NORM WASTE IN OIL&GAS INDUSTRY

HANDLING, TREATMENT AND DISPOSAL

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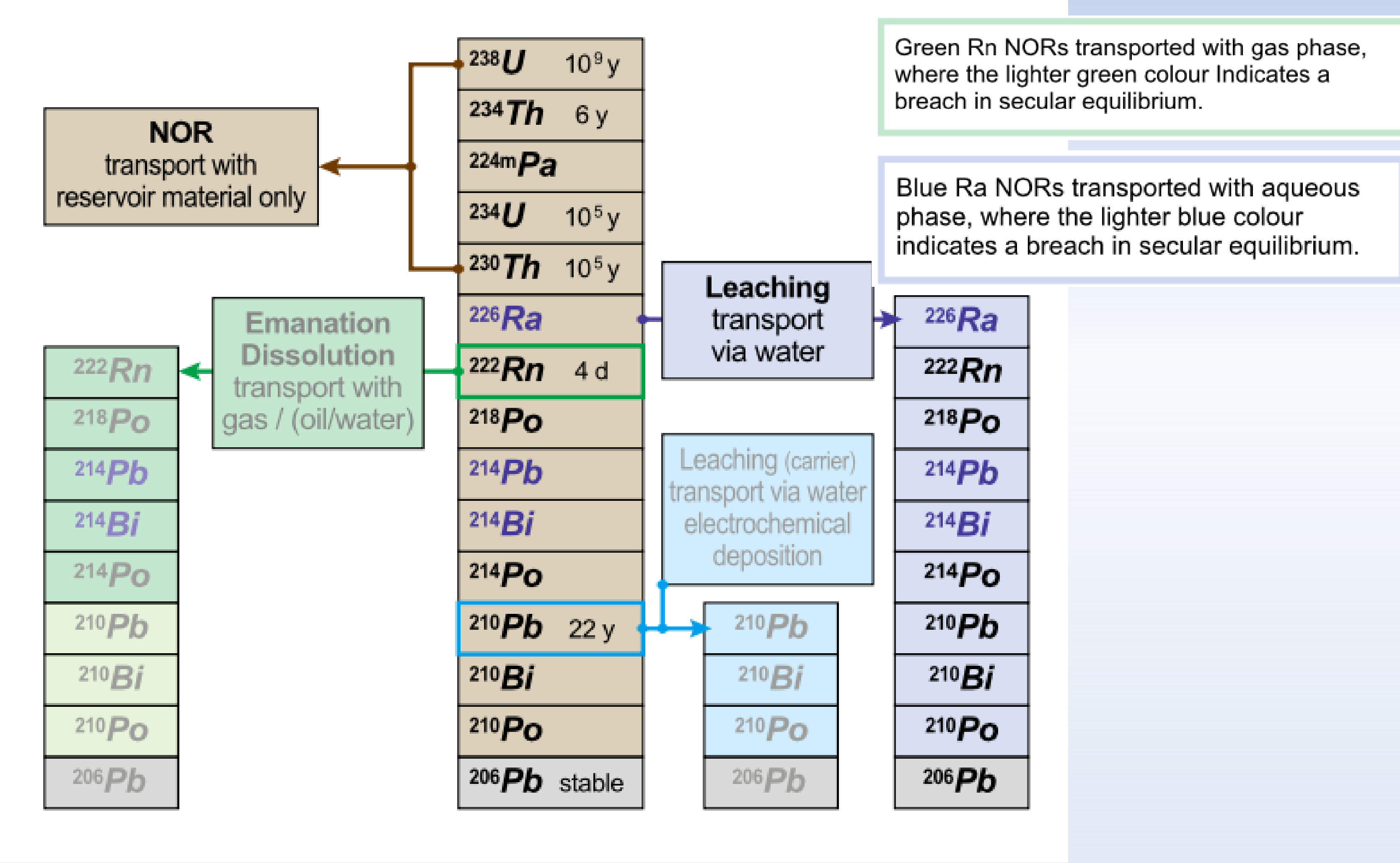
INTRODUCTION TO NORM WASTE

NORM are unstable atoms which emit alpha & beta particles with gamma radiation energy. This process called “Decay Process” continues till the stability point is achieved. The time it takes is measured as “half-life time”. Ra-226/228 have half life is 1600/5.8 years. After this much of time, their atoms will have a 50% less mass.

Waste material contaminated with enhanced levels of NORM requires to be disposed off in a controlled manner to ensure it does not provide an unacceptable risk to the environment and the general public.

