cleaning). April 23, 2015. Editorial Revision August 10, 2016.

2. Definition

2.2. For the purpose of this standard, a “solvent” is defined as any liquid or vapor.

API STANDARD 2015, EIGHTH EDITION, JANUARY 2018

Requirements for Safe Entry and Cleaning of Petroleum Storage Tanks

5.5. Vapor and Gas Freeing, Degassing, and Ventilating.

5.5.2. Vapor and Gas Freeing Methods.

2) displacing vapors and gas by purging the tank with inert gas, flue gas, or steam.

Types of Nozzles Used

Steam buffer nozzle with a Jet speed of 200-400 m/s used for mixing vapor, not liquids and a Sludge heating/mixing nozzle with a Jet speed of 20 m/s used for sludge circulation.

Advantages of non-man entry system

***for downstream storage tanks**



Safety

- Tanks cleaning excludes damage to the shell, roof and coating
- Maintenance of the tank's integrity
- No chemicals, additional crude oil or oil products used
- No personnel exposure inside the tank until the total degassing of the tank
- Creation of a steam blanket to control hazardous atmosphere



Flexibility

- No weather or seasonal restrictions
- Applicable to any size and roof type of the tank
- Can be used for damaged tanks
- Can be tailored to the customers' special needs and requirements



Time

- Cleaning & oil recovery are performed simultaneously
- Minimal downtime against conventional method
- The system requires several times less time-terms than a conventional method



Profit

- Return not less then 95% of oil organic part*
- Profit from oil recovery often significantly exceeds the expenses for the services
- The recovered product is substantially free of mechanical impurities
- Minimal disposal of sediments

Benefits of creating a steam blanket

- Emissions are presented in the tank before the start of the cleaning process. Before the inlet of the steam vapor directly to the oil sludge, the steam is supplied into the space between the sludge and the roof. Thus, the “steam blanket” is created. The temperature of the vapor exceeds the temperature of the evaporating light fractions and, after the interaction with evaporating light fractions, steam condenses (turns into a drop of water) and entrains the hydrocarbon back to the sludge, what prevents transition of light hydrocarbons from liquid state to gaseous. It provides insulation from penetration of hydrocarbon phase outside the tank. Steam vapor doesn't take part in the reaction with hydrocarbons but represents the insulating element.
- The steam is delivered into the sludge via pipes and special designed steam nozzles. The sludge represents tarry- asphaltenes substances and high-molecular paraffins which have high boiling temperatures – over 250-300°C. But it can be subject to dissolution even at 65-70°C.
- During the cleaning process bottom sludge can be heated up to 70°C max. It means that the temperature of the heated sludge doesn't exceed the temperature of sludge dissolution. Besides, the volume of the supplied steam is several times larger than the volume of the bottom sludge in the tank and, undoubtedly, many times exceeds the amount of light hydrocarbons' vapor, which is generated during the heating process. That provides decrease of light hydrocarbons' concentration in the vapor - below MAC (maximum allowable concentration) - as its dilution occurs.

Note: dynamic steam supply also contributes to minimization of emission generation. It allows adjusting the heating time of bottom sludge.

Furthermore, light fractions are condensing and getting back to the bottom sludge. Moreover, application of the steam blanketing method provides complete fire and explosion prevention in the tank and safety of the working process due to the physical nature of the steam.

Benefits of purging a nitrogen buffer

- Nitrogen is dry and non-combustible, and the nitrogen displacement of combustible gases will prevent an unstable and potentially ignitable atmosphere. Simply put, the use of nitrogen in oil and gas industry equipment effectively displaces moisture and oxygen and creates a more stable climate.
- Reducing the amount of oxygen in the vapor space of a chemical storage tank reduces the risk of any sort of explosion when storing combustible chemicals, since air is needed for fire to burn.
- Nitrogen tank blanketing, also referred to as nitrogen padding, is a process where gaseous nitrogen is introduced into an empty or partially filled storage tank or container. The nitrogen will prevent the onset of chemical reactions that may cause explosions, oxidation, or other unwanted effects.
- Nitrogen blanketing is a practice commonly used in the chemical and petroleum refining industries to reduce the hazards associated with flammable liquids which improves the safety in the plant and can help increase productivity. Blanketing or padding is a process of applying nitrogen gas to the vapor space of a tank or vessel, which minimizes the possibility of an explosion or fire by reducing the oxygen content or the concentration of flammable and/or explosive vapors in a tank or vessel with inert nitrogen.
- Purging refers to inserting inert gas in the tank when it is already having less than 8% oxygen to reduce oxygen and/or hydrocarbon volume even further than that.
- The introduction of inert gas into a tank already in the inert condition, with the purpose of further reducing the existing oxygen content; and or reducing the existing hydrocarbon gas content to a level below which combustion cannot be supported if air is subsequently introduced into the tank.

Description of workflow and operations

- Mobilization: Equipment set up, and heated product/steam supply arrangements in accordance with potentially hazardous zone regulations. Depending on the tank's diameter the required number of nozzles installed via the bottom shell entries or the roof – 5 days.
- Heating: Steam or heated product is supplied through tank cleaning nozzles directly into sludge. The heating process continues until all sludge has been liquefied and separated into three fractions: oil, water, and solid sediments. Operators constantly manage the speed of heated product or steam supply and storage tanks' surface temperature (+/- 55C°). The exact duration of heating depends on sludge quantity and composition - 14 days.
- Hydrocarbons (HC) Recovery: HC is pumped directly to the pipeline or holding tank – 5 days*.
- Condensate drain water is drained into the sewage or the same tank. No special water treatment is required, and it can be treated internally – for 2 days.
- Ventilation: After the water drain, manholes should be opened to vent the tank. Once the tank atmosphere has been approved by a safety manager, personnel are admitted to enter.
- Final Cleaning: At this stage, no sludge left in the tank, only a layer of oil-contaminated solid sediments on the bottom. The roof, shell (coating), and legs are clean ideally and oil-free.
- Total for large storage tanks: around 40-50 days.

Example: *50.000 m3 crude oil tank with 5.000 m3 of oil sludge.

*Depends on the technical ability of a refinery/terminal to accept the recovered hydrocarbons.

Requirements

Safety Protocol

To ensure that all site requirements are met a current Site-Specific Safety Plan should be provided which will outline site access requirements, LOTO processes, tank entry procedure (for inspection/repair work), and any other information which would be considered relevant to the work requested to be performed:

Tank Data Required:

1. Tank drawings.
2. Tank product, MSDS.
3. Product chemical analysis:
Density of Clean Oil @ 15°C ASTM D5002 / ASTM D4052;
Total Sulphur (mass %) ASTM D4294;
Pour Point (°C)
ASTM D97/ASTM D5853/ ASTM D7346;
Asphaltene (Pentane Insoluble ASTM D4055);
Wax Content (UOP 46);
Viscosity ASTM D445 / ASTM D7042 @15°C, 40°C, 50°C.
Dean Stark Report. TAN - Total Acid Number.
Iodine value - if possible.
4. Total volume of product.
5. Product temperature.
6. Tank designed temperature.
7. Type and number of mixers connected to the tank.
8. Steam supply: Temperature, pressure, distance to the tank.

Sludge Data Required;

1. Volume.
2. Height.
3. Current Temperature.
4. If tank receiving any heat?
5. Condition: hard, jelly-like, slushy.
6. Consistency.
7. Sludge chemical analysis:
Density of Clean Oil @ 15°C ASTM D5002 / ASTM D4052;
Total Sulphur (mass %) ASTM D4294; Pour Point (°C)
ASTM D97/ASTM D5853/ ASTM D7346;
Asphaltene (Pentane Insoluble ASTM D4055);
Wax Content (UOP 46);
Viscosity ASTM D445 / ASTM D7042 @15°C, 45°C, 70°C.
Dean Stark Report.
8. What is the client planning to do with the sludge?

