

OCCUPATIONAL HEALTH AND SAFETY SPECIFICATION

REGIONAL OFFICE: BLOEMFONTEIN

PROJECT NAME:

DEPARATMENT OF LABOUR: GROUP 8:
PHUTHADITJHABA: PROVISION OF WATER
TANK

Date: JULY 2024

Health and Safety Specification

Compiled by:

NATIONAL DEPARTMENT OF PUBLIC WORKS

OCCUPATIONAL HEALTH

AND

SAFETY ACT

AND

REGULATIONS

PRE-CONSTRUCTION HEALTH AND SAFETY SPECIFICATION

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1. INTRODUCTION AND BACKGROUND

1.1 Background to the Pre-Construction Health and Safety Specification

- 1) The Construction Regulations of February 2014 in terms of Regulation 5(1)(b) places the onus on the Client to prepare a Pre-Construction Health and Safety Specification, highlighting all risks not successfully eliminated during design. Section 37.2 of the Act, Act 85 of 1993 requires the Department of Works as an Employer to enter into a written agreement with the Contractor (Mandatory) as far as arrangements and procedures are concerned to ensure that the Contractor complies with the requirements of the Act, Act 85 of 1993 and all its Regulations.
- 2) This document serves to address all the abovementioned requirements and by submission of his/her tender the Contractor undertakes to abide with the conditions as stipulated by the Department of Works hereinafter referred to as the Client throughout this document.
- 3) This documentation will give the Client or its duly appointed representative the required information to be able to evaluate the Contractors competency and resources as is required by Regulation 5(1)(h) of the Construction Regulations of February 2014 and to determine his/her suitability to perform such work in a safe and healthy manner.
- 4) When submitting his/her tender the Contractor must supply the Client with the following:
 - A detailed Site Safety Plan indicating how the contractor will manage all Safety, Health and Environmental aspects whilst working on the Clients premises or on premises under his/her control, which must be based on the contents of this document as is required by Regulation 7(1)(a) of the Construction Regulations of February 2014.
 - A Cost breakdown of funds being allocated to make adequate provisions for Safety, Health and Environmental requirements as is required by Regulation 5 (1)(g) of the Construction Regulations of February 2014.
- 5) No approval or acceptance of any document required by this specification shall be construed by the Contractor as an absolution of the Contractor from achieving the required level of performance and compliance with legal requirements whatsoever.
- 6) The Contractor is an employer in his/her own right and therefore must assume all the responsibilities as required from any legal obligation imposed on him or her.

1.2 Purpose of the Pre-Construction Health and Safety Specification

To assist in achieving compliance with the Occupational Health and Safety Act 85/1993 and the now promulgated Construction Regulations of February 2014 in order to reduce incidents and injuries.

The Pre-Construction Safety, Health and Environmental Specification sets out the requirements to be followed by the Principal Contractor and other Contractors so that the Health and Safety of all persons potentially at risk and the potential risk to the environment may receive the same priority as other facets of the project such as Scope, Time, Cost and Quality.

1.3 Implementation of the Pre-Construction Health and Safety Specification

This specification forms an integral part of the contract, and the Contractor is required to use it at pre-tender phase when drawing up his/her project-specific Construction Phase Health and Safety Plan as indicated above. The Principal Contractor shall forward a copy of this specification to all Sub-Contractors at their bidding stage so that they can in turn prepare Health and Safety Plans relating to their operations.

2. PRE-CONSTRUCTION HEALTH AND SAFETY SPECIFICATION

2.1 SCOPE

This Specification covers the requirements for eliminating and mitigating incidents and injuries on the particular project.

The scope also addresses legal compliance, hazard identification and risk assessment, risk control, and promoting a Health and Safety culture amongst those working on the project. The specification also makes provision for the protection of those persons other than employees.

2.2 Contractual Issues

- 1) Due to fact that this document is based on legislative requirements the Client requires that all Contractors comply with the requirements of this document and all other relevant legislative requirements not covered by this document.
- 2) The Client or its duly appointed representative reserves the right to stop any contractor from working whenever Safety, Health or Environmental requirements are being violated. Any resultant costs of such work stoppages will be for the Contractors account.

