

PROVISION OF ZERO-MAN ENTRY & AUTO-TANK CLEANING AND SLUDGE REMOVAL, TREATMENT & MANAGEMENT SERVICES AT SELECTED RENAISSANCE FACILITIES IN NIGERIA

(RENAISSANCE Contract / Tender No.: CW-68582 / CW-515913)

DOCUMENT TITLE: PROJECT EXECUTION & RISK MANAGEMENT PLAN (PE&RMP)



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TABLE OF CONTENTS (TOC)

Contents	Page
1.0 INTRODUCTION	3
1.1 Project Execution & Risk Management Plan Purpose	3
2.0 SUMMARIZED PROJECT SCOPE OF WORK (SOW)	4
2.1 Description of Project Scope of Work (SOW)	4
2.2 Description of Project Tanks to be Cleaned	5
2.3 Details of Subject Renaissance Tanks to be Cleaned	5
2.4 Description of Project Waste Management Services to be Performed	10
3.0 CODES, STANDARDS & RECOMMENDED PRACTICES	11
4.0 PROJECT MANAGEMENT & COORDINATION	11
5.0 PLANNING PHASE - HAZARD ANALYSIS & RISK ASSESSMENT	12
5.1 Hazard Identification & Risk Assessment (HI / RA) Plan Purpose	12
5.2 Key Risk Management Responsibilities	12
5.3 Review of Hazard Assessment	14
5.4 Emergency Control of Hazards	14
5.5 Certification of Hazard Assessment	14
5.6 Job Safety / Hazard Analysis (JS / HA)	15
5.7 Site-Specific HSE Plan (SSHSEP)	15
5.8 The Hazard Identification / Risk Assessment (HI / RA) Review Process	15
6.0 INSPECTION PHASE - INITIAL TANK, CONTENTS & SITE ASSESSMENT	15
6.1 Equipment & Personnel Pre-Mobilization Inspection	15
7.0 APPLICABLE PROJECT PERMITS	16
8.0 MANDATORY REQUIREMENTS	16
9.0 PROJECT EQUIPMENT	16
10.0 PROJECT CONSUMABLES	17
11.0 IMPLEMENTATION OF ATC NME SYSTEM PREP & OPERATIONS PLAN	18
11.1 Arrival at Site & Off-Loading Equipment	18
11.2 Ground Mobilization	19
11.3 Roof Mobilization on Floating Roof	19
11.4 Riser Pipe Installation	20
11.5 Cold Tapping - Single-Deck & Fixed Roof	20
11.6 Connection to Tank & Pipelines	21
11.7 Nitrogen Filling & O ₂ Monitoring	22
11.8 Circulation of Products	22
11.9 Changing of Filters	22
11.10 Centrifuging of Wastes	23
11.11 Receiving Cutter Stock / Gas Oil for Tank Cleaning	23

11.12	Discharge of Crude Oil to Client's Tank	23
11.13	Discharge of Wastewater (Hot Water Washing of Tank)	24
11.14	Removal of ATC Nozzle to Facilitate Dipping Test.....	24
11.15	Pipe Drain Down Procedures	24
11.16	Maintenance Work on Tank Roof.....	24
11.17	General Recovered Crude Oil Tanker Operating Procedures	25
11.18	After ATC Cleaning - Tank Entry for Mop-Up Cleaning Procedures.....	26
11.19	Filling Receptacles with Sludge & Products at Renaissance-Designated Areas	27
11.20	De-Mobilization (Non-Entry Tank Cleaning System)	27
11.21	De-Mobilization (Entry Tank Cleaning System).....	28
11.22	Confined Space Entry Procedures	28
11.23	Rescue Equipment (ATC Roof).....	29
11.24	Rescue Equipment (Internal Tank Cleaning).....	30
11.25	Emergency Procedures Check List	30
11.26	Confined Space Check List Reminders.....	30
11.27	In Event of Emergency, the Following Rules Apply	31
12.0	PROJECT CLOSE-OUT PHASE	32
12.1	Inspection of Tank	32
12.2	Handing Over of the Cleaned Tank to the Company.....	32
12.3	De-Mobilization Off-Site	32
12.4	Lessons Learnt.....	32
12.5	Final Project Closure Report	32
13.0	ENGINEERING MANAGEMENT	33
14.0	ENGINEERING MANAGEMENT REPORTING	34
15.0	DOCUMENT CONTROL PROCEDURES	35
16.0	COST CONTROL PROCEDURES	36
17.0	MANAGEMENT OF CHANGE	36
18.0	ENGINEERING ORGANIZATION	36
19.0	INTERFACE MANAGEMENT	37
20.0	INTERFACING PROCEDURAL PLAN	37
21.0	ENGINEERING RISK MANAGEMENT	38
22.0	CONCLUSIONS	38

ATTACHMENTS:

TABLE 1 - RENAISSANCE 18-Tank & Contents Particulars List.....	39
ATTACHMENT 1 - Project Hazard ID & Risk Assessment Matrix.....	40
ATTACHMENT 2 - Safe & Unsafe Gas Levels.....	57

Execution & Risk Mgmt. Plan - For Zero-Man Entry & Auto-Tank Cleaning Services at Selected Renaissance Facilities

1.0 INTRODUCTION

In line with the fulfilment of the Project expectations, South West Design Africa Limited (**SWDA**) has developed this Project Execution & Risk Management Plan (**PE&RMP**) to provide the specific methodological approach & associated Risk Management procedures necessary to successfully execute this 18-Tank Automatic Tank Cleaning (**ATC**) & No-Man Entry (**NME**), Tank Cleaning, Sludge Treatment and Management Project for Renaissance Africa Energy Company Limited (**RAEC**), in accordance with the Contract / Tender Nos.: CW-68582 / CW-515913.

SWDA, with a clear understanding of the scope of work (**SOW**) and with experience in providing all the resources and know-how to achieve the desired results, has developed the Project Execution & Risk Management Plan (**PE&RMP**) in line with **RENAISSANCE** expectations for the Project, detailing the set-out programmes and risk reduction procedures that will be implemented to achieve the project objectives. All considerations for the preparation of this document have been made in accordance with standard industrial best practices and to the highest level of Quality Health & Environmental Systems (**QHES**).

1.1 Project Execution & Risk Management Plan Purpose

The purpose of this Project Execution & Risk Mgmt. Plan (**PE&RMP**) is to provide an outline description of the execution methodology, risk mitigation methods and operational plan that **SWDA** intends to deploy to execute the provision of the **RENAISSANCE** 18-Tank Cleaning, Sludge Treatment and Management Project, especially in accordance with acceptable risk, specifications and standards. This document describes in details the basic and realizable methods that shall be deployed to ensure that Tank cleaning, sludge treatment and management works meet the project expectations as it relates to Health, Environment & Safety (**HES**), Quality, Specifications & Risk.

Tank Cleaning and Sludge Treatment / Recycling is of the utmost importance, not only in order to achieve prolongation of the useful life of large above ground storage tanks (**ASTs**), but also for the proper protection of the environment and for the general health and safety of Project workers, nearby host community members and passersby.

2.0 SUMMARIZED PROJECT SCOPE OF WORK (SOW)

This Project Execution & Risk Mgmt. Plan (**PE&RMP**) covers how this Project shall be executed in accordance with Renaissance requirements, guidelines & standards in line with international industry standards to achieve the Project objectives. This **PE&RMP** Plan is also provided as guidance to minimize project risks and to avoid or reduce waste from source and also collection, transportation, recycling, disposal or processing of waste generated from SWDA operations during the desludging and NME cleaning activities of the subject Crude Oil Storage Tanks, as described below.

2.1 Description of Project Scope of Work (SOW)

Based upon the Instructions To Tenderers (ITT) & Contract Documents within the Renaissance Contract / Tender Nos.: CW-68582 / CW-515913, SWDA describes the prescribed Project Scope of Work (**SOW**) to include the following Main Tasks to be performed to successfully prepare, clean, de-sludge & properly manage all Project-derived Oily Wastes during this Tank Cleaning Project:

- Preparation of Pre-Mob Work Plans (HSE, HAZID, PIP, QA / QC, WMP, Pre-Mob Inspection Test Plan, Security Plan, Community Engagement Plan & Journey Mgmt. Plans) & Renaissance Pre-Mob Inspections & approval of requisite personnel & equipment for Project Mobilization;
- Land & Marine Mobilization of Renaissance pre-mobbed personnel, equipment & materials and initial Tank Site set-up activities;
- Implementation of all pipe connections necessary, removal of sludge from Tank using zero-man entry & automatic means and perform all Safety Requirements defined by Contractor & agreed by Renaissance for the process;
- Processing of sludge & transfer of Oil into Renaissance-designated pipeline, transfer of all Oil-impacted sands to Renaissance-designated area and disposal of Oil-impacted water into appropriate Renaissance-designated location; and,
- De-Mobilization of all personnel & equipment from one Tank Site to another & provision of Final Project Report to Renaissance & NUPRC.

2.2 Description of Project Tanks to be Cleaned

Based upon the Renaissance Contract documents, and for the purposes of this WMP Plan, SWDA has developed the below-attached **Table 1** to summarise the known and assumed (**Sludge 1.0 Meter [M] Depth per Tank**) Tank particulars, which shall guide the Waste Management arrangements per Tank Site, as modified by the Pre-Mob Tank Site Inspection data:

- Eighteen (**18**) Tanks are included within the Tank Cleaning Scope of Work (**SOW**) – Situated at four (**4**) Nigerian Renaissance Facility locations (Bonny – 8 Tanks, Forcados – 8 Tanks, Gbaran – 1 Tank and Soku – 1 Tank);
- Eight (**8**) Crude Oil Storage Tanks (**COTs**) & ten (**10**) Process Tanks (**PTs**) are included, with nine (**9**) Floating-Roofs & nine (**9**) Fixed-Roofs, ranging in Size from **1,060-M³** to **104,707-M³** (See below **Table 1 – Tank & Contents Particulars**); and,
- No actual sludge depth or consistency data was provided by Renaissance, so for costing & planning purposes, SWDA estimated 1.0 Meter (**M**) depth of sludge per Tank, and all Renaissance Tank data & SWDA assumptions indicate a total estimated Sludge Volume of approximately **41,037-M³** or up to **51,101 Tons** of Sludge to be cleaned & all recovered Oil returned to Renaissance.

2.3 Details of Subject Renaissance Tanks to be Cleaned

This Renaissance Tank Cleaning Project includes eighteen (**18**) petroleum above-ground storage Tanks located at four (**4**) different locations across the Niger Delta Region of Nigeria. Below, SWDA provides the following available information with an estimate of Sludge Volume in each Tank of one (**1**) Meter in depth for purposes of Project planning (**See Table 1 for Tanks Info Summary**).

2.3.1 Tank 9 - Crude Storage Tank, with Floating Roof - Bonny

- Height = 22.1 Meters
- Diameter = 48.8 Meters
- Tank Volume = 41,335 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 207,998 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 1,870.4 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 11,764.8 Bbls

2.3.2 Tank 11 - Crude Storage Tank, with Floating Roof - Bonny

- Height = 19.0 Meters
- Diameter = 67.1 Meters
- Tank Volume = 67,187.7 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 338,088.5 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 3,536.2 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 22,242.7 Bbls

2.3.3 Tank T-1201-A - Process Tank, with Fixed Roof - Bonny

- Height = 10.5 Meters
- Diameter = 30.0 Meters
- Tank Volume = 7,422.03 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 37,347.7 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 706.9 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 4,446.4 Bbls

2.3.4 Tank T-1201-B - Process Tank, with Fixed Roof - Bonny

- Height = 10.5 Meters
- Diameter = 30.0 Meters
- Tank Volume = 7,422.03 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 37,347.7 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 706.9 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 4,446.4 Bbls

2.3.5 Tank 13 - Crude Storage Tank, with Floating Roof - Bonny

- Height = 19.0 Meters
- Diameter = 67.1 Meters
- Tank Volume = 67,187.7 M³

- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 338,088.5 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 3,536.2 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 22,242.7 Bbls

2.3.6 Tank 21 - Crude Storage Tank, with Floating Roof - Bonny

- Height = 22.9 Meters
- Diameter = 76.3 Meters
- Tank Volume = 104,706.9 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 526,885.1 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 4,572.4 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 28,760.4 Bbls

2.3.7 Tank 22 - Crude Storage Tank, with Floating Roof - Bonny

- Height = 22.9 Meters
- Diameter = 76.3 Meters
- Tank Volume = 104,706.9 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 526,885.1 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 4,572.4 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 28,760.4 Bbls

2.3.8 Tank T-1401-A - Process Tank, with Fixed Roof - Bonny

- Height = 10.5 Meters
- Diameter = 30.0 Meters
- Tank Volume = 7,422.03 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 37,347.7 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 706.9 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 4,446.4 Bbls

2.3.9 Tank 206 - Crude Storage Tank, with Floating Roof - Forcados

- Height = 21.9 Meters
- Diameter = 76.2 Meters
- Tank Volume = 99,872.3 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 502,557.4 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 4,560.4 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 28,684.9 Bbls

2.3.10 Tank 209 - Crude Storage Tank, with Floating Roof - Forcados

- Height = 21.9 Meters
- Diameter = 76.2 Meters
- Tank Volume = 99,872.3 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 502,557.4 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 4,560.4 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 28,684.9 Bbls

2.3.11 Tank 620 - Process Tank, with Fixed Roof - Forcados

- Height = 9.8 Meters
- Diameter = 33.5 Meters
- Tank Volume = 8,637.9 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 43,465.9 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 881.4 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 5,544.0 Bbls

2.3.12 Tank 901 - Process Tank, with Fixed Roof - Forcados

- Height = 6.0 Meters
- Diameter = 15.0 Meters
- Tank Volume = 1,060.3 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 5,335.4 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 176.7 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 1,111.4 Bbls

2.3.13 Tank 203 - Crude Storage Tank, with Floating Roof - Forcados

- Height = 21.9 Meters
- Diameter = 76.2 Meters
- Tank Volume = 99,872.3 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 502,557.4 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 4,560.4 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 28,684.9 Bbls

2.3.14 Tank 102 - Process Tank, with Floating Roof - Forcados

- Height = 17.0 Meters
- Diameter = 48.0 Meters
- Tank Volume = 30,762.5 M³

- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 154,796.9 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 1,809.6 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 11,382.4 Bbls

2.3.15 Tank 601 - Process Tank, with Fixed Roof - Forcados

- Height = 12.5 Meters
- Diameter = 30.0 Meters
- Tank Volume = 8,835.8 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 44,461.7 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 706.9 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 4,446.4 Bbls

2.3.16 Tank 610 - Process Tank, with Fixed Roof - Forcados

- Height = 9.8 Meters
- Diameter = 33.5 Meters
- Tank Volume = 8,637.9 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 43,465.9 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 881.4 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 5,544.0 Bbls

2.3.17 GCPF Tank - Process Tank, with Fixed Roof - Gbaran

- Height = 13.0 Meters
- Diameter = 39.0 Meters
- Tank Volume = 15,529.7 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 78,145.5 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 1,194.6 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 7,514.0 Bbls

2.3.18 SGP Tank - Process Tank, with Fixed Roof – Soku Gas Plant

- Height = 18.0 Meters
- Diameter = 30.0 Meters
- Tank Volume = 12,723.5 M³
- Tank Capacity (80% Total Vol. x 6.29 Bbls) = 64,024.7 Bbls
- Sludge Volume (Est. 1.0 M Depth) = 706.9 M³
- Total Sludge (6.29 Bbls = 1.0 M³) = 4,446.4 Bbls

2.4 Description of Project Waste Management Services to be Performed

In accordance with the Renaissance-provided Scope of Work (**SOW**), designated as the “**Zero-Man Entry & Auto-Tank Cleaning ATC / NME System**”, complete with Sludge collection by suction systems, sludge rinsing & Oil recovery, waste management services shall be minimized; however, SWDA shall still be held responsible for proper Waste Management Services during the implementation of this Tank Cleaning Project. Therefore, Oily Wastes shall be properly & methodically collected, treated, managed & distributed to Renaissance-designated locations, as follows:

- The residual Sludge within each Tank to be cleaned, shall be recovered through the ATC Suction Module (**M1**), shall pass through an Oil separation phase within the ATC Separation Module (**M2**), the remaining Sands shall be collected & all Oil shall be collected within the ATC Skimming Module (**M4**) and recovered;
- If the residual Sludge is unpumpable, then Renaissance shall provide “**Cutter Stock**” to be added to the Tank Sludge through the ATC Recirculation Module (**M3**) to enable steady Sludge flow through the ATC Suction Module (**M1**) by agitation by means of the “**Single Nozzle Sprayers**” mounted on the Tank’s roof;
- Tank Rinse / Wash Water shall be routed into the Tank Sludge through the ATC Recirculation Module (**M3**) & the series of Spray Nozzles, and the Oil shall be recovered through the ATC Skimming Module (**M4**), and once each Tank rinsing is complete, the final Rinse Water is treated on-site & disposed at the Renaissance-designated location;
- Sands rinsed out of the Oily Sludge shall be recovered through the ATC Tri-Decanter & high-speed Centrifuge, and shall be contained within 1-tonne woven bags and/or 2.5-M³ Waste Skips, which shall be transported in bulk for disposal at Renaissance-designated locations; and,
- All Recovered Oil from the ATC Skimming Module (**M4**), shall be properly stored in Renaissance-designated Tanks on-site, until transfer via vacuum trucks delivery to Renaissance-designated pipelines for re-introduction pumping.

