RFQ Number	**RFQ-Frans-001**
Request for Quotation Date	**2024/05/24**
RFQ Closing Date	**2024/06/14**
RFQ Closing Time	**10:00am**
Compulsory Site Briefing	**None**
Contact Person	**Catherine.Matima@necsa.co.za**
Quotation Validity	**30 Days from the closing date**
Submission Details	**RFQ Response must be sent to: CATHERINE.Matima@necsa.co.za**
RFQ Description	**D&D Process Engineering – CWOPG Basic Design**

Dear Service Provider

Kindly provide a quotation for goods and or services as outlined in section 2 of this document.

1. Introduction

The South African Nuclear Energy Corporation Limited (Necsa) is a state-owned public company (SOC), registered in terms of the Companies Act, (Act No. 61 of 1973), registration number 2000/003735/06.

The Necsa Group engages in commercial business mainly through its wholly-owned commercial subsidiaries: NTP Radioisotopes SOC Ltd (NTP), which is responsible for a range of radiation-based products and services for healthcare, life sciences and industry, and Pelchem SOC Ltd (Pelchem), which supplies fluorine and fluorine-based products. Both subsidiaries, together with their subsidiaries, supply local and global markets, earning valuable foreign exchange for South Africa and are among the best in their field in their respective world markets.

Necsa's safety, health, environment and quality policies provides for top management commitment to compliance with regulatory requirements of ISO 14001, OHSAS 18001 and RD 0034 (Quality and Safety Management Requirements for Nuclear Installations), ISO 9001 and ISO 17025.

Necsa promotes the science, technology and engineering expertise of South Africa and improves the public understanding of these through regular communications at various forums and outreach programmes to the community. We are a proudly South African company continuously striving, and succeeding in many respects, to be at the edge of science, technology and engineering related to the safe use of nuclear knowledge to improve our world.

For more information on Necsa, please visit: **www.necsa.co.za**

2. Scope of Work

Item Description	Quantity
Professional Engineering Services from an Engineering Consultant to perform specific process engineering activities in support of the Basic Design of the Contaminated Waste Oil Plasma Gasification Project. These activities are limited to the Mass and Energy Balances calculations for the Basic Design of the Contaminated Waste Oil Plasma Gasification (CWOPG) demonstration facility at Necsa as defined in the Statement of Work (SOW), ENS-OWPVR-24002 Rev.1.0. The work shall be based on the Process Flow Diagrams (PFDs) and PROCESS Description of the facility, together with the analysed waste oil composition. See also attached ENS-OWPVR-24002 Rev.1.0.	1

3. Pricing

- All price quoted to include all applicable taxes.
- Price must be fixed and firm
- Price should include additional cost elements such as freight, insurance until acceptance, duty where applicable, disbursements etc.
- Quotation must be completed in full, incomplete quote could result in a quote being disqualified.
- Payment will be according to Necsa's General Conditions of Purchase.

4. Evaluation

4.1. Phase 1- Functionality Evaluation / Technical Evaluation

Where functional or technical evaluation criterion is applicable, assessment will be performed in terms of the criterion listed below and the criterion may include Technical, Performance, Quality and Risk.
If the Bidder's response to the Technical templates does not indicate that the Bidder can support an acceptable technical solution, the Bidder's response will be rejected and not evaluated further.

Together the Technical, Performance & Quality and Risk criteria make up the functionality criterion and a Bidder's Proposal will be evaluated for functionality out of a possible 100 points.

Only RFQ responses achieving an evaluation score of greater than the set threshold points out of the possible 100 points and which score a number of points for functionality that is greater than or equal to the set threshold points of the number of points achieved by the highest scoring Bid for functionality will be selected to progress to the second stage.