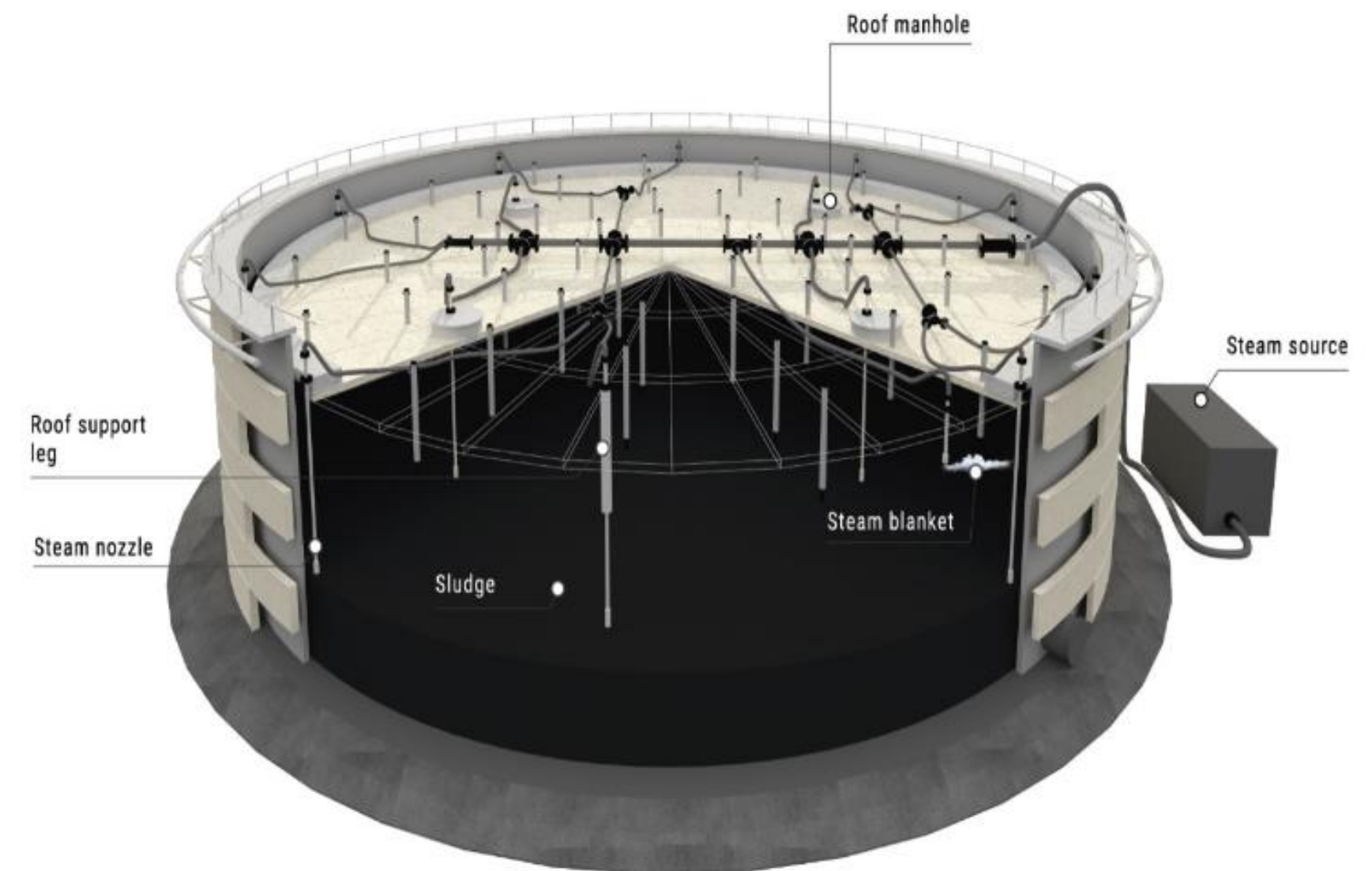
Tank steaming & hot product circulation plan (floating roof)

Sludge Specs – steaming or circulating a heated product from the tank :

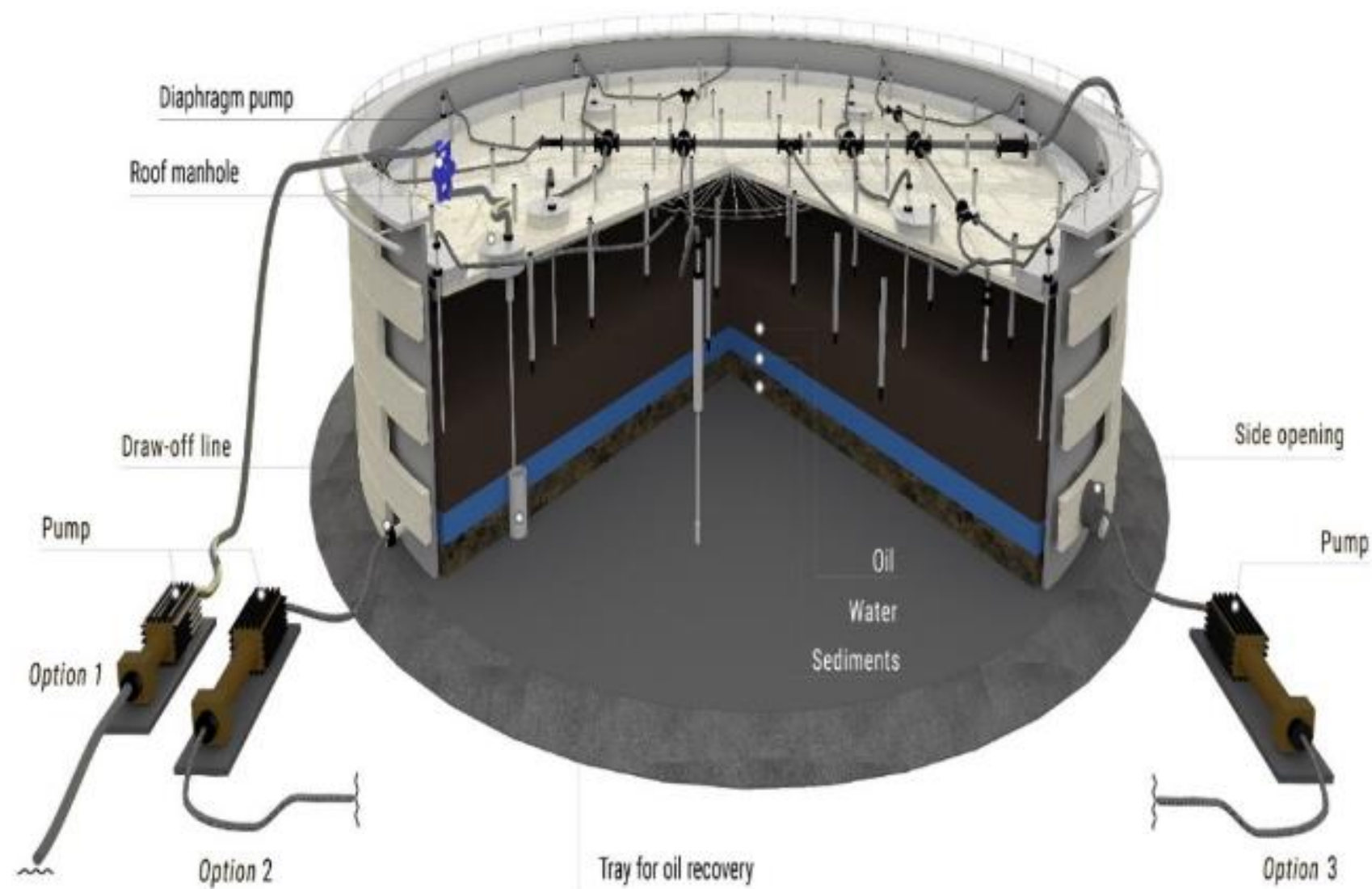
Steam/heated product injection into the sludge, creates separation inside the tank into 3 fractions: Hydrocarbon, Water & Sediments

Steam nozzles can be installed:

- via the space between the shell and the roof
- via the roof manholes
- via the roof legs openings
- via the shell valves/openings



Oil recovery plan



Place designated by the Client.