- 3) The requirements as specified by the Client in this document must not be deemed to be exhaustive and the Client reserves the right to make changes as and if the Client deems fit.
- 4) The Client will not entertain any claim of any nature whatsoever which has come about as result of costs incurred or delays being experienced due to the Contractor not complying with the requirements of this document or any other applicable legislative requirements imposed on the Contractor.

2.3 Safety, Health and Environmental Standards and Procedures

- 1) The Contractor will ensure that all work performed by him/her is executed in accordance with work procedures which comply with accepted safety practices and applicable safety, health and Environmental legislation.
- 2) Procedures as indicated above may be the Contractors own procedures on condition that they comply with the conditions as stipulated above.
- 3) Where procedures have been specified by this Client in the contents of this document such procedures must be adhered to unless otherwise agreed to with the Client or it's duly appointed representative.

2.4 Interpretations

2.4.1 APPLICATION

This specification is a compliance document drawn up in terms of South African legislation and is therefore binding. It must be read in conjunction with relevant legislation as noted previously.

2.4.2 DEFINITIONS

- 1) The definitions as listed in the Occupational Health and Safety Act 85/1993 and Construction Regulations of February 2014 shall apply unless otherwise stipulated.
- 2) Any reference to "The Contractor" includes – the Principal and Sub - Contractor unless otherwise stipulated.

2.5 Minimum Administrative Requirements

2.5.1 Notification of Intention to Commence Construction Work

- 1) The Contractor shall notify the Provincial Director of the Department of Labour in writing before construction work commences if required in the format of Annexure 2. A copy of this notification must be forwarded to the Client prior to the commencement of Construction work.
- 2) Copies of such notification can be obtained from any

2.5.2 Assignment of Contractor's Responsible Persons to Supervise Health and Safety on Site.

- 1) The Contractor shall submit in the format of Annexure B, proof of all supervisory as well as any other relevant appointments as is required by the OHS Act and the Construction Regulations.
- 2) It is acknowledged that the Contractor may need to allocate more than one appointment to certain staff members. This practice may only take place if Safety, Health and Environmental Standards would not be negatively affected.
- 3) Should the Client or its representative deem such practice as having a negative affect on Safety, Health and Environmental Standards, then alternative arrangements will have to be made.
- 4) ***It is a specific requirement for this project that a competent Health and Safety Officer be appointed for the project on a full time basis for the duration of the Project.***

2.5.3 Competency of Contractor's Appointed Competent Persons

- 1) Contractors' competent persons for the various risk management portfolios shall fulfill the criteria as stipulated under the definition of "Competent Person" in accordance with the Construction Regulations of February 2014 and the Occupational Health and Safety Act, Act 85 of 1993.
- 2) The Client reserves the right to require levels of Competency, which exceeds the requirements as stipulated by the Act and or Construction Regulations.
- 3) In the event of the Client requiring additional levels of Competency, alternative arrangements will have to be made.

2.5.4 Compensation of Occupational Injuries and Diseases Act, Act 130 of 1993 (COID ACT)

- 1) The Contractor warrants that his and all his workmen are fully covered in terms of the COID, Act 130 of 1993 and that such cover shall remain in force for the duration of his contractual relationship with the Client or whilst working on the Clients premises or premises under the Clients control.
- 2) The Contractor will supply proof of such insurance cover to the Client with his/her tender submission.
- 3) The Contractor undertakes to ensure that all Sub-Contractors appointed by him/her will be fully covered in terms of the COID Act, Act 130 of 1993 and that such cover shall remain in force for the duration of their contractual relationship with the Contractor

- 4) The Contractor must also ensure that he has additional insurance cover that will adequately make provisions for any losses and/or his employee's acts and/or omissions whilst working on the Clients premises or on premises under the client's control.

2.5.5 Occupational Health and Safety Policy

- 1) The Contractor shall submit a Health and Safety Policy signed by the Chief Executive Officer.
- 2) The Policy must outline objectives and how they will be achieved and implemented by the Company / Contractor.
- 3) A copy of such policy must be included in the Site Safety Plan and the Site Safety File.