Technical, Performance & Quality and Risk Criteria

Item	Requirement	Weight	Points	Criteria
1	Evidence of experience in the performance and review of Mass, energy and pressure balances of plasma chemical process facilities 9i.e. individual resources).	40	40	Performed similar reviews ≥ 5 times
			20	Performed similar reviews > 2 times
			10	Performed similar reviews > 1 time
2	Experience of personnel reflected in CVs	20	20	ECSA registration (Pr Eng) and > 8 years' experience as a Chemical/Process Engineer.
			10	ECSA registration (Pr Eng) and > 5 years' experience as a Chemical/Process Engineer.
			5	ECSA registration (Pr Eng) and > 3 years' experience as a Chemical/Process Engineer.
3	Delivery time	40	40	< 15 working days after receipt of order
			20	< 20 working days after receipt of order
Total			100	

4.2. **Phase 2 - Evaluation In Terms Of Preferential Procurement Policy Framework Act, 2022**

This bid will be evaluated and adjudicated according to the 80/20 point system, in terms of which a maximum of 80 points will be awarded for price and 20 points will be allocated based on the specific goals (B-BBE status level).

	POINTS

PRICE	**80**
SPECIFIC GOALS (B-BBEE status level)	**20**
Total points for Price and SPECIFIC GOALS	**100**

Preference goal
B-BBEE status level contributor

B-BBEE Status Level of Contributor	Number of points (80/20 system)
1	20
2	18
3	14
4	12
5	8
6	6
7	4
8	2
Non-compliant contributor	0

5. Required Documentation
   - Tax Clearance Certificate (Tax pin issued by SARS)
   - Declaration of interest (SBD 4)
   - BEE Certificate / Applicable Affidavit if classified as EME
   - Letter of Good Standing (COID) only if Applicable due to the nature of work required
   - Any other document or certification that might have been requested on this RFQ

6. Important

6.1. Quotation must be submitted on or before the RFQ closing date and time stated above.
6.2. Orders above R 30 000 will be evaluated according to the PPPFA 80/20-point system and a functionality scorecard where applicable and the ones above R 1 Million will be subjected to the tender process.

6.3. This RFQ is subjected to the Necsa's General Conditions of Purchase, Preferential Procurement Policy Framework Act 2000 and the Preferential Procurement Regulations, 2022, the General Conditions of Contract (GCC) and, if applicable, any other legislation or special conditions of contract

6.4. Failure on the part of a bidder to submit proof of B-BBEE Status level of contributor together with the bid, will be interpreted to mean that preference points for specific goals are not claimed.

6.5. The purchaser reserves the right to require of a bidder, either before a bid is adjudicated or at any time subsequently, to substantiate any claim in regard to specific goals, in any manner required by the purchaser.

6.6. For a Bidder to obtain clarity on any matter arising from or referred to in this document, please refer queries, in writing, to the contact details provided above. Under no circumstances may any other employee within Necsa be approached for any information. Any such action might result in a disqualification of a response submitted in competition to this RFQ.

6.7. No goods and/or services should be delivered to Necsa without an official Necsa Purchase order.

6.8. Necsa reserves the right to; cancel or reject any quote and not to award the RFQ to the lowest Bidder or award parts of the RFQ to different Bidders, or not to award the RFQ at all.

6.9. The supplier shall under no circumstances offer, promise or make any gift, payment, loan, reward, inducement, benefit or other advantage, which may be construed as being made to solicit any favour, to any Necsa employee or its representatives. Such an act shall constitute a material breach of the Agreement and the Necsa shall be entitled to terminate the Agreement forthwith, without prejudice to any of its rights

6.10. By responding to this request, it shall be construed that: the bidder, hereby acknowledge to be fully conversant with the details and conditions set out in the Necsa's General Conditions of Purchase, Preferential Procurement Policy Framework Act 2000 and the Preferential Procurement Regulations, 2022, the General Conditions of Contract (GCC), Technical Information and Specifications attached, and hereby agree to supply, render services or perform works in accordance therewith

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South African Nuclear Energy Corporation SOC Limited

Title	**Scope of Work - Mass & Energy Balances for the Contaminated Waste Oil Plasma Gasification Project**
Doc. No.	**ENS-OWPVR-SOW-24002**
Revision	**1.0**