- 1.Oil recovery is performed via a roof manhole/rim space openings
- 2.Oil recovery is performed via a draw-offline if the sludge level is higher than the level of the side manhole
- 3.Oil recovery is performed via a side manhole if the sludge level is lower than the level of the side manhole

International experience

Netherlands 2017



Type : Vertical Steel Tank

Diameter: 72.5 meters

Roof type: Floating roof

Product: Crude Oil

Sludge quantity: 4,000 m³

Storage Capacity: 80,000 m³

**British Petroleum,
Rotterdam 2015**



Type : Vertical Steel Tank

Diameter: 19.5 meters

Roof type: Floating roof

Product: Crude Oil

Sludge quantity: 6,500 m³

Storage Capacity: 120,000 m³

Brunei Shell 2019



Type: Vertical steel tank

Diameter: 36 m

Type of roof: fixed roof

Product: Slop

Sludge quantity: 6,600 m³

Storage Capacity: 12,300 m³

Egypt 2019



Type : Vertical Steel Tank

Diameter: 59.12 m

Roof type: Floating Roof

Product: Crude Oil

Sludge quantity: 2,500 m³

Storage Capacity: 39,750 m³

Syncrude Base Plant, Tank 20D-08

May – October 2019



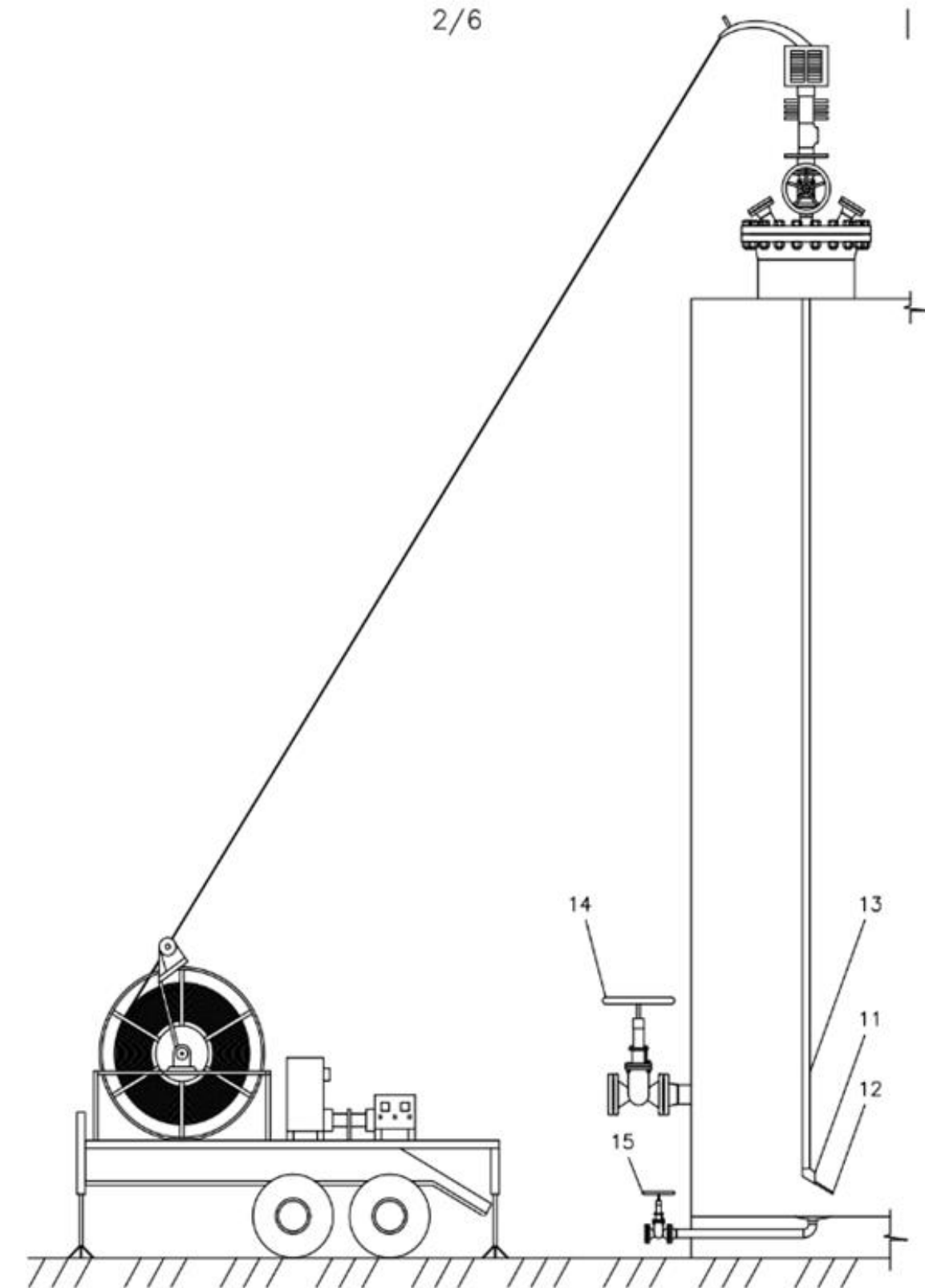
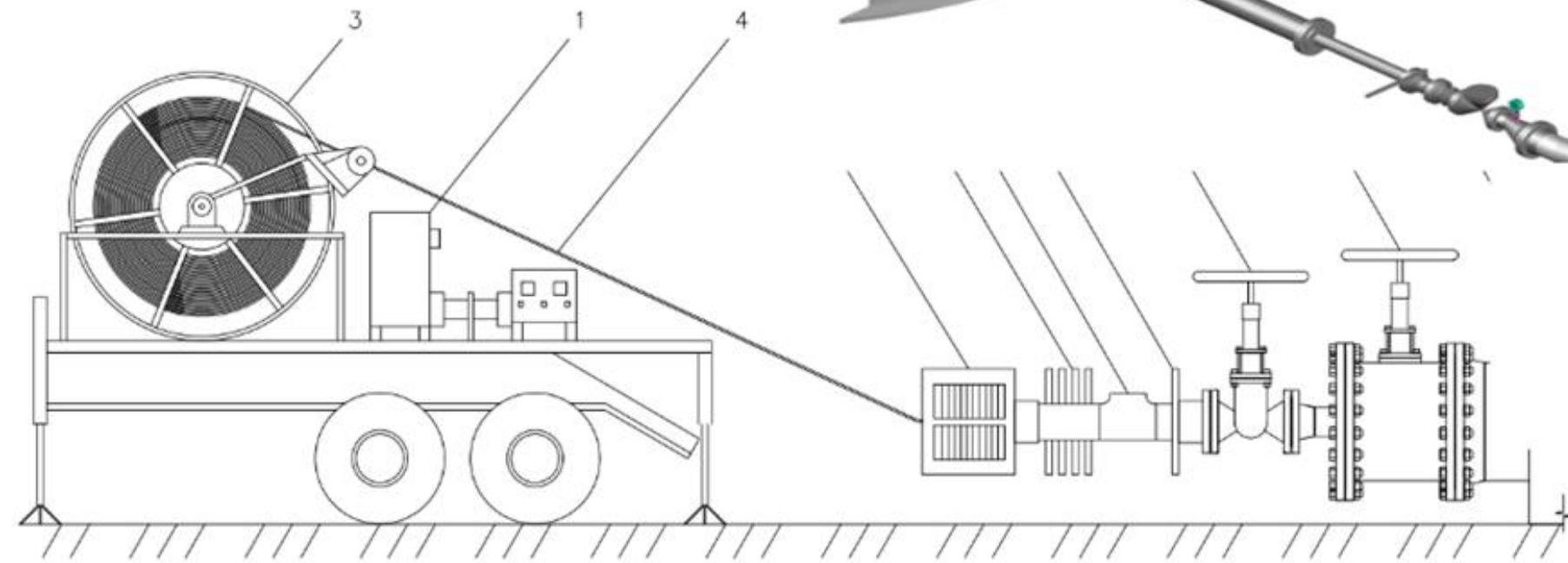
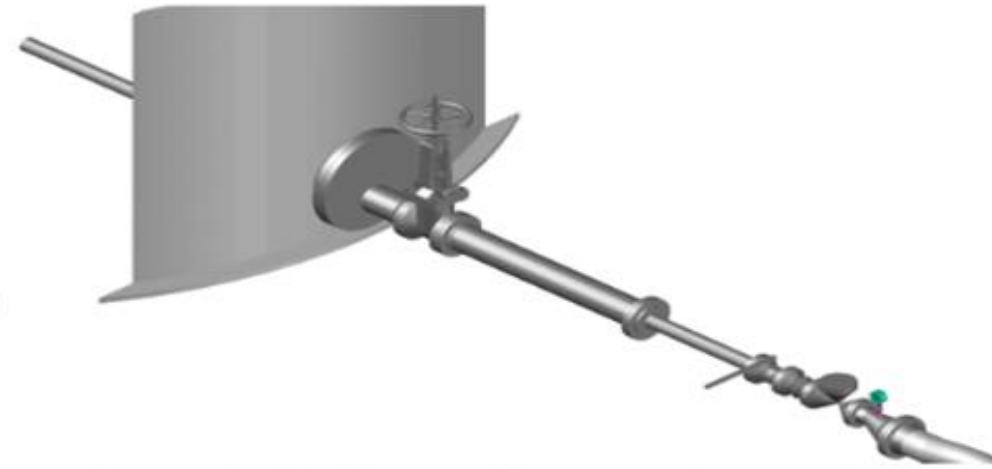
Online sludge Breakdown Methodology

