PART 3: SCOPE OF WORK

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C3.1: EMPLOYER'S SCOPE

1. DESCRIPTION OF THE *SERVICES*

1.1 Executive overview

Arnot power station has been running for the past 46 years, each unit consists of the main items to generate electricity. Arnot power station is a coal fired power station that uses coal and air as part of boiler firing.

As part of the FFFR oxygen in the boiler must be monitored, controlled and should be kept above 2%.

Currently Arnot have four oxygen analysers on each boiler installed on the economiser. The left hand and right have two measurements each, each side having an inboard and outboard analyser.

There is a built-in logic that is used to bias the oxygen analysers on the LHS and RHS.

Initially when the logic was designed, there were not stringent rules from the FFFR committee. The design on the inboard analysers had an added 0.8% to the reading coming from the stratification test that was conducted by P&T.

After a presentation done by boiler engineering to FFFR committee, we were given a limit to operate at a percentage difference of about 0.5.

Meaning that if there is a percentage difference of about 0.5 between the left-hand side and right-hand side the automatic O2 balance control is not able to function.

This is intended to balance the LHS and RHS of the boiler oxygen process. There is an automatic

O2 bias with an option of manual control for the operator.

Since the new C&I systems was commissioned at units 4 to 6 at Arnot in 1997 onwards these units have

experienced numerus drum level trips which can be contributed to poor drum level control. When the new C&I was commissioned on units 1-3 in the early 2000's this problem started on these units as well but with the poor mill control of unit 1 tube mills the problem is greater on unit 1. In addition, several boiler-wall tube leaks were caused by, circulating pump cavitation and specific tubes then overheating. Since the ACIP 2 the problem escalated with the resultant problem of the SFPT not coping with full boiler pressure.

This report highlights the drum level issues identified over years of incident investigations with recommendations to how to solve or drastically improve these issues.

The following issues are discussed:

Poor drum level control philosophy implemented

EFP selections on control system overly complicated

SFPT not coping since ACIP 2

Unit 1 mill control problems

Drum level measurements inaccurate

Combustion control issues

The problem is that due to the gas flow transmitters that cannot be calibrated accurately as a result of duct vibrations and very low differential pressures the philosophy creates flow im-balances that it is meant to solve.

Often the flow through the two draught groups is unbalanced resulting in uneven back-end temperatures and one side bag-filters working harder than the other side.

A new control logic can be programmed that only use the fan vane positions similar to that of unit's 4-6 with the exception that during cell isolation there would be a fixed offset between the two draught groups to ensure one cell is not over worked. This results in the bag-filters on one draught group to work considerably hard than that of the other and some load losses because one ID fan would reach its maximum control limit before the other.

1.2 Interpretation and terminology

The following abbreviations are used in this Scope:

Abbreviation	**Meaning given to the abbreviation**
ECSA	Engineering Council of South Africa
SACPCMP	South African Council for Project and Construction Management Professionals
DCS	Distributed Control System
OEM	Original equipment manufacture
O2	Oxygen
ACIP	Arnot Capacity Increase Project
SHEQ	Safety Health Environmental Quality
P&T	Performance and Testing
SMS	Short Message Service
PM	Project Manager
FFP	Fabric Filter Plant
LHS	Left Hand Side
RHS	Right Hand Side
C&I systems	Control and Instruments
SFPT	Steam Feed Pump Turbine
ID fans	Induced Draft fans
NEC	New Engineering Contract
OHSA	Occupational Health and Safety Act
SHALL	Denotes a requirement
FFFR	Fossil Fuel Firing Regulation

2. SPECIFICATION AND DESCRIPTION OF THE SERVICES

2.1 Description of the services

2.1.1 The contractor shall work on the Arnot ABB DCS logic, contractor will be given read rights only on the DCS, any other changes will be conducted by ABB site engineer; the contractor shall investigate, design and conduct tests on the DCS logic or simulator.