3.0 CODES, STANDARDS AND RECOMMENDED PRACTICES

Towards the execution of this Renaissance 18-Tank ATC & NME Tank Cleaning Project, SWDA shall align with the most recent codes, standards and recommended practices issued by the various agencies and approved regulatory bodies.

The following standards will be adopted in the execution of the Project:

1. **API 2015** – Requirements for Safe Entry and Cleaning of Oil Storage Tanks;
2. **API 2016** – Guidelines & Procedures for Entering and Cleaning Petroleum Storage Tanks;
3. **NFPA 326** – Safeguarding of Tanks and Containers for Entry, Cleaning and Repair;
4. **99 / 92 / EC (ATEX 137)** – ATEX Workplace Directive; and,
5. **94 / 9 / EC (ATEX 95)** – ATEX Equipment Directive.

4.0 PROJECT MANAGEMENT AND COORDINATION

Project Management and Coordination for the execution of the project is critical to ensuring that the project is adequately planned, and that the plan is effectively deployed. SWDA is committed to achieving the desired project objectives, bearing in mind Local Content maximization, cost optimization, risk reduction, project delay / slip avoidance, Quality, Safety and Protection of the work environment.

4.1 Project Management Organization

Management Interface System

SWDA considers that an effective interface management is vital to the successful completion of the Project. SWDA will manage her interface especially with Renaissance closely, and in such a manner that there shall be no disruption to work and communication constraints to operations at the various work sites.

In order to provide for an effective interface management process on the project, SWDA will ensure that all parties have clear understanding of the scope of work and definition of responsibility. In addition to this, alignment meetings shall be held internally within SWDA, while externally with Renaissance to help clarify any issues and resolve points of concern or misunderstanding with all participating parties on the project. SWDA maintains an organizational structure that identifies the various levels and chains of positions with an insight of the tasks expected to be performed by her key personnel.

4.2 Project Management and Control Plan

Scheduling, Planning & Progress Reporting

This activity identifies the strategies that best suit the Tank cleaning and Sludge removal, treatment and management support services. It shall be of supreme importance during project start-up and shall continue to be important during the life of the Tank, Sludge & Waste Management Project as it provides the basis for progress checks and monitoring, especially in line with set targets. The reporting shall be implemented by a well-resourced Scheduling, Planning and Progress reporting personnel for a successful completion to meet the target date. In this regard, on commencement of the job, the first task is to draft, submit and gain Renaissance Approval for the Project Reporting Methodology.

The Project Execution & Risk Mgmt. Plan (**PE&RMP**) is drawn from the Scope of Work (**SOW**) which clearly identifies Renaissance expectations, as well as the quality requirements, the HSE requirements and the community affairs / security requirements, as detailed within separate plans. The Project Schedule shall be prepared with specific and due considerations to the Scope of Work for each separate Tank, matching a manpower histogram in accordance with the volume of work associated with each task activity for the specific Tank and Purchase Order (**PO**).

5.0 PLANNING PHASE – HAZARD ANALYSIS & RISK ASSESSMENT

For the successful completion of the Project with zero fatality, zero injury and incident, SWDA shall follow the prescribed Project Targets / KPIs, analyze the hazards, institute controls and appoint / monitor Responsible Persons (**RPs**), and all shall be captured during the Planning Phase Hazard Analysis and Risk Assessment meetings, which shall be used in the Job Safety Analysis (**See Attachment 1 - Job Hazard Analysis & Risk Assessment at End of Plan**).

Indeed, any Tank Cleaning & Sludge Removal Project embodies many Challenges; therefore, SWDA has also developed a Project-specific Hazard Identification (**HI**) & Risk Assessment (**RA**) Plan, as attached in **Attachments 1 & 2**. As enumerated below, there are Challenges / Risks identified with this Tank Cleaning Project, and SWDA has developed various Mitigation Measures (**MM**) to be employed within the SOW to address these Risks, and various **“Risk Mitigation Measures Analyses”** have been developed and are outlined on **Attachment 1**.

5.1 Hazard Identification (HI) / Risk Assessment (RA) Plan Purpose

In order to identify Project Hazards and design Risk Management procedures to ensure safe and efficient operations, SWDA has developed the attached Job Hazard Analysis & Risk Assessment Matrix as a guide for project operations. The purpose of this **HI / RA Plan** includes, but is not limited to, the following:

- To perform an Advance Tank, Tank Contents & Site Inspection & Assessment to determine exact Tank particulars (**See assumptions on attached Table 1**).
- To provide guidelines for identifying, assessing and controlling workplace hazards.
- To ensure the potential hazards of new processes and materials are identified before they are introduced into the workplace.
- To identify the jobs / tasks which require a proper Risk Assessment.

5.2 Key Risk Management Responsibilities

As separately-specified within the Project Plans prepared and submitted to Renaissance for this ATC NME Tank Cleaning Project with respect to the proper performance of this Tank Cleaning & Sludge Management Project, SWDA must assess the Work Sites initially and periodically and identify existing or potential hazards before Work begins (**in accordance with SWDA's Permit to Work [PTW] from Renaissance**), as Work is on-going & with a view for future Work to be performed at the various Tank Cleaning Work Sites. The Hazard Identification (**HI**) Process is used for routine and non-routine activities, as well as new processes, changes in operation, products or services as applicable. This HI / RA Process shall be instituted by the Project Team, and the following responsibilities shall be performed in order to implement the HI / RA process.

The Site Safety Manager (**SSM**) shall conduct a Baseline Work-site Hazard Assessment (**BWHA**) which is a formal process in place to identify the various tasks that are to be performed and the identified potential hazards. The results are included in a Report of the results of the Hazard Assessment and the methods used to control or eliminate the hazards shall be identified. The Hazard Assessment Report must be signed & dated by the appropriate SWDA-Authorized Representative. A specific **HI & RA Matrix** for this Renaissance 18-Tank ATC & NME Tank Cleaning, Sludge Treatment & Waste Management Project, complete with Risk Mitigative Measures, is attached as **Attachment 1** below.

Inputs into the Baseline Hazard Identification (**BHI**) include, but are not limited to:

- Scope of Work (**SOW**) Review;
- Initial Tank & Tank Contents Assessment;
- Legal and other requirements;
- Previous incidents and non-conformances;
- Sources of energy, contaminants and other environmental conditions that can cause injury; and,
- Walk through of work-site environment.

Hazards identifications (**as examples**) are to include, but not be limited to, the following:

- Working Alone;
- Thermal Exposure;

- Isolation of Energy;
- Hearing Protection;
- Musculo-skeletal Disorders;
- Blood-borne Pathogens;
- Confined Spaces;
- Driving & Transportation of Waste Materials;
- General Safety Precautions;
- And any other established policy or procedure by SWDA; and,
- Any other Site-Specific Work Scope.

SWDA has a formal process for identifying potential hazards. Processes are in place to identify potential hazards by the use of Job Safety & Hazard Analyses (**JS&HAs**), facility-wide or area-specific analysis / inspections. All identified hazards are assessed for Risk and Risk Controls (**See Mitigation Measures – Attachments 1 & 2**), which are assigned within the Work-site Hazard Assessment for that specific hazard.

SWDA's HI / RA Programme provides processes to ensure employees and/or sub-contractors are actively involved in the Hazard Identification (**HI**) Process, and hazards are reviewed with all employees concerned. Employees are trained in the Hazard Identification (**HI**) Process, including the use & care of proper Personal Protective Equipment (**PPE**). Unsafe Hazards must be reported immediately and addressed by the Site Supervisor (**SS**). The Site Supervisor discusses the Work-site Hazard Assessment with employees at the respective work location during the employee's documented orientation.

5.3 Review of Hazard Assessment

Existing Work-site Hazard Identifications are formally reviewed annually or repeated at reasonably practicable intervals to prevent the development of unsafe and unhealthy working conditions and specifically updated when new tasks are to be performed that have not been risk assessed, when a work process or operation changes, before the construction of a new site or when significant additions or alterations to a job site are made.

The respective Supervisor or Project Manager (**PM**) advises the Safety Manager (**SM**) when additional hazards are introduced into the work place in order to revise planning and assessment needs. Hazards are classified and ranked based on severity. The program identifies hazards which are classified / prioritized and addressed based on the risk associated with the task.

The following describes how Identified Hazards are addressed and mitigated by Risk Controls:

- Risk-assessed Hazards are compiled with and addressed and mitigated through dedicated assignment, appropriate documentation of completion, and implemented controls methods including engineering or administrative controls and PPE required into the Worksite Hazard Assessment of the Site-Specific HSE Plan (**See separately submitted SSHSEP**). No work will begin before the work-site assessment is completed. Additionally, no Risk assessed as Significant (**Level III**) or High (**Level IV - Intolerable**), shall be performed without various Mitigative Measures performed, lowering the Risk Category to **Level II - Tolerable**.
- If an existing or potential Hazard to workers is identified during a Hazard Assessment, SWDA must take measures to eliminate the hazard, or if elimination is not reasonably practicable, control the Hazard. If reasonably practicable, SWDA must eliminate or control a hazard through the use of engineering controls. If a Hazard cannot be adequately controlled using

engineering controls, SWDA must use administrative controls that control the Hazard to a level as low as reasonably achievable. If the Hazard cannot be adequately controlled using engineering and/or administrative controls, SWDA must ensure that the appropriate Personal Protective Equipment (**PPE**) is used by workers affected by the Hazard. SWDA may use a combination of engineering controls, administrative controls and personal protective equipment, if there is a greater level of worker safety because a combination is used.

5.4 Emergency Control of Hazards

Only those employees competent in correcting emergency controls of Hazards may be exposed to the Hazard, and only the minimum number of competent employees may be exposed during Hazard Emergency Control activities. An Example is a gas leak in a building. Only those personnel with training on fire safety, gas supply shut-off and other related controls will attempt to resolve the emergency control of a Hazard. SWDA will make every possible effort to control the Hazard while the condition is being corrected or under the supervision of Client Emergency Response Personnel in every emergency.

5.5 Certification of Hazard Assessment

The Safety Manager (**SM**) completes and signs the Certification of Hazard Assessment for the Work-site Hazard Assessment (**also see PPE Programme**) and includes it within the Site-Specific HSE Plan (**SSHSEP**). Hazard Assessments are reviewed at beginning of Job, periodically throughout the performance of the Job & annually and updated when new tasks are to be performed that have not been previously Risk-assessed.

5.6 Job Safety / Hazard Analysis (JS / HA)

For those jobs with the highest injury or illness rates, jobs that are new to our operation, jobs that have undergone major changes in processes and procedures or jobs complex enough to require written instructions shall have a Job Safety & Hazard Analysis (**JS / HA**) performed. The **JS / HA** is identical to the attached Risk Mgmt. Matrix (**RMM**), and shall be available from the Safety Manager (**SM**) on-site.

5.7 Site-Specific HSE Plan (SSHSEP)

Each work location shall have a Site-Specific HSE Plan (**SSHSEP**), attached to the Overall Project Health Safety & Environment Plan (**HSEP**). Each employee reporting to a location shall receive a documented orientation from an SWDA Supervisor, which shall include the SSHSEP for that site. The SSHSEP contains the SWDA Health and Safety Policy (**HSP**), site-specific safety requirements as well as a PPE matrix and a signed Site-Specific Work-site Hazard Assessment for that location, which SWDA has a responsibility to provide to all Project Crew members.

5.8 The HI / RA Review Process

The Hazard Assessment Programme (**HAP**) will be reviewed to ensure no new Hazards derived from the corrective measures. The review shall include a management of change consideration as well. The SWDA Safety Committee shall be involved in the review process as well. As evidenced by SWDA's Safety Performance Data for the Years of 2023, 2024 & 2025, which clearly indicates that SWDA takes Health & Safety as a Cornerstone within its Business Implementation Plans, and the results are clear.

6.0 INSPECTION PHASE – INITIAL TANK, TANK CONTENTS & SITE ASSESSMENTS

Prior to mobilizing to any Renaissance Tank Cleaning Site location, there will be Pre-Mobilization Inspection of each Subject Tank to be cleaned, led by Renaissance Representatives & including Key SWDA Team members. The purpose of this exercise is to identify, determine & confirm the Tank & Site integrity, contents & atmospheres within each Tank, depth & volume of Tank contents & for Waste profiling purposes. These per Tank details must be confirmed before any Mobilization to any Site, in order that Final Mobilization arrangements are designed for each Tank site. After the successful Tank Inspection exercise, Renaissance shall sign-off on each of the Tank particulars.

6.1 Equipment & Personnel Pre-Mobilization Inspection

Prior to mobilizing to any Renaissance Tank Cleaning Site location, there will be Pre-Mobilization Inspection of the Tank Cleaning Equipment by Renaissance & SWDA Representatives, and this event will take place on a Renaissance-appointed date in Port Harcourt, at our SWDA Kidney Island Warehouse. After the successful exercise, Pre-Mobilization Clearance Stickers shall be stamped on each of the equipment. In addition, all pre-qualified Tank Cleaning Crew Personnel shall also be pre-mobbed by Renaissance with regards to the provision, review & approval of all appropriate Fit-For-Duty (**FFD**) medicals, training & certifications, prior to the provision of our **“Notice to Proceed – NTP”** to commence Mobilization of Pre-Mobbed Equipment & Personnel to the Project Site.

7.0 APPLICABLE PROJECT PERMITS

Prior to commencement of work and for every day, the SWDA Team shall ensure that the Permit to Work (**PTW**) is approved and re-validated by the asset operator and all necessary equipment certifications (Personnel Permits, Gas Tester Calibration Certificates and Pressure Test Certification for hoses) shall be available on-site.

