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TERMINAL DECOMMISSIONING PLAN

Client:
Bradwood Landing

Contract No.: 31

Project Title:
Bradwood Landing Terminal

CONTENTS

Definitions and Abbreviations:

ALARP	As Low As Reasonably Practical
IPPC	Integrated Pollution Prevention Control
SSOW	Safe Systems of Work

1.0 INTRODUCTION

1.1 Purpose

This document provides a general overall description of the decommissioning plan to be implemented after operation of the Bradwood Landing Terminal finally ceases.

Considering that there may be future extensions to the operating process plant and storage facility, any final decommissioning procedure should also take into account these changes and incorporate them into the final detailed decommissioning procedure to be prepared at a future date.

When the terminal ceases to import LNG, it can be mothballed (allowing it to be utilized again in the future) or decommissioned.

At the request of Clatsop County, Bradwood Landing prepared a Decommissioning Plan setting out the steps for the eventual decommissioning of the facility when the permitted activities cease.

The environmental aspects associated with decommissioning must be identified and measures proposed to ensure that the risk of pollution is minimised according to ALARP principles. The plan should provide for the Bradwood Landing Terminal site to be restored to a useful, non-hazardous condition following the cessation of the facility's operation.

The Bradwood Landing Terminal design includes measures to facilitate decommissioning. This includes the avoidance of land or ground water contamination during the complete lifecycle of the facility. There will be no underground tanks on site.

Provision is made for the shutdown and cleaning of all vessels prior to dismantling. The principle cryogenic design calls for the use of almost entirely stainless steel so that solids (such as iron oxide and sand) will be minimal. Any residual solids will be removed during decommissioning of vessels, together with any scale.

The insulation materials used on Bradwood Landing Terminal are selected for ease and safety of removal, there will be no asbestos in the facility any dust hazard is minimised by utilising vacuum unloading in the case of removal of the Perlite insulation used in the interspace of the LNG Tanks.

The materials used in the construction of the facility can largely be recycled, with the majority of the plant being stainless steel. Site structures will be steel and all foundations are made of reinforced concrete. The structural steel is suitable for recovery. The foundations can be re-used and crushed for use as aggregate.

During dismantling of the tanks the reinforcement steel will be separated from the concrete for recycling, the concrete itself being crushed for re-use as aggregate.

Full details of civil works and plant designs will be retained for use during final decommissioning planning. Overall, the level of contamination and difficulty of decommissioning is expected to be extremely low due to the nature of the fluids handled.

The decommissioning plan is not intended to be overly prescriptive or completely binding as it is recognised that new and unforeseen methods and issues may arise at the time of decommissioning. However, the objectives and standards for decommissioning have been described and the anticipated methodologies to reach them outlined.

1.2 General

The Bradwood Landing Terminal will be located on the Columbia River in Bradwood, Clatsop County, Oregon, United States of America. The terminal is designed for continuous 365 day 24 hourly sendout. The purpose of the terminal is to receive and store LNG unloaded from LNG carriers, vaporise the LNG and deliver this as natural gas product to the gas pipeline network.

2.0 GENERAL RISKS AND MEASURES

2.1 Risk Assessment

All activities, which are conducted as part of general terminal operations during planned and unplanned shutdowns, have been risk-assessed and therefore the consequences are defined and measures in place to address any potential hazards or risks. However, decommissioning activities add a new element of risk, due to the fact that new or unfamiliar tasks would be involved. To manage and minimize this risk, safety and environmental risk assessments on all activities that are not carried out as part of normal operations would be assessed prior to decommissioning.

2.2 Management and Competence

It is critical that adequate and competent resources are deployed for the decommissioning of the Bradwood Landing Terminal installation. The terminal would retain key personnel in order to safely fulfil its decommissioning obligations. Consultants and Contractors with the appropriate skills, experience and resources will be vetted and selected to conduct the work to the required standards.

This may include specialist activities including the cleaning of vessels containing hydrocarbons or chemicals and removal of internal packing and surface contamination such as lubricating oil. This will likely include utilising the services of an engineering consultant to provide additional expertise on the health, safety and environmental impacts of dismantling and demolition.

All decommissioning activities will take place under the auspices of the governing regulations or their equivalent at the time.

2.3 Security

Terminal management would review the security arrangements prior to and during decommissioning. The reduced numbers of personnel on site could make the site more vulnerable to trespassers and fence line security would need to be maintained for as long as considered necessary.