(Patent Pending US 63/148.976, PCT International 17/484.013)

STEP 1: High pressure line launcher and supporting pump unit setup near the tank and connection to hot water supply line.



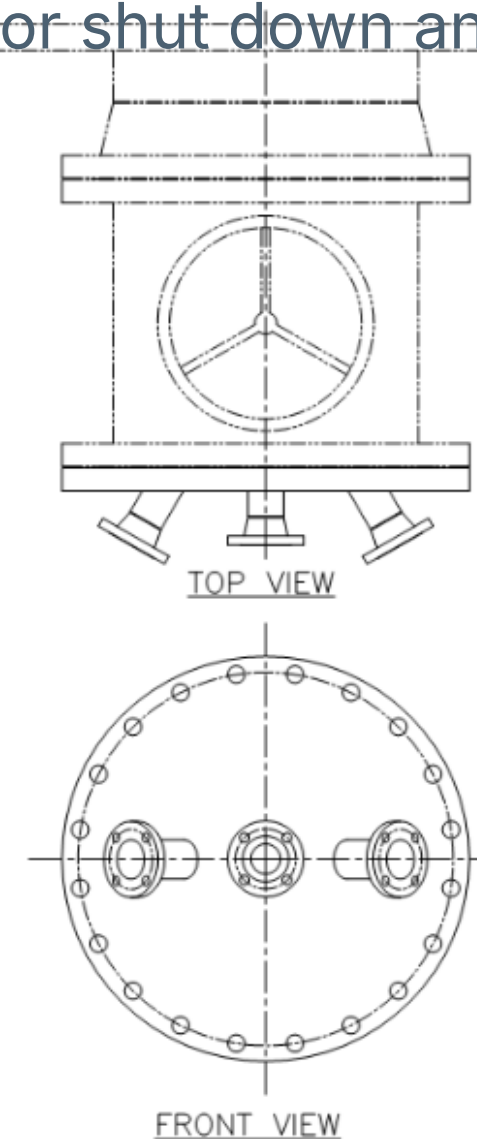
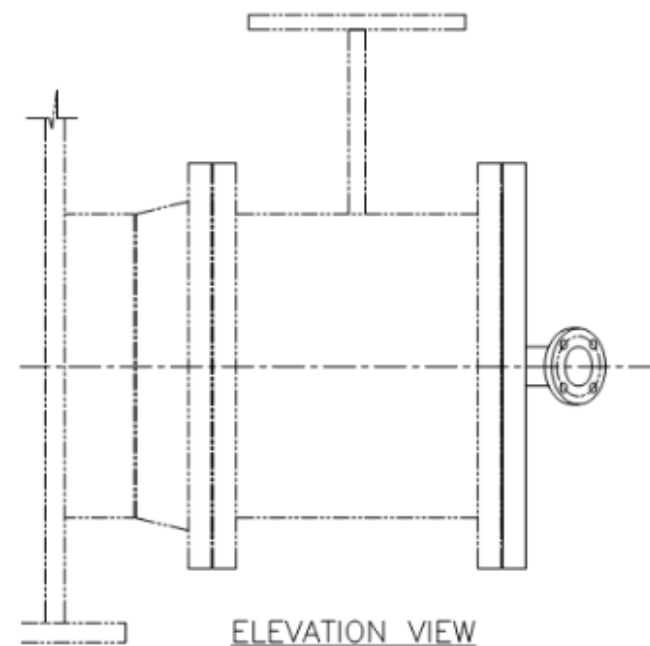
Coiled Tubing Unit connection to the tank



Sludge Breakdown Methodology

STEP 2:

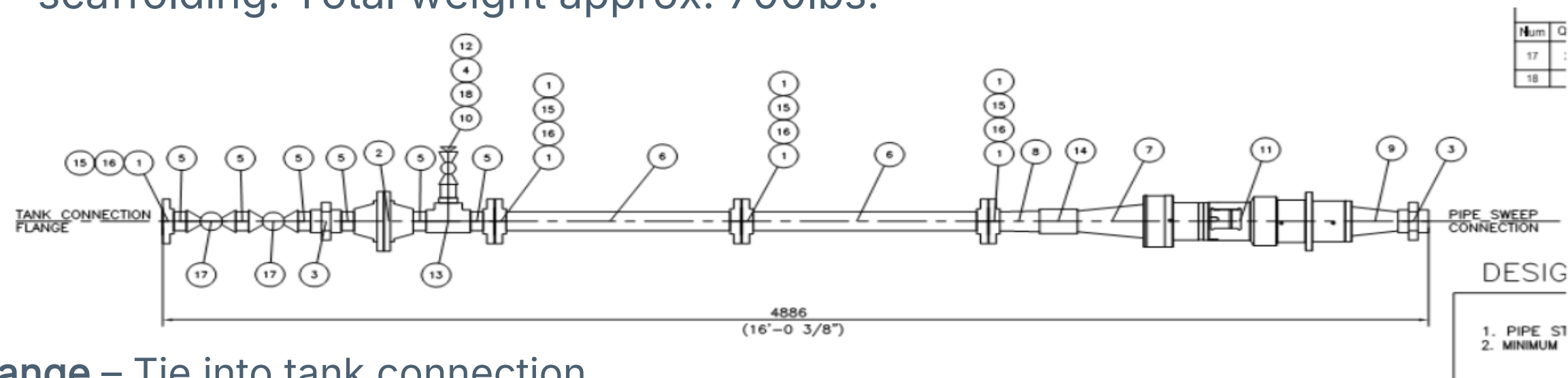
- Single or Multi Flange Cover will be installed on tank shell nozzles equipped with valves 3" in diameter or bigger
- Installation will require client supplied crane during mobilization and demob
- Each of the 3" nozzles will have two ball valves installed for shut down and lock-out daily



Sludge Breakdown Methodology

STEP 3:

- Install casing pipeline coming off the multiport flange. This will be supported by pipe stands on the scaffolding. Total weight approx. 700lbs.



Flange – Tie into tank connection

X2 full port Ball Valves – To provide extra barrier of protection.

Annular Rod Bag – Create seal along the pipe to isolate the annulus

Flow Tee - To be able to isolate and remove any trapped pressure in system

X2 sections of Lube – To be able to dress/install nozzles

Crossovers/Swedge – Self explanatory

High Pressure Stripper – Additional annulus isolation

Flow Tee - To be able to isolate and remove any trapped pressure in system

Annular Rod Bag - Create seal along the pipe to isolate the annulus

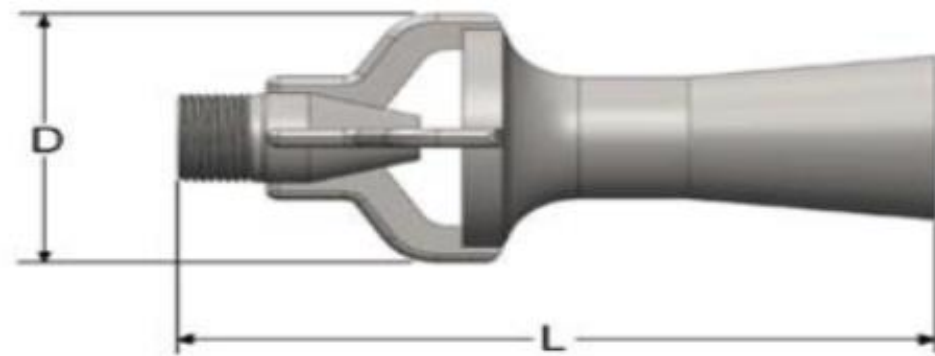
Hammer Union– Tie into pipeline



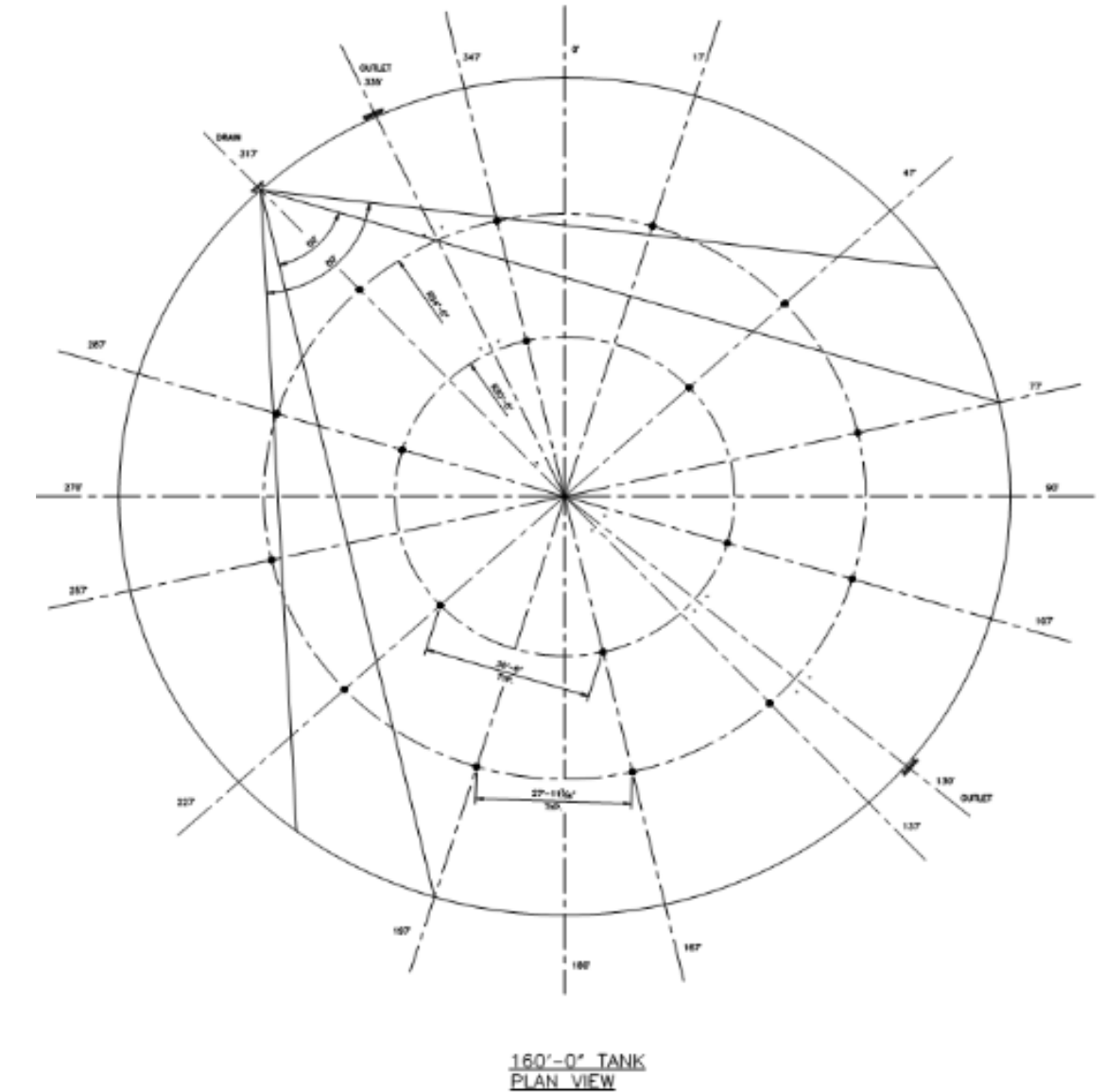
Sludge Breakdown Methodology

STEP 4:

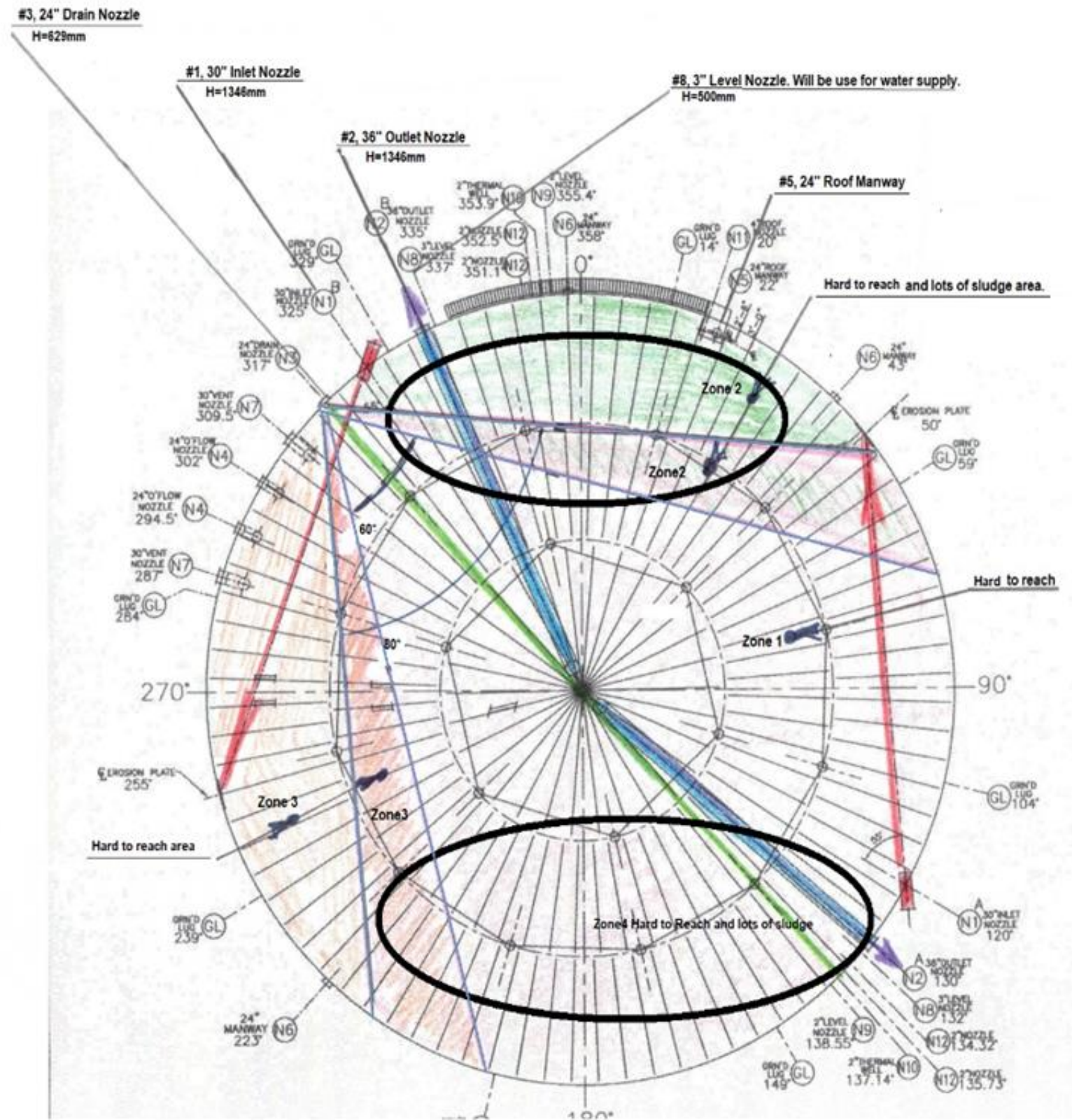
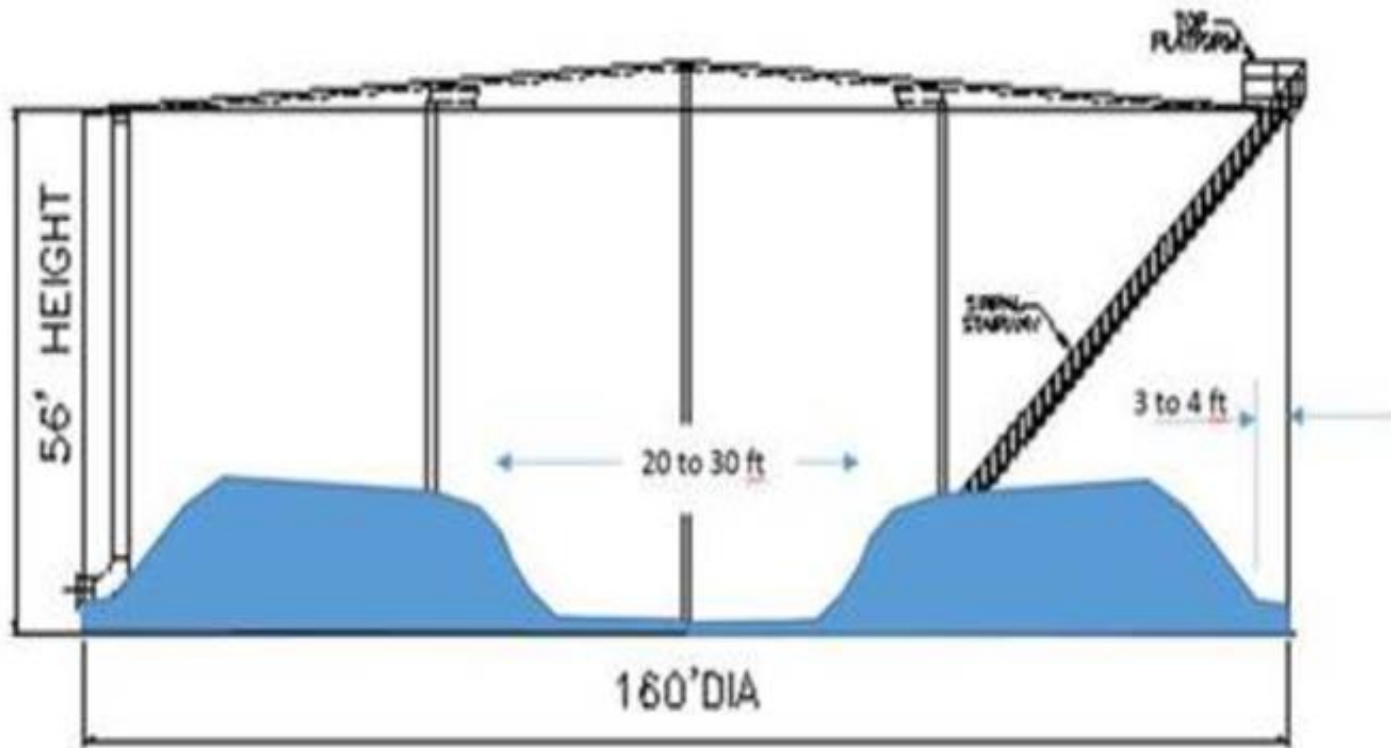
- Enter Tank to start cleaning
- Monitoring of pressure constantly
- Multiple nozzles will be used in each of the ports