As part of Quality Control and in the safe execution of the various tasks, which must comply with SWDA tenets of operational excellence, the following Permits shall be maintained & followed:

- NUPRC OGISP – Tank / Vessel Cleaning, Sludge & Waste Management Permit (**NUPRC**);
- General Work Permit (**GWP**);
- Confined Space Entry Permit (**CSEP**);
- Permit to Work (**PTW**);
- Hot Work Permit (**HWP**);
- ER Water Permit (**ERWP**);
- Emergency Rescue Plan (**ERP**); and,
- Save Your Life Action (**SYLA**) & Start Work Checklist (**SWC**).

8.0 MANDATORY REQUIREMENTS

In order to ensure that SWDA personnel shall be engaged to carry out the Renaissance NME Tank Cleaning Project in accordance with all regulatory guidelines, are Fit-for-Duty (**FFD**), and the following mandatory requirements shall be fulfilled:

i. Medical Fitness

For the purpose of the Project, the personnel that will be deployed to the Renaissance Tank Cleaning Sites must have their Medical Fitness Test in an approved hospital.

ii. Basic Off-Shore Safety Induction & Emergency Training (BOSIET)

Personnel for the Renaissance Tank Cleaning Project shall have their BOSIET Certification at any of the OPITO (**Off-Shore Petroleum Industry Training Organisation**) and approved Training Centers.

iii. Off-Shore Safety Permit (OSP)

All personnel shall have the Off-Shore Safety Permit (**OSP**) before proceeding to the Renaissance Tank Cleaning locations.

9.0 PROJECT EQUIPMENT

Due to the hazardous nature of the Tanks & contents, the various equipment that will be used for the Tank Cleaning Project are the type that can be used in both Zone 0 and 1, and so the following equipment will be mobilized to the various Renaissance Tank locations in accord with the various Tank SOWs. The main equipment to be utilized on this Project is the ATC NME Tank Cleaning System, which comes on-site in seven (7) 20-FT Containers, and this system shall perform 90% of the Work. However, once the sludge has been removed, there shall be the necessity to **“Mop-Up the Tank”** with the use of standard Tank Cleaning Equipment, such as those listed below:

S/N	LIST OF TANK CLEANING EQUIPMENT
1	4-Module No-Man Entry (NME) Auto-Tank Cleaning (ATC) System & Sludge Mgmt. Equipment & 2-YRS Spare Parts or Equivalent Semi-Auto Tank Cleaning System (Remote Crawlers, Hydro-Jets, Centrifuges & Oil / Water Separators)
2	Air Loader Pump (also known as Vacuum Recovery Unit), 900 cfm and 1,200 cfm
3	Air Compressor – 1,600 cfm operating @ a pressure of 10 bar
4	Air Accumulator
5	Pneumatic Air Dryer
6	Mariner 320-E Breathing Air Compressor
7	PAS Air Pack 1
8	Heavy-duty Flapper / Sandpiper Pump
9	Pneumatic Ventilators or Exhaust Fans with Ducting
10	High-pressure Pumps
11	Nozzles for the High-pressure Pumps
12	Explosion-proof Lighting
13	Self-Contained Breathing Apparatus (SCBA)
14	Fire Extinguishers & Brass Buckets, Shovels, Scrapers & Packers
15	MSA Altair 5X Gas Detectors
16	Approved Hand-held Radios
17	Emergency Eye Wash Stations
18	Emergency Alarm System (Sirens)

10.0 PROJECT CONSUMABLES

In order to properly & safely implement this Tank Cleaning Project, various Consumables shall be utilized every day during the Project, and the on-site Materials Manager (**MM**) shall monitor all Consumables & Personal Protective Equipment (**PPE**) in order to ensure that none of the materials finishes before re-stocking, and these Consumables / PPE Equipment includes, but is not limited to, the following:

S/N	LIST OF COSUMABLES & PPEs
1	Hard Hat
2	Safety Glasses
3	Various Hand Gloves
4	Disposable Coveralls over Fire-Retardant Coveralls
5	Oil Absorbent Pads
6	Steel-Toed Safety Boots
7	Approved Rain Gear (Up & Down)
8	Approved Intrinsically-Safe Brass Shovels, Scrapers, Buckets & Squeegies
9	Approved 1-Tonne Woven Bags for Sand Conveying and/or Waste Skips
10	Approved Self-Contained Breathing Apparatus (SCBA) & Respirators & Cartridges, as required during Post-NME Phase during Final Mop-Up

11.0 IMPLEMENTATION OF ATC NME SYSTEM PREPARATION & OPERATIONS PLAN

The ATC No-Man Entry (**NME**) Automatic Tank Cleaning System is a State-of-the-Art series of Equipment that works together in various Modules that support one another. This ATC NME Tank Cleaning System is the Best, Safest & most Economical Tank Cleaning System in the World, which comes in four (4) Main 20-FT Containers, with four (4) Support Containers of various sizes. The following Sections of this Project Execution Plan (**PEP**) describes the preparation & operational phases of how this Project shall be implemented.

11.1 Arrival at Site & Off-Loading Equipment

- Appropriate work permits to be obtained from Renaissance Site Safety Officer (**SSO**) at the beginning of each shift prior to commencing any works on-site.
- Personnel will don appropriate levels of PPE.
- Warning Signage / Barriers will be erected where required.
- Renaissance SSO to have carried out CBR Testing on ground to ensure it is suitable for crane operations and equipment laydown.
- Conduct Toolbox Talk prior to start of mobilisation. Toolbox Talk to include all interested parties including crane driver, banksman, slingers and truck drivers. Instruct all personnel of appropriate behavior when working inside Zone 1 and with heavy lifting operations.
- Check condition of bund & road. Crane operator & truck drivers' advice must be taken into consideration to avoid potential dangers.
- Banksman required for all maneuvering of vehicles.
- All vehicles to observe speed limits, site rules and follow designated routes within the site.
- Ensure that the crane fulfills Renaissance SSO requirements, and that permit / entry can be obtained.
- Renaissance SSO to supply Lifting Plan and Risk Assessment for crane operations. Ensure Crane is setup in accordance with the Lift Plan.

- Only trained and competent crane operator to operate the crane. Only a suitably-trained and competent slinger signaler (Banksman) to attach and detach equipment, etc.
- Always keep visual / radio contact between crane driver and Banksman.
- Make sure that all personnel are familiar with hand signals.
- Assess weather conditions prior to commencing lifting operations. If adverse weather is encountered prior to, or during lifting operations, works must be halted. If lifting operations have commenced, objects must be returned to ground level as safely as possible.
- Use tag lines to prevent objects swinging.
- Appoint responsible person for monitoring around moving objects.
- Instruct personnel of dangers, and request vigilant behavior. Under no circumstances should any person stand under a suspended load.
- Containers are placed as described in the approved SWDA Mobilisation Plan.
- Make sure ATC Modules and mobile crane are placed on solid and even ground, not on weak, soft or uneven ground. Renaissance to prepare ground in advance and, if necessary, place load bearing metal plates in potentially soft areas.
- Clear the lifting area. Only allowing competent and essential persons in area. Instruct all non-essential personnel to keep distance.
- Ensure proper securing of equipment. Secure tools if possible with ropes to prevent dropping to the ground.
- Setup ladders securely, use safety harness when working at heights.
- Check and verify condition of lifting equipment prior to start of operation.
- Suspend operation immediately if crane or other equipment shows indications of abnormal function.

11.2 Ground Mobilisation

- Appropriate work permits to be obtained from Renaissance Site Safety Officer (**SSO**) at the beginning of each shift prior to commencing any works on-site.
- Personnel will don appropriate levels of PPE.
- Warning Signage / Barriers will be erected where required.
- Remove all potential trip hazards prior to commencing work.
- Cordon off / segregate any hazards that cannot be removed.
- Access ways and work area shall be kept clean and tidy.
- Practice GOOD HOUSEKEEPING throughout the operation.
- Do not leave tools or equipment lying around or in places where it could be a hazard.
- Report any near miss, unsafe act or safety issues.
- Designated PPE to be used correctly. Use leather gloves when handling pipes (sharp edges).
- During manual handling of equipment: Assess the lift & use proper lifting techniques.
- Any kind of lifting of heavy pipes or cables must be done by at least two persons. Use mechanical aids where possible.
- All pipes and cables must be laid in an appropriate manner and according to approved Mobilization Plan.
- Optimize the pipe, cable & hose laying, lay lines off access roads and walk paths.
- Use crossing bridges when cables and pipes are crossing roads or fence off / block the road.
- Fence off cable areas. Follow local restrictions (cables to be placed on poles, scaffolding, or buried in the ground).
- Electrical connections will be approved by Renaissance SSO.
- Plant, including electrical generator, must be earthed.
- ATC equipment will be electrically powered by a generator to be supplied by SWDA. Renaissance to inspect and tag electrical generator prior to usage. A suitably-sized CO₂ fire extinguisher is to be left with generator in case of engine over-run.
- Fuel for generator to be stored in a bunded fuel tank.
- Suitable and adequate lights must be provided, taking technical possibilities and EX zones into account.

11.3 Roof Mobilisation on Floating Roof

- Entry to the Tank Roof is only permitted during day hours with a valid Confined Space Entry (**CSE**) Permit and Permit to Work (**PTW**), including gas testing. Access to the roof during night shift is only carried out by special approval.
- Access is via Escape Breathing Air (**EBA**) Set and with four (**4**) permanent Gas Detection Units. Only personnel with Confined Space Entry (**CSE**) Card shall be permitted to enter Roof. Confined Space Attendant must be utilised for all Roof entries.
- Personnel will don appropriate levels of PPE.
- Conduct toolbox talk prior to start of operation. Instruct all personnel of appropriate behavior when working at heights and on top of Roof.
- Maintain ATEX Radio contact between Watchman on Tank rim to Operator in Charge on Tank Roof.
- All work on the Roof shall be performed using 4 Gas Personal Monitors at all times.
- Access ways and work areas shall be kept clean and tidy (good housekeeping).
- All equipment to be hoisted to work area (in secured bags and cases) before personnel access the work area.
- Rescue system to be set up prior to entry to Roof. Rescue system (Tank Davitt Arm System) to be suitably-certified and free from defects. Rescue Basket and Crane to be utilised for initial mobilisation.
- All entrants to familiarize themselves with the rescue plan.
- All entrants to the Tank Roof to follow Confined Space Entry (**CSE**) procedures detailed below.
- Do not access Tank Roof under severe weather conditions (electrical and/or rainstorms). Evaluate weather conditions prior to job. Authorise person in charge to stop work if weather conditions change to unacceptable level.
- Crane operation as per **Arrival at Site & Offload Equipment Procedures**.
- Any kind of lifting of Single Nozzle Sweeper (**SNS**) must be done by at least two persons. Use the pallet lifter to move SNS boxes and Cold Tapping Tools.
- Use pallet lifter to move the oil distributors or by using the crane.
- Any forms of ignition sources are not allowed in controlled areas.
- All battery-powered appliances (radio communication system, pagers, torches, etc.) are to be intrinsically-safe.
- Check the condition of the Tank Roof for corrosion.
- If Tank Roof drainage system is blocked, then use a membrane pump to remove water (Roof stability problem).
- Distribute equipment on the Roof to avoid stability problems.

11.4 Riser Pipe Installation

- Appropriate work permits to be obtained from Renaissance SSO at the beginning of each shift, prior to commencing any works on-site. For entry to Tank Roof, a Confined Space Entry (**CSE**) Permit is required.
- Personnel will don appropriate levels of PPE.
- Warning Signage / Barriers will be erected where required.
- Remove all potential trip hazards prior to commencing work.
- Assemble pipes in one piece and ensure load bearing to enable crane lift into position. Ensure no stones etc. can be trapped between the flanges causing a leak.
- Conduct toolbox talk prior to start of operation. Instruct all personnel of appropriate behavior when working at heights and on top of Tank Roof
- Rescue system to be set up prior to entry to Tank Roof. Rescue system (Tank Davitt Arm System) to be suitably certified and free from defects. Rescue Basket and Crane to be utilised for initial mobilisation.

- All entrants to familiarise themselves with the rescue plan.
- Watchman with radio contact to Control Room at wind girder when personnel enter the Roof.
- Access ways and work area shall be kept clean and tidy (good housekeeping).
- All equipment to be hoisted to work area (in secured bags and cases) before personnel access the work area.
- Use a harness when working at the wind girder, if the hand railing condition is not adequate (subject to Site Risk Assessment - **SRA**).
- Do not access Tank Roof under severe weather conditions (electrical and/or rainstorms). Evaluate weather conditions prior to job. Authorize person in charge to stop work if weather conditions change to an unacceptable level.
- Secure inner & outer riser pipe to prevent movement.
- Crane operation as per **Arrival at Site & Offload Equipment**.

11.5 Cold Tapping – Single-Deck & Fixed-Roof

Provided there is no air space present beneath the Tank Roof, except the Oil / Sludge. It is possible, but not advised, to cut without prior nitrogen inertization. Cold Tapping is performed using the SafeTap Cutting Tool, which is specially-designed for tapping holes in the Tank Roof. A trunk is fastened with screws on the Roof and the SafeTap Cutting Tool is mounted on the trunk.

The hole is then made inside the trunk by using the Cutting Tool. When the hole is made, a Single Nozzle Sweeper (**SNS**) can be installed directly on the trunk and connected to the ATC piping. Just before inserting the SNS, a dipping can be made to determine the Sludge level just beneath the SNS.

Placing the Spool

- Have toolbox talk prior to start of operation. Record toolbox talk and fill out all related safety checklists.
- Instruct Personnel in appropriate behaviour.
- Personnel will don appropriate levels of PPE.
- Do not place trunk on weak or excessively rusty spots on the Roof.
- Make sure that the trunk is placed at least 50 mm away from any Roof welding.
- Clean roof area where trunk will be mounted. Remove rust scales or other objects before placing the soft gasket.
- Always earth the trunk before it is lifted.

Mounting the Spool

- When inserting the self-tapping screws, use the outer mounting holes, not the inner holes.
- Do not continue for more than 10 seconds trying to get the self-tapping screw to catch hold.

Mounting the Safe Tap Tool

- Start to fill out the “**Check List for SafeTap Cutting**”
- Never lift the SafeTap alone. The SafeTap should be lifted by at least two operators.
- For less weight stress when lifting, mount the SafeTap Tool without the drive unit. Then install the drive unit afterwards.
- Always earth the SafeTap and drive unit before it is lifted.

Cold Tapping

- Always remember to add the prescribed amount of cutting liquid before cutting begins.
- Do not turn the handle too fast. Listen to the torque on the air motor. Faster speeds or greater pressure can lead to excessive temperature and/or damage the equipment.

- Have at least one powder-type fire extinguisher at hand when using the SafeTap Tool.
- Use proper personal BA equipment when removing the Cold Tap Tool from the trunk.

Installing the SNS (Single Nozzle Sweeper)

- Do not lift the SNS alone. Two operators should lift the SNS.
- Always earth the SNS before it is lifted.
- Use proper personal BA equipment when removing the SafeTap, performing a dipping, and finally installing the SNS.

11.6 Connection to Tank & Pipelines

- Appropriate work permits to be obtained from Renaissance SSO at the beginning of each shift, prior to commencing any works on-site. For entry to Tank Roof, a Confined Space Entry (**CSE**) Permit is required.
- Personnel will don appropriate levels of PPE.
- When removing existing pipes, check for leaking valves. Drip trays to be positioned under flange joints to catch any minor spills.
- Install a second valve as safety, if needed.
- Install a Non-Return valve in the discharge line.
- If same line is used for receiving fresh Oil, then install a bypass line with isolation valves.
- Build the lines so that unused lines can release the pressure (eventually into the suction line).
- To prevent blocked un-used lines: Build pipes with a slope towards a drain valve.
- Perform a leak test of all pipes with hydrant water.
- Check conductivity over all joints to ensure proper earthing.

