

**MOKOLO AND CROCODILE
WATER AUGMENTATION PROJECT
PHASE 2 (MCWAP-2)**

TENDER NO 054/2024/PMID/MCWAP2/RFB

**PART C3.1
SPECIFICATION**

SECTION 48

TESTS ON COMPLETION

PART C3.1 SPECIFICATION

SECTION 48 TESTS ON COMPLETION

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SECTION 48

TESTS ON COMPLETION

48.1 SCOPE

Further to the description of the Contractor's design obligations and related Employer's Requirements in Section 1 – General of the Specification, this Section covers all aspects associated with Tests on Completion of this integrated multi-discipline bulk water supply system.

The Tests on Completion obligations applicable to this Contract is a combination of an Employer's design and a Contractor's design.

Section 48 shall be interpreted as follows:

- a) For Tests on Completion of the Employer's design aspects it shall be regarded as a part of the Specification; and
- b) For Tests on Completion of the Contractor's designed aspects this Section shall be regarded as Employer's Requirements.

In Section 48, definition is provided for the components of the Works that shall be completed to achieve the relevant "readiness" status for Tests on Completion thus enabling work activities to move to the next stage.

The Conditions of Contract define three testing stages associated with Tests on Completion namely:

- a) Pre-commissioning testing ("dry" or "cold" testing);
- b) Commissioning testing ("wet" or "hot" testing); and
- c) Trial Operation.

Each of these stages has a uniquely defined project specific event that triggers the commencement of the stage as summarised in Table 48/1.

**TABLE 48/1
SEQUENCE OF STAGES AND ASSOCIATED TRIGGER EVENTS OF TESTS ON
COMPLETION**

STAGE	TRIGGER EVENT
1) Early use of a Part of the Works	Ready for Beneficial Operation (RFBO)*
2) Pre-commissioning	Ready for Pre-Commissioning (RFPC)
3) Commissioning	Ready for Commissioning (RFC)
4) Trial Operation	Ready for Trial Operation (RFTO)
5) Operation	Ready for Operation (RFO)

*Not currently planned under this Contract.

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Refer to the Project Structure Diagram (PSD) on Drawing 2A-P2-001 for interfaces between Parts of the Plant or Works and between Employer's design and Contractor's design.

When the Tests on Completion are successfully completed the status of Ready for Operation (RFO) is achieved. RFO is the trigger event for the Operation stage.

Preceding the Tests on Completion are the following stages as reflected in Table 48/2 with associated trigger events.

**TABLE 48/2
SEQUENCE OF STAGES AND ASSOCIATED TRIGGER EVENTS OF STAGES PRECEDING
TESTS ON COMPLETION**

STAGE	TRIGGER EVENTS
1) Manufacturing and factory testing and factor acceptance testing (FAT) of Plant (Progressive testing)	Approval of manufacturing and corrosion protection QCPs
2) Transportation and delivery to site or into storage	Plant released from manufacturing
3) Plant installation	Plant installation access granted

48.2 DEFINITIONS, ABBREVIATIONS AND REFERENCES

48.2.1 Definitions

In this Section the word or words:

- a) **“Battery limits”** means the clearly defined interfaces between Parts of the Plant or Works and between Employer's design and Contractor's design as indicated in the Project Structure Diagram.
- b) **“Cold’ or ‘dry’ commissioning”** means pre-commissioning.
- c) **“Component”** means a functional element of the Plant or Works.
- d) **“Contractor's design”** includes, as applicable, the submission of design documentation for designs undertaken by the Contractor for approval by the Engineer. The Contractor's design also includes the commissioning plan and commissioning of the components designed by the Contractor.
- e) **“Contractors training programme”** means the combination of all the training activities carried out within the training period.
- f) **“Hot’ or ‘wet’ commissioning”** means Commissioning.
- g) **“Part”** means clearly defined sections of the Works or Plant as indicated in the Project Structure Diagram.
- h) **“Works”** means the complete Scope of Work.
- i) **“System”** means all the multi-discipline functional components linked together to perform all the various aspects of the intended operation and includes Components, Parts that spans across multiple Works and Contracts.

48.2.2 Abbreviations

AIA	:	Approved Inspection Authority
BoQ	:	Bill of Quantities
CDT	:	Current Drain Test
CIPS	:	Close Interval Potential Survey
CMS	:	Construction Method Statement
CoC	:	Certificate of Compliance
DCVG	:	Direct Current Voltage Gradient
DGEOT	:	Double Girder Electric Overhead Travelling
DWS	:	Department of Water and Sanitation
EIA	:	Environmental Impact Assessment
HDPE	:	High Density Poly-Ethylene
ICC	:	Installation Completion Certificate
MCC	:	Motor Control Centre
MCWAP-2	:	Mokolo Crocodile Water Augmentation Project, Phase 2,
MHD	:	Mass Hall Diagram
MMS	:	Management Method Statement
NDE	:	Non Drive End
NoE	:	Notice of Energisation
OH&S	:	Occupational Health and Safety
PC	:	Performance Certificate
PCM	:	Pipeline Mapping Survey
PFD	:	Process Flow Diagram
P&ID	:	Process and Instrumentation Diagram
PLC	:	Programmable Logic Controllers
PSD	:	Project Structure Diagram
QCP	:	Quality Control Plan
RFC	:	Ready for Commissioning
RFO	:	Ready for Operation
RFPC	:	Ready for Pre-Commissioning
RFTO	:	Ready for Trial Operation
RMS	:	River Management System
SAPS	:	South African Police Force
SCADA	:	Supervisory Control and Data Acquisition
TCTA	:	Trans-Caledon Tunnel Authority
TOC	:	Taking Over Certificate
TOP	:	Turn Over Package
TRC	:	Time-Related Charge
UG	:	under ground
UPS	:	Uninterruptable Power Supply
VSWR	:	Voltage Standing Wave Ratio
WTW	:	Water Treatment Works

48.2.3 References

When reference is made to a Code of Practice, Specification or Standard, the reference shall be taken to mean the latest edition or replacement at time of tender of the Code, Specification or Standard; including addenda, supplements, modifications and revisions thereto. Where a previous version is intentionally used, it will be indicated as such. Where reference is made to a Code, Specification or Standard that has subsequently been withdrawn and not replaced, the intended content will remain relevant unless confirmed otherwise in writing by the Engineer.

48.3 TESTS ON COMPLETION MANAGEMENT PROCESS

Various control documentation shall be used by the Contractor to ensure that the various stages of the Tests on Completion process complies with all the required specifications, standards, recommendations and policies.

The following documents shall as a minimum requirement be submitted by the Contractor to the Engineer for review and approval:

48.3.1 Tests on Completion Involvement Matrix

An integrated project matrix shall identify all the Tests on Completion activities that are required for sub-systems and systems. The Employer, Engineer and Contractors shall nominate various role players to a Tests on Completion team. This matrix shall clearly indicate the responsible drivers for a specific test area, discipline and/or activity.

48.3.2 Integrated Tests on Completion Plan and Programme

The Tests on Completion and start-up of newly completed Components, Plant or Parts of the Works and tie-in to existing systems introduces increased risk to the work area. The Engineer will be involved in the coordination of the Tests on Completion and shall be consulted when the system Tests on Completion plan and programme are being prepared by the Contractor.

The Contractor shall provide the plan and programme input for both the Employer's design and Contractor's design Works and submit it for the Engineer's approval. The program will provide a framework for the scheduling of tests and related activities, for making available suitable personnel and equipment at the proper time and for the timely preparation and provision of all documents.

The Integrated Tests on Completion Plan shall be submitted by the Contractor to the Engineer for approval covering all factors contributing to risks and the formats of the plan and programme shall comply with the following and shall be submitted and approved before RFC is achieved:

- a) It shall be written in such a format as to enable the objectives and methods of testing to be understood and to allow management control and coordination to take place;
- b) The process proceeds concurrently with construction and production activities;
- c) Involve operational personnel whom are unfamiliar with the new facilities and/or equipment;
- d) The Plant is tested in stages with varying levels of connection with existing facilities;
- e) Temporary utility feeds are introduced;
- f) Dealing with time pressures to get the facility operating by a predefined date in accordance with the Programme;

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- g) Responsibility for the Plant transfers from one group of individuals to another;
 - h) The Programme shall list all required tests and related activities in their proper sequence. Each test shall be covered by a detailed procedure which shall include the following:
 - i) The purpose of the test, the results expected under test conditions, the acceptance criteria and their relevance to the proposed operational limits and conditions where applicable. The title and number of each test should enable unique identification of that test;
 - ii) The pre-requisites for each test, clearly specifying, inter alia, all required man power and special equipment;
 - iii) The interdependence of test procedures by giving suitable cross references to other documents relevant to commissioning;
 - iv) The minimum technical and administrative provisions and safety precautions required during the test; and
 - v) Requirements for the witnessing of the test (witness points).
 - i) The programme shall be divided into suitable phases and shall show the planned duration of activities and their inter-relation with one another. The programme shall also include activities that may be required in order to provide opportunities for the operating personnel to gain familiarity with the operation of the Plant.

Once the Integrated Tests on Completion Plan and programme have been agreed, the functional completion of all the aspects of the Works has been achieved as defined in 48.6.2, the Engineer shall determine whether the RFC status has been achieved.

The Tests on Completion team shall complete a risk assessment workshop specific to the management plan to identify and address all key risk items associated with the Tests on Completion activities.

Upon completion of the workshop, the Tests on Completion team shall prepare a commissioning safety plan which will include the following:

- a) A summary of the identified risks with a mitigation plan for each risk (a team member shall be assigned responsibility for each risk area and mitigation plan);
- b) A work plan, with appropriate roles and responsibilities shall be defined, developed to provide appropriate safety training, reduce unsafe conditions and minimise work interferences;
- c) A summary of safety protocols for controlling plant and equipment; and
- d) A plan to commission and accept safety systems prior to the introduction of any form of energy like water pressure, electricity, etc. Commissioning permits shall be in place to legally authorise the Contractor and/or his specialist suppliers to carry out work on any apparatus that is live (i.e. electrically or hydraulically) and to ensure that the necessary lockout procedures are put in place before commencing with execution of work.

48.3.3 Tests on Completion Method Statement

Method statements shall be submitted for each test activity to ensure that the execution is done in a safe manner. The primary function of the method statement is to identify and evaluate all risks from quality, environment and safety points of view and risk mitigations proposed.

48.3.4 Notice of Energisation (NoE)

A preliminary notice or notice of completion shall be submitted to certify certain types of electrical installing work. The notice of completion form shall include a certification of compliance of the electrical work to the relevant network operator. The Contractor shall, to the approval of the Engineer, issue a NoE upon completion of Stage 1, authorising the start of Stage 2 for pre-commissioning.

48.3.5 Pre-Start Check Lists

This document shall identify all the safe pre-start check-ups of sub-systems and systems before pre-commission and commissioning stages. This will also serve as a test sheet to record all visual inspections and functional checks, i.e. recording pressures, flows, power, current, voltage, etc. to ensure compliance with the specifications and design intent.

48.3.6 Tests on Completion Activity Notes

This document shall describe step-by-step the procedures that were followed during each Test on Completion activity.

48.3.7 Punch List

Punch lists shall be used as a tool to achieve safe, tested and contractually complete facilities prior to handing over equipment and process circuits for pre-commissioning at the end of construction. They shall similarly be employed at the end of pre-commissioning when handing over sub-systems and systems at practical completion ready for commissioning and load testing.

This document shall identify all outstanding work and/or work not conforming to contract specifications and may include incomplete or incorrect installations or incidental damage to existing finishes, material and structures identifiable by discipline and category.

Punch listing facilitates:

- a) Ensuring that any safety or OHS issue gets priority attention;
- b) The identifying of any deficiencies in the installation to be done as early as possible;
- c) Ensuring that any equipment, process circuits and facilities handed over for commissioning are complete and safe to use for the intended commissioning purpose;
- d) Enabling the Contractor and Engineer's representative to mutually identify and agree any deficiencies to be completed after practical completion and assign a timeframe for these works;
- e) Any deficiencies noted by either the individual formal punch listing sessions or by a group observation shall be evaluated and documented on the punch list showing:
 - i) Location and description of the deficiency and affected discipline;
 - ii) Remedial action required, and responsibility assigned for close-out;
 - iii) Target completion date and actual completion date; and
 - iv) Classification category.

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The disciplines shall be civil, mechanical, electrical, control and instrumentation, cathodic protection and AC mitigation, dams, weirs, pipelines and structures, while Categories A to D will identify at what stage items need to be cleared.