Relevant management systems and procedures would continue to operate. This includes the emergency response plan and the environmental reporting procedure.

Any reportable environmental incidents during the decommissioning phase would be reported to the Oregon Department of Environmental Quality, or the appropriate agency at the time, and subject to investigation.

2.4 Contractor Control

All contractors working on the site will have a mandatory safety orientation course. Following the orientation, they will be issued with a site rules booklet. This booklet would cover the following issues:

- Roles and responsibilities;
- Key staff and contractor contact details;
- The requirement to report and follow-up on safety and environmental incidents
- Guidance on waste management and determining hazardous wastes -including a list of possible items that may be encountered;
- Details of health and safety rules and procedures;
- Details of environmental procedures i.e. incident response and emergency spillages.

2.5 Monitoring Returns

Reporting conditions within the various environmental permits would continue to be fulfilled until the permits are surrendered. The Terminal would continue to report data for the outfall discharge and any alternative discharge point established during the latter stages of decommissioning.

3.0 SPECIFIC RISKS AND MEASURES

3.1 Waste Management

The principles of eliminate, reuse and recycle will be applied in the development of a detailed waste plan prior to decommissioning. Wastes that require disposal will have the most appropriate disposal route identified. Risk assessments will be conducted and suitable handing and personal protection measures employed. No wastes with the potential to contaminate the soil or groundwater will be permitted to be stored outside of suitably protection and licensed facilities. The duties of care obligations for waste will be fully applied.

3.1.1 **Process hydrocarbons**

Inventory heel in the LNG Storage Tanks would be reduced to a minimum by utilising specialist pumps (See LNG Tank Decommissioning Procedure). Pressure would be dropped in the system as far as possible and, if necessary and feasible, further pressure reduction by utilising units brought on site specifically for the purpose of pressure reduction. Once pressure is reduced to as low as practical, the remainder will be flared or vented to atmosphere.

Vessels and pipework will be purged with nitrogen to remove gas and leave the vessels in a safe condition prior to opening to atmosphere, if necessary followed by steam cleaning to remove the last traces of heavier hydrocarbons in any lines or drains.

3.1.2 Caustic System

The system will be drained and flushed to the Caustic Pumps for disposal and neutralisation off-site, following specialist procedures written for the Caustic distribution system.

3.1.3 Chemicals

The quantities of any chemicals would be run-down to minimum levels prior to decommissioning. Levels remaining would be drained and returned to vendor. The corrosion inhibitor and pH controllers in concentrated form are toxic to the aquatic environment and particular care will be required. Final cleaning of the chemical vessels is likely to involve a specialist contractor and may generate wastes for disposal.

3.1.4 Lubricants

Lubricants present in the Boil-off gas compressor units will require draining and will be processed through the Bradwood Landing Terminal waste management system.

3.1.5 Debris and Scale

For vessels that are likely to be contaminated by debris and scale, specialist contractors would carry out monitoring prior to decommissioning and during decommissioning.

3.1.6 Transformer Units

The transformer units on Bradwood Landing Terminal are not of a type which could give a risk of PCB's forming. Nevertheless, the unit removal will involve a risk assessment and appropriate handling, possibly involving a specialist contractor.

3.1.7 Lagging and Insulation

No asbestos has been used in the Bradwood Landing project, but precautions are required with all lagging materials and removal will be subject to a risk assessment. The insulation material will likely be recycled or put into a landfill depending on the opportunities at the time of decommisionning.

3.1.8 Other Hazardous Wastes

It is expected that within the entire decommissioning process, there may be a number of hazardous wastes that could occur. These may include cabling, electrical and electronic equipment, light bulbs, etc. and these will be listed in the Contractor standards pack.

A specialist licensed waste contractor will be employed to assist in the classification of unusual wastes. Storage containers, storage arrangements, transport and disposal of these wastes would all be co-ordinated between the Terminal, contractors and specialist advisors.

3.1.9 Steel

Steel vessels, pipework and structural steel are available for reuse or recycling. There will likely be a market for certain plant items, such as valves, vessels, pumps, unloading arms, compressors, etc.

3.1.10 Concrete

All concrete structures and foundations will be removed to grade level. Piles will be cut off at the surface. It is not practical to remove deeper material, which by its nature is innocuous and not considered a contaminant. The presence of these deeper structures should not compromise the return of the land to a useful condition.

