

Hydrocarbon Tank Cleaning Best Practice

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environmental protection policy

خطة حماية البيئة

Policy Statement

Saudi Aramco considers environmental protection an integral pillar of its social license to operate. Emanating from this firm belief, the Company will ensure that its projects/operations are in compliance with the Kingdom's environmental regulations and do not create undue risks to the environment, public or workers' health. Saudi Aramco will strive to conserve natural resources and minimize emissions and the environmental footprint of its activities through continuous optimization of Company operations, and leveraging technology advancements and industry best practices. The Company will work toward promoting the conservation of natural biodiversity within its reservations.

بيان الخطة

تعتبر أرامكو السعودية حماية البيئة ركيزة أساسية من ضمن مسؤولياتها تجاه المجتمع. و من هذا المنطلق ستضمن الشركة أن مشاريعها و أعمالها ملتزمة بالأنظمة البيئية وأنها لا تشكل مخاطر على البيئة أو الصحة العامة أو العاملين. وستبذل أرامكو السعودية قصارى جهدها للمحافظة على الموارد الطبيعية و تقليل الانبعاثات والحد من الآثار البيئية لأعمالها من خلال التحسين المستمر لأعمال الشركة بالاستفادة من أحدث التطورات التقنية وتطبيق أفضل ممارسات الصناعة. وستعمل الشركة على تعزيز المحافظة على التنوع البيولوجي ضمن محجوزاتها.

Regulations

- In all its projects/operations, the Company will attain the highest level of compliance with the Kingdom's environmental regulations. Where there are no established national regulations, the Company will develop environmental standards aligned with industry best practices and compatible with the Kingdom's environmental protection objectives.
- It is the responsibility of each Company organization to ensure that its facilities are designed, constructed and operated in compliance with the corporate Environmental Protection Policy.
- The Company will maintain corporate environmental programs to monitor the compliance of Company organizations with environmental regulations/standards.
- Each Company organization shall strive to continuously enhance its environmental performance to conserve natural resources, reduce the environmental footprint of its activities and conserve biodiversity within areas of its operations.