An example of punch list is shown in Annexure 48/5 with explanation of the categories given in Table 48/3 below.

**TABLE 48/3
PUNCH LIST CATEGORIES**

CATEGORY	DESCRIPTION	TIMEFRAME OF COMPLETION
A	Assessed as a critical deficiency / activity which prevents the safe and/or proper commissioning of the plant e.g. guarding, couplings, alignment, electrical terminations	Before energisation and pre-commissioning begins.
B	Assessed as a significant deficiency / activity but will not prevent the safe and/or proper pre-commissioning of the plant e.g. labels, painting, wire / cable markers.	Before commencement of commissioning.
C	Assessed as a non-critical deficiency / activity which may be safely rectified whilst the plant is in operation.	No later than a set period agreed with the Engineer after granting of notice of completion.
D	Assessed as a non-significant deficiency / activity which may be safely rectified whilst the plant is in operation.	Items to be rectified before Taking-Over Certificate can be issued, unless otherwise approved by the Engineer.

48.4 STAGES PRECEDING TESTS ON COMPLETION

48.4.1 Manufacturing and Factory Testing

Manufacturing of Plant shall only commence after manufacturing and corrosion protection Quality Control Plans (QCPs) have been developed and signed-off as acceptable by the Engineer or Approved Inspection Authority (AIA).

A Quality Control Plan (QCP) shall be developed for each manufacturing process to manage the signing-off on all hold points.

A Turn over Package (TOP) containing all relevant signed QCP's and data packs shall accompany the relevant Plant component as part of the transfer of the quality records. The TOP initially involves factory acceptance testing where required, pre-delivery and post-delivery inspections, storage inspections and pre installation inspections. Figure 48/1 depicts the factory testing process.

The manufacturing process comes to an end when the Plant is released from the manufacturer.

48.4.2 Transport of Plant to Site or Storage

Plant shall only be transported to Site after it has been released from manufacturing.

Transportation to Site or storage and receiving directly onto Site or from storage to Site depends on site specific situations and the relevant application shall be agreed with the Engineer. Transportation to Site comes to an end when the Plant has been received onto Site or into storage and Figure 48/2 reflects the Site installation testing.

48.4.3 Installation of Plant

Before installation of Plant or a component thereof can commence all preparatory work must be completed in the area where the Plant or component is to be installed. The area must then be inspected by the various disciplines representatives (civil, mechanical, electrical, control and instrumentation etc. and as applicable) of the Contractor and Engineer and defects (snag listed) must be identified. If the defects are of such a nature that they can be completed at a later stage access for installation can be granted.

If access for installation is granted Plant that has already been received onto Site or into storage should be inspected. If the condition of the Plant is such that it can be installed, it can be released for installation.

Alternatively the Plant can come directly from the manufacturer (after it has been released from manufacturing) and be placed in its permanent position after it has been received onto Site as described in Clause 48.4.2.

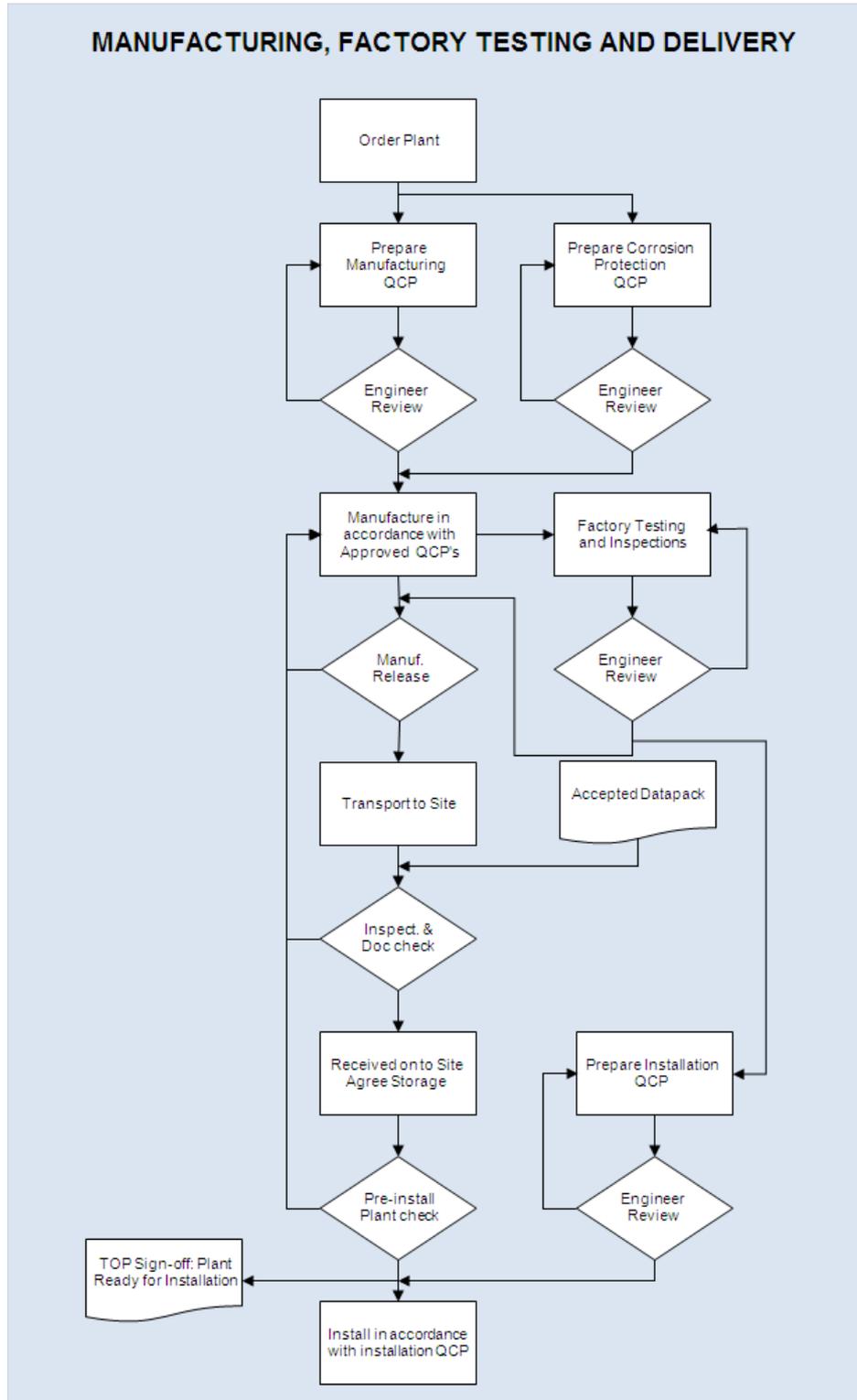
After installation of the Plant has been completed it must be inspected by the various disciplines representatives (civil, mechanical, electrical, control and instrumentation etc. and as applicable) of the Contractor and Engineer and any defects must be identified on the Installation Completion Certificate (ICC) (which will form part of the TOP).

Concomitant with the installation process of the Plant the pre-commissioning Method Statements must be prepared and submitted to the Engineer for approval.

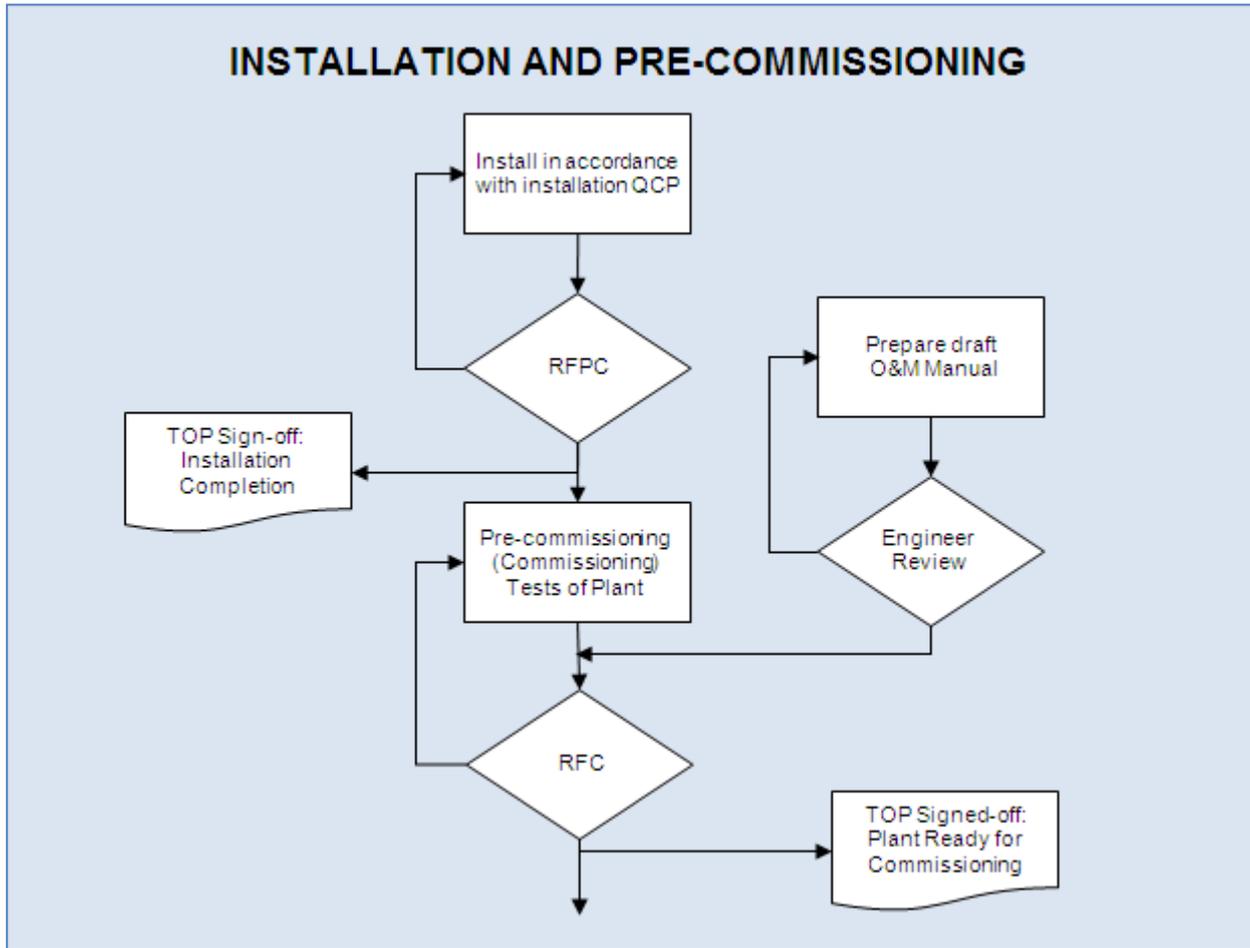
If the installation defects are of such a nature that they can be completed at a later stage and functional testing of the Plant can safely be undertaken and the pre-commissioning Method Statement has been approved by the Engineer (which will form part of the TOP) then the Plant has achieved the status "Ready for Pre-Commissioning" (RFPC).

Figure 48/2 reflects the Site installation testing.

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**FIGURE 48/1
MANUFACTURING And FACTORY TESTING PROCESS**



**FIGURE 48/2
SITE INSTALLATION TESTING PROCESS**

The Contractor shall determine the sequence of construction work, Plant manufacturing and Plant installation and thus the commencement and sequence of the pre-commissioning that is to follow.

48.5 STAGES OF THE TESTS ON COMPLETION PROCESS

The tests on completion process normally involves the staged passing of project ownership from the construction manager to the commissioning manager(s) and ultimately to the operations manager responsible for long-term performance.

The Contractor shall perform tests on completion in the following stages, each with its own deliverables, contractual requirements and stated completion milestone by the Engineer signing-off C1 to C4 Acceptance Certificates as the Contractor progresses through the various stages of tests on completion. An explanation for each of the commissioning stages is as follow:

- a) Stage 1: Construction verification (C1 Acceptance Certificate) – all construction activities (civil, mechanical, C&I, electrical, cathodic protection, communications, etc.) of individual sub-systems have been completed (system not energised). Ready for Pre-Commissioning (RFPC) is achieved at the end of this Stage.