11.7 Nitrogen Filling & O₂ % Monitoring

- Check couplings for damaged gaskets and use “whip lash” wires.
- Secure the hose at the wind girder so no blockage due to flattened hose is possible.
- Nitrogen flow is monitored at the Suction module and shown on the ATC computers. A 24 HRS Report is printed every morning at 7:00 AM.
- The O₂ % is monitored via a Draeger meter. The value is shown at the ATC computers. An alarm will come up on the screen, if the O₂ level is above the operational value (Normally 8%).
- There is minimum of 2 O₂ hoses installed. The one not in use is blown with compressed air to remove any condensate before switching hoses on a regular basis.
- Nitrogen filling is stopped when crew enter the Tank Roof.

11.8 Circulation of Product

- Ensure suitable Oil / Sludge level in the Tank to prevent pump from cavitating.
- Ensure Oxygen level is below 8% prior to commencing circulation.
- Open Tank Drain Water Valve and allow line to charge.
- Open Filter Valves and the ATC Suction Module valve.
- Open the required Nozzle Valve to receive the circulating fluid.
- Activate Suction Pump and Booster Pump and monitor pressure and flow. Maximum Pressure = 13 bar and Max Flow = 95 M³ / HR.
- Monitor SCADA to ensure circulating fluid is operating normal.
- Monitor O₂ Level inside the Tank. If level of O₂ increases above 8%, the equipment will stop automatically and go into Alarm Mode.
- If operatives hear the Alarm, they should ensure that system has shut-down, and if not, carry out a manual shut-down.
- Ensure Operating System is on Automatic.

- In the event that the pressure increases above 13 bar or less than 1 bar, the system will shut-down automatically and the Alarm sounds.
- Check Alarm on PLC to determine the problem.
- Rectify problem and restart system.
- If accessing Tank Roof, have BA Escape Set easily accessible, 4 Gas Personal Monitor and Safety Harness and ensure Confined Space Attendant is present. See Confined Space Entry (CSE) Procedure.

11.9 Changing of Filters

- If there is a large pressure difference between inlet and outlet pressure gauges (larger than 0.5 bar), the filter basket requires cleaning.
- Isolate valves on the said filter unit (inlet and outlet).
- Open suction line and close inlet valve to filter and then open vent line carefully to allow the filter to be drained by suction.
- Close suction valve and vent line.
- Open cover of basket carefully.
- Remove basket and insert clean basket.
- Close cover securely.
- Open inlet valve and vent using the vent valve.
- Close vent valve and then activate suction line.
- Clean the removed basket in a contained area and place deposits into Renaissance-Approved Drum for disposal.

11.10 Centrifuging of Waste

- The Sludge is transferred from the suction pump to the Sludge Holding Tank by pump.
- The Sludge Holding Tank has automatic levels, and when the Tank is 75% full, it closes the inlet valve automatically.
- If not closed, the Alarm sounds, and the operators need to manually close the emergency closure valve or activate the Emergency Stop Button on the Centrifuge to shut-down the system.
- The Decanter pump suctions the Sludge from the Sludge Holding Tank at the required rate inside the Decanter.
- Polymer is added on line to thicken the Sludge, if required.
- Monitor SCADA to ensure the system is operating normally.
- Monitor Sludge processed to ensure quality and also sufficient capacity in receiving container (IBC).
- Change out receiving container (IBC) at circa 70%. (Close valve during changeover).
- Oil recovered is pumped into the Product Recovery Tank which is subsequently transferred to the Renaissance-designated Tank via mono pump and temporary pipeline.
- Maintain polymer level in mixing tank. Ensure adequate volume of polymer granules in hopper. Ensure water supply is maintained to polymer mixing system.

11.11 Receiving Cutter Stock / Gas Oil for Tank Cleaning

- Renaissance to supply the diluent (**Cutter Stock = Fresh HFO or Gas Oil**) via pipeline to the Subject Tank in accordance with the Renaissance-Approved Programme.
- RAEC controls the quantity being delivered to the Tank – we require batches of 138 M³ maximum.
- If there is an issue with the delivery of the Diluent, Renaissance to contact the Site Supervisor.
- Renaissance is to ensure that after the delivery has been concluded, that they close and isolate the inlet valve to the Subject Tank.

11.12 Discharge of Crude to Clients Tank

- Renaissance to open the valve on the Renaissance-designated Crude Oil Receiving Tank to allow the transfer.
- We open our transfer valve in the Decanter Module or Suction Module.
- Check for any leaks in the line continuously during the transfer.
- If pressure increases more than 6 bar, our safety valve opens and releases the product to the Receiving Tank. The PLC then Alarms and shuts-down the process.
- When the transfer has been completed, close the transfer valve on Module 2 and the Decanter, and Renaissance closes the valve on the Receiving Tank.
- The quantity of Recovered Crude Oil transferred is recorded on the PLC.

11.13 Discharge of Wastewater (Hot Water Washing of Tank)

- Renaissance to open the valve on the receiving line to the Water Washing Tank via the WRO Line.
- We open our transfer valve in the Suction Module.
- Check for any leaks in the line continuously during the transfer.
- If pressure increases more than 6 bar, our safety valve opens and releases the Wastewater to the Renaissance-designated Tank. The PLC then Alarms and shuts-down the process.
- When the transfer has been completed, close the transfer valve on Module 2, and RAEC closes the valve on the receiving pipeline.
- The quantity of Wastewater transferred is recorded on the PLC.

11.14 Removing of ATC Nozzle to Facilitate Dipping

- Shutdown the ATC System.
- Ensure O₂ level is <8%.
- Switch off Nitrogen System to Tank.
- Enter onto Roof using Confined Space Procedure (**CSE Permit, Attendant & SCBA**)
- Close manual valve on Single Nozzle Sweeper (**SNS**).
- Open 4 bolt flange carefully using correctly-sized spanners / sockets.
- Do not lift the Single Nozzle Sweeper (**SNS**) alone. Two operators should lift the SNS and place on plastic.
- Always earth the SNS before it is lifted.
- Carry out Dip.
- On completion of dip, replace SNS and secure with bolts tightly.
- Carry out housekeeping and dispose of any contaminated absorbents into hazardous waste drums.
- Full Self-Contained Breathing Apparatus (**SCBA**) must be worn for personnel on the Roof when undertaking this work.

11.15 Pipe Drain Down

- Renaissance to isolate a section of pipe the requires to be drained down.
- Renaissance to identify point where drain down is to commence.
- One of our ADR Combination Units will connect to this drain down point and provide for the drain down of this section.
- Renaissance shall provide for all earthing and bonding arrangements.
- Once drained down in so far as is possible, Renaissance shall place a portable spill tray under the flange to enable opening and rotation of the spool.

- The ADR Combination Unit will provide for the continuous suction of the spill tray during this procedure to collect any remaining volumes in the pipeline.
- The cracking of this spool piece will need to be completed under controlled conditions to limit the potential volume of Oil flowing into the spill tray.
- When the discharge has been completed, the valves will be closed, the lines suctioned dry and the hoses disconnected.
- Oil to be discharged at a point identified by Renaissance personnel.

11.16 Maintenance Work on Tank Roof

- The roof is classified as a Confined Space when Nitrogen is filling, and all entries are carried out in accordance with the CSE Permit.
- If entry work is for Non-SCBA Task, then check O₂ Sensors, Abnormal Nitrogen Usage and any damage to packing prior to commencing entry.
- It is necessary to carry out daily inspections of the equipment on the roof to ensure they are operating correctly and that there are no leaks.
- It may be necessary to clear a blockage or to change the nozzle on the Tank. This is identified if the pressure increases on the circulation pump, but we do not have a flow on the specific nozzle. This is monitored via the SCADA system.
- In the event that a nozzle change is required, then the recirculation system and suction system is shut-down. All the nozzle valves are opened to allow the system to drain by gravity into the designated Tank.
- The SCADA is monitored to ensure that there is no pressure remaining in the system.
- Close all the nozzle valves and visually check nozzle unit that valve has closed securely.
- Full SCBA must be utilised for the following procedure as Nitrogen Atmosphere is present under the nozzle flange.
- Unbolt flange and remove from Receiving Tank. Insert new Nozzle and retighten flange.
- Open valve to this nozzle and ensure there are no leaks. If a leak is evident, correct same before reactivating system.

11.17 General Recovered Crude Oil Tanker Operating Requirements

- Renaissance to confirm they have tested or know the composition of the Waste prior to loading / unloading of Waste to any on-site Tanker Truck. The product / Waste should conform with the Renaissance Tank data.
- The ADR Class of the vehicle must conform with the Waste material. In this instance Class 3.
- Ensure Combination Tanker has current Renaissance Oil Inspection Sticker affixed to Tanker. If not present or expired, contact Renaissance Maintenance Dept. before proceeding.
- Operators must check in with every operating area they will work in before starting work.
- Confirm that Tanker is empty and clean prior to loading any Waste. Wash out in Renaissance-designated area, if necessary.
- All Tankers must be grounded and bonded at all times whilst loading or unloading hydrocarbon or flammable / combustible material. Ask the Renaissance SSO to carry this out and to test same.
- Operators are not to occupy the Tanker cab while loading or unloading is in progress and must stay within 8 M of the Tanker in order to be ready to shut-down the transfer in the event of an emergency.
- If potential for release of hazardous chemicals from the exhaust, such as Hydrogen Sulfide, Benzene, etc., exists during the Tanker operation, follow additional specific requirements on the Work Permit or within the special instructions.
- Vacuum pump vapours to be controlled if they present a hazard. The following control measures need to be implemented for non-liquid ring pumps when risk of hazardous vapours being emitted.
- Return Vapours to the source container using conductive hosing and closed connections.

- Connect vent hose to pump exhaust and extend a minimum distance of 15 meters downwind of the truck exhaust. Vapours must not discharge onto roadways or other areas where source of ignition may inadvertently occur or where people may be exposed to toxic gases.
- Vent to atmosphere via vertical exhaust at least 3.65 M above vacuum truck to dissipate vapors before they reach sources of ignition or other potential hazards.
- Liquid ring pumps provide a scrubbing effect of vapours, and Renaissance shall confirm if the following additional control measures need to be implemented.
- Only Operatives ADR-Trained can load / unload dangerous goods / Waste.
- Complete HSI Appendix 1 Vacuum Truck Loading / Unloading Risk Assessment with each Loading / Unloading Operation on-site.
- Complete Vacuum Truck Loading / Off-Loading Log for each load loaded / unloaded.

11.18 After ATC Cleaning - Tank Entry Cleaning for Mop-Up

- A Job Safety Analysis (**JSA**) shall be completed each morning by the SWDA Site Team following collection of a signed Permit to Work (**PTW**).
- The Tank is classified as a Confined Space, and all entries are carried out in accordance with the CSE Permit.
- Ensure Tank is fully ventilated prior to entry commencing.
- Setup entry point (***Renaissance to erect Scaffold Weathered Enclosure for changeout of footwear at entry manway and Site Cabin for CSE Attendant***)
- Renaissance to open Tank manway – Beware of Asbestos Gasket – We can provide for the removal of the asbestos gasket under separate WMSRA, if requested.
- Ensure Tank is nominally empty.
- Renaissance to carry out initial Gas Test on Tank prior to work commencing. LEL must be below 5% to proceed. Carry out forced ventilation of the Tank using ATEX Blowers, if necessary.
- **NOTE:** If Tank LEL's exceed 10%, Renaissance SSO or Supervisor must be notified immediately, as well as all work stopped.
- Renaissance to carry out all necessary earthing and bonding of hosing and equipment.
- Position suction hose through dedicated utilities entry point into sump remotely without entry, if possible.
- Carry out high volume flushing of the Tank from the various manways whilst suctioning up the washings using the ADR Combination Unit, if necessary. As the Non-Entry Tank Cleaning will have been completed using the ATC System, this task should be limited, if required at all.
- After the bulk of the free product has been removed, commence remote washing of Sludge to break down same and suction it up remotely using the suction hose. Continue this process until the bulk of the Sludge has been removed, and it is no longer feasible to continue remote cleaning.
- Once the above has been completed, carry out repeat testing of Tank to enable Tank Entry procedure to commence, if necessary. The LEL must be ~5% for Tank Entry procedure to commence. This allows for levels to increase during the initial cleaning up to a maximum of 10% LEL. At 10% LEL, the Tank Entry procedure must stop and the Tank vented using ATEX Blowers or naturally.
- **NOTE:** If Tank LEL's exceed 10%, Renaissance SSO or Supervisor must be notified immediately, as well as all work stopped
- Commence Tank Entry Cleaning process as follows:
 - Setup Rescue System.
 - Check all CSE Equipment and quarantine as appropriate.
 - First Entry checks to be completed by Renaissance Process, maintenance & HSE Supervisor.
 - CSE Permit will be issued thereafter based on all safety checks being completed.
 - Entry into the Tank is via SCBA or ALBA, or if Cleanliness and Gas Levels permit, Entry can be by way of Powered Filter Respirators with permanent Personal 4 Gas Monitors and Escape Sets.
- Follow CSE Procedure detailed below.

- To enable the full Tank Cleaning procedure to commence, the Cribbing must be installed. These are large timber blocks to provide additional safety support for the Floating Roof. The floor under the placement should be washed remotely using extension lances. The Cribbing will then be installed by two-man teams using manual handling techniques in accordance with the Renaissance Tank Entry Safety Plan. See attached document (***Tank Signed Entry Safety Plan***)
- Once the Cribbing has been setup, the full Tank Cleaning procedure can commence.
- The Tank will be initially cold washed using extension lances with the Waste being suctioned up by the ADR Combination Unit.
- The roof, walls and floor of the Tank will be cold-washed. The Tank will be given a hotwash thereafter, before handing over the Tank for maintenance works.
- Beware of sumps and other obstructions in the Tank.
- Place suction hose into the localised wells / sumps in the Tank through the dedicated utilities entry point.
- Suction Sludge / Washings from Tank using the ADR Combination Unit.
- When near full, transfer Sludge / Washings from ADR Combination Unit to Renaissance-Approved IBCs using the procedures detailed below.
- Bring suction hose to localised deposits to reduce manual handling. Evaluate whether heavy scale solids are to be removed by suction or placed in buckets / wheelbarrow. If not suctioned into Tanker, transfer solids from buckets / barrow into Renaissance-Approved Drums or Waste Skips at entry point.
- Rotate roles to prevent heat exhaustion.
- On completion of the cold wash works, commence high pressure hot wash of floor, walls, columns, etc. in the Tank up to 2.5 M height.
- This work to be carried out under full BA or powered respirator according to PTW permit conditions.
- Hot water will be delivered to site via articulated tanker and transferred into ADR Combination Unit as required.
- The Tank (floor and first plate weld) will be washed using jetting lances, and the washings collected by ADR Combination Unit. When operator roles are changed inside the Tank, shut down the jetwash machine before.
- The legs will be jetted using small jetting hose to remove remaining product / Sludge from same. Renaissance shall provide suitable access openings for legs.
- The washings will either be discharged to the Renaissance's WWTP or off-site to Renaissance-designated location or Waste Treatment Facility.