<u>NORM can cause health problems in large exposure situations.</u>

NORM WASTE TREATMENT PLANTS



TYPES OF NORM WASTE

Several types of NORM wastes are produced during Oil&Gas operation:

1) Tubulars with scale
2) Sludge
3) Metallic equipment with scale or sludge
4) Burnable Miscellaneous
5) Non Burnable Miscellaneous

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NORM RADIATION EXPOSURE PATHWAYS

1) Seven pathways: radon inhalation, external gamma exposure, groundwater ingestion, surface-water ingestion, dust inhalation, food ingestion, and skin beta exposure
2) The greatest risk of exposure to NORM – workers at equipment cleaning facilities and oil filed
3) External exposure occurs when
   - The concentration of NORM inside equipment is high enough that gamma rays penetrate the equipment walls
   - Contaminated scale and sludge are removed from the equipment thereby eliminating the shielding factor provided by the equipment walls
4) Dust inhalation is possible when dry cleaning processes are used without adequate control
5) Direct contact with contaminated scale and sludge can result in skin beta exposure

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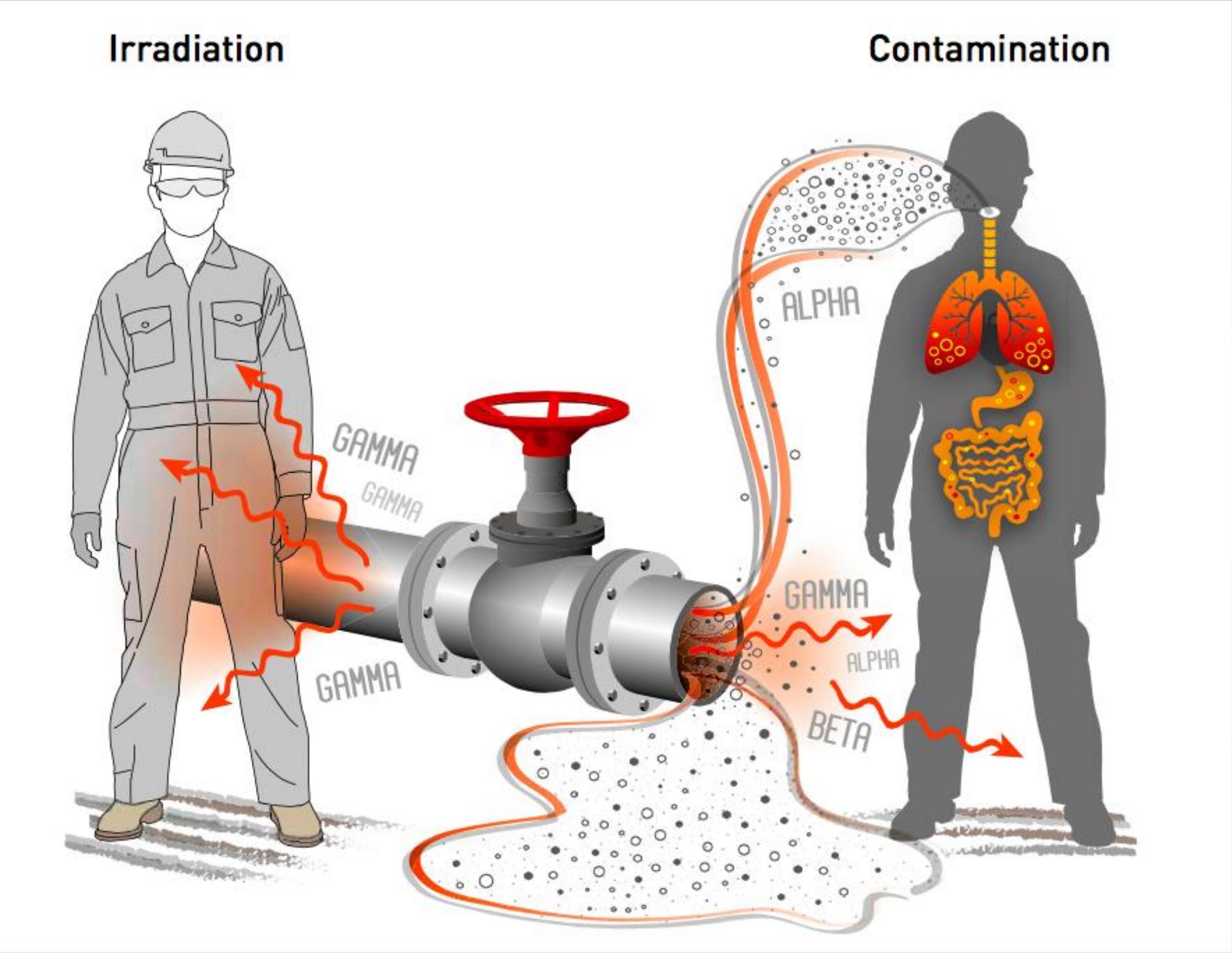