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- b) Stage 2: Pre-commissioning (C2 Acceptance Certificate) – completed functional and operational tests of individual sub-systems (system energised). Ready for Commissioning (RFC) is issued at the end of this Stage.
- c) Stage 3: Commissioning (C3 Acceptance Certificate) – Completed Commissioning tests of Works / Sections by testing systems and sub-systems locally and remotely via the SCADA (system is dynamic, i.e. introducing product water).
- d) Stage 4: Ramp-up (C4 Acceptance Certificate) – Completed testing operability of integrated system from automatic sequence. Demonstrated reliability and availability of system, system integrity in terms of system loss and continued system performance. Ready for Trial Operation (RFTO) is issued at the end of this Stage.

The signing-off of the Acceptance Certificates will be the responsibility of the Engineer and will only be done if when the Engineer is satisfied that a Stage has successfully been completed.

Examples of Acceptance Certificates C1 to C4 are given in Annexure 48/4.

48.6 PRE-COMMISSIONING

48.6.1 Pre-commissioning Process

The pre-commissioning stage for specific Plant can commence when that Plant (or component or Part of the Plant) has achieved RFPC. Pre-commissioning of specific Plant or a component thereof can be undertaken individually, if it is practically possible. Only when pre-commissioning has been successfully completed will the Plant be deemed to have achieved functional completion. However, even though a Section or Part of the Works or specific Plant may have achieved functional completion in accordance with Clause 48.6.2 and therefore have achieved RFC for that Section or Part of the Works or specific Plant RFC for the Works would not have been achieved.

RFC for the Works (or the functional completion of the integrated system) would only be achieved when the requirements of Clause 48.6.2 have been satisfied.

All processes will be subject to the Engineer's approval before the subsequent process may commence.

48.6.2 Functional Completion

A minimum level of functional completion (subject to the Engineer's approval) is required for different parts or sections of the bulk water transfer infrastructure prior to achieving the status of "Ready For Commissioning (RFC)" for that part of the Works. Functional completion for the following parts include, inter alia:

48.6.2.1 Functional Completion of Pipelines

- a) All construction work inside the pipeline shall be complete;
- b) All chambers complete;
- c) A final lining inspection shall be signed off by the Engineer;
- d) A coating inspection that will comprise of a DCVG survey and a CDT as a minimum;
- e) Manual check shall be undertaken on the full range of operation of all valves and fittings;

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- f) Functionality of insulating flanges where fitted;
- g) Hydrostatic testing of the pipelines and proving of compliance shall be complete;
- h) Final filling of the complete pipeline;
- i) Visual check for leaks and repairs along the whole length and at all installations on the pipeline;
- j) Anchoring of pipes where temporarily exposed;
- k) Complete check on drainage from scours;
- l) Control of access to valves and fittings shall be complete;
- m) The AC Mitigation system installation shall be complete; and
- n) Any project specific aspect or test related to the functioning of the pipe that may be instructed by the Engineer within reasonable time, shall be complete.

48.6.2.2 Functional Completion of Reservoirs, Balancing Dams, Sedimentation Works or Weirs

- a) All construction work inside the water storage facility shall be complete;
- b) A manual check on the full range of operation of all valves, gates and sluices shall be complete;
- c) Functionality of insulating flanges where fitted;
- d) A manual check on the full range of operation of water level sensors shall be complete;
- e) Leakage testing and proving of compliance of water retaining structures shall be complete;
- f) Interfacing with SCADA and remote control system shall be checked;
- g) Final filling of water retaining structures shall be complete;
- h) Control of access shall be complete; and
- i) Any project specific aspect or test related to the functioning of the structures that may be instructed by the Engineer, shall be complete.

48.6.2.3 Functional Completion of Pumping Stations**(a) Civil**

- i) The construction of all the civil structure / building shall be functionally complete;
This means that the walls, cladding, roof, doors, windows and ventilation ducts shall be fully functional to support items ii) and iii) on this list;
- ii) Control of access to the inside the pump station shall specifically be in place;
- iii) A dust suppressed environment shall be maintainable inside the pump station;
- iv) All structural finishing inside the pump station shall be complete;
- v) All safety Plant and notices shall be installed; and

Any project specific aspect or test related to the functioning of the structure or building that may be instructed by the Engineer, shall be complete.

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(b) Mechanical

- i) The installation of all Mechanical Plant shall be complete;
- ii) The readiness of the cooling water system shall be confirmed;
- iii) The readiness of the seal water system shall be confirmed;
- iv) The readiness of the dewatering system shall be confirmed;
- v) The readiness of the ventilation and temperature monitoring shall be confirmed;
- vi) The readiness of the air conditioning system shall be confirmed;
- vii) A manual check on the full range of operation of all valves shall be complete;
- viii) Joint leakage testing and correction shall be complete;
- ix) Interfacing with SCADA and remote control system shall be checked; and
- x) Any project specific aspect or test related to the functioning of the mechanical Plant that may be instructed by the Engineer, shall be complete.

(c) Electrical

- i) The installation of all Electrical Plant and cabling shall be complete;
- ii) All cable terminations and connections shall be checked (all cable insulation test certificates to be in place);
- iii) The readiness of the permanent power supply shall be confirmed. Confirm that all Certificates Of Compliance (COC's) are in place;
- iv) The readiness of the permanent power supply at remote locations shall be confirmed;
- v) The readiness of the switch gear shall be confirmed;
- vi) The readiness of the soft starters / variable speed drives shall be confirmed;
- vii) The readiness of the low voltage and lighting system shall be confirmed;
- viii) The readiness of the earth - system and CP interfacing / insulation shall be confirmed;
- ix) The functionality of all insulating flanges shall be checked;
- x) Interfacing with SCADA and remote control system shall be checked; and
- xi) Any project specific aspect or test related to the functioning of the Electrical Plant that may be instructed by the Engineer, shall be complete.

(d) Control and Instrumentation

- i) The installation of all instrumentation and cabling shall be complete (confirm that all calibration certificates are in place);
- ii) The readiness of the primary data communication system shall be checked;
- iii) The readiness of the secondary data communication system shall be checked;
- iv) All cable terminations and connections shall be checked;
- v) The readiness of the SCADA system shall be confirmed; and
- vi) Any project specific aspect or test related to the functioning of the Electrical Plant that may be instructed by the Engineer, shall be complete.

48.6.2.4 Functional Completion of Ancillary Infrastructure

- a) Operation and control centre;
- b) All communication links;
- c) Complete SCADA interface; and
- d) Secure access control.

48.6.2.5 Functional Completion of the Integrated Systems

The successful pre-commissioning of all Plant is one of the requirements to achieve the status Ready for Commissioning (RFC). All items that have been categorized to be completed before RFC, must be signed-off as completed. On condition that it is agreed with the Engineer, the pre-commissioning can be completed in sections to facilitate the early independent commencement with Commissioning of Parts of the Works. However, the contractual RFC status of the Works shall only be achieved on the completion of the integrated RFC status for the last of such Parts. No commissioning will be allowed to commence before the detailed commissioning plan and programme has been approved by the Engineer. This is reflected in Figure 48/3.

Functional completion shall further include the following, unless otherwise approved by the Engineer:

- a) The complete primary (fibre optic) communication network shall be completed;
- b) The complete secondary (microwave radio) communication network shall be completed;
- c) All communication switches and configuration shall be completed;
- d) The installation and connection of instrumentation, PLC's at all satellite sites shall be completed;
- e) Pre-commissioning of all satellite sites shall be completed;
- f) The Cathodic Protection and AC Mitigation system installation shall be completed;
- g) The draft Operational and Maintenance Manual shall be completed and approved;
- h) The Contractor shall confirm the availability of all required Commissioning spares and lubricants;
- i) The initial training of the Employer's operating staff shall be completed;
- j) Any project specific aspects or tests related to the functioning of the larger bulk water system that may be instructed by the Engineer, shall be completed; and
- k) The commissioning plan and commissioning programme must have been agreed.

48.6.3 Operational Staff Training**48.6.3.1 Scope of Training Required**

The Contractor shall be responsible for training the designated operational personnel of the Employer.

The overall objectives of the Contractor's training programme shall be:

- a) To achieve a high standard of awareness, knowledge and understanding of the Plant and plant systems;

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- b) To provide an effective contribution to the overall training and development of the personnel; and
- c) To provide coaching for the personnel during this training period and an assessment of each of the personnel on completion of training.

The Contractor shall ensure adequate training in all aspects of codes of practice and safety rules including the training of the personnel engaged in Plant Commissioning. The aim is for the Employer's Personnel to be trained early enough to allow full participation in the Commissioning processes under the direction of the Contractor's Commissioning staff.

The training programme shall be agreed with the Employer at an appropriate stage of the Contract but no later than 30 days before the training is to commence. The Contractor shall develop and submit a comprehensive training programme for approval by the Employer. The training programme shall include all aspects necessary to enable the Employer to effectively operate and maintain the system.

The personnel to be trained on-site could consist of managers, engineers / team leaders, operations and maintenance personnel. The Contractor shall also train a team of two (2) welders to be accredited and certified by the Contractor at the end of training to carry out high pressure and pressure parts welding.

Each element of the on-site training programme shall concentrate on a specific system / Plant area and shall include but not be limited to the following components:

- a) Standard performance of Plant;
- b) Control and protection functions;
- c) Tools and equipment;
- d) Safety requirements; and
- e) Operation and Maintenance Manuals, including manufacturers' manuals, drawings and Plant documentation.

48.6.3.2 Facilities and Training Materials / Aids

The Contractor shall provide suitable on-site facilities to support the training programme jointly agreed by the Employer and the Contractor.

The Contractor shall provide for training materials, textbooks, manuals and other materials required for the Contractor's training programme. Classroom equipment such as overhead projectors, white / blackboards, DVD players and monitors, shall be provided by Contractor. Training aids such as films, slides, interactive videos, software packages materials and supplies considered necessary by the Contractor to support, maintain and successfully supplement the Contractor's training programme shall be furnished by the Contractor for the training period. Instruction manuals, provided by plant suppliers, for operations and maintenance as included in the Operation and Maintenance Manuals shall form part of the basic reference material, in addition to any other references that may be required.

48.6.3.3 Language Requirements

The language for training shall be English.

48.6.3.4 Trainer's Qualifications

Trainers shall be suitably qualified, through experience and education, to teach their respective subjects and shall be fluent in English.

48.6.3.5 Training Period

The training period shall be as defined in the Contractor's Training Programme and such training shall be completed prior to Taking Over. Contractor on-site training sessions shall be conducted over time scales within the training period as detailed in the Programme.

48.6.3.6 Training Evaluation Plan

The Contractor's training programme shall include a section dealing with a skills audit and a training evaluation plan. The success of the training programme will be measured against the training evaluation plan.

The Employer reserves the right to review and discuss with the Contractor all training materials / aids, course outlines, training schedules, steps, procedures, guidelines and other training matters.

Trainees will undergo competency assessment at two points within the training period. The Employer will first undertake a competency assessment prior to commencement of training and secondly at the completion of training. The Contractor shall keep comprehensive records of all the personnel who have been trained in a format agreed by the Employer and these records shall become the property of the Employer, to be used in the final assessment of staff. As a minimum the records kept by the Contractor shall include:

- Training subjects and material covered;
- Name and ID number of all trainees trained;
- Outcomes of examination of trainees; and
- Final sign-off from the Contractor that all training in terms of the Specification has been completed.

The Contractor shall arrange for representatives from selected major Plant suppliers to provide specific training concerning the construction, engineering, operation and maintenance of the Plant and equipment provided under the Contract, including Civil Works. The Employer will review and audit the training programme and individual performance at any time for Contractor's compliance before accepting the successful completion of any part of the training programme.