APPROVAL & DISTRIBUTION

	NAME	SIGNATURE & DATE
Prepared	Dr K Moodley Chief Process Engineer	21/05/2024 09:14:07(UTC+02:00) Signed by Kasuren Moodley, kasuren.moodley@necsa.co.za SIGNIFLOW.COM
Checked	Mr F Erasmus Systems Engineer	21/05/2024 17:01:06(UTC+02:00) Signed by Frans Erasmus, frans.erasmus@necsa.co.za SIGNIFLOW.COM
Accepted	Mr T Modise Project Manager	22/05/2024 08:30:48(UTC+02:00) Signed by Tankiso Modise, Tankiso.Modise@necsa.co.za SIGNIFLOW.COM
Approved	Mr SM Mosinki General Manager: Engineering Services	22/05/2024 10:30:18(UTC+02:00) Signed by Stephen Mosinki, stephen.mosinki@necsa.co.za SIGNIFLOW.COM
Distribution (Electronic only)	ES Records Mr F Erasmus Mr T Modise	Docman Mr L Mogotlhong Dr K Moodley Mr M Ramatlou

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1 PURPOSE AND SCOPE

1.1 Purpose

The purpose of this document is to give a high level Scope of Work (SOW) for the sourcing of Professional Engineering Services from an Engineering Consultant to perform specific design calculations for the South African Nuclear Energy Corporation SOC Ltd (Necsa). These design activities are constrained to the Basic Engineering Design of a Contaminated Waste Oil Plasma Gasification (CWOPG) demonstration facility at Necsa. This project constitutes part of Necsa's Decommissioning and Decontamination (D&D) programme to manage its nuclear liabilities arising from past strategic nuclear facilities.

1.2 Scope

The SOW is limited to the Mass & Energy Balance calculations for the Basic Design of the CWOPG facility. All of this work shall be based on the Process Flow Diagrams (PFDs) and Process Description for the facility, together with the analysed waste oil composition.

Process design changes are not permitted unless endorsed and authorized by Necsa.

Engineering design activities not directly related to the above deliverables are currently excluded from this SOW.

2 REFERENCES, ABBREVIATIONS AND DEFINITIONS

2.1 References

The list of references given below is divided into two sections, viz. Engineering Design Pack (Section 2.1.1) and Supporting Information (Section 2.1.2). The former constitutes the engineering documents to be provided by Necsa as the main input to the SOW defined here. The latter comprises all other documents, which are referenced in this SOW, but do not form part of the Engineering Design Pack.

Unless otherwise indicated, parties using this document shall apply the most recent edition of the documents listed in Sections 2.1.1 and 2.1.2.

All documents shall be made available to the Engineering Consultant assigned to the CWOPG project following appointment.

2.1.1 Engineering Design Pack

This SOW makes reference to the following design documents:	
[1]	ENS-OWPVR-CLC-23001 Rev. 1, Finalization of Waste Oil Composition for the Uranium Contaminated Waste Oil Plasma Gasification Project
[2]	ENS-OWPVR-DGM-23001 Rev. 1, Uranium Contaminated Waste Oil Plasma Gasification – Basic Engineering Design: BFD (B4)
[3]	ENS-OWPVR-FDM-23001 Rev. 1, Process Flow Diagram (PFD) for the Waste Oil System of the WOPG Demonstration Facility
[4]	ENS-OWPVR-FDM-24001 Rev. 1, Process Flow Diagram (PFD) for the Gas Supply System for the WOPG Demonstration Facility
[5]	ENS-OWPVR-FDM-24002 Rev. 1, Process Flow Diagram (PFD) for the Plasma Gasification System of the WOPG Demonstration Facility