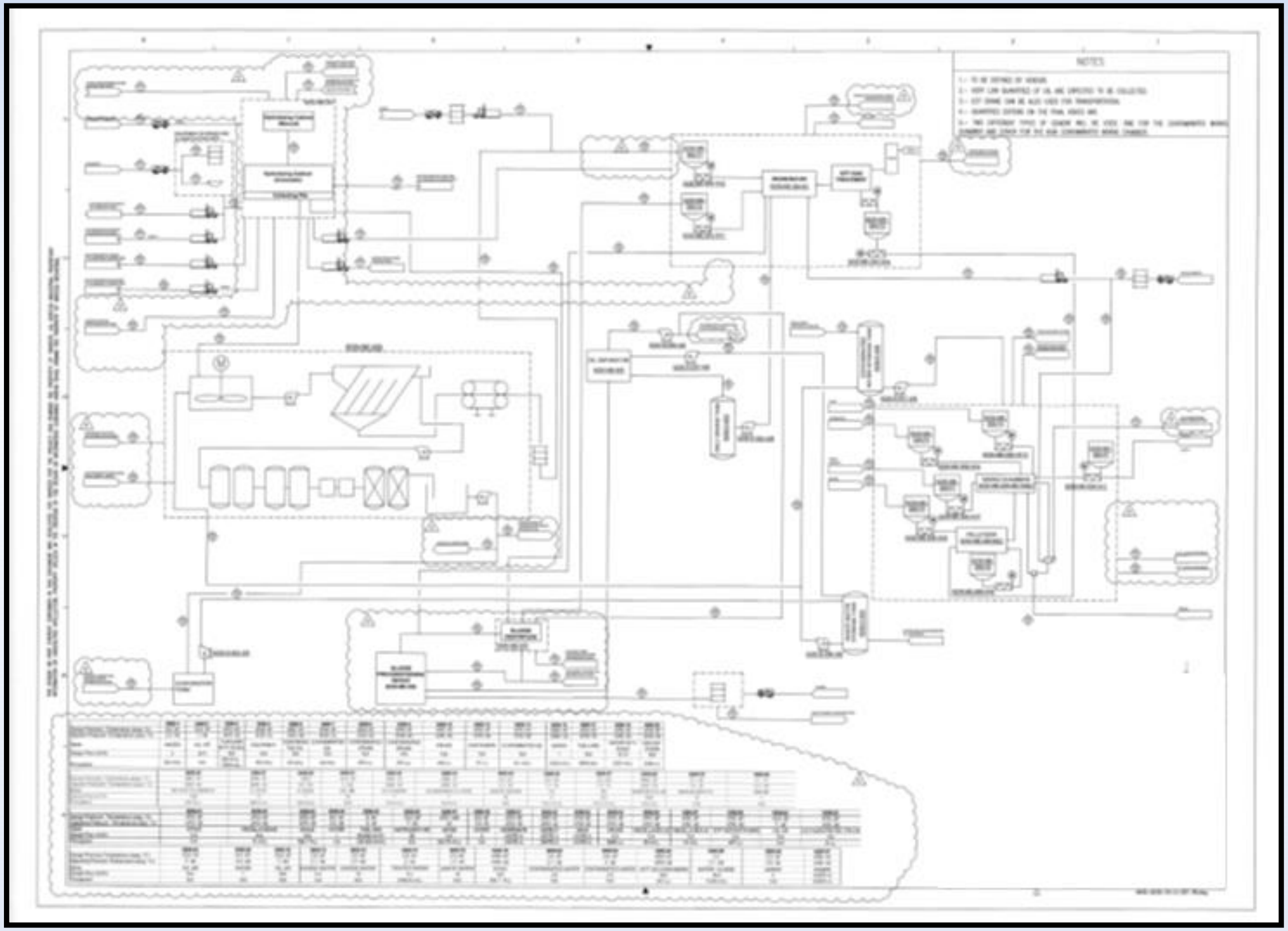
NORM HANDLING, TREATMENT AND DISPOSAL PLANTS

In order to treat the waste, NORM treatment plants are delivered

The NORM waste treatment plants are designed to combine handling, treatment and disposal units for NORM waste.

NORM WASTE TREATMENT PLANTS

Process Flow Diagram (PFD)



Transportation and Acceptance

The NORM treatment plants are not intended to treat any kind of radioactive contaminated waste. They are specifically design for NORM waste and no other type of waste such us hospitals wastes, nuclear power plants wastes, etc.

The correct characterization of the waste is critical for defining the best treatment.

Waste Transfer Protocols (WTP) and Waste Acceptance Protocols (WAP) are defined in order to check that waste can be transported, accepted and treated in the NORM plants.