48.7 COMMISSIONING

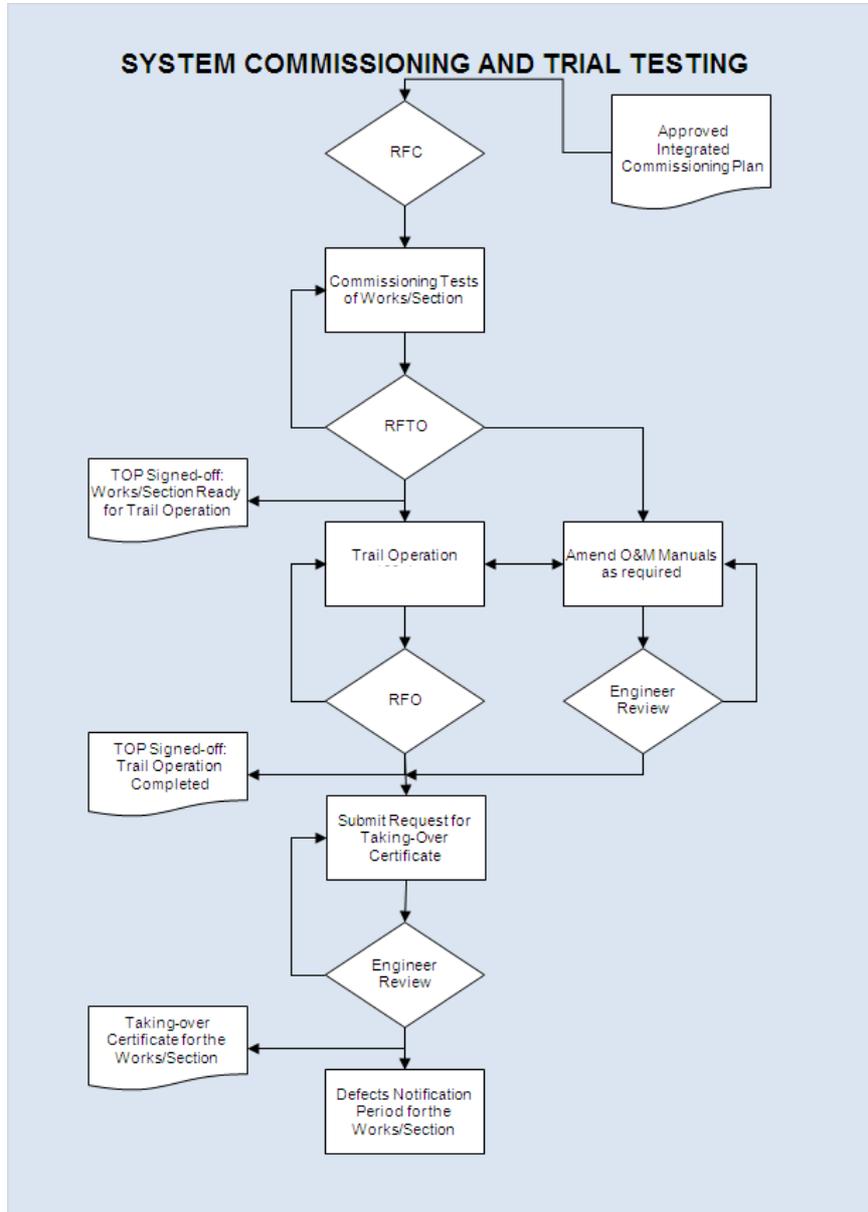
48.7.1 Commissioning Process

The Commissioning process forms part of the Contractor obligations. The Commissioning process confirms compliance of the performance of the various structures and Plant components with the Specification.

Due to the fact that in this Contract design responsibilities are shared between the Employer and the Contractor, the integration of the Commissioning processes is essential. The Contractor shall

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co-ordinate and be responsible for the Commissioning of all the Works and the integrated system and shall request specific inputs from the Engineer related to the areas designed by the Employer. The Contractor shall plan and co-ordinate the Commissioning of the all the Works in close collaboration with the Engineer (Refer to the establishment of a commissioning team in Clause 48.3.1).



**FIGURE 48/3
COMMISSIONING AND TRIAL OPERATION PROCESS**

All Commissioning tests shall be performed in accordance with approved procedures in the Integrated Commissioning Plan in the form of formal Method Statements. The number and combination of system tests intended for the pump and gravity systems are reflected in Annexure 48/1 and 48/2. The tests indicated in the annexures are indicative only and the Engineer may change the number and or combination of tests as may be required.

48.7.2 Commissioning Functional Parts of the Works

The Engineer retain the right to instruct the Contractor to commission Parts of the Works which are functional and Ready for Commissioning should it be required in the interest of efficient integration of the tests on completion process.

The Contractor shall allow for independent commissioning of each Part (and sub-Parts where necessary and applicable) as per the Project Structure Diagram. The planned commissioning of Parts and sub-Parts shall be detailed in the Tests on Completion Plan.

48.7.3 Use of Plant during construction

The Contractor is allowed to commission and use the DGEOT and portal cranes during construction under certain conditions to be agreed by the Engineer. These conditions shall be at least, but not limited to the following:

- a) The Contractor shall take over the crane for coordinated use during Construction;
- b) The Contractor shall perform monthly routine examinations during regular working hours with competent personnel and conduct the necessary preventive maintenance operations. The cost for "call-outs" during this period must be included in the rates;
- c) Taking over by the Contractor shall not be deemed as Taking Over by the Employer / Engineer in terms of the Conditions of Contract;
- d) The Contractor shall touch up paint work, service and re-commission the DGEOT crane prior to achieving the Ready for Trial Operation (RFTO) milestone;
- e) The Contractor shall arrange and provide the support services required for the Trial Operation and Defects Notification Period;
- f) All electrical installations shall comply with the requirements of the latest Electricity Regulations and Code of Practice, SANS 10142 as amended and a Certificate of Compliance (CoC) shall be issued by an independent accredited electrical contractor; and
- g) The crane and the Contractor's operator(s) need to comply with all OHS regulations including, but not limited to load tests, lifting tackle tests, operator certification.

48.7.4 Local Wet Commissioning

After each component has been designated as Ready for Commissioning (RFC), the Contractor shall commence with Local Wet Commissioning test runs which shall include the same operations as for Dry Commissioning tests but with the Plant loaded (e.g. energised and filled with water).

Local Wet Commissioning shall include:

- a) Performance testing of all Plant at specified duties and efficiencies for at least 24 hours continuously;
- b) Checking of levels, flows, pressures, temperatures, vibration and sound levels at minimum and maximum operating conditions for all operational scenarios;
- c) Water tightness tests of installations at full load;
- d) Local functional and local control loop testing; and
- e) Power consumption and Efficiency of Plant.

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After the Local Wet Commissioning of each Section of the Works has been completed successfully, the Remote Wet Commissioning of the integrated Works will commence. This can only commence once all the Parts and the entire system have been wet commissioned successfully at a local level. Following the successful completion of Local Wet Commissioning the Contractor will designate each completed Part as Ready for Remote Wet Commissioning.

48.7.5 Remote (Regional) Wet Commissioning

After each process has been designated as Ready for Remote Wet Commissioning, the Contractor shall commence with Remote Wet Commissioning test runs which shall include the same operations as for Local Wet Commissioning tests but with all the Plant operated as an integrated system transferring water. In addition to the tests indicated for Local Wet Commissioning the following additional tests shall be performed:

- a) Control and communication tests on both communication networks and the entire system;
- b) System transfer rates;
- c) Pumping line system curves and pump performance (duty points, efficiency, NPSH, kW etc.) demand for all possible operation scenarios as agreed with the Engineer;
- d) Off-take flow control rates and pressures;
- e) Confirmation of the actual steady state and transient (surges / water hammer) system behaviour through independent high-frequency pressure (and flow if deemed necessary) logging;
- f) System water losses; and
- g) Energy consumption at each pump station.

After successful completion of the Remote Wet Commissioning of all components of the Works, the Ready for Trial Operation (RFTO) status shall be achieved.

48.7.6 Spare Parts Requirements

Spares required by the Employer are indicated in the BoQ Part for Tests on Completion. Spares are to be delivered to the respective pumping station sites or stores prior to achieving RFO. Where applicable, spares are subject to quality control procedures and witness testing. Spare rotating elements of pumps must be supported on a purpose made stand in the respective pumping station.

The spares must be handed over as a complete unit, to be taken into stock in a DWS store for safe keeping (except for the rotating elements). Any spares used during the Commissioning period must be replaced before RFO.

The Contractor shall identify in separate lists, additional critical spare parts required for the continued operation of all mechanical, electrical and electronic Plant based not only on a reliability analysis of the Plant, but also on the reliability and availability of local suppliers of spare parts. The lists shall also include all long lead maintenance items and special maintenance tools that will be required during the maintenance of the Plant by the Contractor. The final lists of additional critical spare parts must be submitted to the Engineer prior to achieving RFTO.

48.8 TRIAL OPERATION

48.8.1 Trial Operation Process

The third stage for Tests on Completion is the Trial Operation Stage which shall demonstrate that the Works perform reliably and in accordance with the Contract over the required period as stated below. This stage is triggered by the Engineer certifying that the Commissioning has been successfully completed and that the Ready for Trial Operations (RFTO) status has been achieved. However, this shall not constitute a Taking-Over of the Works.

The Trial Operation shall be continued until the following is achieved:

- Demonstration of system reliability / availability;
- Demonstration of system integrity with regard to system losses; and
- Demonstration of continued system performance.

A detailed procedure for conducting the Trial Operation shall be developed by the Contractor and agreed between the Contractor and the Employer.

Once the Trial Operation has commenced, the Works shall be operated successfully for a minimum period as stated in the Appendix to Tender with interruptions only to alter Plant settings, effect final settings and optimization, test auto-functionality and train the Employer in the final detail functioning of the Plant. During the Trial Operation Period, the Contractor shall record all operational data and on completion submit to the Engineer a report confirming final settings, calibration, auto control functions and approved tests, all to the satisfaction of the Engineer.

The Contractor shall programme and price for providing full technical and operational support during this Trial Operation Stage.

Figure 48/3 reflects the flow of information during this stage of the Tests on Completion.

Once the Trial Operation Stage has been completed successfully in the opinion of the Engineer, the Contractor shall agree the date of the final Performance Test with the Engineer. The Performance Test shall establish:

- The transfer capacity for the level in the supply sources (dams, weirs, reservoirs etc.) at the time of test, functionality and efficiency of the Works; and
- That the Works meet the required performance under the specified operating scenarios.

If the outcome of the Performance Test is not satisfactory it shall be repeated again immediately after any required modifications are completed. During the execution of the Performance Test, the Contractor shall provide all appropriate technical information derived from the results. On successful completion of the Performance Test, a takeover report shall be drawn up by the Contractor and submitted for the Engineer's approval and signature.

Despite a finite time period be allocated for the Trial Operation Stage, this Stage will only be complete when the Taking-Over Certificate is issued for the Works.

All failures occurring during the Trial Operation Stage will be subject to a root cause analysis and repaired accordingly by the Contractor. A failure investigation analysis and close-out report shall be submitted for each failure of any part of the Works.

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If declared unsuccessful, the Contractor may request a repeat of the Trial Operation Stage. Under such circumstances the Contractor shall repeat the Trial Operation or the Performance Test as determined. The costs in performing this, or any further Performance Tests, will be for the Contractor's account.

48.8.2 Pipe Coating Integrity Surveys

Although covered under the trial operation stage of tests on completion, the pipe coating integrity surveys shall be undertaken at the following stages of pipeline construction:

- a) Stage A: Pipe laid in the trench prior to backfilling (Part of daily production);
- b) Stage B: Backfilling completed before achieving RFC (5 km sections);
- c) Stage C: Commissioning and all construction completed but before issuing the TOC; and
- d) Stage D: At the end of the Defects Notification Period (DNP) before issuing the PC.

Surveys during pipe construction stages A and B shall be undertaken by the Contractor. Surveys related to TOC (Stage C) and DNP (Stage D) shall be executed by a Specialist Subcontractor appointed by the Contractor and approved by the Engineer.

The following surveys shall be done:

Stage A: Holiday detection "over the ditch" prior to backfilling.

- a) High Spark EID testing as per relevant system in Section 37.

Stage B: After backfilling of pipes and before commissioning: This will be executed in sections not exceeding 5 km of the pipeline (unless otherwise approved by the Engineer) and, if the survey indicates complete integrity, the section will be approved and signed off by the Engineer as an interim construction testing milestone.

- a) Construction DCVG – Clause 37.34.3; and
- b) Specific coating conductance – Clause 37.34.4.

Stage C: At completion of the pipeline and before achieving RFTO:

- a) Pipeline overall current drainage test (CDT) – Clause 37.34.5; and
- b) Hybrid CIPS/DCVG – Clause 37.34.5.

Compliance is a requirement for achieving RFTO.

Stage D: At the end of the Defects Notification Period (DNP):

- a) Hybrid CIPS/DCVG – Clause 37.34.5.

A Performance Certificate (PC) will only be issued if the pipe coating survey process proves the integrity of the coating of the complete pipeline.

All survey results shall be submitted to the Engineer as per the agreed format and timeframe.

Acceptance criteria:

- a) Holiday detection – no defects;

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- b) Construction DCVG – No defect indications > 5 %IR or as determined by excavation;
- c) Specific Coating Conductance – <60 $\mu\text{S}/\text{m}^2$;
- d) Pipeline CDT – <60 $\mu\text{S}/\text{m}^2$; and
- e) Hybrid CIPS/DCVG – full protection in terms of relevant CP criteria and as determined by the Engineer.