Concrete removed from site includes steel-reinforced material, which may be crushed to recover the steel and generate aggregate for sale to construction projects. The demand for aggregate means that little, if any material needs to go to landfill.

3.1.11 Wharf

It is intended to leave the wharf structure intact (following the removal of the topsides piping and equipment) as it is seen as having great value for any future marine industrial site.

3.1.12 Asphalt and paved areas

The paved areas and asphalt roads on site will be left in place.

3.1.13 Aggregate /Rocks /Chippings

Aggregate imported for the building of Bradwood Landing Terminal will be stripped, cleaned and sold for reuse.

3.1.14 Fiberglass and Plastics

There are a number of fiberglass pipes and plastic materials used on site. Every effort will be made to recycle these materials, and by the time of decommissioning suitable facilities for recycling are considered likely to be available.

3.1.15 Sludge

Sludges may be expected in the bottom of the slops and other drainage structures, including sumps. The quantity is expected to be low and analysis will be required to determine if the waste should be classified as hazardous or general. Disposal will be to an appropriate licensed facility.

3.1.16 Contractor Waste

In additional to wastes from the material decommissioned, a certain amount of waste will be generated by the decommissioning contractors from the offices, workshops and equipment used. The waste management plan will include such wastes which are likely to be dealt with under the Bradwood Landing Terminal waste management system.

3.2 Site Drainage

A comprehensive surface water and process drain plan exists for Bradwood Landing Terminal. The information available will be used to determine all site post-decommissioning drainage requirements. Consultation would be sought in advance with the regulatory authorities on changes to drainage during decommissioning and site restoration. .

There are no effluent streams from Bradwood Landing Terminal during decommissioning for consideration.

3.3 Site Utilities

Electricity and mains water supplies will be progressively isolated during decommissioning and cabling and pipework removed. The materials will be largely recycled. The electrical power lines to the site may remain as a utility to a future occupant.

The water well would be capped or left to a future occupant.

The communication lines will be dismantled or left to a future occupant

4.0 DECOMMISSIONING COST ESTIMATE

The following cost estimate is based on conditions today. Conditions will change as the years pass and relative values of labor, recycled materials and markets change.

The estimated duration of the demolition is estimated to be slightly less then one year.

The biggest credit is the scrap value of bulk metals, from structures, vessels, pipes and the like, together with crushed recycled aggregates from the above ground civil structures.

The overall estimate cost for demolition of the site in accordance with the attached scope of work is $19 million. The cost categories are as follows:

Labor and Supervision	$ 13.3 million
Equipment and site establishment	$ 4.0 million
Consumables	$ 1.0 million
Concrete demolition (after allowance for sale of recycled materials)	$ 2.5 million
Scrap plate, pipe and rebar	($ 5.3 million)
Equipment dismantling and sale (after allowance for sold materials)	$0
Insulation disposal	$ 2.1 million
Electrical recycling and disposal and scrap sale	$1.4 million
Estimated Total:	$ 19 million

LNG TANK DECOMMISSIONING PLAN

Client:
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1 INTRODUCTION

The purpose of this document is to provide an outline of the method for de-commissioning the Bradwood Landing Terminal LNG tanks. (De-commissioning as defined below.)

Starting from an operational tank containing liquid LNG, the de-commissioning process can be separated into a series of stages: -

Pump-out	The tank is taken to minimum liquid level by pumping;
Boil-off	The tank is completely emptied of liquid (by boiling it off);
Warm-up	The tank is warmed up to approaching ambient temperature;
Gas freeing	The tank atmosphere is purged of flammable gas;
Inert gas freeing	The tank atmosphere is purged of inert gas and filled with breathable air;
Preparation for entry	Tank isolations to ensure tank cannot receive any hydrocarbon;
Personnel training	Training in entry, exit and emergency procedures to ensure personnel are safe whilst working inside the tank.

N.B. All relevant Health, Safety and Environmental requirements shall be identified, assessed and strictly adhered to prior to / during the tank decommissioning activity.

2 ABBREVIATIONS AND DEFINITIONS

De-commissioning	Taking the tank out of service to a point where personnel can safely enter.
ITP	In-tank pump
NPSHR	Net positive suction head required
LIN	Liquefied nitrogen
TE	Temperature element
BOG	Boil-off gas – actually boil-off vapour from the tank due to heat leak plus fill/recycle flash and "displacement" vapour.
LFL	Lower flamability limit
W.r.t.	With respect to

3 PUMP-OUT

3.1 Function and Basic Outline

The function of the "pump-out" is to reduce the liquid content of the tank to a minimum by the most efficient method. It may also include means to maximise liquid recovery for either economic or environmental reasons.