2.1.2 The contractor shall evaluate, conduct boiler and turbine plant process monitoring, and design correct control and test on the following systems: all units' optimization, Boiler drum level, condensate control, feed water control, burner tilt control, ID fan biase, O2 balance control, and super heater and Reheater control and investigate drum level protections. The supplier shall conduct process analysis in line with each controller, considering different loads each unit must perform of all the above mentioned. The boiler protections shall be investigated being specific with the boiler drum and circulation pump low flow capability this scope will be led by boiler engineering as it is the mechanical scope, which will be determined by boiler.

2.1.3 The supplier shall provide new protections for boiler circulating pump capability having evaluated the whole control narratives as per boiler engineering requirement for (control narrative describes a system and includes sequence of operation of what the system does in response to specific inputs) of the boiler drum. The supplier shall ensure that the drum control narratives are functional in line with the process, improve the operational capability of quick reaction of the feed water pumps maintaining the drum level. Provide a solution which is the best controller to be used of all the above-mentioned systems. The supplier shall support and assist the operators with the operations of attempting the maintain the drum level, thereby meaning that any improvements to better drum level control will be corrected on the logic design and implemented by ABB.

2.1.4 Supplier shall supply the following reports : process evaluation report of all units , root cause , required operation report , current boiler philosophy covering these systems (Boiler drum , ID fan biase , O2 balance control, combustion , feed water pumps, burner tilt , super heater and re-heater, condensate), the drum level combustion , hand in hand with boiler pressure control and fuel master control should all be in-cooperated together, single line drawings of all the above mentioned controllers, concept design report , stake holder requirements, tuning report , basic Design , detail design , performance test report and commissioning report , Supply single line drawings of each controller. Detail background information of the basic controller to be used to be submitted as part of the document. Units performance of each unit in line with the controller, Red line logic where all changes have been made. The supplier with the Arnot DCS OEM (Distributed Control system Original equipment manufacturer) shall ensure that the red line logic report be implemented on the simulator, tested, commissioned and proven to be functional.

2.1.5 The Supplier shall evaluate current controllers ensure the functionality of the following controllers: Drum level, electrical feed pumps controller, fuel control, oil burner control, O2 analogue control, Steam feed pump controller, Combustion, feed pumps controller, super heater and re-heater.

2.2 Works to be performed by Contractor

2.2.1 The contractor shall conduct investigation of all units process performance on different loads, the contactor shall supply a root cause report of the investigation where investigation have been identified

2.2.2 The contractor shall investigate the current DCS controllers layout (Boiler drum, ID fan biase, O2 balance control, combustion, feed water pumps, burner tilt, super heater and re-heater, condensate), these system controllers will be investigated in-line with the process, and the supplier shall supply a root cause report detailing the deviations on the controller in-line with the process and single line drawings of all processes where the investigation has been conducted.

2.2.3 The contractor shall design the correct DCS philosophy logic, contract shall supply design report, with red line drawings of where the changes will be done on the DCS logic

2.2.4 There is a specific built-in error on the boiler drum controller which is not a true three element controller which the supplier must correct, also there is an error on the actual value of the drum level transmitter as per calculation that is on the DCS. The contractor shall review all the boiler protection and calculation done to ensure that it is correct. The supplier will design the new trip protection for drum level that corresponds with circulating pump flow capability protection.

2.2.5 The contractor will ensure that all the above-mentioned systems are tested in-line with operational and new design requirements. The test criteria to be used, after the design is approved, a request will be made to production if there is any trip risk to test the new implemented logic and with the provided single line diagrams, all requirements of the unit process and objective of each test to be met.

2.2.6 The contractor shall supply all suggested designs as per the tests conducted on the specific controllers and indicate on the design system interfaces, and what each design change will improve and benefit the process and optimize the operation of the unit or that particular system.