[6]	ENS-OWPVR-FDM-24003 Rev. 1, Process Flow Diagram (PFD) for the Primary Solids Capturing System of the WOPG Demonstration Facility
[7]	ENS-OWPVR-FDM-24004 Rev. 1, Process Flow Diagram (PFD) for the Off-gas Handling System of the WOPG Demonstration Facility
[8]	ENS-OWPVR-FDM-24005 Rev. 1, Process Flow Diagram (PFD) for the Cooling Water Supply System of the WOPG Demonstration Facility
[9]	ENS-OWPVR-FDM-24006 Rev. 1, Process Flow Diagram (PFD) for the Effluent, Waste and Emission Handling System of the WOPG Demonstration Facility
[10]	ENS-OWPVR-FDM-24007 Rev. 1, Process Flow Diagram (PFD) for the Utilities System of the WOPG Demonstration Facility
[11]	ENS-OWPVR-DES-24001 Rev. 1, Process Description for the Uranium Contaminated Waste Oil Plasma Gasification Plant

2.1.2 Supporting Information

This SOW makes reference to the following supporting documents:	
[12]	ISO/IEC 15288:2008, Systems and Software Engineering – System Life Cycle Processes
[13]	SHEQ-INS-0189, Overview of Necsa's Security Processes
[14]	SHEQ-INS-8920, Access Control to Necsa Sites and its Facilities
[15]	SHEQ-INS-8921, Necsa's Requirements for the Security Clearance of Items (Deliverables and Removals)
[16]	SHEQ-INS-8923, Requirements for the Searching of Persons, Vehicles and Items Accessing and Egressing Necsa's Sites
[17]	SHEQ-INS-0113, Overview of Necsa's Information Security Processes
[18]	SHEQ-INS-0310, Information Security: Acceptable Use Procedure
[19]	SHEQ-INS-0320, Information Security: Requirements for Third Party Access
[20]	SHEQ-INS-8930, Security Requirements for the Control of Classified Information
[21]	SHEQ-INS-0234, Necsa QMS Requirements for External Design Organisations

2.2 Abbreviations

Abbreviation	Description
BDOR	Basic Design and Operability Review
BFD	Block Flow Diagram
°C	Degrees Celsius
$C_{25}H_{52}$	n-Pentacosane
CO_2	Carbon Dioxide
CWOPG	Contaminated Waste Oil Plasma Gasification
D&D	Decommissioning and Decontamination
Doc.	Document

Abbreviation	Description
etc.	And So Forth
HAZOP	Hazard and Operability (Safety Study)
HCl	Hydrogen Chloride
HEPA	High Efficiency Particulate Air (Filter)
HF	Hydrogen Fluoride
IEC	International Electrotechnical Commission
ISO	Internal Organization for Standardization
KOH	Potassium Hydroxide
kW	Kilowatt
Necsa	South African Nuclear Energy Corporation SOC Ltd
NLM	Nuclear Liabilities Management
No.	Number
NQF	National Qualifications Framework (as defined by SAQA)
P&ID	Piping and Instrumentation Diagram
PAL	Pelindaba Analytical Laboratories
PFD	Process Flow Diagram
PlasGas	Plasma Gasification
Ref.	Reference
Rev.	Revision
SAQA	South African Qualifications Authority
SHEQ	Safety, Health, Environment and Quality
SOW	Scope of Work
SQEP	Suitably Qualified and Experienced Person

2.3 Definitions

Term	Meaning
Basic Design	All the design activities and documents necessary to confirm that the system (product or facility) specification (including SHEQ criteria/objectives) can be met. It typically includes the BDOR, Control Review and HAZOP 3 safety study, together with updating of the design based on recommendations and findings emanating from these exercises.
Chemical Engineer	A competent individual holding a degree in chemical engineering (*B Eng* or *BSc Eng*) from an accredited university, equivalent to NQF Level 8. It shall be noted that technologists and technicians are excluded here.