NORM WASTE TREATMENT PLANTS

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NORM WASTE TRANSFER PROTOCOL

REV.	DATE	DESCRIPTION	PREPARED	CHECKED	REVIEWED	APPROVED
1		Issued for Approval				
0		Issued for Comments				

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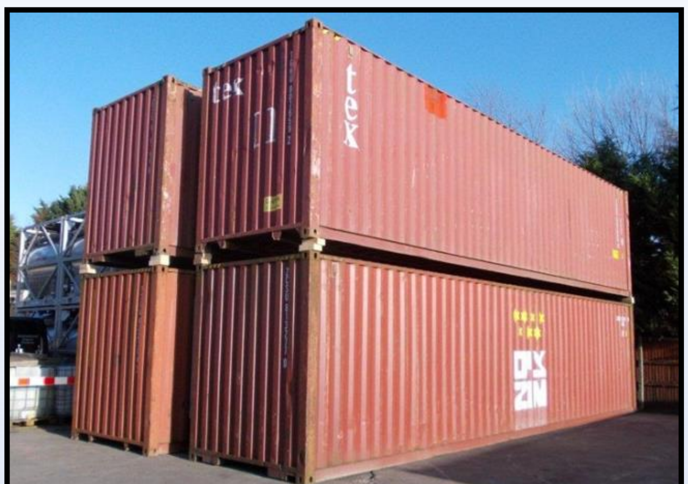
Transportation and Acceptance

Waste should be transported properly packed in 40ft or 20ft containers.

Transportation and Acceptance

The container pass through a vehicle portal monitor that provides the information about the activity of the container (cps).

The container code is checked according to the WTP and, if correct, is preliminary accepted and routed to the Container Storage Area.



Transportation and Acceptance

During transportation, Radon concentration tends to increase due the natural decay of Ra226. As already explained, Radon is a gas that can be inhaled an produce serious injury to lungs.

Transportation containers should include a proper ventilation system in order to avoid Radon concentration in it.

If the container doesn't include a proper ventilation system, it should be kept opened for 24 hours in order to facilitate natural ventilation prior to the next handling stage, the acceptance.

Transportation and Acceptance

During the acceptance process, the different wastes are stored in a temporary storage area where samples are collected in order to check its characteristics with the WAC.

If the waste complies with the WAC, it is accepted. If not, then plant managers should decide if corrective actions can be taken in order to accept the waste. If not, the waste is rejected and return to the operating companies.

Classification and storage

After waste acceptance, a proper classification is performed and the wastes are stored in the appropriate areas in order to start with its specific treatment process.

Classification and storage

During this stage, the wastes are identified and monitored by a software application specifically designed for this purpose. The application's main function is to control the inventory of waste in every step of the treatment process. By means of this application, a record of the waste properties (weight, volume, activity, etc.) can be stored and consulted remotely by the country authorities in case of accident.

DESCALING unit

The purpose of the descaling unit is the elimination of the scale adhered to the tubulars and metallic equipment used during Oil&Gas operations.

For tubulars decontamination, the scale is eliminated by means of high pressure water (up to 2500 bar) that removes the adhered scale. Then the tubulars are blown with compressed air in order to dry it.

The system is fully automated, only requiring operator supervision.

DESCALING unit

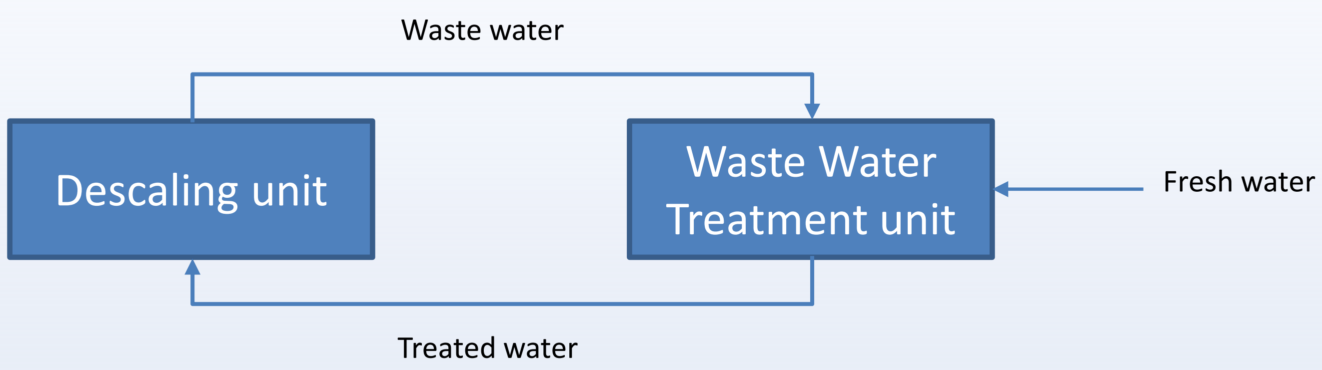
DESCALING unit

In case of contaminated metallic equipment, a manual cleaning cabinet is installed in order to perform the decontamination operation manually by means of a "high pressure water gun".

A hoist is installed inside the cabinet in order to make easier the metallic equipment handling.

DESCALING unit

All drainage are collected and transferred to a waste water treatment plant in order to withdrawn the radioactive scale and treat the water so the fresh water consumption is optimized.