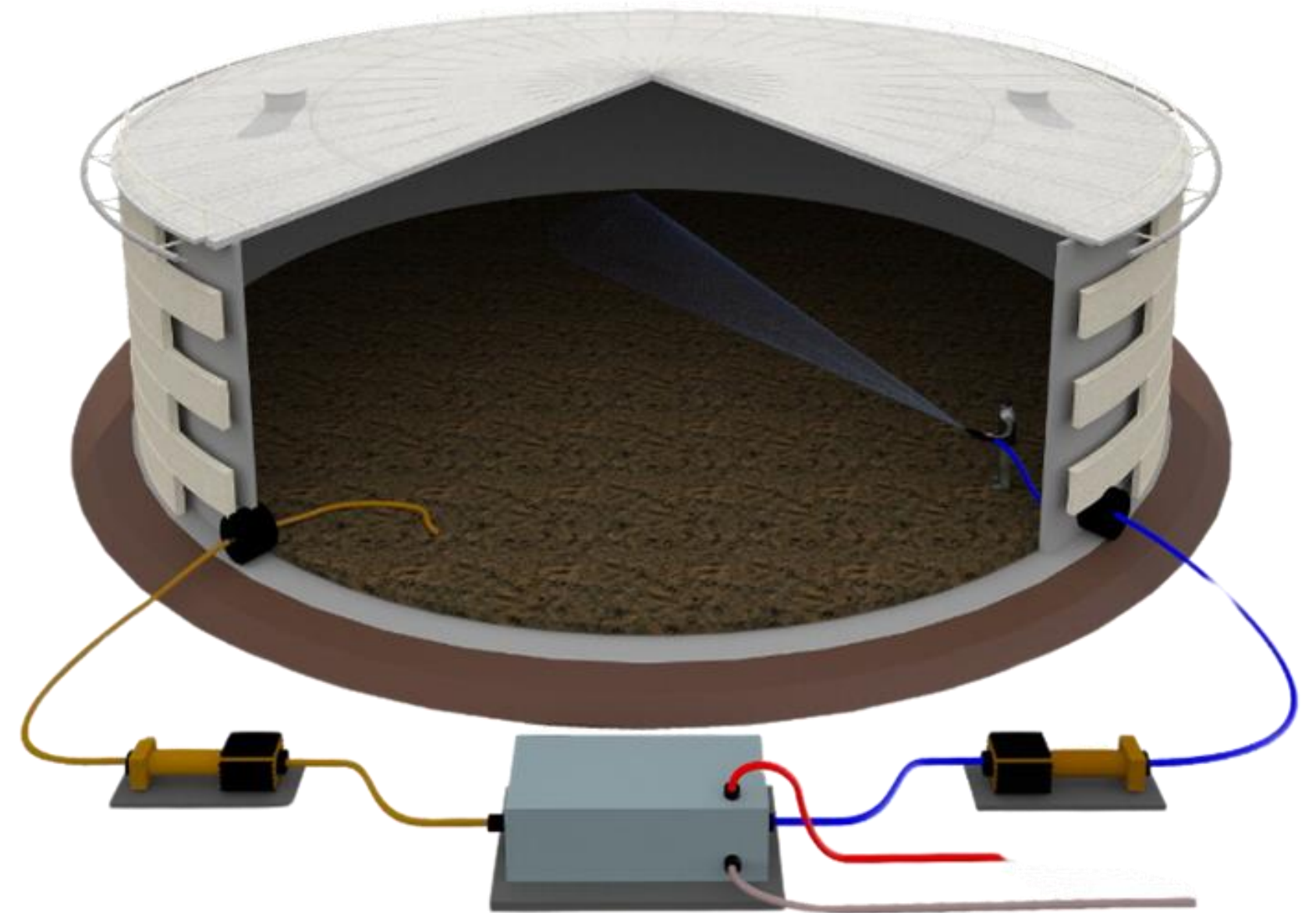
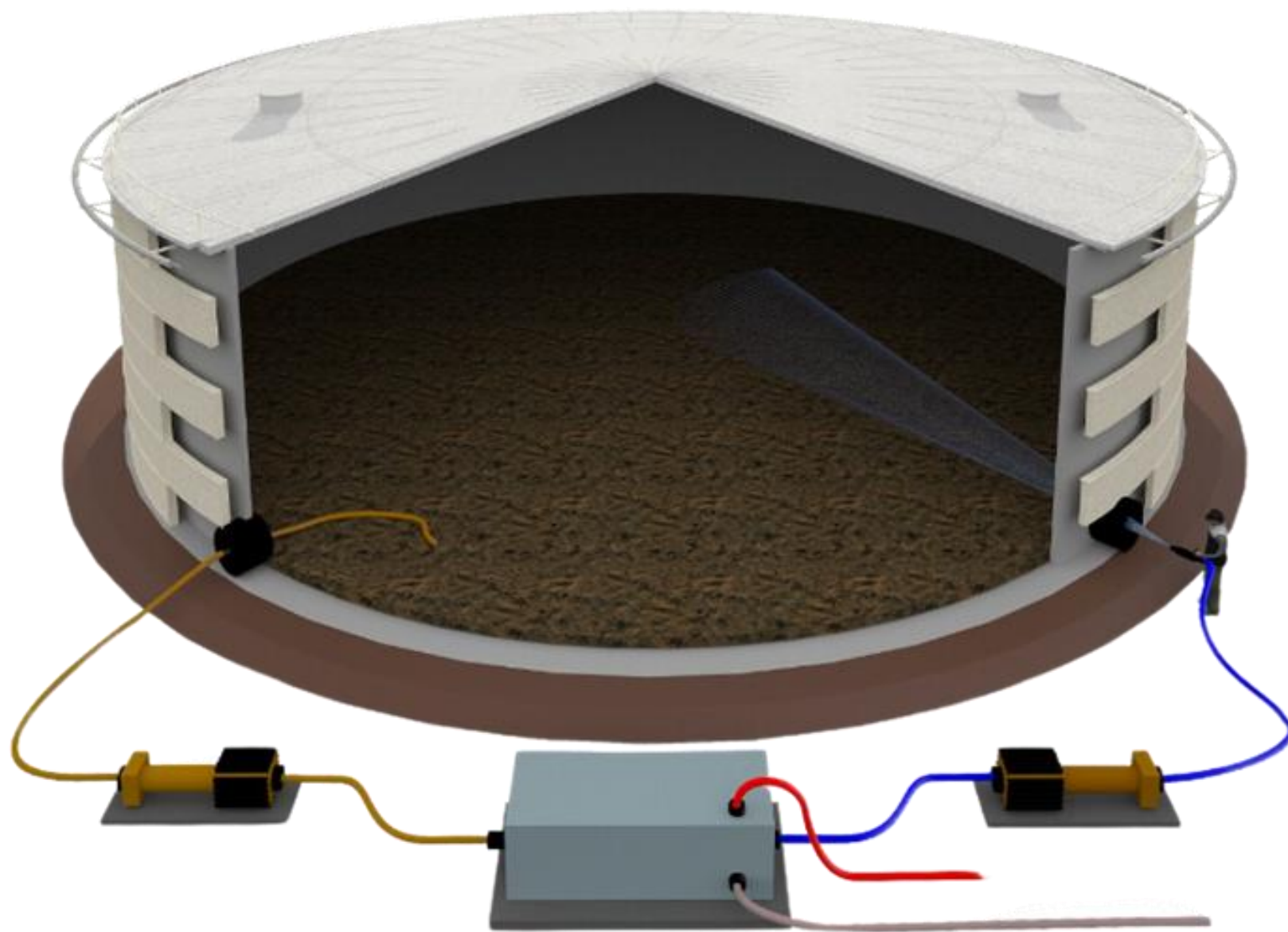
Multi-Jet Wash



SUNCOR – Base plant 82D-7 PHW Tank sludge removal



The final wash



TOTAL EST. oil storage tanks Millions Barrels CAPACITY in Canada :