Should it be necessary for the Engineer to undertake additional pipe coating integrity surveys as a result of coating defects, the Contractor will be responsible for the cost thereof.

Refer to Section 37 for more detail of these surveys / tests.

48.8.3 Maintenance Support

The Employer requires continuous maintenance support on Plant after completing commissioning. The Contractor shall provide maintenance support for all Sections of the Work for which a Taking Over Certificate has not been issued. To this end, only Plant which has a demonstrated historical, current and future maintenance support presence in South Africa will be accepted for incorporation into the Works.

The Contractor shall specify for use in the Permanent Works only such items of Plant and Materials as have proven track records of being adequately maintained within South Africa. Whether or not such requirement is met in respect of any Plant or Materials shall be determined by the Employer on a case-by-case basis using the following approach:

- a) The successful operation and maintenance of such Plant and Materials manufactured by the same manufacturer of a similar size and design for a minimum of five years; and
- b) Current on-going operation and maintenance support on three or more infrastructure projects in South Africa.

48.9 OPERATION AND MAINTENANCE MANUALS

The stages at which the review and approval process of the Draft and Final Operation and Maintenance Manual (OMM) shall take place shall be agreed as part of the approval of the Tests on Completion Plan and Program. A draft copy of the Operation and Maintenance Manual (OMM) shall be available during Pre-commissioning Stage 2 for all the components of the Works. The draft copy of the manuals shall be submitted for approval together with the TOP's (i.e. signed-off manufacturing drawings and the relevant quality documentation).

The draft copy of the OMM shall be updated during the Commissioning and Trial Operation stages for submission of the final OMM to the Engineer for approval before the issuing of the Taking-Over Certificate.

48.9.1 General Contents

The purpose of these documents is to simultaneously provide a permanent and accurate record of all the Plant provided as well as a usable guide in simple language covering operating, maintenance and fault-finding procedures.

Where appropriate copies of approved final design calculations shall form part of the manuals. It shall provide complete particulars, charts and diagrams with regard to lubrication, servicing,

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overhauling as well as testing operations (including the Tests on Completion prescribed in the Specification as may be amended) and maintenance of all items of equipment referred to above.

Where these manuals contain sections which have been translated, one copy of the translated sections in the original language shall also be submitted in a similar file and cross-referenced with the related manual(s). Refer to OMM format included in Annexure 48/3.

Operating instructions shall be clear, concise and easy to follow and must include, where applicable, pre-start, start up, shut down and safety procedures.

The Operation and Maintenance Manuals shall further provide all the information required to identify and obtain replacement parts and shall include parts lists and the addresses of local suppliers as well as pictorial presentations of the sequences of disassembly and assembly of major as well as sub-assemblies down to the component parts.

A collection of manufacturer's descriptive leaflets, instruction sheets, charts, lists, pamphlets and the like will not be acceptable in place of these requirements, though it may be provided as complementary thereto.

The Turnover Packages (TOP) shall be in a separate file system than the OMM as discussed in Clause 48.10. The main reason is that the OMM files will be used on a regular day-to-day basis by operators and maintenance personnel while the TOP will only be used by supervisors to track any history on the production and/or testing of systems and subsystems that were executed at the factory and on site.

48.9.2 Format and Layout

The Contractor shall produce Operation and Maintenance Manuals in the following format for all the components of the Works (refer to Annexure 48/3).

The manual shall comprise of volumes covering the following aspects:

- Volume 1 – Systems Overview: This volume shall describe an overview of the project with scheme outlay with its system components and will include a copy of the PFD's, layouts and P&ID's for reference purposes, and will be developed for any person wishing to gain a general insight into the scheme and sub-system components.
- Volume 2 – System Operation and Control Manual: This volume shall describe detailed operational instructions to be used by operations and maintenance personnel explaining the daily running procedures and scheduled maintenance of the Plant and its components. This volume shall also explain alarm signals and interpretation thereof, listing possible fault conditions and remedy actions with cross reference to Volume 4.
- Volume 3 – System Maintenance Matrix (Discipline Reference): This volume shall summarise the detailed maintenance instructions provided in Volume 4 to be used by operations and maintenance personnel and presented per discipline.
- Volume 4 - System Maintenance Manual (Area Integration): This volume shall provide technical information and specifications to be used by operators and maintenance personnel required for the routine maintenance requirements of the Works, Plant and Components presented per operational area.

This Volume 4 shall contain the manufacturer IOM's (Installation, Operation and Maintenance) documents from specialist suppliers providing manufacturer's routine maintenance, troubleshooting, repair and refurbishment instructions to be used by mechanical, electrical and instrumentation personnel, supervisors and procurement

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officers. This volume shall also provide specifications and technical schedules of all mechanical, electrical and instrumentation components supplied by specialist suppliers together with spare parts list from suppliers / agents. It shall furthermore include suppliers / agents original brochures and instrumentation literature. It shall also include general arrangements drawings, assembly drawings, hydraulic and electrical diagrams, parts and material lists in A3 and flow discharge curves.

The content of the following volumes are described in 48.10: Turnover Packages:

- a) Volume 5 – Manufacturing Records;
- b) Volume 6 – Installation Records;
- c) Volume 7 – Commissioning and Trial Operation Records; and
- d) Volume 8 – Record Drawings.

Drawings and as built drawings of the Contractors design shall comply with the requirements stated in Section 28.6. The production of as built drawings shall be paid for as part of the payment items for design and documentation covered under the different Sections of the Specification. Where the Employers designed drawings are marked up (“red lined”) by the Contractor for as-built record purposes, the Engineer will produce the record drawings for inclusion in Volume 8. The cost to mark up these drawings are covered by payment item 48.003.

Each of the volumes with their sections shall be separated by plastic dividers, clearly and visibly marked to match the index, and shall be set out as follows:

- a) Title page;
- b) Table of Contents;
- c) Document Map to give a relative orientation to the complete suite of OMM documents for ease of quick reference; and
- d) List of Annexures applicable to each of the volumes.

Where it is not possible to include all items of a particular section of the Plant in one binder, several binders as necessary shall be provided and all binders for that section of the Plant shall bear the same volume number, but with the sections contained therein clearly defined on the front cover and spine.

48.9.3 Binding

Two (2) hard copies and two (2) soft copies of the final version of each manual shall be delivered to the Engineer together with the Contractor’s drawings before the Taking-Over Certificate can be issued.

Each manual shall be securely bound in A4 size, hard backed plastic / waterproof 4-ring binders, with clear pockets on the spine and front cover for the insertion of title slips, giving the Contract Number, Scheme, Functional Area and a description of the Plant covered.

Drawings shall be securely bound in A3 size. Drawings larger than A3 size, index and other title pages shall be contained in separate plastic pockets, bound in the appropriate section of the manual.

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Where it is not possible to include all items of a particular functional area or a particular element of Plant in one binder, several binders as necessary shall be provided and all binders for that functional area or element of Plant shall bear the same volume number, but with the sections contained therein clearly defined on the front cover and spine.

48.9.4 Manual Printing Quality

Information and data supplied in the manuals shall be original documents or high quality copies thereof. Copies of faxes will not be accepted. Where these manuals contain sections which have been translated, one copy of the translated sections in the original language shall also be submitted in a similar file and cross-referenced to the related manual(s).

48.9.5 Approval

Two (2) draft copies of each manual shall be delivered to the Engineer, for his approval, before the commencement of the Tests on Completion. The final version of the manuals shall further incorporate any amendments found necessary during execution of the Tests on Completion.

48.10 TURNOVER PACKAGES**48.10.1 General Contents**

The Contractor shall be responsible for the compilation of the Turnover Packages (TOP's) and submission thereof to the Engineer for approval. The main purpose of the Turnover Packages (TOP's) is to collect all manufacturing and installation records for all engineering disciplines as well as commissioning records and as-built records to demonstrate that the complete installation performs as per design requirements. The TOP's will be used to track any history on production and/or testing results of sub-systems and systems.

48.10.2 Format and Layout

The Turnover Package (TOP) shall as a minimum contain the following volumes:

- a) Volume 5 – Manufacturing Records: The purpose of this volume is to provide all manufacturing and factory testing records for all engineering disciplines, i.e. civil, mechanical, electrical and instrumentation. All relevant Data Packs shall accompany the relevant Plant component as part of the transfer of the quality records. This shall inter alia include material certificates, manufacturing QCP's, welding procedures and certificates, factory acceptance testing (FAT) where required, pre-delivery and post-delivery inspections, storage inspections and pre-installation inspections.
- b) Volume 6 – Installation records: The purpose of this volume is to provide records that a particular system has been checked and tested and correctly installed as per design requirements. This volume shall include all onsite signed inspection reports, non-conformances, testing records (results) of construction activities for all engineering disciplines, i.e. civil, mechanical, electrical and instrumentation. All relevant Data Packs shall consist of installations QCP's that inter alia shall include pipeline construction records (i.e. welding records, joint repairs, hydrostatic pressure testing, pipe coating integrity survey results, AC Mitigation and Cathodic Protection survey, etc.), concrete test results, pipeline backfilling records, etc. The various discipline leads of the Contractor and the Engineer shall sign off the C1 Acceptance Certificate to demonstrate that installation has been successfully completed.

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c) Volume 7 – Commissioning and Trial Operation Records:

Pre-commissioning Records: The purpose of this volume is to provide pre-start check lists of a particular system(s) to be dry tested accompanied by pre-commissioning activity notes and tests results. The various discipline leads of the Contractor and the Engineer shall sign off the C2 Acceptance Certificate to demonstrate that pre-commissioning has successfully been completed. The record of the Engineer's confirmation of the RFC status shall be included.

Commissioning Records: The purpose of this volume is to provide pre-start check lists of a particular system(s) to be wet tested accompanied by commissioning activity notes and test results to confirm compliance with the design requirements. The various discipline leads of the Contractor and the Engineer shall sign off the C3 and C4 Acceptance Certificates to demonstrate that commissioning has successfully been completed. The record of the Engineer's confirmation of the RFTO status shall be included.

d) Volume 8 – As-built Information: The purpose of the volume is to provide all as-built drawings to record the final as constructed dimensions, levels and materials of the various system components installed.

The above volumes shall furthermore be divided into various sections as required representing each of the systems and sub-systems, i.e. pipelines, pump stations, reservoirs, control rooms, etc.

The Contractor shall submit one (1) original hardcopy and two (2) electronic copies of the Turnover Package to the Engineer.

48.10.3 Binding

One (1) hard copy and two (2) soft copies of the final version of Turnover Package shall be delivered to the Engineer together with the Contractor's drawings before the Taking-Over Certificate can be issued.

The TOP shall be securely bound in A4 size, hard backed plastic / waterproof 4-ring binders, with clear pockets on the spine and front cover for the insertion of title slips, giving the Contract Number, Scheme, Functional Area and a description of the Plant covered.

Drawings larger than A3 size, index and other title pages shall be contained in separate plastic pockets, bound in the appropriate section of the TOP.

Where it is not possible to include all items of a particular functional area or a particular element of Plant in one binder, several binders as necessary shall be provided and all binders for that functional area or element of Plant shall bear the same volume number, but with the sections contained therein clearly defined on the front cover and spine.

48.10.4 Manual Printing Quality

Information and data supplied in the TOP's shall be original documents or high quality copies thereof. Copies of faxes will not be accepted.

48.10.5 Approval

The original copy of the TOP's shall be available to the Engineer, for his review and approval, before the commencement of the Tests on Completion, unless otherwise approved by the Engineer. Since

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the TOP is a live document it can be expected that tests results will be slotted into the TOP during execution of the Test on Completion.

48.11 SPECIFICATION INTEGRATION

This Section should be read in conjunction with the following Specification Sections:

Section 1	:	General
Section 28	:	Mechanical General
Section 29	:	Hydro Mechanical Plant
Section 30	:	Pumps and Ancillary Plant
Section 31	:	Cranes, Hoists and Winches
Section 32	:	Pipes and Pipe Specials
Section 33	:	Laying and Pressure Testing of Steel Pipes
Section 34	:	AC Mitigation and Cathodic Protection
Section 35	:	Valves
Section 37	:	Painting and Corrosion Protection
Section 38	:	Electrical General
Section 39	:	Electrical Plant and Installation
Section 40	:	Control and Instrumentation General
Section 41	:	Control and Instrumentation - Plant and Installation
Section 43	:	Security General
Section 44	:	Security Plant and Installation
Section 46	:	Building Work

The requirements of the Dam Safety Office shall also be taken into account as communicated by the Approved Professional Person (APP) via the Engineer.