11.19 Filling of Receptacles with Sludge & Product at Renaissance-Designated Areas

- Renaissance's Representative will ensure that any drain valve etc. in the bund / transfer area is securely closed prior to transfer works commencing.
- The IBC, Waste Skips or Drums shall be checked for damage prior to filling, and the valve will be checked to ensure it is fully closed, and the sealing cap is securely closed on the valve.
- The Drums will be checked for damage prior to filling.
- Label the Waste Skip / IBC / Drum prior to filling.
- Waste to be filled into empty and clean Waste Skips / IBCs / Drums only. No mixing of wastes permitted, unless Renaissance confirms that Waste is fully compatible with receiving receptacle.
- The cover of the Waste Skip / IBC / Drum will be removed and the filling hose securely placed in the receptacle.
- The operation will consist of one operator at the hose end and one operating the controls.
- Discharge operation to be monitored at all times.
- After the Tanker has discharged its last contents for the day, the Operator will activate the Tankers Internal Tank Wash System to ensure remaining contamination is removed.

- Solids will be filled into receptacles up to a maximum of 70% to ensure receptacle is not overweight.

11.20 De-Mobilisation (Non-Entry Tank Cleaning System)

- Prior to De-Mobilisation, the Cleaned Tank shall be vented for 1 Day.
- Drain systems – Shutdown Recirculation Module, system and Suction Module. All the nozzle valves are opened to allow the system to drain by gravity into the Renaissance-designated Tank. The SCADA is monitored to ensure that there is no pressure remaining in the system.
- Flush all pipelines and equipment with water using the circulation system. On completion of same, shutdown Recirculation Module, system and Suction Module. All the nozzle valves are opened to allow the system to drain by gravity into the Renaissance-designated Tank. The SCADA is monitored to ensure that there is no pressure remaining in the system.
- Carry out electrical isolations – Remove Generators.
- Isolate and disconnect lines from all Tanks and Transfer Lines.
- Commence De-Mobilisation from Tank Roof.
- Removing and cleaning nozzle flanges and pipelines on Roof (2 Days).
- Lower equipment from Roof onto ground (1 Day – Crane and Banksman).
- Dismantling pipelines and cables on the ground.
- De-Mobilise Decanter (replace Roof and put screw conveyor into travel position on Decanter Module (crane and Banksman).
- Place pipelines in transport racks.
- Load ATC Modules and pipe racks onto transport units and De-Mobilise from site (crane and Banksman).

11.21 De-Mobilisation (Entry Tank Cleaning System)

- Remove all equipment, recoil hosing and clean same prior to storing onto trucks / vans.
- Ensure all Wastes are in Waste Skips or drummed / packed and labelled.
- Carry out walkaround checks on-site to ensure no equipment is left behind and no hazards exist as a result of our works.
- Handover Cleaned & Approved tank to Renaissance, and receive Job Completion Certificate (**JCC**).
- De-Mobilise from Site.

11.22 Confined Space Entry

All Works will require gas testing and relevant permitting (Confined Space & General Work Permit) to work before starting each day. After ATC Operations are complete, and on the first day that Manned Mop-Up Entry is required, and before issuing the Confined Space Entry (**CSE**) Permit, the Renaissance Process Area Lead must ensure that a job site visit has been conducted by the Area Leader (**or nominated deputy**), the Maintenance or Contractor Supervision (**or nominated deputy**) and the HSE Rep. The Process Area Lead must ensure the equipment is prepared for the Work.

A Renaissance-Trained **Confined Space Attendant** is required for any Permit-Required Confined Space Entry, and the Attendant must ensure the following:

- Adherence to the Confined Space Attendant Instructions listed on the back of the CSE Permit.
- Signs the permit designated for the Attendant, verifying that they understand the conditions, hazards and requirements of Permit-Required Confined Space Entry.
- Maintaining a written Entry Log of each Entry and Exit of all Tank Entrants (**See CSE Entry Log**).

- Print the name and time of each Entry and Exit on the Entry Log provided on back of each CSE Permit or on an Entry Board.
- Make sure the atmospheric monitoring requirements of the CSE Permit are in place.
- Maintaining audible and/or visual communications with each Entrant within the Confined Space.
- Identifying themselves as an Attendant by wearing a red or coloured vest.
- Allowing only authorised personnel who are assigned to the Work to enter the Confined Space.
- Being fluent enough in English (capable of communicating) to evacuate all Entrants in an emergency.
- Ensuring that each Point of Entry into the Confined Space has a Danger Sign identifying a CSE Permit-Required Confined Space. The Sign must state **"Danger – CSE Permit Required Confined Space - Authorised Personnel Only"** or other similar warning.
- Activating the Emergency Notification System (**ENS**) in an Emergency within the Confined Space using the English language.

Each **Confined Space Entrant** must know the hazards related to the specific Permit-Required Confined Space as communicated by the Operations Representative and described in the CSE Permit or the Material Safety Data Sheet (**MSDS**). The Tank Entrant must be trained and knowledgeable in the scope of the assigned work. Each employee has the right to know about the hazards of the Work and should consult with their Supervisor about the specific hazards of the job.

Each Tank Entrant must comply with the following:

- Logging in and out with each Entry and Exit, with the Renaissance CSE Attendant, by printing your name and marking the time on the Entry Log.
- Adhering to the immediate Supervisor's instructions when working within a Permit-Required Confined Space Entry, this includes:
- Being knowledgeable of the requirements of the job and precautions and/or concerns listed on the CSE Permit.
- Maintaining audible and/or visual communication with the Renaissance CSE Attendant.
- Wearing and using Personal Protective Equipment (**PPE**) when required.
- Using tools and equipment that are designed for the work and that are in good working condition.
- Knowing the hazards within the confined space, including signs of symptoms or consequences of exposure, limited access or egress.
- Leaving the space in an emergency or as instructed by the Renaissance CSE Attendant.

The Confined Space Entry Team will have a Confined Space Attendant at all times, who will act as the coordinator between the men in the confined space and **"Outside World"**, i.e. Renaissance Control Room (**by radio**), and Site Supervisor and Plant Operators (**radio / verbally**).

The Confined Space Attendant must be at the Entry Point at all times when personnel are in the Confined Space. The Entry Team will be logged on a Daily Register; and, it will be the Confined Space Attendant's responsibility to record all Entry and Egress from the Confined Space (Tally Board).

The Confined Space Entry Team have a dedicated **"Plant Man"** whose duties include monitoring the BA and all the Plant; and, importantly he remains in contact with the Confined Space Attendant and the Site Supervisor (**radio / verbally**).

The Confined Space Entry Team are trained and certified in Confined Spaces. The Confined Space Rescue Team names will be nominated by Renaissance & SWDA, and their contacts added to the CSE Permit. It will be the Site Supervisor's responsibility to complete the Confined Space Register with Renaissance collaboration.

11.23 Rescue Equipment (ATC Roof)

The following Rescue Equipment is the minimum required, and will be located within easy reach on the Roof top side:

- 5 x 15 min Emergency Life Support Apparatus (**ELSA**) positioned (well distributed for all the Roof area).
- 1 Self-Contained Breathing Apparatus (**SCBA**) equipped with positive pressure mask and rescue mask connected through a safety valve positioned (**foot of the ladder**).
- 1 SCBA equipped with positive pressure mask positioned (**in the middle of the Tank's Floating Roof**).
- ATEX Radios to connect the SWDA Crew working on the Roof with the Safety Man (**to be provided by SWDA**).
- ATEX Radio with connection to Renaissance SSO Emergency Channel (**to be provided by Renaissance**),
- Rescue Winch.

11.24 Rescue Equipment (Internal Tank Cleaning)

The following Rescue Equipment is the minimum required, and will be located within easy reach on the Roof top side:

- 3 x 15 min Emergency Life Support Apparatus (**ELSA**) positioned (**well distributed for the SWDA Tank Cleaning Team**).
- 1 SCBA equipped with positive pressure mask and rescue mask connected through a safety valve positioned at Entry Point.
- ATEX Radio with connection to Renaissance Emergency Channel (**to be provided by Renaissance**).
- Rescue Line.

11.25 Emergency Procedures Check List

- Prior to Work commencing on-site, the personnel will be inducted in site rules and emergency procedures.
- On a daily / weekly basis as access to the Roof top side is required, the Site Supervisor will carry out a Team / Toolbox Talk, which will cover general topics, but will specifically detail who the Rescue Team will be for the day.
- The contact of the Rescue Team will be provided by Renaissance to Site Supervisor each day and entered on the CSE & Permit to Work (**PTW**) system.
- The Crane will be setup and on standby to provide Rescue from the Roof. Subject to agreement, the Crane may be stood down, and the Davitt Arm Rescue System may be employed to act as the main Rescue System.
- BA and ELSA (**Escape Sets**) will be distributed for all the Floating Roof area.
- When any man enters or exits the Confined Space, the Confined Space Attendant will record the information on the Man Register / Tally Board.
- A single radio frequency will be nominated for all Emergency Messages by SWDA & Renaissance.
- All plant equipment / nitrogen purge is stopped during Rescue.

11.26 Confined Space Check List Reminders

- Ensure all Rescue Equipment is in place, in proper working order and within test date.
- Respirators / Dust Masks do not supply Air, only filter contaminants. SCBA must be worn, if Air Quality is poor.
- Ensure all Operators (**Attendants / Standby Personnel / Rescue Personnel**) have valid training (**including Confined Space Attendant Training by SWDA / Renaissance**).

- Review Emergency Rescue Procedure via Toolbox Talk prior to Entry commencing.
- Establish how Communication between Entrants and Attendants is to be carried out.
- Ensure Attendant and Entrants are in Constant Communication.
- Establish how the Rescue Team / Emergency Services can be contacted (**ATEX Radios, Blackline Gas Detectors, Phone - Is there a Phone Signal??**).
- The CSE Attendant must be notified immediately, if an Entrant recognizes: - Unusual Action / Behavior - an Unexpected Hazard - an Unsafe Act or - detects a condition prohibited by the CSE Permit.
- Entrants must exit the Confined Space as quickly as possible, when: - an **“Order to Evacuate”** is given by the CSE Attendant or Entry Supervisor - an Entrant recognizes a Sign or Symptom of Over-Exposure - an Unacceptable Condition arises or - an Evacuation Alarm is activated.

In the event of a Confined Space Rescue: The CSE Attendant **does not enter** the Confined Space, but **immediately summons** a Rescue Response from the On-Site Rescue Team or the Emergency Services, using the means of communication described in this CSE Permit.

11.27 IN THE EVENT OF AN EMERGENCY, THE FOLLOWING RULES WILL APPLY:

1) EMERGENCY ON THE TANK FLOATING ROOF

The Confined Space Attendant will raise the Alarm by notifying Renaissance Control Room, Site Operators and Site Supervisor by radio / verbal contact. Depending on the type of emergency, the following actions will be carried out by the Emergency Rescue Team:

- If Site Alarm sounds, follow appropriate Alarm procedures as described in the Site Induction.
- If an Injury, one person to remain with the injured person, if his own safety is not at risk, to keep him comfortable, while Rescue Team enters Tank Roof to assist.
- SWDA / Renaissance Rescue Team enters the Tank Roof via the Roof ladder wearing full SCBA and remove the injured man. This will be done with the aid of the stretcher.
- Rigger / Banksman must be in place on the wind girder whilst the injured person is being lifted off the Tank Roof to a safe location.
- PTW & CSE Permits shall be withdrawn during investigation.
- It is important that the Confined Space Attendant maintains regular radio contact with SWDA / Renaissance Control Room to report any changes in Site conditions.

NOTE: IF FOR ANY REASON THIS PROCEDURE AFFECTS THE SAFETY OF THE OPERATORS, THEY WILL BE WITHDRAWN IMMEDIATELY FROM THE TANK ROOF, AND THE SITE SUPERVISOR WILL BE NOTIFIED.

2) NITROGEN (DURING NO-ENTRY TANK CLEANING PROCEDURES):

- The Tank under the Roof is inerted with Nitrogen, and the Nitrogen is produced on-site using a Nitrogen Generator.
- Nitrogen is not toxic since about 78% of the air we breathe contains this gas. However, it is **not harmless**, and it has **NO SMELL**, rendering it quite **Dangerous**.
- It can cause suffocation by replacing the Oxygen in a Confined Space.
- Its presence will give false readings when using Explosimeters or Flammable Gas Detectors.
- Nitrogen is an asphyxiant that can cause death or unconsciousness by suffocation.
- Nitrogen displaces Oxygen in Air, and so becomes especially **Dangerous** in Confined or Enclosed Spaces (**See Attachments 1 & 2 below**).

Before entrance will be made into any of the Tanks, and for the safety of the personnel, the Gases mentioned below and their concentrations would have the following readings:

- CO₂ – 0%
- LEL – 0%
- H₂S – 0 PPM
- O₂ – 20.8%

However, the acceptable working ranges of these Gases for personnel working inside the Tanks are:

- CO₂ – 0%
- LEL – 0% - 10%
- H₂S – 0 PPM – 5%
- O₂ – 19.5% - 23.5%
- Benzene – 25 PPM – 50 PPM

Pneumatic / Hydro-Ventilators (**blowers and extractors**) shall be used continuously, to vent the Confined Space prior to any Entry. The Emergency Response Team (**ERT**) shall be notified and shall be on ground before any Tank Entry commences.

12.0 PROJECT CLOSE-OUT PHASE

12.1 Inspection of the Tank

After the Final Cleaning & Mop-Up of each of the Tanks, the Renaissance Inspection Team, in the presence of SWDA Representatives, shall inspect the Tank based on the Scope of the Project.

12.2 Handing Over of the Tank to the Company

After the Tank had been ascertained for cleanliness such that **“Hot Work”** can be carried out, it will be handed over to Renaissance; thereafter, a Job Completion Certificate (**JCC**) will be issued to SWDA for completing each Tank cleaned during the Project.

12.3 De-Mobilization Off-Site

Personnel and Equipment will be properly De-Mobilized from the Renaissance Tank Project Site after completing the Tank Cleaning Project, all JCCs have been executed by Renaissance, and De-Mobilization Authority & Clearance has been granted to SWDA by Renaissance to fully De-Mobilize.

12.4 Lessons Learnt

The Lessons Learnt from the successful execution of the Project will be captured into Operational Plans for the subsequent ATC NME Tank Cleaning Projects embodied within the Renaissance Tank Cleaning Contract.

12.5 Final Project Report

As part of the Project Requirements, a Final Tank Cleaning Project Report both in hard and electronic copies shall be submitted to Renaissance & NUPRC, as Final Documentation, including Waste Management services, locations & Waste Manifests.

13.0 ENGINEERING MANAGEMENT

SWDA shall mobilize Engineering Personnel on the Project in accordance with relevant Sections of the Contract, in line with the specific demands of the Project, job requirements and Scope of Work which indicates the Organizational Structure adopted for the Project and serves as information for Renaissance concerning the Crew Personnel working on the Project.

The Project shall leverage on the resources mobilized for Tank cleaning and sludge removal, treatment and waste management support services with additional personnel provided when required.

13.1 Engineering Management Documents

SWDA shall prepare all required engineering management documents (**verified**) for the Project. In order to ensure the quality of documents and optimize the engineering schedule, SWDA shall follow its Integrated Management System (IMS) Procedures, such as **“Design Control Procedures”**, **“PFD and P&ID Control Procedures”**, **“Internal Design Safety Review”**, etc.

The Project Engineer (**PE**) shall prepare the documents as required and assign a document number to each new document, in compliance with the Renaissance’s documentary procedures.