2.3 Specifications and standards

2.3.1 The contractor shall conduct investigation of all unit's process performance on different loads, the contractor shall supply a root cause report of the investigation where investigation have been identified

2.3.2 The contractor shall investigate the current DCS controllers (Boiler drum, ID fan biase, O2 balance control, combustion, feed water pumps, burner tilt, super heater and re-heater, condensate), these system controllers will be investigated in-line with the process, and the supplier shall supply a root cause report detailing the deviations on the controller in-line with the process and single line drawings of all processes where the investigation has been conducted.

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improve and benefit the process and optimize the operation of the unit or that particular system

2.3.7 The Contractor shall ensure all investigation report, designs, red lined logics, single line drawings, control philosophy of all the mentioned system and test documentation are intellectual property of the employer.

2.3.8 The contractor with the Arnot DCS OEM (Distributed Control system original equipment Manufacturer) shall ensure that the red line logic is implemented on the DCS.The Supplier shall evaluate current controllers ensure the functionality of the following controllers: Drum Level, electrical feed pumps controller, Steam feed pump controller, Combustion, feed pumps controller, super heater and re-heater

3. QUALITY MANAGEMENT

3.1 System requirements

An approved Quality Control Programme is to be implemented in conjunction with, and to the approval of, the *Project Manager*.

Clause 40.1 requires that the Contractor operate a quality management system as stated in the Scope.

3.2 Information in the quality plan

3.2.1 Clause 40.2 requires that the Contractor provide a quality policy statement and quality plan which complies with requirements stated in the Scope.

3.3 Constraints on how the *contractor* is to Provide the Services

The contractor shall supply for the following resources.

3.3.1 2xPrincipal Engineer BEng degree (Mechatronics, Electrical engineer, Computer and control engineering, control instrumentation engineering)

3.3.2 1xSenior engineer BEng degree (Mechatronics, Electrical engineer (light current& heavy current), Computer and control engineering, control instrumentation engineering)

3.3.3 All engineers shall be professionally registered with ECSA

3.3.4 All engineers shall have 10 years' experience related in Control, power plant unit optimization, process experience in power stations

3.3.5 Principal engineer must be familiar and understand the ABB P13 and P14 control logic

3.3.6 Principal engineer must have experience and expertise in determining control philosophy

3.3.7 Principal engineer must have background in project management, also a certificate in project management/ Diploma

3.3.8 Senior engineer must be experience in power plant unit process control and unit process systems

3.3.9 The contractor shall supply at least 5 reports of past projects conducted in Eskom power stations with contract order numbers at different power stations involving control philosophy, process system design testing and test results thereof.

3.3.10 The contractor complies with all site regulations issued by the Employer

3.3.11 The contractor is to be available during Employer working hours

3.3.12 The contractor carries out the works in accordance to the OHS Act.

3.3.13 The designer carries professional liability for the design as far as is reasonably practicable.

4. MANAGEMENT MEETINGS

Regular meetings of a general nature may be convened and chaired by the *Project Manager* as follows:

Title and purpose	Approximate time & interval	Location	Attendance by:
Risk register and compensation events	To be determined by the Project manager	Contractors site office	Project stakeholders
Overall contract progress and feedback	To be determined by the Project manager	Contractors site office	Project stakeholders

4.1 All meetings shall be recorded using minutes or a register prepared and circulated by the person who convened the meeting. Such minutes or register shall not be used for the purpose of confirming actions or instructions under the contract as these shall be done separately by the person identified in the *conditions of contract* to carry out such actions or instructions.

4.2 There will be daily meetings (which covers day to day activities that tie up with the overall project plan), between the contractor, engineering and project department

4.3 A weekly meeting (the weekly meetings will cover overall feedback of the work that had been done on the month) will be held on Fridays before knock off time, for the overall week's performance and works done

4.4 Monthly meetings (monthly meetings will be held and ran by project manager to give overall status of the project and progress) will be held for overall project progress meetings

4.5 Adhoc meetings will be held, whether requested by contractor or employer

5. Consultant's key persons

An organogram shall be submitted to indicate lines of communication in line with the services provided.