Waste Water Treatment Plant

The out coming water of Descaling unit is treated in the Waste Water Treatment Plant (WWT). The plant includes physical and chemical processes that guarantee the appropriate water quality for Descaling operation.

Waste Water Treatment Plant

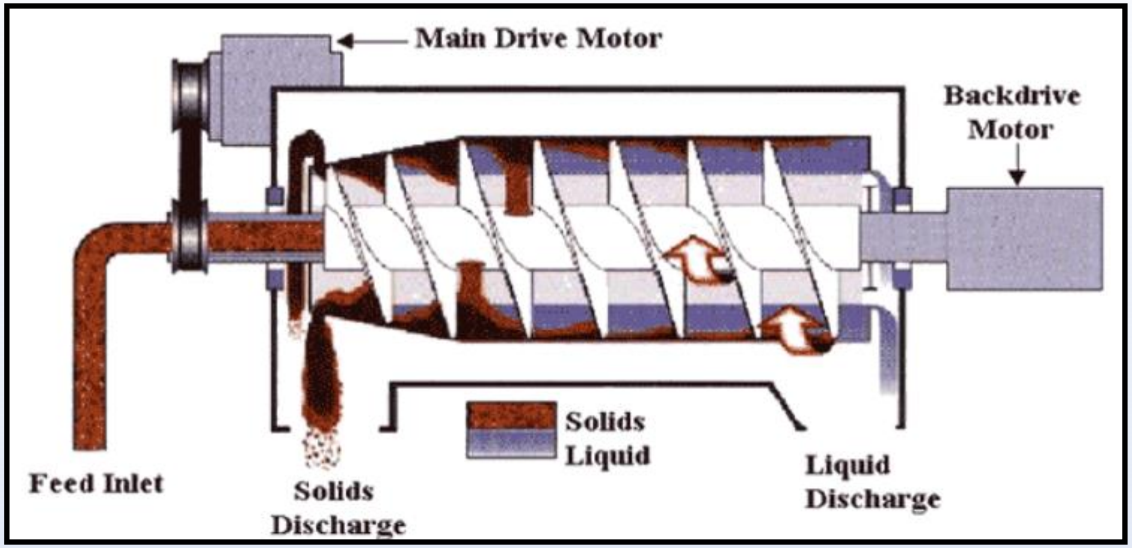
The main process includes decantation, filtration, activated carbon, ion exchange, stripper, etc.

-Decantation and filtration eliminates the solid particles.
-Activated carbon removes the oily particles
-Ion exchange removes the Radium and decrease the conductivity
-Stripper is used for Radon removal

Once the water is treated and quality checked, it can be recirculated to the Descaling unit.

Centrifuge

One of the most common operations for treating sludge is centrifugation. By means of densities differences of the sludge components (water, oil and solids), the centrifuge is capable of splitting the sludge into two or three phases depending on the selected device.