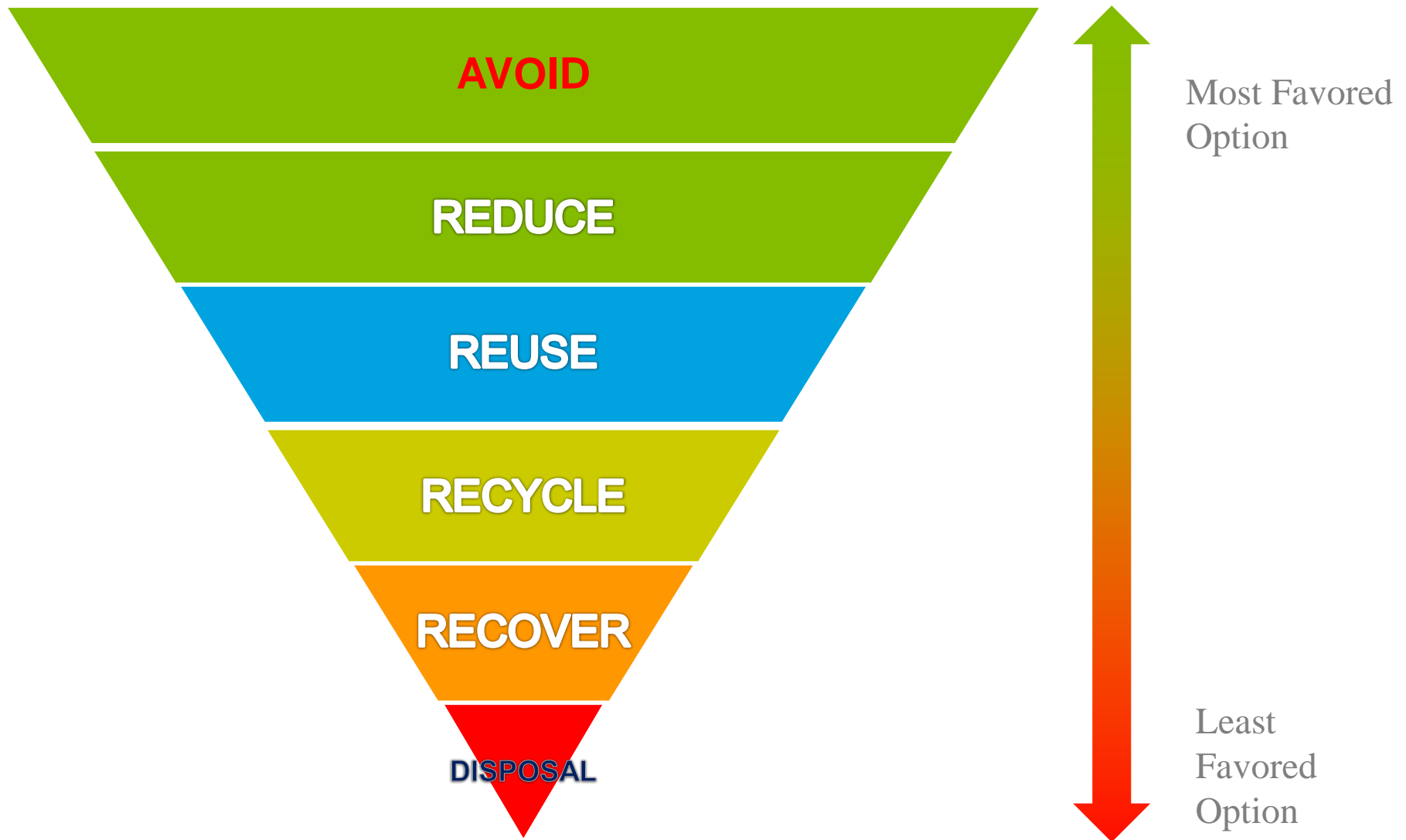
الأنظمة

- ستتقيد الشركة بأعلى مستويات الالتزام بالأنظمة البيئية في جميع مشاريعها أو أعمالها. وحيثما لا توجد أنظمة وطنية مطبقة، ستعد الشركة معايير بيئية تتطابق مع أفضل ممارسات الصناعة وتتماشى مع أهداف حماية البيئة في المملكة.
- تقع على عاتق كل دائرة في الشركة مسؤولية ضمان تصميم مرافقها وإنشائها وتشغيلها وفقاً لخطة حماية البيئة في الشركة.
- ستحرص الشركة على تنفيذ برامج بيئية مركزية لمراقبة التزام دوائرها بالأنظمة والمعايير البيئية.
- يتعين على كل دائرة في الشركة أن تسعى إلى تحسين أدائها البيئي باستمرار من أجل المحافظة على الموارد الطبيعية وتقليل الآثار البيئية لأنشطتها والمحافظة على التنوع البيولوجي ضمن مناطق أعمالها.

President & Chief Executive Officer

الرئيس و كبير الإداريين التنفيذيين

Waste Management Hierarchy:



Hydrocarbon waste from tank bottoms:

- Major source of hazardous waste in Saudi Aramco
- Current method:
 - Manual scarping during T&I events
 - Health issue
 - Lengthy cleaning process
 - Generates hazardous waste
 - No recovery of hydrocarbons
 - Costly
 - Potential land contamination
 - Lose-lose cleaning method



Regulations and procedures:

- ✓ Oily sludge is hazardous waste
- ✓ More than 20,000 m³ is generated every year from tank bottoms
- ✓ Managed through third party hazardous waste management facilities
- ✓ Generated during T&I events every 10 years
- ✓ Waste management method is through land-farming



Ways to minimize oily sludge generation

- Keep turbulent flow in tank to prevent sedimentation by the use of mechanical stirring devices
- Add appropriate chemical agents to reduce tank bottom accumulation
- Recover product by recycling light oil tank bottoms through heavy oil dehydration facilities
- Reduce the number of tanks by consolidating produced fluid storage facilities
- Keep a gas blanket on tanks to reduce oxygen and formation of iron oxides
- Identify and minimize the source of solids

Saudi Aramco crude oil tanks

- Locations

- Refineries
- Terminals
- Pump stations
- Oil stabilization plant

- Types of crude oil:

- Arab Light
- Arab Medium
- Arab Heavy
- Arab Super Light
- Arab Super Extra Light



Approach and methodology:

1

- Evaluate existing tank sludge characterizing data

2

- Collect oily sludge samples during T&I

3

- Review results for tank cleaning technology demos and determine availability in the local market

4

- Review current best company practices at Saudi Aramco facilities, including local joint ventures

5

- Compile results and develop best practice

Review current best company practices

- Surveyed all crude oil tank operators
 - Refineries
 - Terminals
 - Pump-stations
 - Oil stabilization plants
 - Local joint ventures
- Reviewed previous questionnaire
- Reviewed internal procedures
- Reviewed previous T&I reports