The alternative to liquid recovery is fundamentally flaring. (Gas phase recovery would be both slow and uneconomic). Flaring is wasteful of product and environmentally less friendly than pumped recovery.

It is evidently most practical to utilise the in-tank pumps insofar as practical to empty the tanks, as they are a usable resource already installed. However with respect to pump-out there are two fundamental decisions to make: -

1 Where to transfer to;

2 Whether to use assisted pump-out.

W.r.t. 1 above, the fundamental options are considered to be adjacent tank and export system. Adjacent tank has the advantage that it is not dependant on a demand for export, and does not require the use of the ex-tank pumps and vaporisers.

W.r.t. 2 above the use of a "mini-pump" is an option. A mini-pump is installed through a spare nozzle on the tank that passes into the inner tank; it comes complete with all necessary extension pipework and glands to form a complete system to a connection on the tank roof.

The ITPs have a limited capacity to "pump down". This is fundamentally restricted by the NPSHR of the ITP. It is probable that the ITP can pump down to about 16 inches for this very infrequent scenario – should be checked with ITP vendor. The ITP would be cavitating at this low level and would experience (limited) wear. If a mini-pump is utilised there is practical evidence that liquid level can be reduced below 2 inches. The mini-pump approach therefore allows the recovery of about 1,800 m^3 of additional product, which might otherwise be flared (though it could also be exported via the BOG compressors and recondenser if export is being maintained from the other tank(s)).

Dependent on the minimum pump down level of the ITPs, the use of a mini-pump would also save time. Natural boil-off (see 4.0) would reduce liquid level by only about 1/4 inch per day, so reduction from 16inches to 2 inches would take about 60 days by natural boil-off, but probably only about a week with a mini-pump.

The disadvantages of using a mini-pump are that it requires considerable additional planning and its purchase cost is significant.

3.2 Outline Procedure

1 Determine minimum pump-down level of ITPs;

2 Determine preferred send-out location;

3 Determine whether mini-pump or assisted boil-off are viable;

4 Pump out to selected location to as low a tank level as practical;

5 Proceed to "boil-off".

4 BOIL-OFF

4.1 Function and Basic Outline

The function of boil-off is to remove all liquid from the tank. In particular, the liquid below the "minimum pumping level".

The boil-off may be natural or "assisted".

Natural boil-off is reliant only on heat leak through the tank to effect boiling.

Assisted boil-off is where some additional means is used to increase the rate of boil-off. This fundamentally consists of adding "hot" gas to the tank. The "hot" gas should be introduced near the bottom of the inner tank. This will require some temporary works, in particular a hose connection from a suitable supply point to supply the gas to a nozzle on the tank roof, which provides a suitable means of introducing gas to the bottom of the tank.

The hot gas may be either vaporised LNG (from for example the BOG compressor discharge) or inert gas. Vaporised LNG has the advantage that it is essentially free (though there is the compressor running cost). Inert gas has the advantage that it can be used to induce partial pressure effect cooling, which in turn increases natural boil-off by: -

- Increasing the heat transfer driving force (temperature difference between tank contents and external ambient);
- Extracting sensible heat from the tank construction materials.

If inert gas is used, care must be exercised to ensure temperature remains within the design envelope of tank.

Whichever hot gas is used, its use should be stopped at a minimum liquid level of about 1.25 inches so that no hot spots or excessive temperature profiles can develop on tank base or shell.

It is also recommended that the "hot" gas is no hotter than ambient temperature, to avoid excessive temperature profiling.

The use of assisted boil-off may be considered as an alternative to mini-pump use.

4.2 Outline Procedure

1 Determine if natural or assisted boil-off is to be used.

2 If assisted boil-off, determine which hot gas to use and effect appropriate mechanical modifications to facilitate.

3 Determine whether boil-off is to be flared of recovered.

4 If recovered, effect appropriate mechanical modifications to facilitate.

5 Allow tank contents to boil-off. If assisted boil-off is utilised, stop enhancing at 1.25 inch level and continue with natural boil-off only.