6. Provision of bonds and guarantees

N/A

7. Documentation control and retention

7.1 Identification and communication

7.1.1 Documentation will be identified with an alpha numeric which indicates source, recipient,

communication number etc.

7.1.2 All contractual Documentation must have relevant contract number and Purchase Order Number as reference as per Eskom Holdings SOC Limited Standards (List).

7.1.3 Contractual communications will be in the form of properly compiled letters, letters attached to emails, emails, NEC template and urgent consultant meetings can be in the form of sms and as outlined on core clause 13 of the NEC3 PSC.

7.1.4 The use of sms's, emails does not override the use of applicable and relevant NEC3 PSC standard templates, forms and Eskom Holdings SOC Limited procedures.

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7.1.8 The use of sms's, emails does not override the use of applicable and relevant NEC3 PSC standard templates, forms and Eskom Holdings SOC Limited procedures.

7.2 Record management

7.2.1 Each document is provided as a searchable electronic PDF format and included all signatures obtained internally, from the consultant and from employer, electronic signatures are generally acceptable

7.2.2 Each document is provided with editable Microsoft file which corresponds to all final documentationissued by employer.

7.2.3 The consultant corrects all identified documentation /configuration anomalies required to implement the service and notifies the employer's agent of any other he may notice

7.2.4 Programmes prepared by the consultant, for the service and acceptant by the employer's agent areconsidered as records

7.2.5 All reports to be in a format agreed. Preferred formats are MS excel, Power point and PDF documents must be searchable and must allow manipulation of data, copy .paste edit

7.2.6 Consultants must sign off from the employer's agent for all reports and presentations. The sign offwill be electronically

7.3 Retention of documents

7.4 Eskom Root cause report

7.5 Analysis report of all the controllers' evaluation

7.6 Eskom Required operational capability

7.7 Eskom Concept design documentation

7.8 Basic Detail design review

7.9 Detail design report

7.10 Recommendation reports for all the above mentioned controllers.

7.11 Ensure safe execution of the recommendation to resolve these controllers.

7.12 Units performance of each unit in line with the controller

7.13 Supply single line drawings of each controller.

7.14 Technical specification of all the controllers

7.15 Scope of work for the rest of the units designs with logics included and single line drawings

7.16 Detail background information of the basic controller to be used to be submitted as part ofthe document.

8. INVOICING AND PAYMENT

8.1 Invoicing and payment

At the assessment stage a Payment Certificate will be prepared by the *Project Manager* in conjunction with the *contractor*. After the submission and approval of the Payment Certificate, the *Contractor* provides the *Employer* with a tax invoice showing the amount due for payment equal to that stated in the *Project Manager*'s payment certificate.

The *Contractor* includes the following information on each tax invoice:

Name and address of the *Contractor*
The contract number and title;
Contractor's VAT registration number;
The *Employer*'s VAT registration number 4740101508;
The total Price for Work Done to Date which the *Contractor* has completed;

Other amounts to be paid to the *Contractor*;
Less amounts to be paid by or retained from the *Contractor*;
The change in the amount due since the previous payment being the invoiced amount - excluding VAT, the VAT and including VAT;

The *Contractor* attaches the detail assessment of the amount due to each tax invoice showing the Price for Work Done to Date for each item in the Price List for work which he has completed.

Details on how to submit invoices and additional information:

- Ensure that the Eskom order number is clearly indicated on your invoice together with the line number on the order you are billing for. All Electronic invoices must be sent in PDF format only.
- Each PDF file should contain one invoice; or one debit note; or one credit note only as Eskom's SAP system does not support more than one PDF being linked into workflow at a time.
- Email addresses for invoice submission: invoiceseskomlocal@eskom.co.za

9. CONTRACT CHANGE MANAGEMENT

For any compensation event relating to changes to scope and additions to scope which were not part of the original scope, such changes shall be treated under compensation event core clause section 6 of the NEC3. The consultant shall notify the Project Manager of any changes to Site Personnel within 5 (Five) days.