Documents will be checked as below:

- **Single Discipline Check (Verify)** within the concerned discipline by the discipline checking engineer to meet the design basis, accuracy and compliance to format. The Project Engineer / Checker will sign-off and date the document in the appropriate spot.
- **Inter-Discipline Review** within the concerned interfacing disciplines by the discipline checking engineers to ensure that interface points are checked and mismatches are eliminated. Such inter-discipline reviewed documents will be signed by all interfacing discipline engineers and the QHSE Engineer.
- The steps listed below will be followed for each intended issue of a document to other disciplines.
- Review current basis of design information and ensure that the level of validity of this information supports the intended issue level of the document being prepared.
- Prepare / revise each discipline document to meet the intended project requirement:
- **Approving Deliverables for Issue** – After a deliverable document has been prepared and verified by the originating discipline, it shall be approved by the Engineering Manager (**EM**). A project coordination procedure will be prepared, which will include project-specific requirements.
- **Inter-Disciplinary Documents** (i.e.: **PFD, P&IDs, electrical load lists**) will be approved first by Lead Engineer (**LE**) of each engineering packages and then by the Engineering Manager (**EM**). Formal Renaissance approval may be required for some documents as per Contract requirements, which will be specified in the Project Coordination Procedure. The Project Engineer (**PE**) is responsible for following-up and obtaining Renaissance’s approval.

13.2 Review and Endorsement Engineering

For review of third-party documents, SWDA will organize the Engineering Review Team (**ERT**). The engineers of different relevant disciplines will be selected according to Renaissance’s Tank Cleaning Contract to review the documents. SWDA will provide the necessary assistance to the Renaissance Project Management Team (**PMT**) reviewing the third-party documents:

- Review IFCs and provide clarifications;
- Check compliance to Project Schedule and Engineering requirements; and,
- Assist in Engineering Safety Exercises.

SWDA will submit the selected Key Personnel CVs to Renaissance for approval. After approval of Key Personnel, SWDA will prepare the relevant procedures for Renaissance approval, such as Document Review procedures, QA / QC procedures, etc.

Renaissance may send the third-party documents to SWDA for review. SWDA's Engineering Manager (**EM**), through the Lead Engineer (**LE**), will assign the document to the relevant Discipline Engineer to check. After finishing the review, checking and signing, the Lead Engineer (**LE**) will send back the document to the Engineering Manager (**EM**) who will review, and if everything is ok, will approve, and then send back to Renaissance for approval. SWDA confirms that the comments made by the Engineer are comprehensive and considering Renaissance's point of view, to reduce engineering schedule, package cost and overall delivery.

SWDA will prioritize to handle and review the documents which belong to the Critical Path of the Project:

- Timely completion of Critical Reviews;
- Review & approval of key philosophies and deliverables;
- Long lead items supplier's documents;
- Review of enquiries and TBEs;
- Cost Reporting and Change Order administration;
- Reviewing and recommending Design Changes;
- Reviewing of Engineering Progress and status of engineering activities; and,
- Compliance to Project Schedule & Engineering Requirements.

14.0 ENGINEERING MANAGEMENT REPORTING

The Progress Control Engineer (**PCE**) shall submit to Renaissance the Project Progress Analysis Reports (**PPARs**) developed against the approved Target Schedule at specified intervals. The progress information shall be collected from the individual disciplines and summarized by levels according to the Renaissance-approved Work Schedule. The weekly reports of the Engineering Verification works will clearly reflect the work progress and focus on the analysis of the existing problems, suggestions and deviation corrective measures from the point of view of technical scheme, design progress and human resources.

(1) ***Project Progress Reports:***

The Project Progress Reports (**PPRs**) shall be developed according to the template provided by Renaissance and submitted on time. The contents of the Reports which shall mainly be in form of Daily, Weekly or Monthly Reports, which will report with the actual conditions occurring within the period. If the engineering verification lags behind the Target Schedule by more than 10%, and thus affects the Target Completion Period, then once the adjusted plans are approved, the implementation of expediting plans will be made public in the form of Daily Reports.

(2) ***Contents of Weekly and Monthly Reports:***

A) Weekly Progress Reports:

The Weekly Progress Reports (**WPRs**) on execution of the Engineering Verification will be submitted according to the Contract requirements. The Engineering Team will submit to

Renaissance the Weekly Progress Reports for the previous week on the Friday of every week. The Reports will be prepared by the Project Progress Control Engineer (**PPCE**) and reviewed by the Project Manager (**PM**). The form of the Weekly Progress Reports will be in accordance with Renaissance's requirements. The Weekly Progress Reports shall include the following contents:

- Overall progress of the Project Engineering Verification;
- Completion of the IFCs Review;
- Completion of the Out-Sourcing Plans;
- Plans for the next week; and,
- Challenges that are required to be coordinated and addressed by Renaissance.

B) Monthly Progress Reports:

The Engineering Team Lead (**ETL**) will submit to Renaissance the Monthly Progress Reports (**MPRs**) for the previous month as of the last Friday each month. The Reports will be prepared by the Project Progress Control Engineer (**PPCE**) and reviewed by the Project Manager (**PM**). The form of the Reports will be in accordance with Renaissance's requirements. The Monthly Progress Reports (**MPRs**) shall include the following contents:

- Overall progress of the Project Engineering Verification;
- Completion of the IFCs Review;
- Completion of the Out-Sourcing Plans;
- Plans for the next Month; and,
- Challenges that are required to be coordinated and addressed by Renaissance.

15.0 DOCUMENT CONTROL PROCEDURES

The Document Control Procedure (**DCCP**) is defined as the procedure for preparation of the Document Management System (**DMS**) for the Project.

1) Document Control Centre (DCC):

SWDA will establish a Document Control Centre (**DCC**), and the DCC Manager is responsible to examine the project requirements, prepare the Document Control Manual and coordinate with the Project Control Manager (**PCM**) for the Document Control Register (**DCR**) Database.

The Document Control Center (**DCC**) with a Document Controller is assigned to this Project. All received and issued documents shall be centrally controlled by the DCC.

The Document Controller is responsible for issuing, receiving, logging, filing and distribution of all Project documents received or issued during the whole course of the Project. Other duties include the following:

- Maintaining and updating the Document Control Procedure;
- Receipt, control, storage and issue of Project documentation;
- Supervising the establishment and maintenance of Project Central Filing System;
- Establishment and control of the Project Reference Library; and,
- Supervision and control of printing facilities.

(2) Document Control and Numbering Procedures:

SWDA will prepare Document Control and Numbering Procedures, which includes, but is not limited to, the following main items:

- Document templates which include all types will be submitted to Renaissance for Review and Approval by Renaissance;
- Master Document Register (**MDR**), which shall list all documents and reports produced as part of the Work;
- Correspondence Document Register (**CDR**), which shall list all Documents transmittal letters, TQs, MOMs and other formal correspondence;
- Document Numbering System for documents, correspondence and others; and,
- Other documents, if necessary.

(3) **Document Control and Data Management Systems:**

SWDA will create a Document and Data Management System (**DDMS**) for the electronic storage and administration of all data generated or received during the performance of the Works.

16.0 COST CONTROL PROCEDURES

SWDA shall provide Cost Control Services (**CCS**) to establish budgets for engineering elements of the work, monitor and report commitments and actual costs. These services are summarized below:

- Establish budgets for Engineering Services, track and monitor services, man-hours and cost expenditure and prepare forecasts;
- Develop Project Engineering Budgets based on Renaissance's norms;
- Provide Monthly Cost Reporting in accordance with Renaissance's requirements; and,
- Assess the impact of changes.

17.0 MANAGEMENT OF CHANGE

Management of Change (**MOC**) consists of establishing a formal process to identify and process changes and effectively notify the Project Team of Cost and Schedule impacts to the system design, procurement, construction and organization proposed on the Project. All changes shall be measured with respect to the Control Estimate Baseline (**CEB**). The SWDA MOC Plan shall provide an auditable process to both track and document MOC through the use of established procedures. The logical sequence for MOC actions is as follows:

- Identify potential change(s);
- Prepare Project Variation Notice (**PVN**) for the proposed change including order of magnitude cost and estimated schedule impacts;
- Screen PVN(s) to obtain agreement to proceed with change assessment;
- Update PVN register and communicate PVN approval and timeline;
- Hold Variance meeting in conjunction with Client and obtain PVN alignment;
- Prepare and enter details of CTR and deliverables into Project database;
- Generate Project Change Request (**PCR**);
- Gain alignment of multi-discipline / stakeholder / impacted parties prior to MOC execution;
- Meet with or forward PCR to Renaissance for approval;
- Upon PCR approval updates PCR register; and,
- Update Project Schedule and proceed with work on Areas of Impact.

18.0 ENGINEERING ORGANIZATION

The success of any Project is measured in terms of the following objectives:

- **Quality** – Technical compliance with facility requirements;
- **Time** – To execute the Contract Scope of Work within the agreed period; and,
- **Cost** – To execute the Contract within the budgeted cost.

SWDA's approach to Project Management is to develop and define a plan in which the relationship between the three Objectives of Quality, Time and Cost is most effective. The plan is implemented and maintained through a system of progress feedback and Corrective Actions by the SWDA Project Management Team (**PMT**).

The Key to achieve the Overall Objective of proper Project Management is to mobilize and maintain an experienced Team with timely and accurate information on progress and forecasts. The Team will be further compliant to prevent slippage of progress.

For above reasons, SWDA expresses its commitment to work with Renaissance and all other Parties with its best cooperation to achieve the shared Project goals and objectives.

This schedule introduces details of SWDA's Engineering Organization as well as key personnel to be employed in the Project.

19.0 INTERFACE MANAGEMENT

SWDA will be responsible for all the technical and organizational interfaces with concerned departments. This includes the Contract, Renaissance-supplied IFCs, technical clarification and discussion and any other information during the whole project duration. Technical and organizational interfaces between different groups, which input into the design process, will be defined and necessary information will be documented, transmitted and regularly reviewed.

SWDA will confirm acceptance of its responsibility to establish final locations for all tie-ins, hook-ups, integrations, bondings, with other existing facilities (**completed by others**), including piping, instrumentation, telecommunication, fire protection and electrical as well as civil works, which may differ from those indicated in the ITT, with no impact to the Project. Management, coordination and supervision services of external interfaces with all Parties involved including provision of advice to Renaissance of any interface matters arising thereof. Obtaining and maintaining all the permits, authorizations & licenses as may be required to be obtained in the name of SWDA for the performance of the work. Management and coordination of all external interfaces associated with the work, covering the site survey, Engineering Review / Verification Phase, Execution Phase, Safety Studies, etc.

SWDA shall actively participate in the interface meetings with Technical clarifications with Renaissance's Engineering Department during the Verification Phase of the Project.

20.0 INTERFACE PLAN

SWDA shall co-ordinate all their internal and external interfaces with the Works and its mediation with all Third Parties involved with or affected by those external interfaces, in accordance with at least the following requirements, except where stated otherwise.

Identifying, specifying and resolving all interface matters, such as the type of information needed by SWDA from other Parties shall be an integral part of the Scope of Work. The Renaissance Engineering

Department / Contractor shall prepare the design, planning, scheduling or other work required for progressing the resolution of such interface matters.

SWDA shall be responsible for the management and coordination of all external interfaces associated with the Works. These interfaces cover engineering, procurement and supply, construction, pre-commissioning, commissioning and start-up activities. Interfaces include those areas where the Contractor has to exchange information with other Parties for carrying out the Works, as well as physical interfaces at the limits of supply between SWDA and other Parties. SWDA shall issue documents as requested by other Parties and shall be responsible for the review of all Engineering Work associated with the interface in question to ensure that the final design is in accordance with its own Engineering Works, always subject to Renaissance's agreement. All official contacts with Third Parties (**including Governmental Authorities**) involved at the external interfaces with the Works shall be directed through Renaissance, who may however, at its discretion, instruct the Contractor to have direct contact with the interface Party in question in accordance with the conditions as set down by Renaissance.

21.0 ENGINEERING RISK MANAGEMENT

Engineering Risk Management will generally be as described earlier within this document, called: **“Risk Assessment & Management Plan”**. Each issue contained on the Risk Register (**RR**) will have a nominated individual responsibility for management or mitigation of the Risk. Team Members shall be responsible for Hazard Identification (**HI**) during the Engineering Verification Phase (**EVP**).

Identified Risks shall be communicated through the Lead Engineer (**LE**) to the HSE Manager for addition to the Risk Register. Each item on the Risk Register will be assigned a Risk Ranking following the Risk Management Matrix (**See Attachment 1 below**). The responsibility of the Risk Manager (**RM**) is to mitigate the Risk, and develop / maintain a milestone for completion. The Risk Register will be issued and reviewed on a monthly basis to ensure the management / mitigation prescribed for the individual Risk is providing the desired effect.

22.0 CONCLUSION

SWDA's Target as a Company is to ensure a safe delivery of this Renaissance ATC & NME Tank Cleaning, Sludge Recovery, Treatment & Waste Management Project across Nigeria, within the prescribed Cost and on Schedule. All SWDA's equipment and tools shall be in perfect condition to avoid delays and consequent inability to deliver jobs at specified and agreed time frames. SWDA as a Company is an efficient entity, and we shall work hard and intelligently to ensure that our Client, Renaissance Africa Energy Company (**RAEC**) is satisfied with All Works and happy with the Project Results.

TABLE 1 - RENAISSANCE TANK CLEANING CONTRACT NO.: CW-68582 - TANK & CONTENTS PARTICULARS LIST

SWDA - RENAISSANCE 18-TANK SEMI-AUTO & MANUAL TANK CLEANING & SLUDGE REMOVAL PROJECT - 17 / 7 / 2026

(PLEASE NOTE THAT THESE ESTIMATED VOLUMES ARE NOT CORROBORATED BY RENAISSANCE, AWAITING TANK AS-BUILT DRAWINGS, MERELY OUR ESTIMATES FOR PLANNING PURPOSES.)