Term	Meaning
Concept Design	Constitutes the first iteration of translating functional user requirements into an architectural representation of the intended system. This system perspective consists of subsystems, system elements, as represented by hardware, software, and human elements. The Concept Design is typically reflected by a system breakdown structure and functional flow diagrams that describe the relationship between system elements and the sequencing of process flows.
Consultant	An organization or entity specializing in process engineering design and providing a technical solution to developing the Basic Design of the CWOPG demonstration facility.
CWOPG Demonstration Facility	A new pilot-scale facility which Necsa plans to establish in a laboratory on-site to investigate the destruction of radiologically contaminated waste oil via a plasma gasification process.
Detail Design	The translation of the output from the Basic Design, e.g., general assembly layouts, P&IDs, design datasheets, control philosophies, etc. into executable manufacturing/procurement and construction specifications/requirements.
Engineering Consultant	See definition of *Consultant*.
Plasma Gasification	An extreme thermal process using plasma which converts organic matter into a syngas which is primarily made up of hydrogen and carbon monoxide. A plasma torch powered by an electric arc is used to ionize gas and catalyse organic matter into syngas, with slag, inclusive of the uranium residue, remaining as a by-product.
Professional Engineering Services	A service that requires or is based on the application of process engineering principles and data to a design relating to engineering.
Professionally Registered Engineer	A chemical engineer who is registered as a Professional Engineer (*Pr Eng*) with the Engineering Council of South Africa (ECSA).
Report	A document which summarizes the objectives, findings, conclusions and recommendations made regarding a specific investigation.

3 BACKGROUND

Necsa is tasked with managing the nuclear liabilities from the South African Nuclear Programme, in accordance with the provisions of international treaties to which South Africa is a signatory. The waste generated by the South African Enrichment Programme is of particular concern as this waste is contaminated with various amounts of uranium. The waste falls into different categories, depending on the level of enrichment of the uranium and the associated radioactivity.

The oil used for lubrication of the compressors constitutes one such consignment of radioactive waste. This oil was not in direct contact with the uranium hexafluoride stream, but was indirectly contaminated and may contain uranium in the form of natural uranium, depleted uranium, or uranium enriched to various degrees. The uranium is dissolved in the oil as various species, particularly as uranium fluorides, but the exact identity of the uranium compounds is not known.

Waste oils of this nature are typically disposed of by entombment. This method simply requires the safe storage of radioactive waste in such a manner that it cannot leak into the environment and is stored until the radioactivity of the waste has decreased to the point that the waste may be disposed of in a conventional manner or until novel waste disposal techniques are developed. The entombment technique, though, is not ecologically favourable as vast quantities of radioactive waste are stored for extensive time periods and may be subject to accidental or deliberate release into the environment over the storage period.

Approximately 200 m^3 of the radioactive waste oil is currently in storage at the Necsa Pelindaba site. This oil is currently stored in steel drums. The steel storage drums have started to degrade and Necsa has considered that a permanent solution for the waste oil is required. As the repackaging and entombment of the waste oil will simply result in an even larger quantity of radioactive waste that must be stored, a volume reductive waste disposal technique is desirable.

Necsa has thus considered a plasma gasification (PlasGas) process, whereby the uranium contaminated waste oil is combusted in the presence of oxygen in an ecologically and socially responsible manner, for disposal of the oil. This method results in the recovery of the various uranium contaminants as metal oxides that can be captured and reprocessed. At the same time, it reduces the total quantity of uranium-contaminated waste and permits the elimination of any radionuclides by recycling through uranium reprocessing.

To date, the process has only been tested in a laboratory scale developmental system. It is now intended to use a demonstration facility (pilot plant), referred to as the CWOPG facility in this SOW, to fix the process parameters that could not be fully determined in the laboratory system and to further optimise the process in general. The demonstration facility will be established in H-Building on Necsa's Pelindaba-East site and will be designed to the scale equivalent to the future operational plant in order to ensure that it is capable of providing meaningful process data.

It is estimated that five drums of uranium contaminated waste oil (total volume of 1 m^3), at most, will be destroyed within the demonstration plant. In addition, only drums that contain natural uranium or depleted uranium will be selected. No oil contaminated with enriched uranium will be destroyed in the facility.

4 PROCESS OVERVIEW

The waste oil destruction process involves the high temperature oxidation (combustion) of the uranium contaminated oil using a 30 kW nitrogen-based plasma torch reactor. The plasma process is selected as the high energy density of a plasma flame ensures total combustion of the hydrocarbon content and total oxidation of the metal. The process is summarised by the Block Flow Diagram (BFD) presented in Figure 1. This BFD shows the boundary limits for the process to be considered in this SOW.