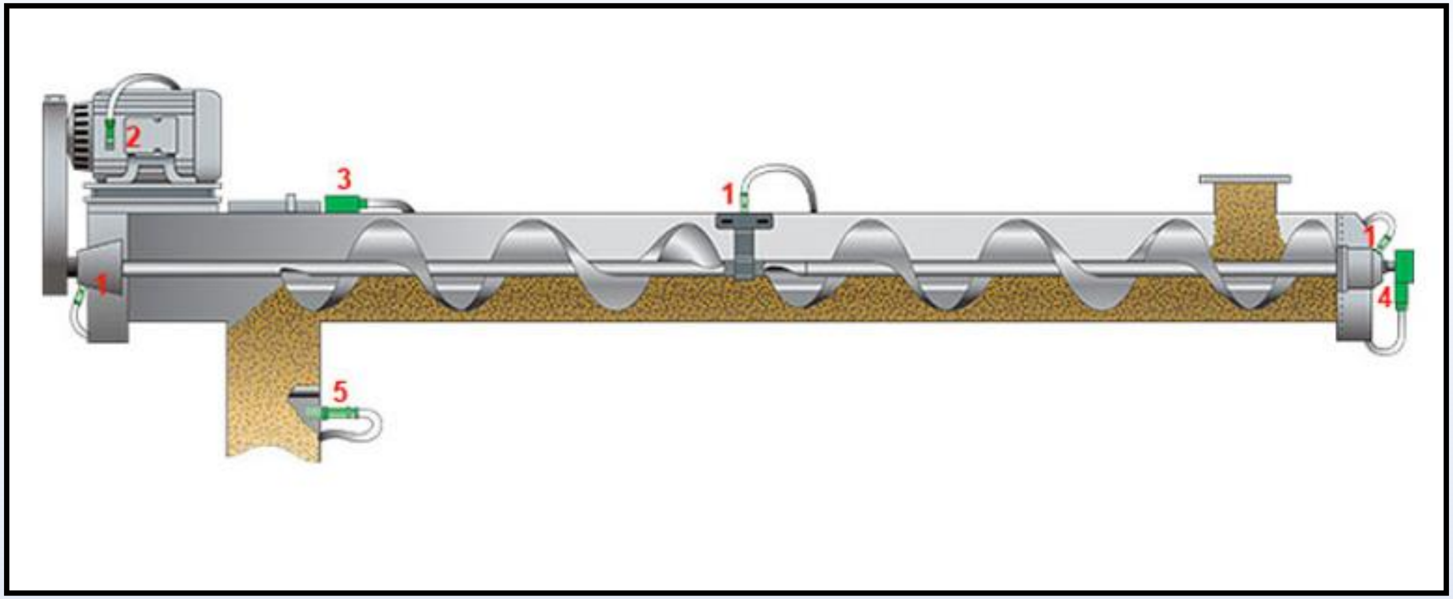


Centrifuge

In order to make more effective the centrifugation, sludge is preliminary filtered for eliminating big solid particles. After that, and depending on the density and viscosity, it is heated and diluted with a medium-light hydrocarbon. Now the sludge is ready to be fed to the centrifuge.

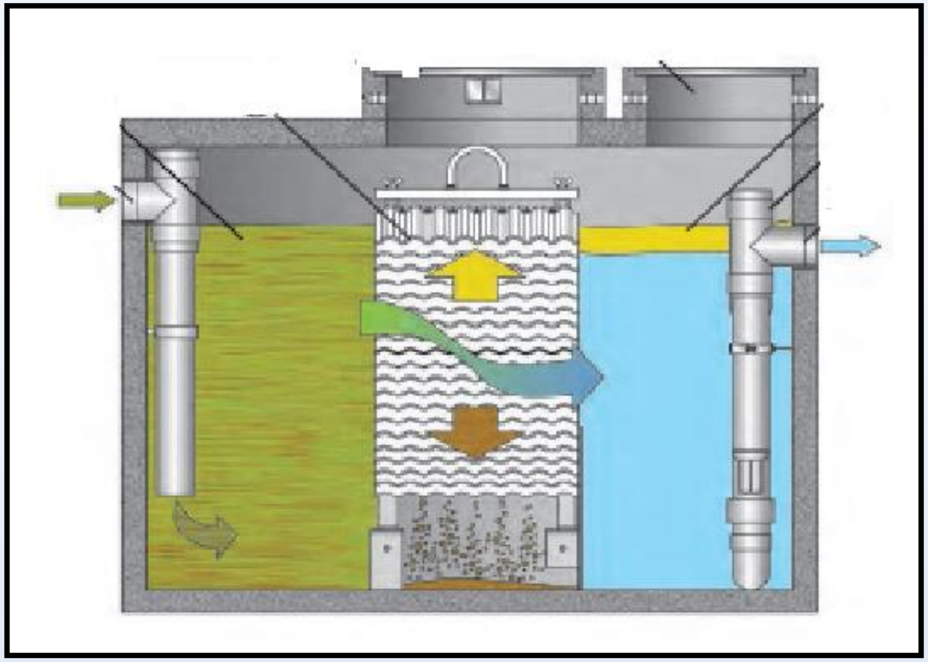
Centrifuge

The solid phase, that contains most of the radiation, is transferred to storage silos in order to be incinerated by means of screw conveyors.



Centrifuge

The liquid phase is treated in an oil separator for separating the oily phase from the water phase.



Incinerator

Incineration is installed when waste volume reduction and organic compounds elimination are required.

Incineration units typical includes one or two combustion chambers, flue gas treatment and ash recovery systems.

The wastes (burnable miscellaneous, dewatered scale, sludge) are fed into the combustion chamber by means of screw conveyors, pipe connection or double gate systems.

Incinerator

Rotary kilns are installed as primary combustion chambers due to its high performance when handling solid wastes

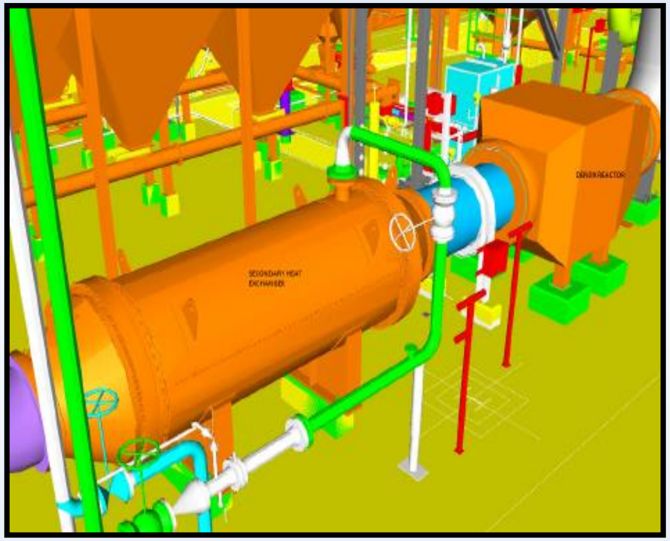
Incinerator

The flue gas that leaves the combustion chamber is treated in order to reduce the temperature and eliminate the remaining ashes and contaminating particles.

