ANNEXURE 1 - SCOPE OF WORKS 10415950

1. Background

Rand Water is a bulk water distribution company supplying potable drinking water to mainly Gauteng province and surrounding areas in proximity. It currently supplies over 4600 ML/day through its vast pipeline network spanning over 3500 km's.

To meet their client's needs, Rand Water's pumping infrastructure consists of multi-stage high-pressure pumps used to deliver potable water, commonly referred to as main pumps, which are high voltage (MV) equipment. Each main pump has supporting equipment that ensures its optimal performance such as cooling water pumps and their respective motors.

Figure 1: An image of a typical multistage MV pump-set.

Problem description:

At most, Rand Water is practicing a proactive approach in the form of periodical planned maintenance informed by yearly online and offline condition assessments and visual checks on pumpsets at Vereeniging Pumping Station. This is a costly approach, as many of these periodical assessments are unnecessary. In addition, underdeveloped failure signatures may not be visible during such periodical checks. Moreover, despite this approach, Rand Water experiences failures monthly on its critical pump sets. The failures of this equipment can potentially cause water service disruptions to Rand Water customers should they occur at an unplanned time (for example, when a standby pump is out of commission for maintenance/Overhaul).

Rand Water's current maintenance program is based on unreliable and widely varied condition monitoring data due to widely varied tests performed by various service providers with varied technologies, e.g., Leap Tests, Partial Discharge, etc. Trend analysis of Condition Monitoring

data is difficult without reliable data. Periodic tests most often analyse one type of test, which does not give a complete condition analysis of the equipment. For example, a vibration test only reflects general mechanical problems like soft feet and possible bearing problems.

The time between tests is too long and could lead to failures before detection. Offline condition monitoring requires the shutdown of motors, which is not always possible due to high water demand.

2. Project Aim

The project aims to Install a permanent non-disruptive and non-intrusive real-time online condition monitoring solution based on Electrical Signature Analysis to improve Asset Reliability, Maintenance, and Performance on pump set 19 (Fixed speed pumps), a single pump set with two stages.

3. Project Objectives

The objectives of the project include:

- To obtain reliable, real-time condition and performance data for Pump-set 19 (Two (2) stages) at Vereeniging pump station
- To prevent electrical and mechanical failures of the monitored motors and pumps, and avoid water service disruption.
- To obtain a thorough understanding of the use of the solution and its functionalities to enable Rand Water to undertake the correct maintenance interventions at the right time and thereby significantly reduce loss of production, disruptions to supply, and overall costs of maintenance

4. Tasks and Deliverables

The following tasks and deliverables are anticipated outputs:

- Preparing and providing the necessary SHERQ documentation in accordance with Rand Water requirements for the works to be undertaken.
- Provision of a complete, real-time online condition monitoring solution on pumpsets 19 (Two (2) stages) at Vereeniging pump station with the following characteristics:

Equipment/General

- The system must use ESA (Motor Current Signature Analysis + Voltage; MCSA+V)
- The system must use installed permanently and be online
- The system must measure and communicate data 24/7 autonomously
- The system must use AI (Artificial Intelligence) and ML (Machine Learning)
- The system must support API functionality to transmit data to existing systems

- The system must be capable of working on both low and medium voltage units
- The system must be able to work on variable speed drives and soft starters
- The system must be able to be installed within the MCC / control room
- The system must have internal storage for communication outages
- The system must be capable of communication over
    - IEEE 1588 Ethernet Gigabit
    - Wireless Ethernet
    - GPRS
- The technology provider must be ISO certified:
    - ISO 9001:2015 (Quality Management System)
    - ISO 27001:2022 (IT accreditation)

Analytics

- The system must detect the following faults in advance using AI. Please note that the list is not exhaustive.
    - Supply
        - Voltage/current unbalance
        - Current/voltage harmonic distortion
        - Power Quality issues
        - Voltage drops/overvoltage
    - Motor
        - Stator faults
        - Electrical unbalance
        - Broken rotor bars
        - Rotor eccentricities
        - Misalignment
        - Bearing degradation
        - Mechanical unbalance
    - Transmission
        - Coupling eccentricity
        - Coupling unbalance
        - Broken/cracked gear teeth
        - Pulley unbalance
        - Belt/chain wear
    - Load or Asset (ie. the connected centrifugal pump)