2.5.6 Health and Safety Organogram

- 1) The Contractor shall submit an Organogram, outlining the Health and Safety Site Management Structure including the relevant appointments / competent persons.
- 2) In cases where appointments have not been made, the organogram shall reflect the intended persons to be appointed to such positions.
- 3) The organogram shall be updated when there are any changes in the Site Management Structure.

2.5.7 Preliminary Hazard Identification and Risk Analysis and Progress Hazard Identification and Risk Analysis

- 1) A Preliminary Hazard Identification and Risk Analysis was conducted and can be found in the format of Annexure D. This Hazard Identification and Risk Analysis was performed to make the Contractor aware of potential Hazards, which could be present on the site and may not be comprehensive.
- 2) The Contractor shall cause a Hazard Identification and Risk Analysis exercise to be performed by a Competent Person before commencement of construction work, and the assessed risks shall form part of the Construction phase Health and Safety Plan submitted for approval by the Client. The Risk Assessment must include:
 - a) A list of hazards identified as well as potentially hazardous tasks;
 - b) A documented risk assessment based on the list of hazards and tasks;
 - c) A set of safe working procedures to eliminate, reduce and/or control the risks assessed;
 - d) A monitoring and review procedure of the risks assessment as the risks change.

- 3) The Principal Contractor shall ensure that all Contractors are informed, instructed and trained by a Competent Person/s regarding hazards, risks and related safe work procedures before any work commences and thereafter at regular intervals as the risks change and as new risks develop.
- 4) The Contractor shall be responsible for ensuring that all persons who could be negatively affected by its operations are informed and trained according to the hazards and risks and are conversant with the Safe Work Procedures, control measures and other related rules (tool box talk strategy to be implemented and so on).
- 5) Should the Client or its duly appointed Representative identify alternative hazardous activities performed by the Contractor or its Sub-Contractors on site for which a Risk Assessment was not performed then the contractor will be required to perform such an exercise before continuing such work.

2.5.8 Health and Safety Representative(s)

- 1) The Contractors shall ensure that Health and Safety Representative(s) are appointed under consultation and trained to carry out their functions.
- 2) The appointments must be in writing and the Health and Safety Representative shall carry out regular inspections, keep records and report all findings to the Responsible Person forthwith and at Health and Safety meetings.

2.5.9 Health and Safety Committees

The Principal Contractor shall ensure that project Health, Safety and Environmental meetings are held monthly or as deemed necessary by the project requirements.

- 1) Minutes must be kept on record and filled in the Site Health and Safety File.
- 2) Meetings must be organized and chaired by the Principal Contractors' Responsible Person.

2.5.10 Health and Safety Training

2.5.10.1 Induction

- 1) The Principal Contractor shall ensure that all site personnel undergo a site-specific Health and Safety Induction Training Session before starting work. A record of attendance shall be kept in the Health and Safety file. **A suitable venue must be supplied to provide this training.**

- 2) All visitors to the site must also be subjected to site-specific induction training highlighting items such as steps to follow in the event of an emergency, restricted areas and so on.

2.5.10.2 Awareness

The Principal Contractor shall ensure that, on site, periodic toolbox talks take place daily. These talks should deal with risks relevant to the construction work at hand. A record of attendance shall be kept in the Health and Safety File. All Contractors have to comply with these minimum requirements.

2.5.10.3 Competency

- 1) All competent persons shall have the knowledge, experience, training, and qualifications specific to the work they have been appointed to supervise, control, and carry out.
- 2) The abovementioned competency requirements will be assessed on a regular basis by the Client, by means of Audits, Progress Meetings, and any other means deemed fit by the Client.
- 3) The Principal Contractor is responsible to ensure that competent Contractors are appointed to carry out construction work and records should be kept of criteria used to determine competency.
- 4) The Client reserves the right to require competencies which may exceed the Contractors standards in which case alternative arrangements will have to be made to meet the Clients requirements.