S/N	TENDER TANK NO.	RENAISSANCE TANK LOCATION	TYPE OF TANK OPS	ROOF TYPE	TANK DIAMETER (M)	TANK DEPTH (M)	EST. TANK VOLUME (M ³)	EST. TANK 80% CAPACITY (Bbls)	SLUDGE LIKELY TYPE & CONSISTENCY	EST. SLUDGE VOL. (Est. M ³ @ 1.0 M Depth)	EST. SLUDGE VOL. (@ 6.29 Bbls / M ³)	EST. SEMI-AUTO & MANUAL CLEAN (Days)
1	Tank 9	Bonny Tank Farm - 10 KMs South of PHC	Crude Oil Storage	Floating Roof	48.8	22.1	41,335.0	207,998.0	Flowing & Mucky to Dry Sludge	1,870.4	11,764.8	30
2	Tank 11	Bonny Tank Farm	Crude Oil Storage	Floating Roof	67.1	19.0	67,187.7	338,088.5	Flowing & Mucky to Dry Sludge	3,536.2	22,242.7	50
3	Tank T-1201-A	Bonny	Processing Tank	Fixed Roof	30.0	10.5	7,422.03	37,347.7	Flowing to Dry Sandy Sludge	706.9	4,446.4	20
4	Tank T-1201-B	Bonny	Processing Tank	Fixed Roof	30.0	10.5	7,422.03	37,347.7	Flowing to Dry Sandy Sludge	706.9	4,446.4	20
5	Tank 13	Bonny	Crude Oil Storage	Floating Roof	67.1	19.0	67,187.7	338,088.5	Flowing & Mucky to Dry Sludge	3,536.2	22,242.7	50
6	Tank 21	Bonny	Crude Oil Storage	Floating Roof	76.3	22.9	104,706.9	526,885.1	Flowing & Mucky to Dry Sludge	4,572.4	28,760.4	60
7	Tank 22	Bonny	Crude Oil Storage	Floating Roof	76.3	22.9	104,706.9	526,885.1	Flowing & Mucky to Dry Sludge	4,572.4	28,760.4	60
8	Tank T-1401-A	Bonny	Processing Tank	Fixed Roof	30.0	10.5	7,422.03	37,347.7	Flowing to Dry Sandy Sludge	706.9	4,446.4	20
9	Tank 206	Forcados Tank Farm & Depot 39 KMs West of Warri	Crude Oil Storage	Floating Roof	76.2	21.9	99,872.3	502,557.4	Flowing & Mucky to Dry Sludge	4,560.4	28,684.9	60
10	Tank 209	Forcados Tank Depot	Crude Oil Storage	Floating Roof	76.2	21.9	99,872.3	502,557.4	Flowing & Mucky to Dry Sludge	4,560.4	28,684.9	60
11	Tank 620	Forcados Tank Depot	Processing Tank	Fixed Roof	33.5	9.8	8,637.9	43,465.9	Flowing to Dry Sandy Sludge	881.4	5,544.0	20
12	Tank 901	Forcados Tank Depot	Processing Tank	Fixed Roof	15.0	6.0	1,060.3	5,335.4	Flowing to Dry Sandy Sludge	176.7	1,111.4	15
13	Tank 203	Forcados Tank Depot	Crude Oil Storage	Floating Roof	76.2	21.9	99,872.3	502,557.4	Flowing & Mucky to Dry Sludge	4,560.4	28,684.9	60
14	Tank 102	Forcados Tank Depot	Processing Tank	Floating Roof	48.0	17.0	30,762.5	154,796.9	Flowing to Dry Sandy Sludge	1,809.60	11,382.4	30
15	Tank 601	Forcados Tank Depot	Processing Tank	Fixed Roof	30.0	12.5	8,835.8	44,461.7	Flowing to Dry Sandy Sludge	706.9	4,446.4	20
16	Tank 610	Forcados Tank Depot	Processing Tank	Fixed Roof	33.5	9.8	8,637.9	43,465.9	Flowing to Dry Sandy Sludge	881.4	5,544.0	20
17	GCPF Tank	Gbaran-Ubie Central Field - Central Bayelsa (OML-28)	Processing Tank	Fixed Roof	39.0	13.0	15,529.7	78,145.5	Flowing to Dry Sandy Sludge	1,194.60	7,514.0	25
18	SGP Tank	Soku Gas Plant - 40 KMs West of PHC	Processing Tank	Fixed Roof	30.0	18.0	12,723.5	64,024.7	Flowing to Dry Sandy Sludge	706.9	4,446.4	20
TOT	18 TANKS		8 - Crude Oil Tanks 10 - Process Tanks	9 - Floating & 9 - Fixed Roof	TOTAL VOL. OF TANKS (M ³):		793,194.79 M ³	80% CAPACITY: 3,991,357 Bbls		40,247.0 M ³	253,153.5 Bbls	640 Days - or 1.83 YRS

Risk Assessment Method Analysis:

1. Select the most realistic consequence.
2. Select the likelihood of occurrence with the current controls in place.
3. Determine category from risk matrix.
4. Achieve a Category I or II before proceeding with task.
5. Do not proceed with task if risk Category is III or IV.

Category	Consequence Severity	Likelihood
5	Fatality, Public Hospitalization, or Severe Health Effects	Frequent
4	Permanent Disability, Multiple Hospitalizations, or Major Health Effects	Probable
3	One or More Lost Time Workday Cases or Significant Health Effects	Rare
2	Medical Treatment with Restricted Duty or Medium Health Effects	Remote
1	Medical Treatment, Minor Health Effects, First Aid Case, or Less	Improbable

CONSEQUENCE	5	II	II	III	IV	IV
	4	I	II	III	III	IV
	3	I	II	II	III	III
	2	I	I	II	II	II
	1	I	I	I	I	II
		1	2	3	4	5
	LIKELIHOOD					

Risk Categories		
IV 17-25	High	Mitigate with highest priority
III 12-16	Significant	Mitigate with Priority
II 5-10	Medium	Controls Verified - ALARP
I 1-4	Low	No Mitigation Required

ATTACHMENT 1

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
Chemicals - Maintenance Oils, Cleaning Chemicals	Injury to personnel working in the area	Hazardous Chemicals supplied in UN Approved Packaging. SDS Available Permit to Work Inductions.	3	2	II	Trained Personnel (Safe Pass, Hazardous Chemical Safety Awareness, manual handling). Chemicals on Spill Pallet Chemical Spill Kit Appropriate PPE (Gloves, overalls, Safety glasses) for routine work. Use Cartridge Filter Mask if pouring chemical from drum to tank.	3	1	I	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
Tank Cleaning Dilutent – Crude Oil/Gas Oil, Detergent	Injury including fatal to personnel. Damage to property and environment	SDS Available Bunded Site Permit to Work System	5	4	IV	Automatic Tank Cleaning Employed Tank under inert atmosphere (Nitrogen). ATEX Equipment utilised. Safe System of Work. Trained Personnel. Cordon off Works Area. Oil Spill Kit. All lines pressure tested prior to commencing works. O2 Monitoring – Automatic shutdown in Oxygen level rises above 8%. Use ATEX pump to transfer product from pontoon + bonded hosing.	5	2	II	
Hot Surfaces, Hot Water and Steam	Injury to personnel working in the area	Permit to Work System Flame Retardant Overalls. Gloves.	3	4	III	Trained Personnel (Safe Pass, manual handling), Wear heat resistant gloves when handling hot surfaces / equipment, Safety glasses or goggles. Cover hot pipes with protective covering where risk of contact. Works Cordon.	2	2	I	
Fire on Site	Injury including fatal to personnel. Damage to property and environment	Permit to work Fire extinguishers placed on site	3	4	III	PERMIT TO WORK Fire extinguishers placed on site.	3	2	I	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
H2S (Hydrogen Sulfide)	Asphyxiation – Death to Personnel	Fixed Place H ₂ S Monitors and Alarms Permit to Work System	4	3	III	All persons wear H ₂ S Monitors, H ₂ S Awareness Training, Safety Glasses, Gloves. Use of Breathing Apparatus. Leave area on activation of Renaissance carry out line breaking of their system. Work Permit JSA	3	3	II	
Live Services – Electricity, Steam, Nitrogen, Air	Injury including fatal to personnel. Damage to equipment and plant (explosion)	Permit to Work System Site Induction Site Supervision Hot Work Permit Pre checks for Gases HSIs	4	3	III	Review works area prior to mobilisation and plan setup. Separate live services from personnel/moving plant/equipment where possible. Safe system of work. LOTO. Line breaking procedure. Works Cordon. O ₂ Monitors. Tested Hoses, Cables, Equipment. Inspect prior to use. Maintenance. JSA Communication follow energy isolation.	3	2	II	
Electrical 220V, 400V 50Hz system	Injury including fatal to personnel. Electrocution. Damage to equipment and plant (explosion)	Permit to Work System Electrical Inspections Site Induction Site Supervision Hot Work Permit Pre checks for Gases HSIs	4	3	III	Minimal use of Cables. 220V and 400V Cables to ATEX Standard and Armoured or placed in cable trays. Cables inspected prior to use. Use bridges or barriers to where cables cross roadways/walkways. Electrical Breaker protection on system which will shut down system in event of cable failure / impact.	3	2	II	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
Confined Space Entry (entry to top of Roof space while nitrogen purging)	Injury including fatal to personnel. Asphyxiation	Stairwell & Ladder Access / Egress Open Roof – Well Ventilated CSE Permit to Work System CSE Attendant Induction (RENAISSANCE)	5	3	III	Entry only permitted during daylight hours. Out of Hours by exception under authorisation. Safe System of Work Rescue Plan Trained CSE Operatives SCBA, Escape Sets, 4 Gas Detectors. No Lone Working. RAEC to do initial gas test. Evacuate when Gas Detector Alarms or if CSE Attendant orders. 02 Remote Monitoring and Alarm System on Tank Cleaning Control Room. Signage (Nitrogen Hazard) to be erected when tank under Nitrogen. Inspect Equipment Prior to Use. Testing / Maintenance. No access under severe weather conditions. Monitor weather. No sources of ignition permitted. If roof drainage is blocked use diaphragm or Gorman pump.	5	2	II	
Charging Tank with Nitrogen	Injury including fatal to personnel. Asphyxiation	Permit to Work System Gas Detectors (O ₂)	5	3	III	Check couplings for damaged gaskets and use "whip lash" wires. Secure the hose at the wind girder so no blockage due to flattened hose is possible. Nitrogen flow is monitored at the	3	3	II	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
						Suction module and shown on the ATC computers. A 24 hrs. report is printed every morning 07:00 AM. The O₂ % is monitored via a Draeger meter. The value is shown at the ATC computers. An alarm will come up on the screen if the O₂ level is above the operational value (Normally 8%). There are min. 2 ea. O₂ hoses installed. The one not in use is blown with compressed air to remove any condensate before switching hoses on a regularly basis. STOP Nitrogen filling WHEN CREW REQUIRE ENTRY ONTO ROOF.				
Automatic Tank Cleaning Process – ATC NME	Injury including fatal to personnel. Damage to Equipment and Plant	Permit to Work System Gas Detectors (O ₂) Site Induction	5	3	III	Safe System of Work O₂ Monitoring on Plant and Tank. ATEX Equipment Automatic Shutdown if O₂ Levels increase above 8%. Tank purged with Nitrogen. Blockage on lines causes shutdown and alarm. Pressure Relief Valves (back to Receiving Tank). All equipment to be certified fit for purpose, ATEX-certified and inspected.	3	3	II	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
Heater Operation	Injury including fatal to personnel. Damage to Equipment and Plant	Permit to Work System Gas Detectors (O ₂) Site Induction	5	3	III	Heater is fitted with a "Automatic Back flush" system that reverses the flow through the heater if the pressure drop exceeds the pre-set value. Heater is fitted with a Safety Valve, lifts at 6.5 bars. Steam inlet valve is controlled by a fast-reacting valve using a temp. sensor located at the heater as reference. Alarm will be raised on the computers if temp. exceeds pre-set values and steam valve closes. If control air is lost, then the steam valve closes (by spring force) and air operated butterfly valves returns to their positions (NO or NC) thus bypassing the heater and ensuring free flow to the SNS. Steam lines in Module are covered for protection. STEAM HOSES & LINES OUTSIDE MODULE TO BE FENCED OFF.	3	3	II	
Distributors on Roof	Injury including fatal to personnel. Damage to Equipment and Plant. Spillage	Permit to Work System Gas Detectors (O ₂) Site Induction	5	3	III	Valves will stay in position (double acting actuators). SNS WILL STOP ROTATING.	3	3	II	
Booster Pumps	Injury including fatal to personnel. Damage to Equipment and Plant. Spillage	Permit to Work System Site Induction	5	3	III	Alarm will be raised on the computers. Pumps cannot exceed 14 bar. Pressure will increase thus raising an alarm. Flow meter in Module 3 will show no or low flow. Non-return valve is installed after pumps. Module bottom is a sump fitted with a drain valve. Electric motor will switch off, raising a "thermal" alarm.	3	3	II	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
						PUMP IS FITTED WITH A DOUBLE SEAL.				
Filter Cleaning	Injury including fatal to personnel. Damage to Equipment and Plant. Spillage	Permit to Work System Site Induction Fire Fighting System	5	3	III	PPE to be used appropriately. Use appropriate solids containers / drums Any kind of lifting of heavy objects has to be done by two persons or by machinery ANY FORMS OF IGNITION SOURCES ARE NOT ALLOWED TO BE CARRIED.	3	3	II	
Sampling at Sample Points	Injury including fatal to personnel. Damage to Equipment and Plant. Spillage	Permit to Work System Site Induction Fire Fighting System	5	3	III	PPE to be used appropriately. Use appropriate sampling containers Sampling points shall be kept clean and tidy (good housekeeping) ANY FORMS OF IGNITION SOURCES ARE NOT ALLOWED TO BE CARRIED.	3	3	II	
Removal of ATC Nozzles on Roof - to Facilitate dipping of tank whilst tank is under Nitrogen.	Injury including fatal to personnel. Damage to Equipment and Plant. Spillage	Permit to Work System (CSE) CSE Attendant Induction (Renaissance) Site Induction Fire Fighting System Stairwell & Ladder Access / Egress Open Roof – Well Ventilated	5	3	III	CSE Procedures to be followed. Full SCBA to be worn during this activity. Isolate BLABO System prior to commencing works. Ensure O ₂ level is <8% and then shutdown Nitrogen System. Close local manual valve on Nozzle prior to disassembling. Carry out dip on tank and then replace Nozzle securely using procedure. Proceed to next Nozzle.	3	3	II	
Laboratory Testing	Injury to Personnel, Burns, Inhalation of Haz Subs, Splash, Fire, Explosion	Permit to Work System Site Induction Fire Fighting System	5	3	III	PPE to be used appropriately. Use appropriate sampling equipment. Laboratory equipment and workplace shall be kept clean and tidy (good housekeeping). Any forms of ignition sources are not allowed to be carried.	3	3	II	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
Tri-Decanter Operations	Injury including fatal to personnel. Damage to Equipment and Plant. Spillage	Permit to Work System Site Induction Fire Fighting System	5	3	III	Flame Retardant Overalls. Hearing Protection. Keep door closed to Module 3. A vibration sensor will shut the decanter down. Auto torque function will increase conveyor speed to prevent blockage. If it occurs, then the motor will stop on Overload and raise an alarm. If the decanter stops, then 2 valves will switch in Module 3, directing the feed oil back to the tank (bypassing the decanter module). Alarm will be raised on computers. Solids will be wet and eventually oil will be transported via the conveyor to the solids container. Operator is present to monitor the operation and adjust the feed. Hydraulic oil tank level & temp. is monitored and will shut the decanter down.	3	3	II	
Recovered Oil Tank Ops	Spillage – Damage to Environment	Permit to Work System Site Induction Remote Bund Fire Fighting System	3	2	II	Level sensors controls the lobe pump, increasing or decreasing the pump speed to keep a constant level. If the level rises above the pre-set set point a alarm will be raised. Pump will slow down and stop at pre-set set point to avoid "Dry run".	2	2	I	
Replacing Solids Container	Injury to Personnel Spillage – Damage to Environment. Damage to Plant & Equipment	Permit to Work System Site Induction Remote Bund Fire Fighting System	4	2	II	Place IBC on Spill Pallet. Monitor filling of IBC and stop at circa 75% to avoid overfilling. Move filled IBC by Forklift. Ensure adequate supply of IBCs. Ensure IBCs are UN Approved.	2	2	I	
Forklift	Injury to Personnel Spillage – Damage to Environment. Damage to Plant & Equipment	Permit to Work System Site Induction Remote Bund Fire Fighting System	5	2	II	Certified Forklift Forklift Inspections Trained drivers only. No fork riding. Safe use of forklifts.	2	2	I	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
						Flashing Beacons. Ensure load secure and safe.				
Refueling of Plant & Equipment – Diesel.	Injury to Personnel Spillage – Damage to Environment. Damage to Plant & Equipment	Permit to Work System Site Induction Remote Bund Fire Fighting System	5	2	II	Designated PPE to be used appropriately. Conduct a toolbox talk prior to start. Contact supervisor and confirm what equipment is to be filled. Ensure correct fuel filling point on tank is identified. Place Spill Tray locally to collect any drips. Ensure Spill Kit is at hand at the point of filling. Place cordon across any hose run where trip hazard or vehicular impact is possible. Check condition of hosing and all equipment prior to filling. Monitor filling at all times. All vehicles to observe speed limits, site rules and follow designated routes within the site.	3	2	II	
Working at Heights	Injury including fatal to personnel.	Walkways, Platforms & Safety Gates Scaffold Requirements Identified at Planning. Induction Permit to Work	5	2	II	Safe System of Work. Cordon of Works Area during Lifting Ops. Tool Tethers. Scaffold erected with toe-boards. Load Inspected Prior to lifting. Slingers, Banksman.	3	2	II	
Moving Plant & Equipment	Injury including fatal to personnel.	Site Roads Signage Speed Limits (25KM general) and 5km in process area. Drivers with Licenses only. Vehicle Passes Approved Vehicles Contractors Carpark Visitors Carpark	5	2	II	Segregation of People / Vehicles where possible. Banksman for all moving equipment / plant. Reverse In / Drive Out Policy. Reverse Parking & Dedicated Car Parking Areas.	3	2	II	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
						All plant to have flashing beacons and reversing bleeper.				
Access to Tank Roof	Injury including fatal to personnel. Falling from Height	Roof Access Ladder	3	2	II	Classified as Confined Space when filling with Nitrogen. Confined Space Attendant Required. Follow CSE Procedures. Access to Tank under normal conditions is via Escape Set and 4 Gas Detection. When accessing for activity requiring SCBA, the entry team will don SCBA when on tank roof before activity commences. When accessing tank roof under abnormal conditions (rescue) access via crane and man basket.	3	2	II	
Asbestos – if suspected or found	Asbestosis Respiratory Disease	Asbestos Register Asbestos Management Plan Permit to Work System Asbestos HSI	3	3	II	Asbestos Refurbishment / Dem. Survey. Safe Removal Techniques (Shadow Vac, Wetting Agent), Training, PPE, RPE, Face Fit Testing. Asbestos Decon Unit, Enclosure. Client to provide for safe removal of asbestos gaskets unless put onto our Scope of Works. Notify Renaissance Safety Team immediately.	3	2	II	
Line Breaking - Opening Pipelines / Flanges – Crude, Gas Oil, Other Fluids, Gases	Injury to personnel. Damage to Equipment and Environment.	Permit to Work Site Induction Hot Work Permit Energy Isolation Gas Detection	3	4	III	Renaissance to carry out line breaks of their equipment. LOTO on equipment prior to line breaking. Drain lines. Ensure Pressure Gauge is at zero, Spill tray under break,	3	2	II	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
						PPE – Visor / Goggles. JSA, Work Permit. AR to assist in provision of ADR Combination Unit where required to provide drain-down of lines. Renaissance to bond hosing in such circumstances.				
Removal of Solids from Tank (via Tank Entry) – Post Water Wash	Injury including fatal to personnel. Damage to Plant and Equipment	Permit to Work System Site Induction CSE Attendant Training Renaissance LOTO Remote Bund Fire Fighting System	5	3	III	Vent Tank Prior to Entry. CSE Permit. Confined Space Attendant on tank watch at all times during entry. Follow CSE HSI. Commence works when LEL is ~5% or less. Ensure LEL is less than 10% at all times. Suspend works and vent if higher than 10%. Follow CSE HSI. Water temp 60 deg C. Gas Detection, Escape Sets, Filter Masks / Alba / SCBA. Jetting Lance with auto shutoff. Emergency Shutoff Buttons. Use Mechanical methods of removal (jetting & suction). Rotate Entry Personnel to prevent exhaustion. Ensure all hosing / equipment is in good working order. Adequate Lighting. When personnel changeover occurs, shut down jetting machine before. Make sure new operators makes visual contact with jetting operator before approaching.	5	2	II	
Transfer of Waste from ADR Combination Unit to IBCs / Drums	Injury including fatal to personnel. Asphyxiation, Spillage.	Permit to Work System Site Induction Renaissance Earthing Remote Bund	5	3	III	ADR Vehicles. Safe System of Work. Gas Detectors. Trained Operatives.	5	2	II	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
		Fire Fighting System				Ensure IBC is empty and valve is securely closed and capped prior to filling. Carry out transfer in bunded area. No Lone Working. Renaissance to do earthing. Use remote techniques for removing solids. Rotate roles to avoid exhaustion. Inspect Equipment Prior to Use. Testing / Maintenance. Monitor transfer at all times. No sources of ignition permitted.				
De-Mobilisation of Automatic Tank Cleaning Equipment – Dismantling Pipes, Hoses & Cables	Injury including fatal to personnel. Damage to Plant and Equipment	Permit to Work System Site Induction Renaissance LOTO Remote Bund Fire Fighting System	5	3	III	Flush pipes with hydrant water. Drain water-to-water treatment plant using a membrane pump. Use spill trays when opening joints. During manual handling of equipment: Assess the lift, use proper lifting techniques. Any kind of lifting of heavy pipes or cables has to be done by at least two persons. Electrical connections to Customer's power source will be disconnected by Customers' electrician (if not otherwise agreed).	3	3	II	
Emptying Skimming Tank and Decanter Tanks	Injury including fatal to personnel. Damage to Plant and Equipment	Permit to Work System Site Induction Renaissance LOTO Remote Bund Fire Fighting System	5	3	III	Flush tanks with hydrant water. Drain water-to-water treatment plant using a membrane pump. Use spill trays when opening joints.	3	3	II	
Removal of Riser Pipe	Injury including fatal to personnel. Damage to Plant and Equipment	Permit to Work System Site Induction Renaissance LOTO Remote Bund Renaissance Crane & Banksman	5	3	III	Watchman w/radio contact to Control Room at wind girder when personnel enter the roof. Access ways and work area shall be kept clean and tidy (good housekeeping). All equipment to be hoisted to work area (in secured bags and	3	3	II	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
		Fire Fighting System				cases) before personnel access the work area. Use a harness when working at the wind girder if the hand railing condition is not adequate (subject to site risk assessment). Do not access tank roof under severe weather conditions (electrical- and/or rainstorms). Evaluate weather conditions prior to job. Authorize person in charge to stop work if weather conditions change to unacceptable level. Secure inner & outer riser pipe to prevent movement. Renaissance to supply certified Crane and Banksman. Monitor Weather – Suspend works if deemed unsafe.				
Lifting of Equipment from Roof	Injury including fatal to personnel. Damage to Plant and Equipment	Permit to Work System Site Induction Renaissance LOTO Remote Bund Renaissance Crane & Banksman. Fire Fighting System.	5	3	III	Watchman w/radio contact to Control Room at wind girder when personnel enter the roof Confined Space Attendant to be in place for CSE Work. Access ways and work area shall be kept clean and tidy (good housekeeping) Use a harness when working at the wind girder if the hand railing condition is not adequate (subject to site risk assessment) Do not access tank roof under severe weather conditions (electrical- and/or rainstorms). Evaluate weather conditions prior to job. Authorize person in charge to stop work if weather conditions change to unacceptable level. Renaissance to supply certified Crane and Banksman. Monitor Weather – Suspend works if deemed unsafe.	3	3	II	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
						Cordon off Works.				
Packing Pipe Racks & Containers	Injury including fatal to personnel. Damage to Plant and Equipment	Permit to Work System Site Induction Renaissance LOTO Remote Bund Renaissance Crane & banksman Fire Fighting System	5	3	III	Safe System of Work. Cordon off Works. Renaissance to supply certified Crane and Banksman. Monitor Weather – Suspend works if deemed unsafe.	3	3	II	
Scaffold Access	Injury including fatal to personnel. Damage to Equipment.	Permit to Work System Certified Work at Height Equipment Training. Approved Scaffolders. Inspections	4	3	III	Renaissance to provide certified scaffold for our use including carrying out weekly inspections. All modification required to be carried out by Renaissance Scaffolders. Do not interfere with scaffold. Check Scaff-tag prior to use. Do not use scaffold if out of test. Exercise care and attention when using scaffold. Check load bearing of scaffold prior to placing any load on same. Report any defects.	3	2	II	
Loading of Containers and Equipment onto Transport Units.	Injury including fatal to personnel. Damage to Plant and Equipment	Permit to Work System Site Induction Renaissance LOTO Remote Bund, Renaissance Crane & Banksman Fire Fighting System	5	3	III	Work only with a valid working / entry permit. Designated PPE to be used appropriately. Conduct a toolbox talk prior to start. This includes also the crane driver and truck drivers. Instruct all personnel of proper behaviour when working inside zone 1 and with heavy lifting. Check condition of bund & road. Crane operator & truck drivers advice must be taken into consideration to avoid potential dangers. Client to carry out CBR Testing on ground to ensure it is suitable for crange operations and	3	3	II	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
						equipment laydown. Banksman required for all maneuvering of vehicles. All vehicles to observe speed limits, site rules and follow designated routes within the site. Insure that the crane fulfills refinery requirements, and that permit or entry can be obtained. Lifting plan and risk assessment to be provided by approved lifting contractor. Only skilled crane operator and crew allowed operating crane, attaching and detaching equipment etc.				
						Appoint responsible person for monitoring around moving parts. Instruct personnel of dangers, and request vigilance behaviour. Make sure that all personnel are familiar with hand signs. Keep visual / radio contact between crane driver and Banksman at all times. Containers are loaded according to the lifting plan. Clear the lifting area. Only allowing competent and essential persons in area. Instruct all non-essential personnel to keep distance. Insure proper securing of equipment. Setup ladders securely, use safety harness when working in heights. Check and verify condition of lifting equipment prior to start of operation. Use tag lines to prevent swinging objects. Suspend operation immediately				