48.12 EQUIPMENT FOR THE EMPLOYER

The Contractor shall supply all special tools and test equipment to be used by the Employer during the life of the Works, for the Engineer's approval, to enable any erection, dismantling, reassembly or testing to be carried out on all parts of the Plant, whether of an electrical, mechanical or other nature. Payment for these tools and equipment shall be at the rates entered in the Bill of Quantities.

The tools and test equipment shall not be used for erection and except that the Engineer may call upon the Contractor to demonstrate their use and effectiveness, they must be handed over to the Employer in a completely new and unused condition. Should the Contractor require any such tools and test equipment at the Site during erection, he shall provide his own.

The tools for each different type of Plant shall be contained in suitable boxes clearly marked or labelled with their description and a description of the relevant type of Plant. Each tool shall be identified and a list of tools, stamped on a stainless steel plate, shall be affixed to the inside of the box lid. Boxing shall be deemed to be included in the rates entered for the tools. Each set of tools shall be supplied with the Plant with which it is associated.

The test and repair equipment shall include only special purpose items essential for testing or repair.

48.13 TESTING AND ACCEPTANCE CRITERIA

The Contractor shall, at his own cost, render all assistance and supply labour, appliances and any other materials, tools and testing equipment as the Engineer may require for checking the setting out, measuring up and inspecting any Part of the Works at any stage during manufacture. During such operations the Contractor shall if required, suspend any or all the Works without having any claim for delay and/or loss or damage as a result thereof.

The results of all off-site (Factory and other location) and Site tests carried out by the Contractor in accordance with the requirements of the Specification shall be recorded, certified as correct and submitted to the Engineer in triplicate. A test certificate shall be provided for each specific test.

48.13.1 Tests during Manufacturing

The Contractor shall be held fully responsible for the correct and satisfactory testing of all major Plant during manufacturing. Performance tests shall be made on each item of major Plant at the manufacturer's works and test certificates issued on successful completion.

Testing requirements during manufacturing shall include, but shall not necessarily be limited to, the following:

- a) Materials testing;
- b) Weld testing;
- c) Pressure testing of pipe work, pump casings and valves;
- d) Factory performance tests for pumps and motors; and
- e) Testing of linings and coatings.

The detail of these tests during manufacturing and the associated acceptance criteria are covered in the relevant sections of the Specification for this Contract.

48.13.2 Tests during Pre-commissioning

The Contractor shall be responsible for the planning and performance of pre-commissioning tests to obtain operational data for Plant, compatibility of operation with interfacing systems and verification of the functional performance of these systems.

Firstly, the Contractor shall undertake an inspection of the Plant to check conformity with flow diagrams, construction drawings and Specification. The required functional completion of the integrated system is defined in Clause 48.6.2. The successful pre-commissioning of all Plant is one of the requirements to achieve the status of Ready for Commissioning (RFC). The primary acceptance criteria for the pre-commissioning process are based on proof of unloaded functionality. The unloaded functionality does not mean that the pipe system is not filled with water and checked for leaks. The Contractor shall prove the system to be leak free prior to achieving RFC.

The pre-commissioning tests shall commence on the water supply system and circuitry and shall be checked and pressure or load tested to ensure safe testing under full capacity before commencing Commissioning on any part of the installation. The settings on all protective instruments and timing devices shall be checked for compliance in accordance with the manufacturer's characteristic curves. The Contractor shall check and satisfy himself that all items of installation and Plant are correctly aligned, wired and connected and that relevant TOP's and CoC's are signed-off before start-up. The operation of all Plant shall first be tested in "manual" sequence before undertaking "automatic" sequence control.

PART C3.1 - SPECIFICATION

The Contractor shall also ensure that the system components / Plant and piping is cleaned by appropriate flushing / recirculation and that the commissioning tasks can be executed in a safe environment. The commissioning environment inside the pump station, inside the control room and inside the security control room shall be dust free.

All snag listed items that have been categorized to be completed before RFC, shall be signed-off as completed prior to achieving RFC.

All cost associated with tests undertaken during pre-commissioning shall be included in the installation rates and is not measured separately.

48.13.3 Tests during Commissioning

Commissioning tests shall only follow achievement of RFC unless agreed otherwise with the Engineer. The Commissioning tests shall be similar to the pre-commissioning tests but simulating as far as practicable the fully loaded Plant operating conditions, including anticipated operational occurrences at typical temperatures, pressures and flow rates. Refer to Annexure 48/1 and Annexure 48/2. The duration of Commissioning tests shall be such that a steady state operating condition is achieved, in order to determine whether the structures, systems and components are operating according to the Specification.

Trial operations will only be allowed to commence after successful completion of the above tests. All commissioning work is to be carried out by skilled commissioning resources familiar with the Plant and the operation of the installation.

The Contractor shall be responsible for initial checking of flow rates, vibration and clearances and other provisions shall be made for accommodating expansion of components or systems. The safe and stable operation of instruments and other Plant items at high temperatures shall be verified and the relevant operating techniques confirmed.

The Commissioning Test programme shall follow the system testing procedures, prior to start-up of the Plant. The start-up of each system or Plant shall be undertaken in the presence of the authorised representatives of the supplier of the pumps or other mechanical Plant suppliers, the electrical suppliers, the instrument suppliers, the Contractor and the Engineer. All TOP's and CoC's shall be signed off prior to the start-up on any part of the Plant as to ensure safety to personnel, avoid damages to Plant and the environment.

Detailed Plant Commissioning tests are generally covered in the relevant Sections of the Specification. However, the following Plant tests are specifically required under this Section:

48.13.3.1 Valves

Functionality tests shall be undertaken on all installed valves to tests against full operational conditions and check for leakages in jointing material. This test shall consist of taking the valve through one complete cycle, from fully closed to fully open and back again in the case of butterfly and gate valves.

Valves equipped with opening and closing limit switches as position indicators shall be tested and adjusted to coincide with the actual position indicator of the valve. For motorised valves the Contractor shall ensure that the actuators have been correctly assembled to the valve as directed in the installation instructions and that the control circuit wiring is correct and in accordance with the overall control system wiring diagram. Motorised valves shall be checked for correct operation of the valve when power is applied from the controller or device and to confirm that the actuator operates in both directions.

PART C3.1 - SPECIFICATION

It is the responsibility of the Contractor to ensure that the pipelines connected to valves are flushed out before the Plant start-up, as to ensure that pipelines are free of debris, trash, weld slag etc., which could cause damage to the valve's seal compromising its performance and potentially damaging Plant downstream.

48.13.3.2 Pump and Transfer System

The Contractor shall perform tests on pumps as fully described in Section 30 – Pumps and Ancillary Plant. The tests shall include complete design integration between PLC's and SCADA control and instrumentation systems and the maximum quantity of pump lines as per design as well as various combinations between the pump lines. During these tests the Contractor shall verify the inlet / outlet pressure readings, compare to Test and Balance Report, pump design conditions, and manufacturer's performance data. Pumps will be tested at shut-off, 100% flows and compared to readings on pump characteristic curves to confirm that the specified flows are obtained. A NPSH pump tests shall only be conducted when the minimum NPSH required is exceeded by 2 m.

Two separate series of tests called the Preliminary Acceptance Test and Final Acceptance Test shall be carried out by the Contractor on all pumping units after installation. Test measurements shall generally be carried out in accordance with BS EN ISO 9906 Part 1 Class C.

Requirements for system losses, efficiency, effective control, surge conditions and protection shall be addressed as part of the approval of the Contractors design.

a) Preliminary Acceptance Tests

The Preliminary Acceptance Test shall be carried out by the Contractor after he has run the Plant for a period of at least two days in the case of units of 55 kW or over and is satisfied that the pumping units are ready to be taken over by the Employer. The Contractor shall provide all the necessary instruments, staff and labour for the tests. A representative of the Engineer will be present at all tests and shall be provided with full details and the calculated results.

If in the Preliminary Acceptance Test the characteristics in regard to discharge and efficiency at "duty point(s)" head, after allowing a tolerance prescribed by BS EN ISO 9906 Part 1 Class C in the overall efficiency of pump and motor, fall short of those specified or stated in the Data Sheet, as approved, the Contractor shall immediately remedy the defects to ensure that the installation complies with these requirements, at his own expense and within such time as may be laid down by the Engineer. When the Contractor has made good the defects, and is satisfied that the pumping unit is ready to be taken over by the Employer, a second Preliminary Acceptance Test shall be carried out, by the Contractor.

If, in the second Preliminary Acceptance Test, the performance of any of the pump units falls short of requirements, using the criteria in the preceding paragraph, the Plant or part thereof may be rejected, in which case the Contractor shall take immediate steps to replace the rejected Plant with Plant complying with the Specification. Further, any payments made by the Employer to the Contractor in respect of such rejected Plant shall be repaid by the Contractor within 30 days of such rejection or may be recovered from the Contractor by the Employer through payment certificates or recovering it through the Performance Security etc. The Employer reserves the right to claim for damages in such event.

Such replaced Plant shall be subjected to a Preliminary Acceptance Test and the provisions of the two preceding paragraphs shall apply thereto.

b) Final Acceptance Test

The Final Acceptance Test shall be carried out not less than three months after an acceptable Preliminary Acceptance Test. This can be undertaken during the Trial Operation stage. The Contractor shall provide all necessary instruments, staff and labour for the tests and a representative of the Engineer will be present at all tests and shall be provided with full details and the calculated results as specified in Clause 30.11.3.

If, in the Final Acceptance Test, the discharge and efficiency characteristics at "duty point(s)" head fall short of those specified or stated by the Contractor in his Tender, the remedial measures and second Final Acceptance Test procedure shall be carried out, and replacement Plant supplied if required.

Such replaced Plant shall be subjected to a Preliminary Acceptance Test, with the provisions for rejection and replacement stipulated for the Preliminary Acceptance Test, and also to the Final Acceptance Test specified above.

Should any Plant component continue to fail, a root cause analysis shall be performed by a mutually agreed independent party at the Contractors cost. The final accepted results of such analysis shall determine subsequent commercial remedies. Should the Contractor fail to perform such root cause analysis within a reasonable period of time the Employer reserves the right to facilitate such analysis and recover the cost from the Contractor.

48.13.3.3 Hydro-mechanical Plant

The commissioning programme is to be agreed in terms of the requirements of this Section.

Wet testing (in liaison with the Engineer, Contractor and appropriate other Subcontractors where interfaces exist), of the gates shall include (but not necessarily be limited to) the following:

- a) Repetition of all the tests specified under Pre-commissioning Testing, in the presence of water; and
- b) Determination of leakage past gate seals under minimum and maximum available head and adjustment where necessary to meet the requirements of Clause 29.5.3. in Section 29 – Hydro-Mechanical Plant.

48.13.3.4 Regional and Local Communication Systems

During Commissioning the Contractor shall test the following at each node on the primary and secondary communication systems as well as the integrated regional communication system:

- a) Transmitter modulation level operating with Outstations;
- b) Receiver output levels;
- c) Antenna VSWR measurements;
- d) Transmitter output level and frequency;
- e) Repeater Station talk-through tests;
- f) Performance of all links;
- g) Configuration management of switches;
- h) Network analysis tests to identify and resolve communication bottlenecks; and
- i) Performance of primary and secondary networks and switchovers during simulated breakdowns at each communication node.

The Contractor will be required to provide the test equipment necessary for the execution of all the listed tests.

48.13.4 Trial Operations

The Contractor shall be responsible for all operations necessary for the adjustment and testing of the Plant until it has been taken over.

During the whole of the tests to be carried out, the Contractor shall be wholly responsible for the preservation, care and remedying of any defects in the Plant and he shall provide all labour, supervision, apparatus, materials, stores, instruments etc., necessary for these operations.

The Contractor shall permit and facilitate the Engineer's observation of the erection, installation, and testing of all Plant. The Contractor shall submit a report certified by him of the results of the testing to the Engineer prior to achieving RFO.

The Contractor shall ensure that specialist personnel from Subcontractors are available for the entire planned duration of the tests, and have made contingency plans to remain present in the event that the tests over-run their expected duration.