2.5.11 General Record Keeping

- 1) The Contractors shall keep and maintain Health and Safety records to demonstrate compliance with this Specification, with the OHS Act 85/1993; and with the Construction Regulations of February 2014.
- 2) The Contractor shall ensure that all records of incidents/accidents, training, inspections, audits, and so on are kept in a Health and Safety file held in the Site Office.
- 3) The Principal Contractor must ensure that every Contractor opens his/her own Health and Safety file, maintains the file and makes it available on request by any duly authorized person.

2.5.12 Health and Safety Audits, Monitoring and Reporting

- 1) The Client shall conduct monthly Health and Safety audits of the

work operations including a full audit of physical site activities as well as an audit of the administration of Health and Safety.

- 2) The Principal contractor is obligated to conduct similar audits on all Contractors appointed by him/her.
- 3) Detailed reports of the audit findings and resultant corrective measures shall be reported on at all levels of project management meetings/forums.
- 4) Copies of the Clients audit reports will be forwarded to the Contractor and must be kept in the Site Health and Safety File.
- 5) The Principal Contractor must audit the activities and administration of all appointed Sub-Contractors, forward a copy to the Client or its representative within seven days of completion of the audit and file a copy on the Site Safety File.

2.5.13 Emergency Procedures/Plans

- 1) The Principal Contractor shall submit a detailed Emergency Procedure/Plan for approval by the Client prior to commencement of work on site. The procedure shall detail the response plan/s including the following key elements:
 - List of key competent personnel;
 - Details of emergency services;
 - Actions or steps to be taken in the event of the specific types of emergencies;
 - Information on hazardous material/situations.
- 2) Emergency Procedures/Plans shall include, but shall not be limited to, fire, spills, use of hazardous substances, bomb threats, major incidents/accidents major and minor and any other anticipated emergencies.
- 3) The Principal Contractor shall advise the Client in writing forthwith, of any emergencies, together with a record of action taken. A contact list of all service providers (Fire Department, Ambulance, Police, Medical and Hospital, etc) must be maintained and be available to site personnel.
- 4) Emergency procedures/Plans must be developed by a competent person such as a Safety, Health and Environmental Officer or in the absence of a Safety, Health and Environmental Officer by the Construction Work Supervisor.
- 5) Emergency Procedures/Plans must form part of the Agenda of monthly safety meetings as the Procedures/Plans would have to be revisited on a continuous basis due to the changing environment on construction sites.

2.5.14 First Aid Boxes and First Aid Equipment

- 1) All Contractors shall appoint in writing First Aider(s) in terms of legislative requirements.
- 2) The appointed First Aider(s) must be sent for accredited first aid training should they not have received such training prior to commencement of work on site.
- 3) Valid certificates to be kept on site in the Site Safety File.
- 4) The Principal Contractor shall provide an on-site First Aid Station with first aid facilities, where required, including first aid boxes adequately stocked at all times.
- 5) All Contractors with more than 5 employees shall supply their own first aid box
- 6) In the event of hazards chemical substances being present on site, first aiders must be trained to address any incidents of accidental exposure and their first aid kits stocked accordingly

2.5.15 Accident / Incident Reporting and Investigation

- 1) Injuries are to be categorized into the following categories:
 - 1) first aid;
 - 2) medical;
 - 3) disabling; and
 - 4) fatal injuries.
- 2) All Contractors have to report on the 4 categories of injuries to the Principal Contractor as soon as is reasonably practicable.
- 3) The Principal Contractor must stipulate in his/her construction phase Health and Safety plan how he/she will handle each of these categories.
- 4) When reporting injuries to the Client, these categories shall be used.
- 5) All injuries will be investigated by the Principal Contractors or his/her Competent Person, with a report being forwarded to the Client forthwith.
- 6) The Principal Contractor must report all injuries to the Client in the form of a detailed injury report at least monthly.
- 7) All incidents taking place in terms of Section 24 of the Act must be reported in the prescribed period and manner to the

Department of Labour.

- 8) Copies of Section 24 reports, including WCL 1 & 2 forms must be forwarded to the Client immediately after completion.

2.5.16 Hazards and Potential Situations

- 1) The Principal Contractor shall immediately notify other Contractors as well as the Client of any hazardous or potentially hazardous situations that may arise during performance of construction activities.
- 2) Should a hazardous situation require work stoppages the work must be stopped and corrective steps taken such as Written Safe Work Procedures and issuing of Personal Protective Equipment.