Oily sludge sampling data

- Collected oily sludge samples during T&I events
- Objective is to create a waste profile for each type of crude oil
- Analyzed for the following parameters:
 - TCLP
 - TPH
 - VOC
 - SVOCs
 - Physical properties

Review results for tank cleaning technology demos

- Attended demos in Oman-2010
- Attended demos in Saudi Aramco-2015
- Attended meeting with different tank cleaning service providers

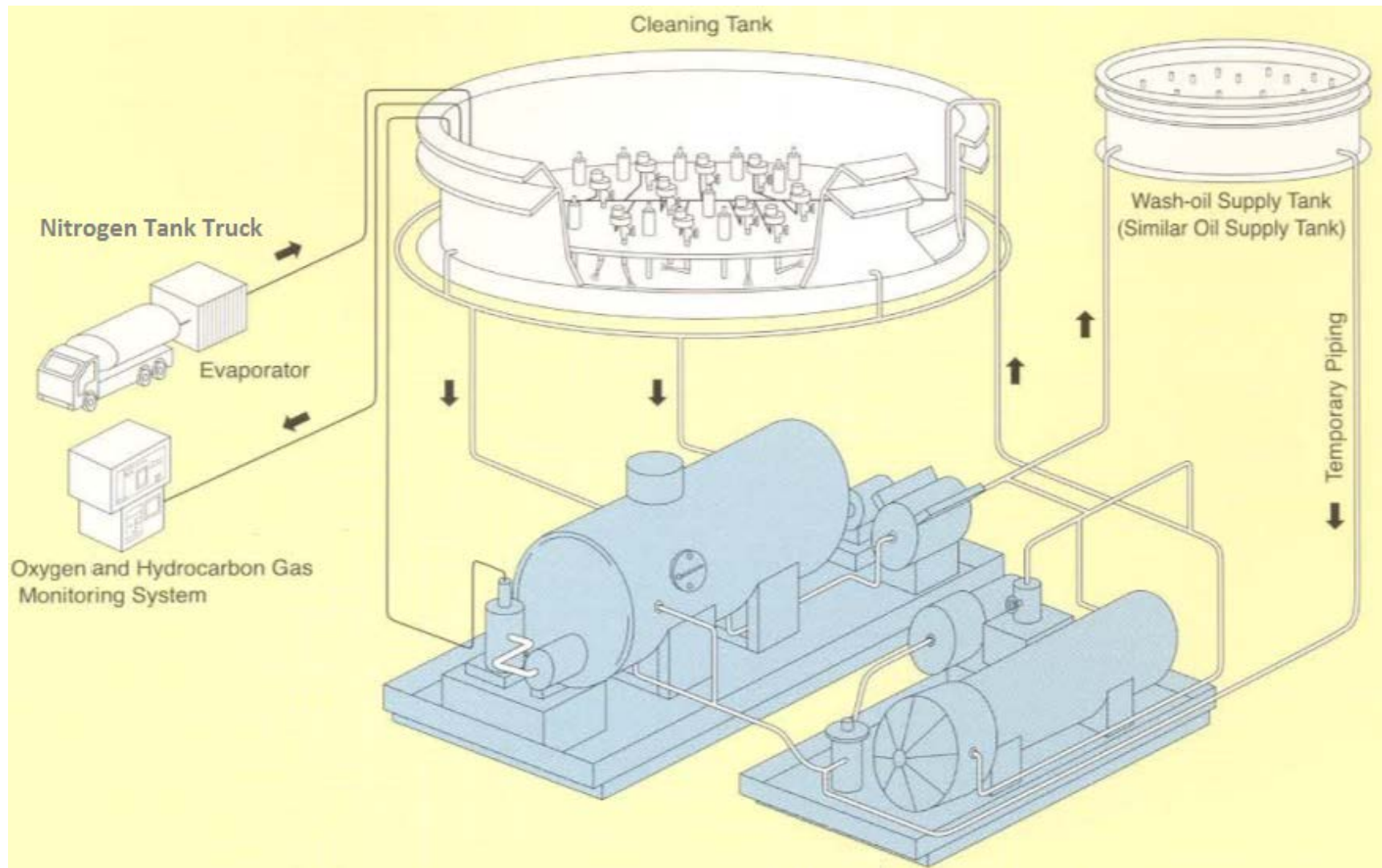
Criteria identified:

- Minimum disturbance to operation
- No or minimum exposure of personnel inside the tank (i.e., technology is fully automated)
- Maximum oil recovery from oily sludge
- No or minimum waste generation from tank bottoms
- Minimum resources needed for cleaning
- No or low design modifications to the crude oil storage tanks intended for cleaning
- A mobile unit
- Comply with minimum hydrocarbon emissions and polluting effluents
- Comply with Saudi Aramco applicable standards with regard to health safety requirements

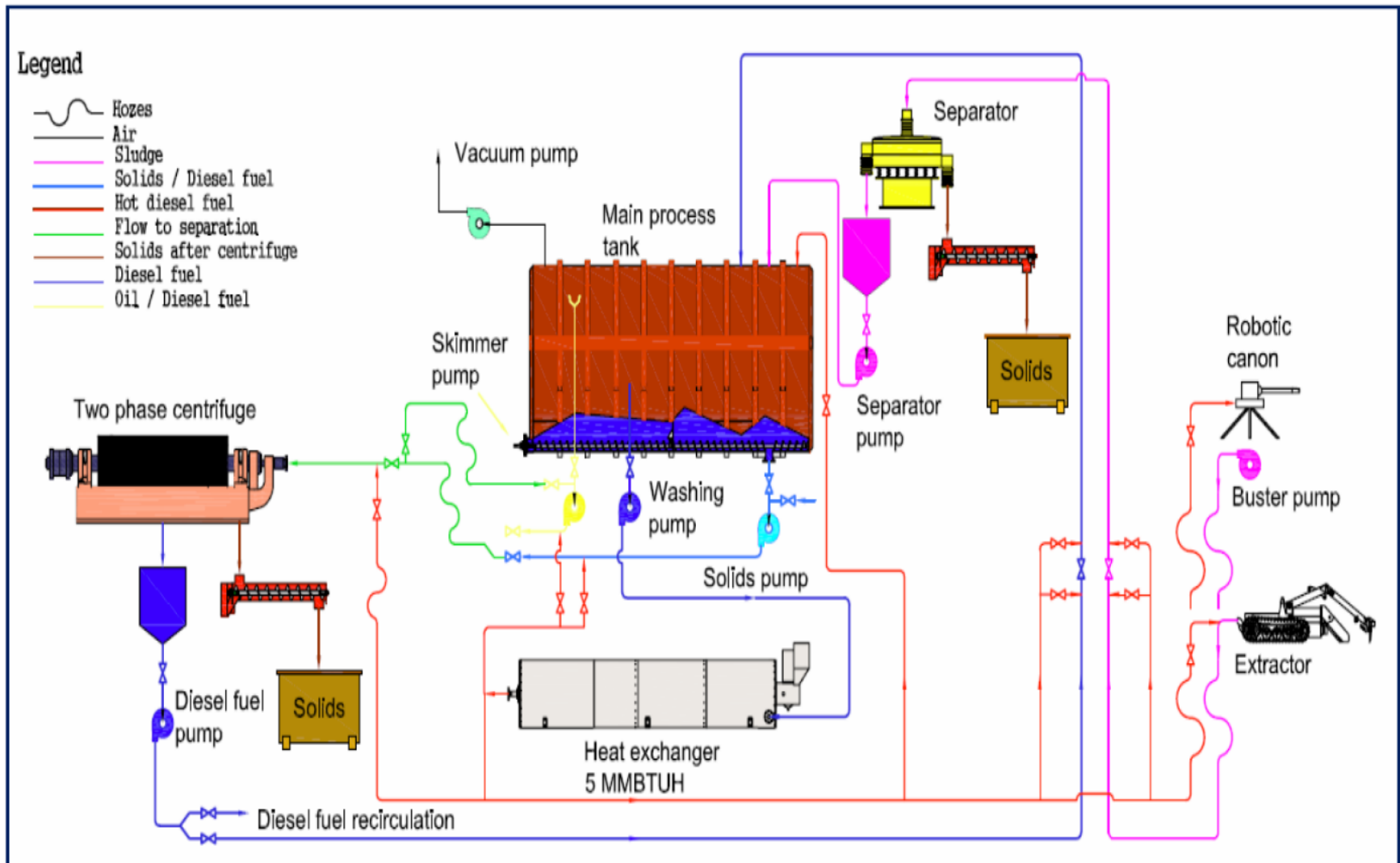
Tank Cleaning methods identified:

- Those that circulate a cleaning fluid (oil or hot water) through nozzles installed inside the tank to dissolve and mobilize the sludge
- Those that use robotic devices to extract the sludge

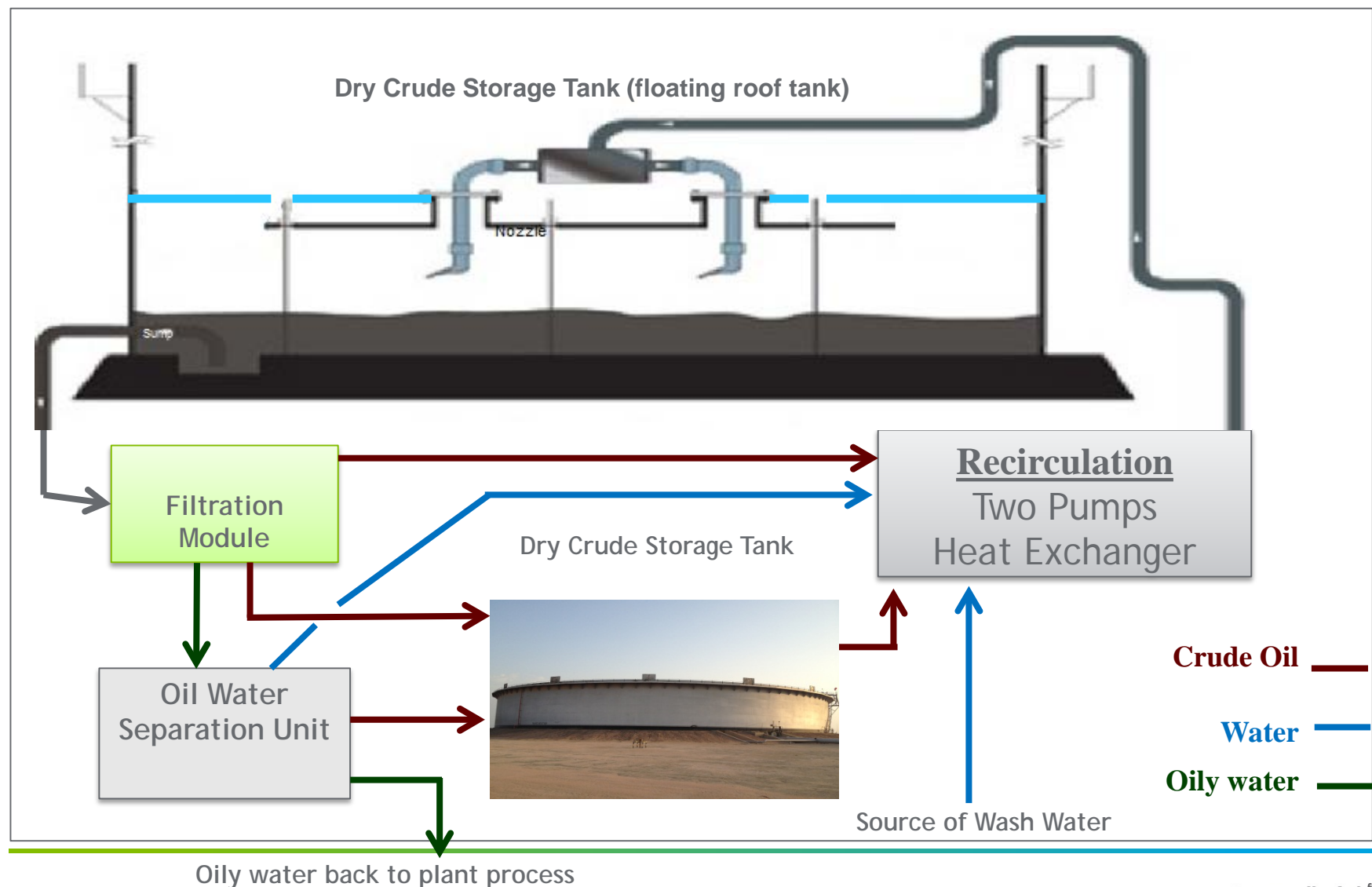
Crude Oil Washing System:



Mechanical removal through hot water using robotics:



Automated tank cleaning method (closed tank):



Benefits perceived from adopting new best practice:

1

- **Health & Safety:**

- No direct exposure to personnel

2

- **Environmental:**

- Closed system, no oil spills, and no sludge accumulation
- Reduce hazardous waste management
- Water Conservation (closed recycled wash water system)