48.14 TESTS AT THE END OF THE DEFECTS NOTIFICATION PERIOD

During the Defects Notification Period, a minimum of three scheduled recalibration visits shall be undertaken in the presence of the Engineer, the last one to coincide with the Final Inspection at the end of the Defects Notification Period for the purpose of issuing the Performance Certificate. During these recalibration visits the Contractor shall confirm compliance with the maintenance requirements as instructed by the Operation and Maintenance Manual to the maintenance staff of the Employer to ensure the execution of the correct maintenance procedures. An inspection report of these visits shall be issued within two weeks following the visit.

The Contractor will be required to perform a root cause analysis of each defect that resulted in a water transfer system interruption during the Defects Notification Period. The root cause analysis shall be documented by the Contractor and submitted to the Engineer.

The Contractor shall provide in his rates for checking the condition of the impellers during the Final Inspection, in order to prove that the pumps are entirely cavitation-free. The pumps shall be run continuously for at least 24 hours before the Final Inspection takes place.

The work to be performed by the Contractor at his cost during the Final Inspection shall consist of:

- a) Checking the pump / motor alignment after disconnecting the coupling;
- b) Visually inspecting of the impeller and casing (in the case of horizontally split casing pumps, removing the upper part will usually be enough for this inspection);
- c) Inspecting all bearings;
- d) Renewing gland packings;
- e) Renewing all lubricants;
- f) Checking that all valves are drop tight under working pressure; and
- g) Re-calibrating all flow, temperature and pressure monitoring Plant items.

Additional visits to Site may be ordered by the Engineer during the Defects Notification Period.

48.15 MEASUREMENT AND PAYMENT

The rates tendered under this Section shall not include for the general obligations, Contractor's Equipment and work deemed to be covered by the items provided in Section 1 – General or any other relevant Section.

The payment of all aspects and processes associated with design, manufacturing, installation up to and including pre-commissioning shall be covered in the relevant rates for such items allowed for under the specific Sections of the Specification. If no specific provision is made it will be deemed to be included in the installation rates for the relevant Plant items.

The rates tendered under this Section 48 deals with the Tests on Completion aspects and more specific processes associated with Commissioning, Trial Operation and Defects Notification Period.

48.001 Commissioning Unit : lump sum (Sum)

The Conditions of Contract and Appendix to Tender allows for a number of calendar days within which the system Commissioning process shall be completed after achieving RFC. The Contractor shall programme and price for providing full technical and operational support, documentation, testing and all other requirements in this Section during this Commissioning process.

48.002 Trial Operation Unit : lump sum (Sum)

The Conditions of Contract and Appendix to Tender specify a number of calendar days for the Trial Operation period after achieving RFTO. The Contractor shall programme and price for providing full technical and operational support documentation, testing and all other requirements in this Section during this Trial Operation process.

48.003 Operation and Maintenance Manuals Unit : lump sum (Sum)

Payment for all Operation and Maintenance Manuals (including Turnover Packages) will be made under this Section. The lump sum shall be inclusive of all cost associated with the input required during preparation, checking, printing copying, binding etc. Refer to Clause 48.9 in this regard. The extent of the services to be provided by the Contractor is covered in the Sections of the Specification. 50% of the payment will be due on achievement of Ready for Commissioning and 50% at the achievement of Ready for Operation (RFO).

48.004 Testing during Commissioning and Trial Operation Unit : lump sum (Sum)

Not applicable to this contract.

48.005 Training Unit : lump sum (Sum)

Payment for Training of Operational Staff will be made under this Section as set out in Clause 48.6.3. The lump sum shall be inclusive of all costs associated with the training programme and on-site training of personnel and shall be due at the achievement of Ready for Operation (RFO).

PART C3.1 - SPECIFICATION

48.006 Inspection and servicing during DNP

Payment for the calibration inspections and final inspection and servicing at the end of the Defects Notification Period (DNP) will be made as a lump sum per successful completion of each inspection event.

- | | |
|---|-----------------------------|
| a) Inspection service 1 | Unit: lump sum (Sum) |
| b) Inspection service 2 | Unit: lump sum (Sum) |
| c) Inspection service 3 and Final Inspection | Unit: lump sum (Sum) |

This lump sum will include for all obligations in respect of transport, travelling, materials, spares, staff and labour and removal of test facilities as required.

48.007 Plant spares required by the Employer Unit : No.

The rates tendered for the Plant spares required by the Employer (refer to Clause 48.7.6) will include for the supply, permanent packing for long term storage, delivery and off-loading on Site or at the DWS stores (as specified) of the Plant items. For the large pump, motor and valve items it will also include for all testing and inspections that are required as specified under the various sections of the Specification.

**48.008 Additional site visits in the Defects Notification Period (provisional) Unit : No of Visits (No)
Or: day (day)**

- | | |
|---------------------|---------------------------|
| a) Transport | Unit: No of Visits |
|---------------------|---------------------------|

The rate tendered for transport shall cover the total cost of transporting all personnel and equipment to and from Site.

- | | |
|---------------------------|------------------|
| b) Site operations | Unit: Day |
|---------------------------|------------------|

The rate tendered for site operations shall cover the full daily cost of all the wages of personnel, equipment, accommodation and local transport.

No payments will be made for additional site visits requested by the Employer or the Engineer unless the Contractor can satisfy the Engineer that the cause of the visit was due to circumstances beyond his control (i.e. other than malfunctioning of his equipment or incorrect programming of his system).

48.009 Routine inspections or services planned by the Contractor during the DNP Unit : lump sum (Sum)

This lump sum will include for all obligations in respect of transport, travelling, materials, spares, staff and labour and removal of service facilities as required and not covered by the above.

**ANNEXURE 48/1
PUMPING SYSTEMS
COMMISSIONING TESTING**

PUMPING SYSTEM COMMISSIONING TESTING

The Contractor shall demonstrate that the Duty Points can be achieved at the efficiency levels specified for all permutations and combinations of pump sets at all pumping stations.

The manner in which the Contractor plans to demonstrate compliance with the Duty Points shall be detailed in the Commissioning Plan.

**ANNEXURE 48/2
GRAVITY PIPELINE SYSTEM
COMMISSIONING TESTING**

Gravity Pipeline System Commissioning Testing by the Contractor shall include the following:

- a) Simulate various flow conditions in the pipeline through the off-takes or by opening selected scour valves. The flow conditions to be tested will be determined by the Engineer;
- b) Measure the flow at all the meters along the pipelines and at the off-takes and internal pressures at positions along the pipeline determined by the Engineer for the various flow scenarios to determine potential water losses and head losses along the pipeline;
- c) Simulate steady state and valve closing conditions to monitor transient system behaviour through independent high-frequency pressure logging at positions identified by the Engineer and flow logging at the flow meters;
- d) Test the functioning of scour valve installation including the energy dissipating structures;
- e) Test the functioning of pressure control valves;
- f) Testing of remote readings from the Operation and Control Centre of flows, pressures and opening / closing status of valves; and
- g) All other testing required by the Engineer.

**ANNEXURE 48/3
O&M MANUAL FORMAT**

Manual Structure and Document Mapping**OMM STRUCTURE (INDICATIVE)**

Volume	Section	Subsection	Description	Colour
1	1		Systems Overview	Salmon
		1.1	Introduction	
		1.2	Asset Management Strategy	
		1.3	Document Map and Manual Structure	
		1.4	Systems Description	
		1.5	OMM Users guide	
		1.6	Risk based decision making	
		1.7	Training	
		1.8	Document Control	
		1.9	Integration of MCWAP-1	
		1.10	Integration of RMS	
		1.11	Annexures	
2	2		System Operation and Control Manual	Yellow
		2.1	Document Use	
		2.2	Condensed Operational Summary	
		2.3	Functional Systems Operation	
		2.4	Security Systems Operation	
		2.5	Environmental Aspects	
		2.6	Health and Safety Aspects	
		2.7	Operational Records	
		2.8	Security Operational Records	
		2.9	Staffing Requirements	
		2.10	MCWAP 1 and RMS Interface	
		2.11	Annexures	

Volume	Section	Subsection	Description	Colour
3	3		System Maintenance Matrix (Discipline Reference)	Turquoise
		3.1	Document Use	
		3.2	Condensed Maintenance Summary	
		3.3	Civil Aspects	
		3.4	Mechanical Aspects	
		3.5	Electrical Aspects	
		3.6	Control and Instrumentation Aspects	
		3.7	CP and AC Mitigation Aspects	
		3.8	Environmental Aspects	
		3.9	Health and Safety Aspects	
		3.10	Staffing Requirements	
		3.11	MCWAP 1 and RMS Interface	
		3.12	Annexures	
4	4		System Maintenance Manual (Area Integration)	Green
			Pipelines:	
		4.1	Document Use	
		4.2	Summary	
		4.3	General Planned Maintenance	
		4.4	Condition Assessment	
		4.5	CP and AC Mitigation	
		4.6	Spares list	
		4.7	Environmental Aspects	
		4.8	Health and Safety Aspects	
		4.9	Maintenance Records	
5	5		Pumping stations:	
		5.1	Document Use	

PART C3.1 - SPECIFICATION

Volume	Section	Subsection	Description	Colour
		5.2	Summary	
		5.3	General Planned Maintenance	
		5.4	Mechanical Plant and Spares Aspects	
		5.5	Electrical Plant and Spares Aspects	
		5.6	Civil Aspects	
		5.7	Environmental Aspects	
		5.8	Health and Safety Aspects	
		5.9	Maintenance Records	
	6		Balancing and Break Pressure Reservoirs	
		6.1	Document Use	
		6.2	Summary	
		6.3	General Planned Maintenance	
		6.4	Condition Assessment	
		6.5	Environmental Aspects	
		6.6	Health and Safety Aspects	
		6.7	Maintenance Records	
	7		Sedimentation Works	
		7.1	Document Use	
		7.2	Summary	
		7.3	General Planned Maintenance	
		7.4	Condition Assessment	
		7.5	Environmental Aspects	
		7.6	Health and Safety Aspects	
		7.7	Maintenance Records	
	8		Weir	
		8.1	Document Use	
		8.2	Summary	

PART C3.1 - SPECIFICATION

Volume	Section	Subsection	Description	Colour
		8.3	General Planned Maintenance	Green
		8.4	Condition Assessment	
		8.5	Environmental Aspects	
		8.6	Health and Safety Aspects	
		8.7	Maintenance Records	
	9		Control Rooms and Integrated System Control	
		9.1	Document Use	
		9.2	Summary	
		9.3	General Planned Maintenance (C&I Functional)	
		9.4	General Planned Maintenance (C&I Security) *	
		9.5	Spares List	
		9.6	Environmental Aspects	
		9.7	Health and Safety Aspects	
		9.8	Functional System Maintenance Records	
		9.9	Maintenance Records (Security System)	
	10		Electrical Building and Substation Interface	Green
		10.1	Document Use	
		10.2	Summary	
		10.3	General Planned Maintenance	
		10.4	Spares List	
		10.5	Environmental Aspects	
		10.6	Health and Safety Aspects	
		10.7	Maintenance Records	
	11		Other Related Infrastructure Components	

PART C3.1 - SPECIFICATION

Volume	Section	Subsection	Description	Colour
		11.1	Document Use	
		11.2	General Summary	
		11.3	Water Treatment Plant	
		11.4	Access and Service Roads	
		11.5	Housing	
		11.6	Wet Services	
		9.7	Fencing	
		9.8	Storage Areas	
		9.9	Workshops	
5			Manufacturing Records	Purple
		12	Factory Data Packs and Spares Supplied Lists	
		12.1	Document Use	
		12.2	General Summary	
		12.3	Pipes and Pipe Specials	
		12.4	Valves and Sluices	
		12.5	Pumps and Motors	
		12.6	Hoisting and Lifting Plant	
		12.7	Transformers	
		12.8	Switch Gear	
		12.9	Flow meters	
		12.10	SCADA	
		12.11	Sedimentation Works	
		12.12	Water Treatment Plant	
		12.13	Oil Separating Plant	
	12.14	HVAC Plant		
6			Installation Records	Blue
		13	Pre-Commissioning Data Packs	

PART C3.1 - SPECIFICATION

Volume	Section	Subsection	Description	Colour
		13.1	Document Use	
		13.2	General Summary	
		13.3	Plant Schedules	
		13.4	Valves and Sluices	
		13.5	Pumps and Motors	
		13.6	Cooling Water Plant	
		13.7	Hoisting and Lifting Plant	
		13.8	Transformers	
		13.9	Soft Starters	
		13.10	Switch Gear	
		13.11	Power Supply and Cabling	
		13.12	Flow meters	
		13.13	SCADA	
		13.14	Sedimentation Works	
		13.15	Water Treatment Plant	
		13.16	Oil Separating Plant	
		13.17	HVAC Plant	
		13.18	Lighting System	
		13.19	Electric fencing System	
		13.20	Communication Systems	
		13.21	CCTV System	
		13.22	Fire Protection System	
		13.23	Biometric Access Control System	
		13.24	Hydrostatic Pressure Testing	
7	14	Commissioning and Trial Operation Records		Brown
		Data Packs		
		14.1	Document Use	

PART C3.1 - SPECIFICATION

Volume	Section	Subsection	Description	Colour
		14.2	General Summary	
		14.3	Pump Systems and Rising mains	
		14.4	Balancing and Break Pressure and Reservoirs	
		14.5	Bulk Water Gravity System	
		14.6	Cooling Water System	
		14.7	Hoisting and Lifting Systems	
		14.8	Power Supply System	
		14.9	Flow Metering System	
		14.10	SCADA System	
		14.11	Sedimentation System	
		14.12	Water Treatment System	
		14.13	Oil Separating System	
		14.14	HVAC System	
		14.15	Flood Protection and Drainage System	
		14.16	Sanitation System	
		14.17	Lighting Systems	
		14.18	Electric fencing System	
		14.19	Communication Systems	
		14.20	CCTV System	
		14.21	Fire Protection System	
		14.22	Biometric Access Control System	
		8		
15	15.1		Document Use	
	15.2		Drawing Register	
	15.3		Drawings	

The structure of the MCWAP Operation and Maintenance Manual (OMM) is flexible to facilitate updating, editing and expansion should it be required in future. It was structured to align with the existing OMM for MCWAP-1.