        - Cavitation
        - Mechanical unbalance
        - Mechanical looseness
        - Misalignment
        - Impeller damage
        - Low-flow, clogging alerts
        - Bearing defects
- The system must be capable of providing the following Energy Insights
    - Electrical metrics
        - Current vs rated current
        - Voltage vs rated voltage
        - Power factor vs desired power factor
        - Supply frequency
        - Active Power vs nominal power
        - Motor efficiency
    - Mechanical metrics
        - Mechanical power
        - Motor speed
        - Real-time pump curve, displaying actual operating pump (mechanical) power, speed, head, flow and efficiency
    - Reporting
        - Energy consumption broken down by business unit, geographical location, individual asset, or other grouping
        - Daily energy usage profile per business unit, geographical location or individual assets
        - Electric motor efficiency at design operation and actual operations
        - Efficiently used energy, energy losses due to inefficiencies in the power supply (power quality), the electric motor, and the driven load (i.e., pump)
        - Benchmark of energy use and efficiency between identical or similar assets
        - Benchmark of kWh per Volume (ML/day) pumped volume to historical performance, similar assets, or external thresholds
        - Tracking of energy savings, energy cost, and indirect CO_2 equivalent emissions versus the established baseline
- The system must have extensive reporting and dashboarding available

- A 24/7 available online dashboard on any device that provides
    - Asset health/status
    - Asset performance benchmarking
    - Reliability and status reports
    - Real-time energy drawdown
    - Real-time energy efficiency metrics
    - Frequency spectrum analysis
    - Pump efficiency and reliability
    - Overview of prevented asset failures
- Alerts/messages can be brought to the customer in various formats
    - Via email
    - Via SMS
    - Via phone
    - Via an analytics platform
- The system must actively monitor the condition of assets and provide Root Cause Analysis.
- Training – The service provider must provide elaborate training to Rand Water employees:
    - Training of (condition monitoring) staff in the cloud-based software and associated systems set-up, configuration, tools, and reporting, and also assisting in developing procedures for the above.
    - Training of staff in the installation and configuration of the hardware.
    - Necessary training manuals
- Support: The Service Provider must always be available for support (help desk) and, if needed, onsite support — 12 months subscription period is required.
- The Service Provider shall provide network, data, and connectivity for the 12 months subscription period through a reliable network provider.
- The Service Provider shall prepare and furnish weekly progress reports outlining the project's performance to ensure that the project remains on schedule.
- The Service provider shall provide all datasheets, operating and maintenance manuals, calibration certificates, and end-of-job documentation in electronic and hardcopy formats.
- All native files shall be provided for documentation, and the right of ownership and usage shall be deemed conferred to the Rand Water Vereeniging Pumping Station.

5. Site / Location

The pilot project will be executed at Vereeniging Pumping Station, located in the southern region of Gauteng.

GPS co-ordinates: 26°41'29.1"S 27°54'58.4"E

The host site shall be specifically the Engine Room 4, Pump-set 19.

Note: During the project preliminary phases, Rand Water reserves the right to nominate alternative pumpsets, should operational requirements render the selected pumpsets unavailable. This change must be accepted as a non-cost impact change.

6. Duration of project

Rand Water requires the project's scope (excluding the support phase) to be fully executed within 14 weeks of award.

It is envisaged that this shall comprise 4 weeks for preparing SHERQ documentation and analysing the existing systems, 8 weeks for equipment acquisition and setup, and 2 weeks for training and end-of-job documentation handover.

The Service Provider shall provide ongoing monitoring, data analysis, and support for 12 months.

7. Key Performance Indicators

The following will be measures of a successful project:

- Completion of the scope of work within budget, schedule, scope, and acceptable quality standards.
- Optimized pumping performance with real-time insights and improved system availability and reliability must be demonstrated.
- All works must be conducted with minimal to no disruptions to Rand Water operations.
- All SHERQ requirements must be adhered to, and the project should ideally proceed incident-free.
- All Rand Water "Enterprise Architecture Principles" and "Data Management principles" must be adhered to.

8. Important Requirements of the service provider

- The Service Provider must be well-established and have a suitable staff complement (ideally greater than 40) to demonstrate the capability of undertaking the complex nature of the works outlined within this scope.
- The scope must be executed by competent, qualified, and professionally registered (within their respective professional bodies) individuals—in particular, the company must employ a competent ECSA registered Electrical Professional Engineer.

- All works must be certified as being fully electrically compliant.
- The Service Provider must have previous experience with Rand Water.
- The Service Provider shall inform the Rand Water Project Manager of all changes to this project for acceptance before implementation.
- The Service Provider shall establish and discuss any unknown risks associated with technology deployment.
- The Service Provider shall procure the required labour, services, plant, and material to perform the required services.
- The Service Provider shall ensure and meet the SHERQ requirements of Rand Water whilst performing this service.
- The Service Provider shall ensure that Rand Water approves/accepts all design work before implementation on site.
- The Service Provider must have a local support team (within Johannesburg / Gauteng) to respond rapidly to Rand Water for on-site support.
- The Service Provider must submit a comprehensive solution in the form of a detailed proposal with their quotation to adequately demonstrate that the proposed solution will resolve the challenges experienced and meet the requirements of this project.

9. Images and Drawings

Refer to images and/or drawings provided for Engine room 4, Pump-set 19.

- Pump-set layout and drawings will be provided.
- Electrical SLD’s and Panel schematics will be provided.