▶ Manitoba		
TOTAL EST. MB CAPACITY:		3,000,000
▶ SASKATCHEWAN		
TOTAL EST. SK CAPACITY:		5,300,000
▶ ALBERTA		
TOTAL EST. AB CAPACITY:		83,900,000
CAPACITY UNDER CONSTRUCTION:		+4,100,000
▶ BRITISH COLUMBIA		
TOTAL EST. BC CAPACITY:		2,800,000
CAPACITY UNDER CONSTRUCTION:		+4,100,000
TOTAL ESTIMATED W. CDN OIL STORAGE CAPACITY:		95,000,000
CAPACITY UNDER CONSTRUCTION:		+8,200,000
UPDATED	DEC 19, 2019	

100 000 000 Barrels (BBL) = 15,898,251 Cubic Meters (m³)
50,000 m³ = 300 Large Tanks

Risks and mitigation

Internal Component Damage	-Use injector tension to dial back the pressure -Sensors used to detect -Calculate safe jet pressure
Tank Cleaning system failure	Completely Stop all tank cleaning activities and commence full investigation. Restart cleaning process after investigation completion and all issues are corrected.
Valve leakage	Crew will not proceed with further action until Client advise how to proceed and it will be safe to do.
Pipe/Hose failure	Replacement or repair.
Poor ground condition	Rig matts will be installed in a heavy equipment parking.
Tank overflow	Client is responsible to monitor tank fluid level. Permanent protection wall will be erected by client to protect site crew.

BP annual report and form 20-F 2015 (extract)

BP is embedding cost efficiency and simplification into everyday activities as well as large-scale changes in response to market conditions

Steam clean savings ▲

Refinery tank cleaning, which is done by hand, is not always efficient as it is based on estimates of waste within the tank. Downstream teams tested an existing steam injection method that was new to BP that separates the build up into sediment on the bottom, then water, and a layer of recoverable oil floating on the top. The oil and water are pumped away, leaving the sediment to be easily cleaned up in the final manual cleaning step. Since the process was implemented at the Rotterdam refinery in 2015, it has significantly reduced cleaning times – from 9-12 months down to three, reduced risks to cleaners and saved more than \$3 million. It is now being adopted across BP with further savings expected.

References



BP Raffinaderij Rotterdam B.V.
1700 AA Rotterdam - Eurocoor
Haven 6625

Uw informatie
Oms. referentie ES15-007
Oms. nummer 0181-259767
Fax direct 0181-253988

Europoort, 23rd November 2015

To whom it might concern

LETTER OF REFERENCE

This letter of reference refers to the performance of the Crude Oil Tank **TK-110** cleaning by ARKOIL Technologies Nederland B.V. (hereafter referred as ARKOIL) for BP Raffinaderij Rotterdam B.V. (hereafter referred as BP).

By this letter we confirm that ARKOIL fulfilled its obligation according to the Contract No 4500133613 and continually produced a high standard in the following:

the production of Risk Assessments and Method Statements.

These are relevant to the task, and contain all necessary information to ensure all aspects have been considered.

ARKOIL has consistently provided an effective and thorough Safe Work Procedures and have followed through with experienced and qualified personnel to execute tank cleaning project on-time and with a very high focus on the safety of the crew and facility.

ARKOIL on a short notice mobilized an experienced planning crew and when the actual cleaning started in March 2015, the crews were excellent in their flexibility to meet BP's schedule, with their attention to detail in executing the procedures, and compliance with wearing the appropriate PPE. ARKOIL team also prepared detailed and timely reports to the project managers.

ARKOIL Non-man Entry Crude Oil Tank Cleaning system renders possible to clean the inner side of the tank and dissolved the accumulated sludge into three fractions: hydrocarbons, water, sediments as well as recover the oil simultaneously with tank cleaning.

ARKOIL Non-man Entry Crude Oil Tank Cleaning system did not cause any emissions of harmful substances into the atmosphere and complies with the required European Safety and Environmental Standards.



Postbus:
Postbus 1030
3760 AA Rozenburg
Nederland

Tel: 06 511 21 25 90 00
Fax: 06 511 21 25 90 00

ARHOIL-AMRO Bank Oostvoorne 48.56.04.241
Oms. nummer 450175

Handelsregister 24178415
BTW nr. NL006706013.001



In conclusion, BP considers ARKOIL as a reliable and efficient company, which delivers the highest standards of work.

Regards,

BP Raffinaderij Rotterdam B.V.


Richard Verhey
Procurement Specialist

2015/05/01

References



Our ref.: SBD-COM-4093-040620

4th June 2020

ARKOIL Technologies Nederland B.V.
Weena 290, 3012 NJ
Rotterdam, The Netherlands

Attn: Marat Nurlygaianov

RE: **TANK-170 CLEANING PROJECT – BRUNEI SHELL PETROLEUM SDN BHD**

By the present letter we confirm that Arkoil Technologies Nederland B.V. in collaboration with CIC Environmental Services Sdn Bhd successfully performed the cleaning of the tank T170 with the capacity of 12 300 m³ for Brunei Shell Petroleum at Seria Crude Oil Terminal.

Arkoil's scope of work included Non-man Entry tank cleaning by means of steaming and hydraulic washing.

Estimated volume of oil sludge prior the commencement of the project was equal to 6 600 m³. Laboratory studies showed a high concentration of solids in the oil sludge (around 78%).

Application of Arkoil tank cleaning technology significantly reduced cleaning time almost thrice compared to the terms of previously executed similar tank cleaning projects at Seria Crude Oil Terminal.

Arkoil Technologies Nederland B.V. fulfilled all its obligations in compliance with the agreed deadlines including but not limited timely mobilization, assembling and manufacturing of its original self-developed equipment based on the tank's peculiarities, available drawings and client's requirements. Notwithstanding the complexity of the project Arkoil maintained tank integrity adapting and customizing its technical approach.

All the on-site works professionally performed by Arkoil engineering team were carried out strictly in conformity with existing local Safety and Environmental Standards. Moreover, the proposed method of cleaning minimized risks for the manpower since its intervention was required only on the final stage – during the mechanical removal of the minor amount of sediments from the bottom of the tank.

Yours faithfully
CIC ENVIRONMENTAL SERVICES SDN BHD


Rusli Sulaiman
Project Manager





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July 15, 2013

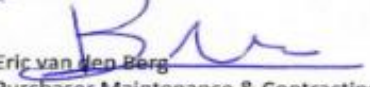
Crude Tank Cleaning Reference Letter

According to the Contract ZR-C-2012 ARKOIL Technologies Nederland performed cleaning of the crude tank 030M103 (storage capacity - 80,000 m3, diameter – 72,5 m) at the tank farm of Zeeland Refinery N.V., Nieuwdorp, The Netherlands.

According to the initial measurements volume of the accumulated oil sludge was 2,000 m3. Upon application of ARKOIL's Non-man Entry Crude Tank Cleaning System the accumulated sludge was separated into three fractions: hydrocarbons, water and solid sediments. Hydrocarbons, free from any sediments or impurities, were successfully recovered by ARKOIL's engineers and were further processed by the Refinery. This recovery allowed to meet the main goal of the Contract and more than 95% of oil was recovered. Water was drained and treated internally. Sediments were removed from the tank and brought to place specified by the Customer. The tank was prepared to hot works.

ARKOIL System allowed no HC emission and accepted by Zeeland Refinery as explosion proof and meeting Safety, Health and Environmental standards.

Zeeland Refinery N.V.



Eric van den Berg
Purchaser Maintenance & Contracting
Eric.van-den-berg@zrefinery.nl



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