The uranium contaminated waste oil will be transferred from the oil drums at the Nuclear Liabilities Management (NLM) storage site at Necsa into a transport vessel and the oil will be moved to the CWOPG facility in H-Building. The uranium is dissolved in the oil, but particulate contamination of various other materials such as dust and rust may also be present. It shall be ensured that the uranium contaminated waste oil supplied is substantially free from entrained solids.

At the CWOPG facility, the oil will be transferred from the transport vehicle into the waste oil feed tank. The oil will be pumped through an inline filter system into the plasma reactor via high-pressure spray nozzles, where the oil will be volatilised and combusted with pure oxygen at temperatures in excess of 1000 °C pressure to form CO_2, water, and metal oxides (uranium or otherwise).

The process gas exiting the reactor will be passed through an annular plasma quench and the metal oxides will be captured from the plasma reactor exhaust stream by cyclone. The off-gas will then be treated using a KOH scrubber to remove any HF and HCl present in the gas stream. The particulate material carried over in the gas stream will be captured by the scrubber and entrained in the scrubber liquor. The particulate matter will be removed from the scrubber liquor in situ by passing the scrubber liquor through fine particle filters installed in the scrubber liquor spray line.

After scrubbing, the off-gas will be discharged to atmosphere via the process ventilation system and building stack. To ensure no potentially radioactive particulate material is emitted, the off-gas from the scrubber will be passed through a system of HEPA filters before being released.