10. Quality management

10.1 System requirements

10.1.1 An approved Quality Control Programme is to be implemented in conjunction with, and to the approval of, the *Project Manager*.

10.1.2 Clause 40.1 requires that the Consultant operate a quality management system as stated in the Scope.

10.2 Information in the quality plan

10.2.1 Clause 40.2 requires that the Consultant provide a quality policy statement and quality plan which complies with requirements stated in the Scope.

11. THE USE OF MATERIAL PROVIDED BY THE CONSULTANT PARTIES

11.1 *Employer*'s purpose for the material

11.1.1 Clause 70.1 states that the Employer has the right to use the material provided by the Consultant for the purpose stated in the Scope.

11.1.2 Clause 70.1 states that the Employer has the right to use the material provided by the Consultant for the purpose stated in the Scope.

11.2 Restrictions on the *Consultant*'s use of the material for other work

11.2.1 Employer has the right to use the material provided by the *Consultant* for the purpose stated in theScope.

12. TRANSFER OF RIGHTS IF OPTION X 9 APPLIES

12.1 The is no exception to clause X9

13. MANAGEMENT OF WORK DONE BY TASK ORDER

13.1 Expenses and Per Diems will be calculated as per consulted final proposal

14. HEALTH AND SAFETY

The *Consultant* shall at all times comply with the health and safety requirements prescribed by lawas they may apply to the *service*s.

Compliance to 5 identified lifesaving rules (Compulsory Adherence):

Rule1: Open, Isolate, Test, Earth, Bond, and/or insulate before touch
(That is, any plant operating above 1 000 V)

- No person may work on any electrical network unless:
- He/she is trained and authorised as competent for the task to be done.
- A pre-task risk assessment to identify all risks and hazards has been conducted prior to any workcommencing.
- An equipotential zone is created for each worker on the job site by earthling, bonding, and/or insulatingaccording to approved procedures.
- All conducting material is connected together, all staff on site wear electrical safety shoes, and insulatingtechniques are applied according to standards; and
- The authorised person (team leader) has certified and shown all team members that the apparatus is safeto work on.

Rule 2: Hook up on heights
Working at height is defined as any work performed above a stable work surface or where a person putshimself/herself in a position where he/she exposes himself/herself to a fall from or into.

- No person may work at height where there is a risk of falling unless:
- A pre-task risk assessment to identify all risks and hazards has been conducted prior to commencingany work at height.
- He/she is appropriately trained;
- He/she is appropriately secured during ascending and descending; and
- He/she is using an approved fall arrest system where applicable.

Rule 3: Buckle up
No person may drive any vehicle on Eskom business and/or on Eskom premises:Unless the driver and all passengers are wearing seat belts.

Rule 4: Be Sober
No person is allowed to work under the influence of drugs and alcohol.

"Under the influence" means the use of alcohol, drugs, and/or a controlled substance to the extent that:

- His individual faculties are in any way impaired by the consumption or use of the substances; or
- The individual is unable to perform in a safe, productive manner; or
- The individual has a level of any such substance in his/her body that corresponds to or exceedsaccepted medical/legal standards; or
- The individual has a level of alcohol in his/her body that is greater than 0% blood alcohol concentration. This includes any level of an illegal substance in the body, irrespective of when the substance was used.

Rule 5: Ensure that you have a permit to work

Where an authorisation limitation exists, no person shall work without the required Permit to Work (PTW), which is governed by the Plant Safety Regulations, Operating Regulations for High Voltage Systems (ORHVS) etc.

- No plant is to be returned to service without the cancellation of all permits on that plant in accordance withprocedure.

NB: in the case of live work, a "live work declaration form" is to be completed by the authorised person who is the person responsible for the safe execution of work according to relevant standards and procedures.

Please ensure that these rules are understood and communicated with the urgency that they deserve. If any of these rules are unclear or the consequences not understood, please do not hesitate to discuss it with Eskom.