The flue gas treatment usually includes flue gas coolers, bag filters, reactors, heat exchangers and exhaust fans.

A Constant Emission Monitoring System (CEMS) is installed in the stack in order to monitor the activity and chemical composition of the flue gas emitted to the atmosphere.

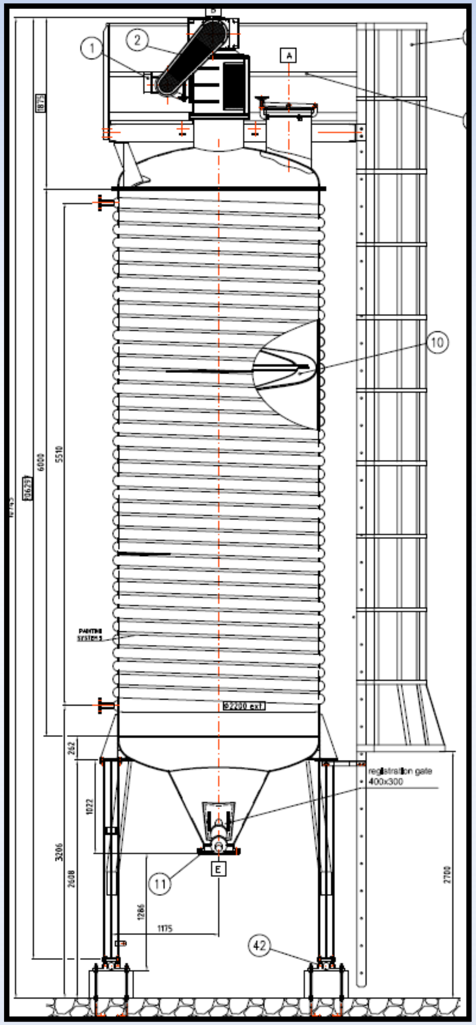
Incinerator



Incinerator

The ashes produced in the combustion chamber are collected, cooled, and transferred to a silo in the solidification plant.

All ashes collected during the flue gas treatment are also transferred to this silo where the ash is stored previous to the solidification process.



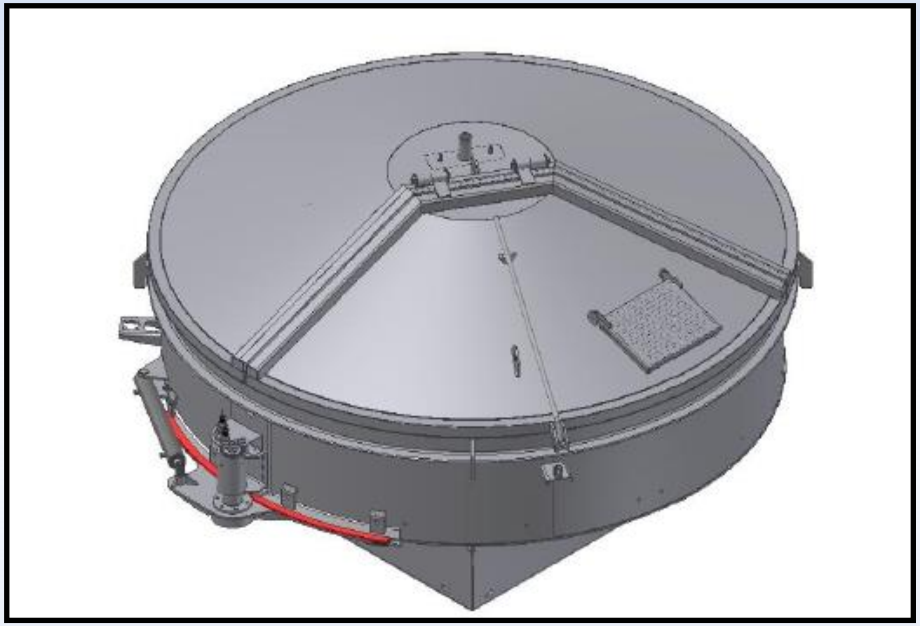
Solidification

The final stage of the waste treatment process is the stabilization and solidification unit.

The non burnable miscellaneous and ashes are mixed with concrete and transferred into 55 gal drums. During the mixing of ash and concrete, some additives are added to chemically stabilize the product. Also a cooling system is include in the mixing chamber since the stabilization reaction is exothermic.