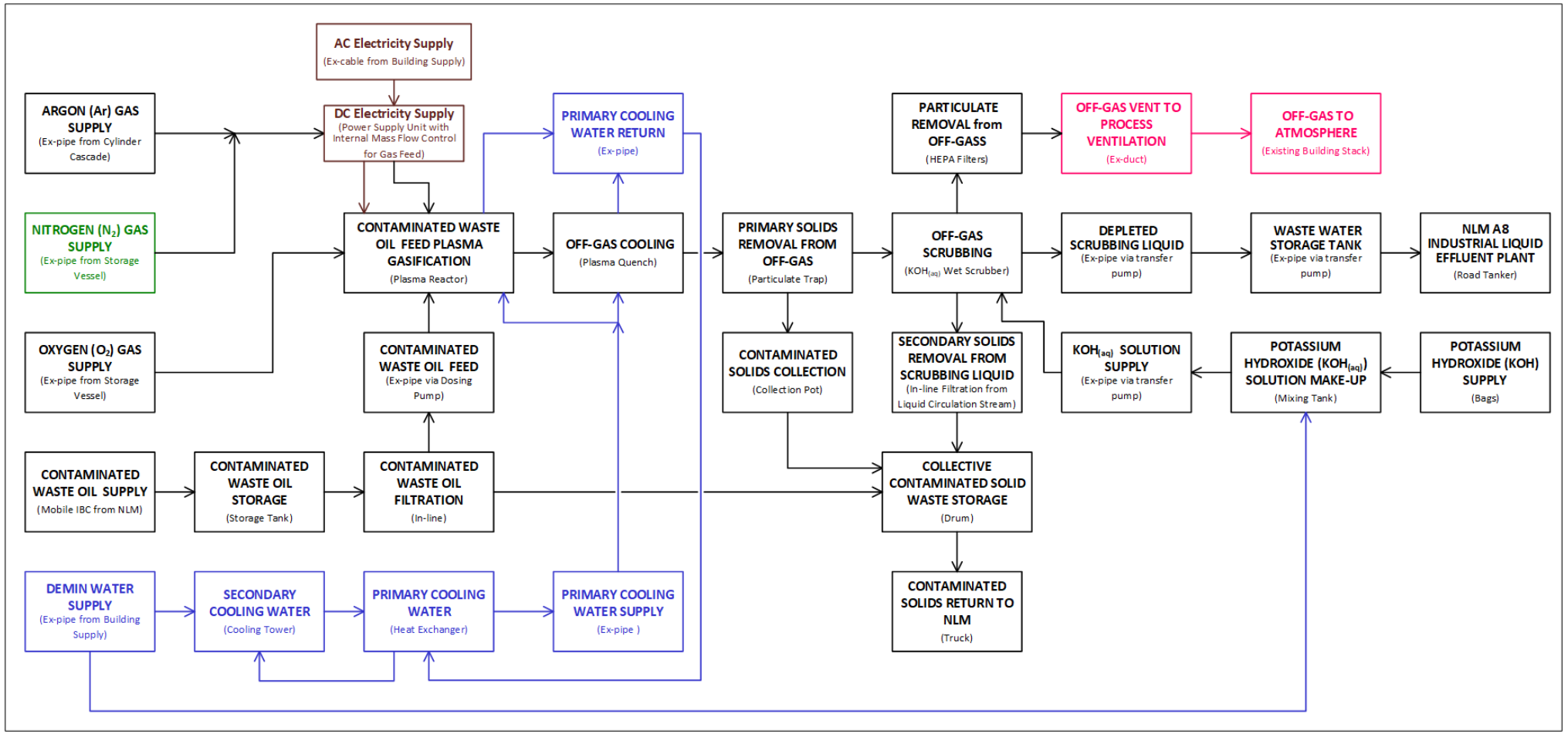

Figure 1: CWOPG Demonstration Facility Block Flow Diagram [2].

5 PROJECT STATUS

The engineering design of the CWOPG was initiated by Necsa. To date, all process engineering work for the Concept Design of the CWOPG facility has been completed. That being said, various design parameters were not available at the early stage of Concept Design. A key parameter was the waste oil composition. The Concept Design was thus based on a recommended waste oil composition. Even though the uranium dissolved in the oil was thought to be present as various fluorides and oxyfluorides, the uranium was simply assumed to be elemental uranium in the design. Similarly, the presence of only free hydrogen fluoride (HF) was assumed. The identity of the hydrocarbon content of the oil was also not known and n-pentacosane ($C_{25}H_{52}$) was recommended as a simulant structure for the reaction and safety calculations during Concept Design.

Subsequent to completion of the Concept Design, an extensive exercise was undertaken to sample and analyse the waste oil, not only to obtain a more representative composition of the material, but also to provide analytical data to aid the Basic and Detail Design. By utilising historic lists for the stored waste oil, suitable oil drums with the lowest reported uranium content and enrichment values were identified. Oil samples were then drawn and submitted to Pelindaba Analytical Laboratories (PAL) for analysis.

The results of the oil analysis and the final oil composition to be used for the remainder of the engineering design are summarized in Ref. [1]. Seeing that this measured composition is notably different from the estimated composition that was used for the Concept Design, the current design must be revised accordingly. This shall be addressed as part of Basic Design.

The Basic Design of the CWOPG facility has already commenced. To date, though, only the BFD [2], Process Flow Diagrams (PFDs) [3]-[10] and Process Description [11] have been prepared. Professional Engineering Services are now sought to complete the Mass & Energy Balance calculation for the Basic Design, as defined in this SOW.

6 ROLES AND RESPONSIBILITIES

6.1 Necsa

Necsa is required to:

a) Provide access to the Necsa site for physical meetings.
b) Provide the relevant information to the Consultant for completion of the engineering work.
c) Appoint a suitably qualified and experienced person (SQEP) to serve as the point of contact for all communication between Necsa and the Consultant.
d) Timeously respond to queries from the Consultant to avoid project delays.
e) Organize and participate in meetings on a regular basis to ensure that all Necsa requirements are fulfilled. This shall include a kick-off meeting to initiate the project, once the Consultant is appointed, and a final close-out meeting at the end of the project.
f) Review and/or comment on the work provided by the Consultant, and eventually accept the work once all issues have been satisfactorily resolved.