2.5.17 Personal Protective Equipment (PPE) and Clothing

- 1) The Contractor shall ensure that all workers are issued and wear Hard Hats, Safety Boots/Shoes and Overalls.
- 2) The Contractor and all Contractors shall make provision and keep adequate quantities of SABS approved PPE on site at all times.
- 3) The Contractor shall clearly outline procedures to be taken when PPE or Clothing is:
 - Lost or stolen;
 - Worn out or damaged.
- 4) The above procedure applies to Contractors and their Sub-Contractors.
- 5) The Contractor must ensure that no person enters the Site without the required Personal Protective Equipment.
- 6) Visitors to the Site must be provided with the required PPE such as Hard Hats, Earmuffs and Eye Protection.
- 7) Records of all PPE issued to staff must be kept on site in the Site Safety File.
- 8) Employees are to be made conversant with the purpose of PPE and where and when it is required to be used by the employee.
- 9) Safety belts are not to be allowed on site due to its associated potential of injury to the user; only double lanyard safety harnesses are permitted.
- 11) Suitable eye protection must at all times be worn by the worker when performing grinding, chipping, chasing and other associated activities.

- 12) In the event that onlookers may be struck by flying objects as a result of work being performed, suitable screens must be erected.
- 13) Any person performing welding or brazing work will wear suitable eye protection, gloves, aprons, and spats. Suitable screens are to be provided to protect onlookers from the harmful rays associated with such activities.
- 14) Where employees are required to work with corrosive liquids, suitable eye protection, gloves and acid resistant overalls must be provided.
- 15) Ear protection must be worn in designated noise zone (in excess of 85dB)
- 16) Suitable respirators must be provided to all employees and visitors required working in or entering areas where toxic vapors could be present.
- 17) All staff working in an elevated position (2m or higher) or where the potential exists that such person may fall must be provided with a suitably secured safety harness.
- 18) Any person refusing to wear personal Protective Equipment must be instructed to wear such equipment and in the event of such person refusing to wear such equipment he/she must be removed from the premises.

2.5.18 Occupational Health and Safety OHS Signage

- 1) The Contractor shall provide adequate on-site OHS signage including but not limited to: "no unauthorized entry", "report to site office", "site office", "beware of overhead work", "hard hat area".
- 2) Signage shall be posted up at all entrances to the site as well as on site in strategic locations e.g. access routes, stairways, entrances to structures and buildings, scaffolding, and other potential risk areas/operations.
- 3) In the event where work is being performed on a premises displaying signage such as no-parking, speed limits and so on, the Contractor will abide by the requirements of such signage except if otherwise instructed.

2.5.19 Permits

- 1) The Contractor shall draft and implement where required permits which may include the following:
 - Use of Explosives and Blasting;
 - Work for which a fall prevention plan is required;

- Use of cradles, and
 - Electrical work
 - Hot works
- 2) The Contractor will ensure that where permits are required that it is used and adhered to.

2.6 Physical Requirements

2.6.1 Demolition Work

- 1) Prior to any demolition work being carried out, the Principal Contractor shall submit a safe working procedure and a detailed engineering survey for approval by the Client.
- 2) Such Safe Work Procedures' must where possible be submitted with the Site SHE Plan
- 3) Acceptance will then be issued to the Principal Contractor to proceed with the demolition work.
- 4) The Principal Contractor shall ensure that demolition work complies with the Construction Regulations of February 2014.
- 5) In the event where a structure identified for demolition includes substances such as lead or asbestos it must be performed within the requirements of the applicable legislative.

2.6.2 Excavations, Shoring, Dewatering or Drainage

- 1) All excavation work must be performed under the supervision of a Competent Person as specified in Annexure B of this document and the Construction Regulations of July 2003.
- 2) Adequate Shoring and Bracing must be provided where required to ensure that the health and safety of the employees working in such excavations are not put at risk.
- 3) Adequate provisions must be made to ensure that water is drained from excavations which may enter such excavations as a result of seepage or rain.
- 4) All excavation made by the Contractor must be clearly demarcated and protected to prevent accidental access.
- 5) Barricading tape may only be used to make solid barricading more visible and may not be used as a means of barricading.
- 6) In addition to the abovementioned the requirements of Regulation 11 of the Construction Regulations of July 2003 must be adhered to.