5 WARM-UP

5.1 Function and Basic Outline

The function of warm-up is to allow the tank to warm-up and expand at a steady rate to avoid unnecessary thermal stresses. It is recommended that the tank is warmed-up no more quickly than it is cooled down (3°C/h).

Warm-up can be either natural or assisted.

Natural warm-up relies on heat leak from the surroundings.

Assisted warm-up utilises additional means (hot gas addition) to increase the rate of warm up.

Typically gas displaced by "warm-up" would be routed to flare, as quantities are small, however, recovery is an option.

5.2 Outline Procedure

1 Determine whether assisted or natural warm-up is to be used.

2 If assisted warm-up, determine which hot gas to use and effect appropriate mechanical modifications to facilitate.

3 Determine whether warm-up displacement gas is to be flared or recovered.

4 Warm up tank by either natural or assisted means to –4°F (–20°C).

5 Proceed to "gas freeing".

6 GAS FREEING

6.1 Function and Basic Outline

The function of gas freeing, is to remove flammable gas from the tank, so that a flammable or explosive atmosphere cannot occur when air is introduced.

The basic method of gas freeing is gas displacement out of the tank by the introduction of inert gas (usually nitrogen).

It is usual when purging out lighter than air gases, such as natural gas, to introduce inert gas at the bottom of the tank and so utilise its density to minimise consumption; the light gas is then displaced (vented) through a pipe from the tank roof.

The gas is normally displaced to flare.

In this case, the inert gas can be introduced into the bottom of the tank using the purge line. For venting the inner tank and dome, the dome vent is used. The interspace is vented using the annulus purge ring and riser. These vent points may be connected to flare using temporary pipework or discharged to atmosphere at a safe location on the tank roof. By this process the inner tank, dome space and annular space are all made gas free.

The regions between the primary and secondary bottoms of the tank and beneath the tank secondary bottom are purged using a pressure swing method. Purge connections for this purpose are provided.

6.2 Outline Procedure

1 Fit temporary works at suitable roof nozzles

2 Connect a flow-metered nitrogen supply to the tank purge line.

3 Purge out inner tank and dome using nitrogen supply and vent to flare/safe location.

4 When HC content of vent gas is less than 1%, stop venting from dome.

5 Purge out interspace using nitrogen supply and vent to flare/safe location.

6 Utilise "hold periods" to validate measured gas concentration (ensure "dead spots" are also purged).

7 When tank has confirmed gas concentration of less than 1% throughout, proceed to "inert gas freeing".

7 INERT GAS FREEING

7.1 Function and Basic Outline

The function of inert gas freeing is to replace the inert atmosphere with a safe breathable one.

Inert gas freeing is effected by displacement of inert gas out of the tank using air.

The inert gas, being low in HC, is usually displaced to atmosphere.

The use of an oil-free compressor/blower is recommended for providing the displacement motive force, to ensure the air is of breathable quality.

If it is intended to re-commission the tank, the use of dry air is recommended, to avoid passing moist air through the perlite. For de-commissioning prior to demolition, dry air is unnecessary.

As air is about to be admitted to the system and the potential for the generation of internal flammable atmospheres can therefore occur it must be ensured that the tank is isolated from hydrocarbon containing systems by a minimum of double block and bleed isolation and preferably positive or physical isolation. Positive or physical isolation is essential if personnel are to enter the tank – see Section 8, below.

7.2 Outline Procedure

1 Fit vents to tank similar .

2 Isolate hydrocarbon containing systems from the tank using a minimum of double block and bleed isolation.

3 Install pressurised (dry) air generation equipment

4 Purge out tank by displacement of inert gas with air using air compressor.

5 When oxygen concentration is greater than 19.5% and HC concentration less than 20% LFL stop purging.

6 Utilise "hold periods" to validate measured gas concentration (ensure "dead spots" are also purged).

7 When tank has confirmed gas composition to acceptance criteria, proceed to "preparation for entry".

8 PREPARATION FOR ENTRY

The purpose of "preparation for entry is to ensure that the confined space that is the tank, is safe for entry by personnel. This means that it must have a breathable atmosphere and be physically or positively isolated from all process and utility systems. The provision of emergency teams/rescue parties and emergency breathing equipment should be addressed in a specific Emergency Preparedness Procedure.

9 PERSONNEL TRAINING

It is of vital importance that personnel entering the tank have been fully trained in access, egress and emergency procedures.

This training should have been on-going during the de-commissioning period where "turnaround time" is important.