6.2 Engineering Consultant

The appointed Consultant is required to:

a) Adhere to Necsa's security requirements in terms of access to the Necsa site and the handling of Necsa's information, as defined in Refs. [13] to [20].
b) Ensure that its quality management system complies with the requirements of Necsa, as defined in Ref. [21].
c) Appoint a SQEP to serve as the point of contact for all communication between Necsa and the Consultant.

d) Perform a comprehensive review of all existing documents and drawings provided by Necsa for the CWOPG facility.
e) Ensure that all process design work is undertaken by suitably qualified and experienced chemical engineers (as defined in Section 2.3).
f) Provide adequate resources (including SQEPs, computer hardware and software, etc.) for the required SOW.
g) Ensure that the scope of each task is carried out in full.
h) Provide regular feedback on the status of the work, no less than once per week.
i) Comply with all Necsa specific policies, procedures and guidelines.
j) Ensure compliance with the relevant design codes and standards.
k) Produce all deliverables for the SOW, with complete traceability through all design work presented.
l) Ensure that each deliverable is reviewed and approved internally by a professionally registered engineer (as defined in Section 2.3), before submission to Necsa for consideration.
m) Offer Necsa the opportunity to review each deliverable, and thereafter, to appropriately respond to the comments received.
n) Take accountability and provide assurance for the quality of the work.

7 STATEMENT OF WORK

The engineering design of the CWOPG facility was previously initiated by Necsa. The Concept Design has already been completed. The Basic Design commenced, thereafter. As part of the Basic Design, the Mass & Energy Balances now need to be performed. The services of an Engineering Consultant are sought for completion of these Balances.

As input to this exercise, the following design documents shall be provided by Necsa:
a) Results of the waste oil analysis (measured oil composition) – Ref. [1]
b) The Basic Design documents completed to date, which include the following:
    i. BFD [2]
    ii. PFDs [3]–[10]
    iii. Process Description [11]

The SOW for the Consultant then largely entails the following:
a) Reviewing the engineering design work completed by Necsa.
b) Performing the Mass Balance calculations required for Basic Design.
c) Performing the Energy Balance calculations required for Basic Design.
d) Preparing and issuing of handover documentation.
e) Attending to technical queries from Necsa.

Both the Mass and Energy Balances shall be performed from first principles using *Microsoft Excel* (“hand calculations”), and thereafter, validated using the *Aspen Plus* simulation software package. It will be the responsibility of the Consultant to source all computer software required.

The calculations shall be undertaken to the extent that the mass flowrate, molar flowrate, composition (mass basis), temperature and pressure for each of the numbered streams in the PFDs [3]–[10] is specified. This includes the process flow streams, waste streams and utilities in the CWOPG facility. The results shall be collated and summarized in the form of a Stream Table that is aligned with the PFDs. Where ad hoc batch quantities of material are involved in the process (e.g. batch of scrubbing solution), these shall also be appropriately defined.

A Risk Register must be initiated at the start and maintained through the course of the exercise to record any risks and uncertainties which are identified. For each risk, the severity must be defined (low risk, moderate risk, high risk or significant risk), together with a recommendation given on how to address the risk.

8 DELIVERABLES

The Consultant shall be required to hand over the following deliverables upon completion of this exercise:

a) An approved Report for the Mass & Energy Balance calculations. At minimum, the Report shall present the following:
   i. Assumptions made and bases for the assumptions.
   ii. Calculation methodology in terms of scientific models, equations, etc. that are applied. Methods used to estimate physical properties must be clearly explained.
   iii. Results of the Balances, which must include the Stream Table identified in Section 7.
   iv. Discussion of the results and conclusions drawn.

b) Electronic copies must be provided for all of the following:
   i. *Microsoft Excel* files for the "hand calculations" performed.
   ii. *Aspen Plus* files for the computer simulations performed.
   iii. Journal articles which may be referenced in the final Report (if applicable).

c) The Risk Register described in Section 7.

9 TIMELINE

All work shall be completed and handed over to Necsa within 2 weeks (14 calendar days) of the Consultant being appointed by Necsa. This includes the review and approval of all documents by both the Consultant, as well as Necsa.

10 REVISION HISTORY

This document has been revised in accordance with the following schedule:

Rev. No.	Date approved	Nature of Revision	Prepared
1.0	See title page	First issue.	Dr K Moodley