2.6.3 Edge Protection .

- 1) All open edges posing the risk of resulting in injuries or damage

to equipment must be adequately guarded fenced or barricaded or other similar suitable means used to prevent injuries or damage to equipment.

- 2) Barricading tape is not deemed to be suitable and may only be used in addition to other suitable means as indicated above.

2.6.4 Explosives and Blasting

- 1) All explosives must be transported or stored according to the requirements of SANS 0228.
- 2) Written approval must be obtained from the Chief Inspector Occupational, Health and Safety prior to any blasting activities taking place.
- 3) A copy of such permission from the Chief Inspector Occupational, Health and Safety must be supplied to the client prior to Blasting.
- 4) Prior to blasting a siren must be sounded, warning flags posted and guards placed at strategic locations points to prevent accidental entry to the blasting area.

2.6.5 Stacking of Materials

- 1) Stacking and storage of materials must be performed under the Supervision of a Competent Person whom has been appointed in writing as required by Annexure B.
- 2) Storage areas must be designated, kept neat and under control. In addition to the abovementioned the requirements of General Safety Regulations as promulgated by Government Notice No R1031 dated 30 May 1986 as amended must be complied with.
- 3) In the event that unauthorized persons may enter an area where materials are stacked such area must be barricaded off to prevent access to such area.

2.6.6 Speed Restrictions and Protections

- 1) Unless otherwise stipulated the speed limit on site to be adhered to is 10 Km/h.
- 2) Vehicle movement routes on site must be clearly indicated where applicable.
- 3) Signage to ensure the safe movement of vehicles on site as well as to ensure the health and safety of all employees and visitors on site must be displayed in strategic locations.

2.6.7 Hazardous Chemical Substances (HCS)

- 1) All employees required to use Hazardous Chemical Substances or products containing Hazardous Chemical Substances must be adequately and comprehensively trained with regard to the requirements of the Hazardous Chemical Substances Regulations as amended in Government Gazette No 25130 of June 2003, the potential sources of exposure and the potential risks to their health caused by exposure.
- 2) In addition to the abovementioned, Material Safety Data Sheets must be kept on site for all materials, which may contain hazardous chemical substances.

2.6.8 Asbestos

- 1) Asbestos work may only be performed subject to prior notification of the Provincial Director, Occupational Health and Safety, Department of Labour, in writing.
- 2) Proof of such notification must be supplied to the Client prior to work proceeding.
- 3) All asbestos work shall be carried out as per the Asbestos Regulations by an approved Asbestos Contractor.
- 4) All employees must be informed and receive training on aspects such as the contents and scope of the Asbestos Regulations as published in Government Gazette 23108 of February 2002, the potential risks of exposure to asbestos, precautionary measures employees have to take and all other requirements deemed necessary to provide a safe and healthy environment for all employees as specified by the Asbestos Regulations as indicated above.
- 5) All asbestos will be removed from site by an approved asbestos contractor to an approved asbestos dump site.

2.7 Plant and Machinery

2.7.1 Construction Plant

- 1) All Construction Plant must comply with and be used in conjunction with the requirements of Section 23 of the Construction Regulations and in specific that all records of inspections rendering such plant safe must be kept on site.
- 2) Operators will be competent and trained and copies of training certificates shall be placed on the health and safety file on site.
- 3) Operators shall be in possession of medical certificate declaring that they are physically and psychologically fit to operate such construction vehicle and plant and copy of medical certificate shall be on the file.
- 4) Original operating and medical certificates shall be kept by the operators and shall be on site in-possession of the operators at all times.

2.7.2 Vessels under Pressure (VUP)

The Principal Contractor and all relevant Contractors shall comply with the Vessels under Pressure Regulations, including:

- Providing competency and awareness training to the operators;
- Providing PPE or clothing;
- Inspecting equipment regularly and keeping records of inspections;
- Providing appropriate fire fighting equipment.