This operation is fully automated in order to avoid operator exposure to the high activity radiation produced by the waste ashes

Solidification



Solidification

Drums are stored for 7 days guaranteeing an appropriate curing time.

Then the drums are characterized in order to obtain the activity of each of them. Characterization is critical for the next treatment stage, the storage in HHISO containers.

In order to avoid "hot spots" in the disposal landfill, the HHISO must be filled with drums considering the activity of each drum.

Solidification

The operation of introducing the drums into the HHISO is performed remotely by means of a vertical drum handler.

Once the HHISO is full of drums (typically 12 drums are stored in each HHISO container), it is filled with concrete and covered with a steel lid.

After curing time, the HHISO containers are stored in the landfill.

Solidification

Landfill

The landfill is a long term repository where HHISO containers are stored.

The landfill is designed according to the highest safety standards in order to guarantee its performance during long periods of time.

The landfill consists of several HDPE liners, geotextile layers and HDPE perforated pipes.

Landfill

Piezometrics wells are made in the boundaries of the landfill in order to monitor potential contamination release into the underground water reservoirs.

Typical Auxiliary Units

- Drainage Collection System
- Laboratory
- Water Supply System
- Instrument Air Supply System
- Natural Gas Supply System
- Fire Water System
- Electrical Substation
- Radiological Protection Equipment

NORM MONITORING

Types of NORM monitoring:

1) Surveillance - this monitoring is done to answer questions such as:
    1) is NORM occurring in this operation?
    2) how much NORM is present, and what type is it?
    3) is the NORM changing over time?
2) Confirmation of controls - this monitoring is done in order to check that assumed parameters on which controls are based are accurate, or that controls are working. Examples of such monitoring are:
    1) Carrying out personal dosimetry for external radiation exposures to confirm that exposures fall into the range expected from external radiation surveillance monitoring;
    2) Measuring airborne radioactive dust during maintenance activities to check that the assumptions upon which respirator selections were made are accurate – or if respirators are needed at all;
    3) a surface contamination survey in a workshop to confirm that NORM contamination controls are working;
    4) sampling and analysis of waste streams to confirm that they remain within regulatory limits.
3) Operational - this is monitoring done during day-to-day operations to determine if NORM precautions are required for a particular piece of equipment, or to determine the NORM status of an item prior to release off site.

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Types of equipment used:

1) External Radiation
    1) Personal Dosimeters – for planning operations and measuring personal exposure to gamma, x-ray and beta radiation. Both direct reading and TLD
    2) Gamma detectors – for detecting contamination areas and equipment via gamma radiation (over metal walls of operating equipment or waste management).
2) Surface contamination
    1) Beta and beta/gamma detectors and measurement assemblies to search for contamination areas and decide on the need for decontamination. Non-flat geometry (cylindrically shaped)
    2) Hands/Foot Closes contamination detectors for decontamination facilities
3) Airborne dusts and water samples
    1) Size-selective air sampling devices and radon detectors
    2) On-filter counting and analysis
    3) Personal radon monitors
4) Radon in products

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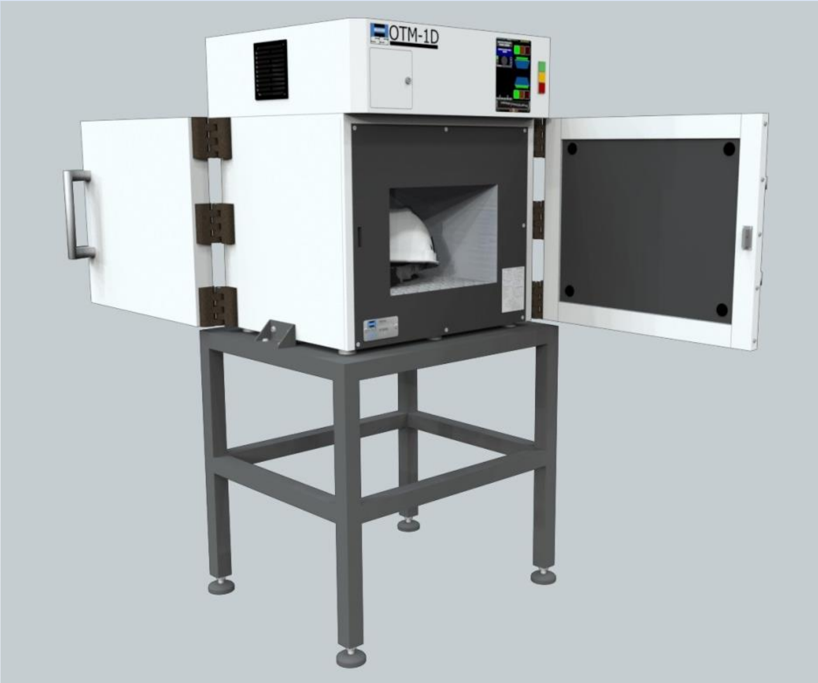

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