PART C3.1 - SPECIFICATION

The structure was selected to facilitate the specific needs of the different technical disciplines as well as the need to integrate the systems at various specific functional service areas. The structure accommodates modular documentation of key sub-systems / components / processes. It also differentiates between the user needs of operating staff and maintenance staff.

The eight volumes are also differentiated by use of colour codes.

Each section of each volume has a document map or “road map” that reflects the document in hand relative to the total Operation and Maintenance Manual (OMM).

Table below shows the use of the map for this document.

OMM DOCUMENT MAP

Volume		Sections	Flags
No.	Description	Description	
1	Systems Overview	1 Systems Overview	
2	System Operation Manual	2 System Operation Manual	
3	System Maintenance Manual (Disciplines)	3 System Maintenance Matrix	
4	System Maintenance Manual (Area Integration)	4 Pipelines	
		5 Pump Stations	
		6 Balancing and Break Pressure and Reservoirs	
		7 Sedimentation Works	
		8 Weir	

PART C3.1 - SPECIFICATION

Volume		Sections	Flags
No.	Description	Description	
		9 Control Room and Control Systems	
		10 Electrical Building and Substation Interface	
		11 Other Infrastructure Components	
5	Manufacturing Records	12 Factory Data Packs	
6	Installation Records	13 Pre- commissioning Data Packs	
7	Commissioning and Trial Operation Records	14 Commissioning Data Packs	
8	Record Drawings	15 Record Drawings	

**ANNEXURE 48/4
ACCEPTANCE CERTIFICATES (C1 TO C4)**

PART C3.1 - SPECIFICATION

MCWAP 2		Certificate C1			
Contract No. _____		Date: _____	Rev: _____		
Acceptance Certificate - C1: Construction Verification (Stage 1)					
CONTRACTOR	Turnover Package : _____				
	Description of the system : _____				
	Sub System TAG No.: _____				
	Sub System description: _____				
Installation : By signing the C1 Certificate, signatories indicate acceptance that: i) Construction completed, ii) Is safe to operate as an individual item (NOT energised), iii) Installation of equipment (piping, electrical services, C&I and utilities) has been completed as per detail design drawings and specifications, and iv) Has been accepted as such by all parties involved.					
	Civil Installation	Mechanical Installation	Electrical Installation	C&I Installation	
Name :	_____	_____	_____	_____	
Signature :	_____	_____	_____	_____	
Date :	_____	_____	_____	_____	
Contractor's Representative: TOP in subject is released for Pre-commissioning (Stage 2) Name : _____ Signature : _____ Date : _____					
ENGINEER	QA/QC : All the QC activities as required by the Contract. - Is Construction completion punch list attached to this certificate? <input type="checkbox"/> YES <input type="checkbox"/> NO - Are all existing NCRs' been dealt with and signed-off? <input type="checkbox"/> YES <input type="checkbox"/> NO - Is all pre-requisite documentation (Data packs, As-built Drawings, O&M Manuals etc.) required for C1 attached and signed-off as acceptable? <input type="checkbox"/> YES <input type="checkbox"/> NO				
		Civil	Mechanical/Welding QC	Electrical QC	C&I QC
	Name :	_____	_____	_____	_____
	Signature :	_____	_____	_____	_____
Date :	_____	_____	_____	_____	
QA/QC Manager Confirmation : TOP in subject is released for Handover to Pre-commissioning (Stage 2). Name : _____ Signature : _____ Date : _____					
The final inspection of the above system is carried out and accepted with / without consolidated punch list.		Confirmation of installation completion by			
	Commissioning Manager (Contractor)	Commissioning Manager (Engineer)			
Name :	_____	_____			
Signature :	_____	_____			
Date :	_____	_____			

PART C3.1 - SPECIFICATION

CONTRACTOR		MCWAP 2			Certificate C2
		Contract No.			ite:
					Rev:
	Acceptance Certificate - C2: Pre-commissioning (Stage 2)				
	Turnover Package : _____ Description of the system : _____ Sub System TAG No.: _____ Sub System description: _____				
	Installation : By signing the C2 Certificate, signatories indicate acceptance that: i) Is safe to operate as an individual item (energised but <u>without</u> product), ii) Functional (operational) "dry" tests on sub-systems has been successfully tested, iii) Critical punch list items have been cleared, and iv) Has been accepted as such by all parties involved.				
		Civil Installation	Mechanical Installation	Electrical Installation	C&I Installation
	Name :				
	Signature :				
	Date :				
	Contractor's Representative: TOP in subject is released for Commissioning (Stage 3)				
	Name :	Signature :			Date :
ENGINEER	QA/QC : All the QC activities as required by the Contract.				
		- Is all pre-requisite documentation required for C2 attached and signed-off as acceptable?			<input type="checkbox"/> YES <input type="checkbox"/> NO
		- Is the master punchlist attached to this certificate?			<input type="checkbox"/> YES <input type="checkbox"/> NO
		- Have all Category A Punch List items being corrected and signed-off?			<input type="checkbox"/> YES <input type="checkbox"/> NO
		- Have all existing NCRs' been dealt with and signed-off?			<input type="checkbox"/> YES <input type="checkbox"/> NO
			Civil	Mechanical/Welding QC	Electrical QC
	Name :				
	Signature :				
	Date :				
	QA/QC Manager Confirmation : TOP in subject is released for Handover to Commissioning (Stage 3).				
	Name :	Signature :			Date :
	The final inspection of the above system is carried out and accepted with / without consolidated punch list.		Confirmation of installation completion by		
		Commissioning Manager (Contractor)		Commissioning Manager (Engineer)	
	Name :				
	Signature :				
	Date :				

PART C3.1 - SPECIFICATION

MCWAP 2		Certificate C3			
Contract No. _____		Date: _____			
Acceptance Certificate - C3: Commissioning (Stage 3)					
CONTRACTOR	Turnover Package : _____				
	Description of the system : _____				
	Sub System TAG No.: _____				
	Sub System description: _____				
Installation : By signing the C3 Certificate, signatories indicate acceptance that: i) Is safe to operate as an integrated system (energised <u>with</u> product), ii) Process commissioning of the process modules has been satisfactorily completed (i.e. operational criteria "wet" tests on integrated system from automatic sequence have been successfully completed), iii) Operators and maintenance personnel have been trained, iv) Critical punch list items have been cleared, and v) Has been accepted as such by all parties involved.					
	Civil Installation	Mechanical Installation	Electrical Installation	C&I Installation	
Name :	_____	_____	_____	_____	
Signature :	_____	_____	_____	_____	
Date :	_____	_____	_____	_____	
Contractor's Representative: TOP in subject is released for Ramp-up (Stage 4)					
Name :	Signature :			Date :	
QA/QC : All the QC activities as required by the Contract.					
- Is all pre-requisite documentation required for C3 attached and signed-off as acceptable? <input type="checkbox"/> YES <input type="checkbox"/> NO					
- Is the master punchlist attached to this certificate? <input type="checkbox"/> YES <input type="checkbox"/> NO					
- Have all Categories A & B Punch List items being corrected and signed-off? <input type="checkbox"/> YES <input type="checkbox"/> NO					
- Have all existing NCRs' been dealt with and signed-off? <input type="checkbox"/> YES <input type="checkbox"/> NO					
- Have operators received basic training? <input type="checkbox"/> YES <input type="checkbox"/> NO					
ENGINEER	Civil		Mechanical/Welding QC	Electrical QC	C&I QC
	Name :	_____	_____	_____	_____
	Signature :	_____	_____	_____	_____
	Date :	_____	_____	_____	_____
QA/QC Manager Confirmation : TOP in subject is released for Handover to Ramp-up (Stage 4).					
Name :	Signature :			Date :	
The final inspection of the above system is carried out and accepted with / without consolidated punch list.		Confirmation of installation completion by			
Commissioning Manager (Contractor)		Commissioning Manager (Engineer)			
Name :	_____	_____			
Signature :	_____	_____			
Date :	_____	_____			

PART C3.1 - SPECIFICATION

MCWAP 2		Certificate C4			
Contract No.		Date:	Rev:		
Acceptance Certificate - C4: Ramp-up (Stage 4)					
CONTRACTOR	Turnover Package : _____ Description of the system : _____ Sub System TAG No.: _____ Sub System description: _____				
	Installation : By signing the C4 Certificate, signatories indicate acceptance that: i) System are performing as specified at steady state operating conditions and performance criteria have been met; ii) All process modules have been tested, iii) All outstanding punch list items have been cleared, iv) Operating & Maintenance Manual for Integrated System has been finalised, and v) Operators and maintenance personnel have been trained.				
		Civil Installation	Mechanical Installation	Electrical Installation	C&I Installation
	Name : _____ Signature : _____ Date : _____	_____	_____	_____	_____
Contractor's Representative:		TOP in subject is released for Performance Testing and Verification being completed			
Name :	Signature :	Date :			
QA/QC : All the QC activities as required by the Contract.					
- Is all pre-requisite documentation required for C4 attached and signed-off as acceptable?		<input type="checkbox"/> YES	<input type="checkbox"/> NO		
- Is the master punchlist attached to this certificate?		<input type="checkbox"/> YES	<input type="checkbox"/> NO		
- Have all Categories A, B, C & D Punch List items being corrected and signed-off?		<input type="checkbox"/> YES	<input type="checkbox"/> NO		
- Have all existing NCRs' been dealt with and signed-off?		<input type="checkbox"/> YES	<input type="checkbox"/> NO		
ENGINEER					
		Civil	Mechanical/Welding QC	Electrical QC	C&I QC
	Name : _____ Signature : _____ Date : _____	_____	_____	_____	_____
	QA/QC Manager Confirmation :		TOP in subject is released for Handover Certificate.		
Name :	Signature :	Date :			
The final inspection of the above system is carried out and accepted with / without consolidated punch list.		Confirmation of installation completion by			
Commissioning Manager (Contractor)		Commissioning Manager (Engineer)			
Name :	Signature :	Date :			
_____	_____	_____			

**ANNEXURE 48/5
PUNCH LIST EXAMPLE**

PART C3.1 - SPECIFICATION

MCWAP 2 PUNCH LIST												No.:	
												Page	of
Turnover Package No. _____						Building _____							
System _____						Subsystem _____							
TAG Code _____						Subsystem No. _____							
Database Item No.	Item No.	Discipline	Description (Including TAG as applicable)	Category	Action Required	Recorded by:		Action by:			Cleared by:		
					Responsible (CONTRACTOR)	Name	Date	Name	Date	Signature	Name	Date	Signature
Discipline : C = Civil, M = Mechanical, E = Electrical, I = Instrument & Control						DESIGN ENGINEER		CONTRACTOR			RESIDENT ENGINEER		
Category : A = Item to be cleared before energisation and pre-commissioning						Name:							
Category : B = Item to be cleared before Commissioning						Signature:							
Category : C = Item to be cleared at set agreed period.						Date:							
Category : D = Items to be cleared before Final Handing Over certificate can be issued													