2.7.3 Fire Extinguishers and Fire Fighting Equipment

- 1) The Principal Contractor and Sub Contractors shall provide or ensure adequate provision of regularly serviced fire fighting equipment located at strategic points on site, specific to the classes of fire likely to occur.
- 2) The appropriate notices and signs must be posted up as required.
- 3) Contractors may not utilize fire protection equipment belonging to the client without prior consent.

2.7.4 Hired Plant and Machinery

- 1) The Contractor shall ensure that any hired plant and machinery used on site is safe for use.
- 2) The requirements as stipulated by the OHS Act 85/1993 and Construction Regulations of February 2014 shall apply.
- 3) The Principal Contractor shall ensure that operators hired with machinery are competent and that certificates are kept on site in the Site Health and Safety File. All relevant Contractors must ensure the same.

2.7.5 Scaffolding / Working at Heights

- 1) Working at heights includes any work that takes place in an elevated position in excess of 2m.
- 2) The Contractor must submit a risk-specific fall prevention plan and include a rescue plan in accordance with the Construction Regulations of February 2014 before this work is undertaken.
- 3) The fall prevention plan must be approved by the Client before work may commence.

2.7.6 Formwork and Support Work for Structures

- 1) The Principal Contractor shall ensure that the provisions of Section 10 of the Construction Regulations of February 2014 are adhered to.

- 2) These provisions must include but not be limited to ensuring that all equipment used is examined for suitability before use; that all Formwork and Support Work is inspected by a competent person immediately before, during and after placement of concrete or any other imposed load and thereafter on a daily basis until the Formwork and Support Work has been removed.
- 3) Records of all inspections must be kept in a register on site.

2.7.7 Lifting Machines and Tackle

- 1) The Contractor shall ensure that lifting machinery and tackle is inspected before use and thereafter in accordance with the Driven Machinery Regulations and the Construction Regulations (Section 20).
- 2) There must be a competent appointed lifting Machinery and Tackle Inspector on site who must inspect the equipment daily or before use, taking into account that:
 - All lifting machinery and tackle has a safe working load clearly indicated;
 - Regular inspection and servicing is carried out;
 - Records are kept of inspections and of service certificates;
 - There is proper supervision in terms of guiding the loads that includes a trained banksman to direct lifting operations and check lifting tackle;
 - The tower crane bases have been approved by an engineer;
 - The operators are competent as well as physically and psychologically fit to work and be in possession of a medical certificate of fitness which must be available on site.

2.7.8 Ladders and Ladder Work

- 1) The Contractor shall ensure that all ladders are inspected at least monthly, are in a good safe working order, are the correct height for the task, extend at least 1m above the landing, fastened and secured, and at a safe angle.
- 2) Records of inspections must be kept in a register on site.

2.7.9 General Machinery

The Contractor shall ensure compliance with the Driven Machinery Regulations, which include inspecting machinery regularly, appointing a competent person to inspect and ensure maintenance, issuing PPE or clothing, and training those who use machinery.

2.7.10 Portable Electrical Tools and Explosive Powered Tools

- 1) The Contractor shall ensure that use and storage of all explosive powered tools and portable electrical tools are in compliance with relevant legislation.
- 2) The Contractor shall ensure that all electrical tools, electrical distribution boards, extension leads, and plugs are kept in a safe working order.
- 3) The Contractor shall apply the following:
 - A competent person undertakes routine inspections and records are kept.
 - Only authorized trained persons use the tools.
 - The safe working procedures apply.
 - Awareness training is carried out and compliance is enforced at all times.
 - PPE and clothing is provided and maintained.
 - A register indicating the issue and return of all explosive rounds is implemented and maintained, and
 - That signs are posted up in the areas where explosive powered tools are being used.

2.7.11 High Voltage Electrical Equipment

- 1) All contractors must be made aware of the presence and location of High Voltage Equipment such as underground cables and overhead lines, and that the necessary precautionary steps are taken where work has to be executed in the vicinity of such equipment.
- 2) Precautionary measures such as Isolation and Lock-Out of electrical systems or the use of electrically isolated tools must be used.