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
						if crane or other equipment shows indications of abnormal function. Assess the weather prior to commencing the work.				
Slips, Trips and Falls	Injury to personnel	Permit to Work Site Induction Pedestrian Walkways	3	1	I	Trained Personnel (Safe Pass, manual handling). Keep work area tidy at all times (clean as you go).	3	1	I	
Working and Interacting with Machinery.	Injury to personnel Entangled, trapped and run over resulting in serious injury that could be fatal.	Permit to Work System Pedestrian Walkways Licensed Drivers only permitted. CSCS Only competent staff are allowed to operate and maintain it. Maintenance records will be kept.	4	3	III	LOTO. Cordon off Works Area. Complete JSA. All machinery used will be properly maintained and guarded.	4	1	I	
Other Persons and Public	Injury to persons Other personnel not involved in the operation. (Staff or other contractors). Could be injured by our activities resulting in serious injuries.	Permit to Work Site Induction Site Notices Walkways Speed Limits	3	1	I	Segregate the working area from all other operational activities by physical barriers and thereby eliminating other persons entering this area. Adequate warning signs will be posted. Permit to Work. Cordon off Works Area. Complete JSA. Communication. Client to establish Pedestrian Crossing on roadway.	3	1	I	
Noise	Possible noise induced hearing loss from the noise level created by the	Permit to Work Site Induction Site notices As part of the mandatory	4	1	I	All persons exposed to noise levels over 80-dB will be required to wear hearing protection.	2	1	I	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
	various operation – boiler, generator etc.	Personal protective equipment requirement, Hearing protection must be worn when noise level is over 80dB.				Permit to Work. Cordon off Works Area. Complete JSA.				
Poor Weather and Light Conditions	Slips, trips and falls leading to injuries. Lightening	Permit to Work Daily Weather Reports Wind Speed Gauge on Cranes and MEWPs. Wind Restrictions on Work. Fire-fighting facilities Existing Plant Lighting	3	4	III	Works to be carried out during daylight hours. Continue to assess weather conditions. Suspend work if risk determines site is unsafe. Suspend works for short duration wet weather if possible. In rainy conditions safety glasses must only be worn when it is safe to do so. Where high winds are present, check with supervisor if risk of wind blown debris. All works suspended during storms. Lighting on site. JSA. Communication. PPE.	1	3	I	
Interaction with On-Site Operations	Injury to Personnel	Work Permit Project Coordination	3	4	III	JSA. Communication. Prior to any operation a work permit will be completed and this will involve an assessment of any particular operations in the area. Where any activity is identified as hazardous staff will be instructed in the controls required and the activity will be either	1	4	I	

HAZARD	RISK / EFFECT	EXISTING CONTROLS	Assessment			RISK MITIGATION	Residual Assessment			COMMENT
			C	L	RR		C	L	RR	
						segregated by physical barriers or shut down for the duration of the works.				
Manual Handling	Injury to Personnel	Permit to Work System Site Induction Crane & Banksman	2	4	II	Forklift on Site. Manual Handling Training. Assess Loads prior to lifting. Use Mechanical Aids where necessary or available. Do not lift an item which is not safe to do so. JSA.	1	4	I	
Waste Management	Spillages, Environmental Damage, Prosecution.	Permit to Work IPPC - IED License	3	3	II	Waste Management Plant. Classification of Waste. Analysis. Multi Region Waste Collection Permit. Licensed Transfer Station, Licensed Disposal Facilities. WTF used for Irish Transports. TFS for Exports. DGSA.	1	1	II	
Environmental Contamination	Oil Leak, Chemical Leak leading to damage to environment and exposure to personnel and others.	Permit to Work System SDS Suitable Disposal Receptacles	2	4	II	Plant & Equipment to be maintained regularly. Spill Kits On-Site Spill Training JSA Permit Care & Attention PPE	1	4	I	
Night Shift Work	Increased risk of injury due to poor lighting and fatigue.	Permit to Work	4	2	II	No lone work allowed. 2 operators will always be present. Lighting to in installed in the work area. Area to be kept clear of obstructions, good housekeeping at all times.	4	1	I	

ATTACHMENT 2 – SAFE & UNSAFE GAS LEVELS

Safe Gas Levels:

Gas Type	Upper Limit	Lower Limit
Oxygen	21.5	19.8
Flammable	5%	0%
H ₂ S	5ppm	0ppm
Other-		

Nitrogen can replace Oxygen, and so an enriched Nitrogen environment will have Oxygen deficiency effects on personnel.

Health Effects from Lack of Oxygen:

O ₂	Level Effects
23 %	Oxygen enriched atmosphere.
20.8%	Normal level – Safe for Entry (± 0.2%).
15-19.8%	Oxygen deficient atmosphere – First Sign of Hypoxia, decreased ability to work strenuously. May induce early symptoms of coronary, pulmonary symptoms.
12-14%	Impaired judgement and breathing. Impaired muscle coordination.
10-12%	Rapid fatigue and faulty judgement & manifestation of Blue Lips.
8-10%	Mental Failure, fainting, unconsciousness, ashen face, blue lips & nausea.
6-8%	6 Minutes = 50% probability of Death & 8 minutes = 100% probability of Death.
4-6%	Coma in 40 seconds, convulsions, respiration ceases & Death.

Lack of Oxygen leads very quickly to Unconsciousness and Death.

Health Effects from Concentrations of Carbon Dioxide:

CO ₂	Level Effects
0.3%	Normal Level – Safe for Entry (± 0.2%).
1-1.5%	Slight effect on chemical metabolism after exposures of several hours.
3%	Gas is weakly narcotic, giving rise to deeper breathing, reduced hearing ability, headache, increase in blood pressure and pulse rate.
4-5%	Stimulation of the respiratory centre occurs resulting in deeper and more rapid breathing. Signs of intoxication will become more evident after 30 minutes exposure.
5-10%	Breathing becomes more laborious with headache and loss of judgement.
10-100%	Unconsciousness will occur in under one minute, and unless prompt action is taken, further exposure to these high levels will eventually result in Death.

High levels of Carbon Dioxide leads very quickly to Unconsciousness & Death.