3

- **Efficient and Effective:**

- 10-12 Weeks (Automated) **vs.** 20-24 weeks (Manual)
- Proved to be effective cleaning method

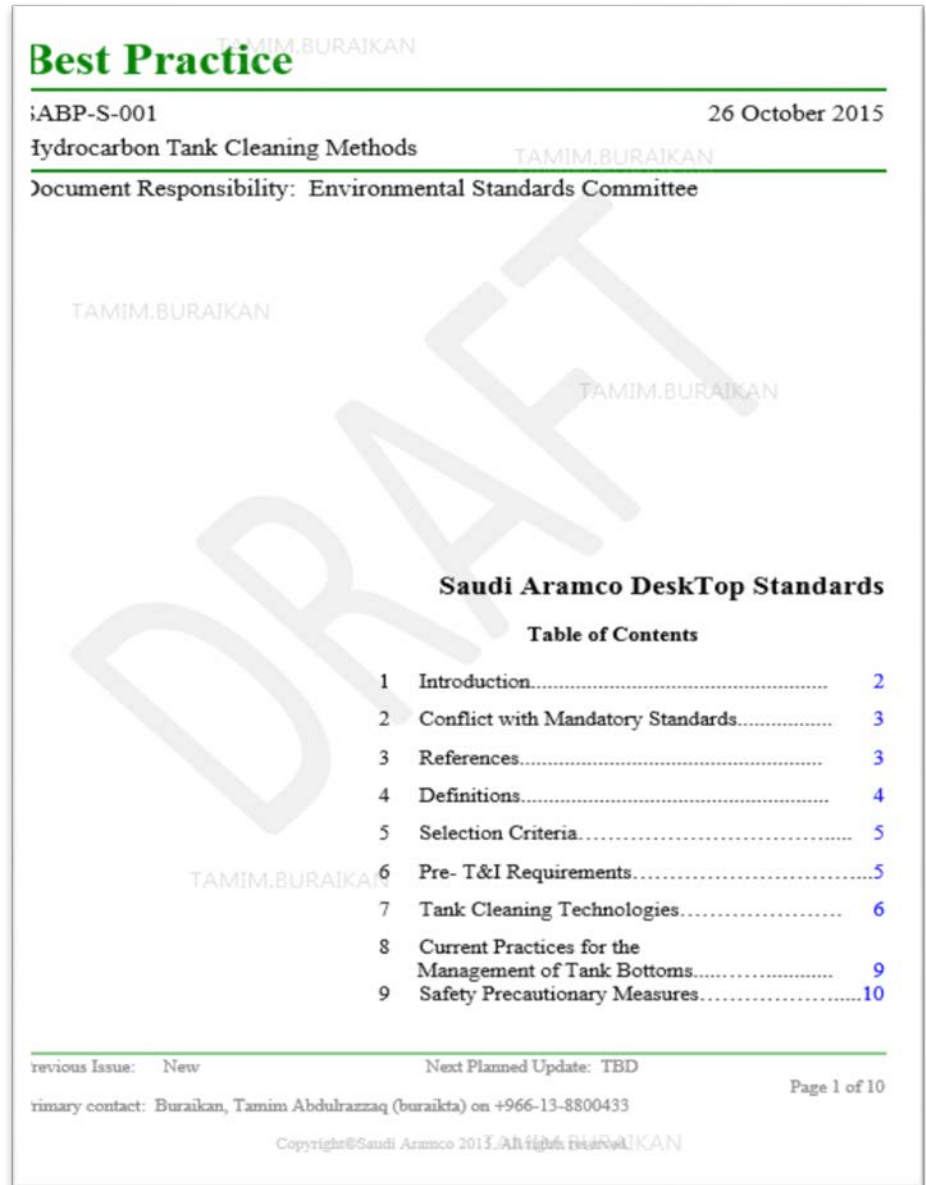
4

- **Economics:**

- Recover valuable hydrocarbons from oily sludge
- Significant reduction in waste management costs

Best Practice Document:

- Selection criteria,
- Technologies available in the region,
- Adopted oily sludge minimization methods,



Conclusion:

- Automatic tank cleaning proved to be a success
- Best practice is a guide for crude oil tank operators to utilize
- Saudi Aramco facilities continue to see the benefits and widespread implementation is observed
- Automatic cleaning method worked with all types of crude oils

Thank you ...