We would like to continue our current partnership and therefore urge your support in the implementation andupholding of these rules.

15. PROCUREMENT

15.1 BBBEE and preferencing scheme

Not applicable.

16. OTHER CONSTRAINTS

16.1 The contractor and his employees are required to conduct themselves at all times in a proper and orderly manner while on the *Employer's* premises. The contractor and his/her employees will, in particular, be required to smoke in designated areas while on the *Employer's* premises. It must be noted that the *Employer* will take immediate steps to institute criminal investigation in the event of any suspected criminal acts e.g. Theft, vandalism etc. Criminal acts by contractor staff will be grounds for the termination of this agreement.

16.2 The Project Manager has the right to stop the Contractor work activities which, in the opinion of Project Manager, does not meet the requirements of the project plan. The contractor may only continue with work activities when all deficiencies have been corrected to the Project Manager's satisfaction. The Contractor shall have no claim against the Employer in respect of delay due to the above.

17. CORRECTION OF DEFECTS

17.1 Defects will be communicated to the consultant, and they will be addresses as per contract conditionsstipulated on the PSC

18. WORKING ON THE *EMPLOYER*'S PROPERTY

18.1 All Site access is controlled through the designated access gate.

18.2 The Consultant is informed of the access procedures through Site regulations and that such procedures may change depending on the prevailing security situation. The *Employer* follows an accident prevention policy that includes the investigation of all accidents involving personnel and property. This is done with the intention of introducing control measures to prevent a recurrence ofthe same incidents. The Consultant is expected to co-operate fully to achieve this objective. The *Project Manager* must be informed within 24 hours of any injuries or damage to property or equipment.

18.3 This report does not relieve the Consultant of his legal obligation to report certain incidents to the Department of Labour, or to keep records in terms of the Occupational Health and Safety Act, andCompensation for Occupational Injuries and Diseases Act.

18.4 All vehicles must be driven with due consideration for personnel and property. A maximum speedlimit of 40 kilometres per hour will be adhered to on the premises at all times.

19. *EMPLOYER*'S ENTRY AND SECURITY CONTROL, PERMITS, AND SITE REGULATIONS

- Note that the speed limit on the site is 40 Km/h. The vehicle permit of any persons contravening anytraffic act on site is cancelled.
- The Consultant complies with the Arnot Power Station Site Regulations, a copy of which is availablefor perusal at the *Project Manager's* offices
- All the assets must be declared and registered with security upon entering site. This includes portable assets such as laptops.
- The Consultant shall have no claim against the *Employer* in respect of delay at the security maingate.
- All Consultant *s'* permits must be returned to Protective Services on completion of the *works*.

20. PEOPLE RESTRICTIONS, HOURS OF WORK, CONDUCT AND RECORDS

Note that the speed limit on the site is 40 Km/h. The vehicle permit of any persons contravening anytraffic act on site is cancelled.

The Consultant complies with the Arnot Power Station Site Regulations, a copy of which is availablefor perusal at the *Project Manager's* offices

All the assets must be declared and registered with security upon entering site. This includes portable assets such as laptops.

The Consultant shall have no claim against the *Employer* in respect of delay at the security main gate.

21. EQUIPMENT

Any equipment, or appliances, used by the Consultant conforms to the applicable OHS Act safety standards and is maintained in a safe and proper working condition. The *Project Manager* has the right to stop the Consultant*'s* use of any equipment which, in the opinion of *Project Manager*, does not conform to the expected standards.

22. THINGS PROVIDED BY THE *EMPLOYER*

Potable water

- Potable water from taps

Meals

- Meals on site for the consultant personnel are not available.

Sanitary Facilities

- Sanitary facilities are provided by the *Employer*.

General

- The Consultant *is* to comply with all Site regulations and instructions. The onus is on the consultantto ensure his familiarity with the Employer's Site regulations and inspections

- Access to working areas
  All consumables in line with providing the services on site