2.7.12 Public and Site Visitor Health and Safety

- 1) The Contractor shall ensure that every person working on or visiting the site, as well as the public in general, shall be made aware of the dangers likely to arise from site activities, including the precautions to be taken to avoid or minimize those dangers.
- 2) Appropriate Health and Safety Notices and signs shall be posted up, but shall not be the only measure taken.

2.7.13 Night Work

The Contractors must ensure that adequate lighting is provided to allow for work to be carried out safely.

2.7.14 Transportation of Workers

- 1) The Contractor and shall not:
 - Transport persons together with goods or tools unless there is an appropriate area or section to store such goods.

- Transport persons on the back of trucks except if a proper canopy (properly covering the sides and top) has been provided with suitable seating areas.
 - Permit workers to stand or sit on the edge of the transporting vehicle.
 - Transport workers in LDV's unless they are closed/covered and have the correct number of seats for the passengers.
- 2) No driver will transport more than six people on the back of a 1 Ton LDV and more than four passengers on the back of a ½ Ton LDV.
 - 3) The driver of any LDV will not permit more than 2 passengers to occupy the cab of any single cab LDV and 4 passengers of any double cab LDV.
 - 4) All vehicles operated on the site will in all aspects comply with the requirements of the Road Traffic Ordinance Act
 - 5) Drivers of such vehicles will have a valid license for the code of vehicle being driven by them.
 - 6) No servicing of vehicles will be permitted on a Construction Site, which is occupied by staff working for the Client.
 - 7) Servicing or repairs of vehicles on site may only take place if such activities are performed with the necessary procedures in place to prevent any harmful effects to the environment.
 - 8) All waste generated from servicing vehicles must be disposed off in accordance with relevant Environmental legislation.
 - 9) In the event where Earth Moving Equipment is present on site the following must be adhered to:
 - Drivers of vehicles must be instructed to avoid parking behind earth moving vehicles to ensure that their vehicles are visible to the operator of earth moving vehicles.
 - Right of way must be afforded to earth moving machinery at all times.
 - Vehicles must only be permitted to park where possible in designated areas

2.8 Occupational Health and Environmental Management.

2.8.1 Occupational Hygiene

- 1) Exposure of workers to occupational health hazards and risks is very common in any work environment, especially in construction.
- 2) Occupational exposure is a major problem and all Contractors must ensure that proper health and hygiene measures are put

in place to prevent exposure to these hazards.

- 3) Contractors must prevent inhalation, ingestion, absorption, and noise induction.
- 4) Site-specific health risks are tabled in Annexure D such as cement -dust, wood-dust, noise and so on but is not limited to these items.
- 5) Water to be utilized for drinking purposes may only be drawn from taps designated for drinking water purposes. Fire hydrants and fire hose reels may not be utilized for drinking water purposes.
- 6) In the event where staff is required to be away from home due to the work they have to perform on behalf of the Contractor, the Contractor will provide suitable clean dry and hygienic accommodation, the cost thereof shall be borne by the Contractor.

2.8.2 Environmental Management

- 1) The Contractor shall take all precautionary steps to prevent any pollution of the Environment.
- 2) Any material, which may pose a harmful effect when disposed of by normal means, must be disposed of in an appropriate manner to eliminate its harmful effect on the environment after disposal.
- 3) The Contractor will ensure that adequate procedures are implemented and maintained to ensure that all waste generated including asbestos waste is placed in suitable receptacles and removed from the site promptly.
- 4) Plans to deal with spillages must be in place and maintained.
- 5) No waste materials liquid or solid may be disposed of in drains.
- 6) No burning of waste material may take place where such material being burned may result in pollution of the air or give off toxic vapors which could be harmful to the health of employees or any other person present on site.

2.8.3 Welfare Facilities

- 1) Contractors will supply sufficient toilets (1 toilet per 30 workers). Toilets will be so positioned that it is in close proximity of the workers. If more toilets are required contractors must make provision for this.
- 2) Showers (1 for every 15 workers).
- 3) Changing facilities.

- 4) Hand washing facilities, soap, toilet paper, and hand drying materials.
- 5) Waste bins must be strategically placed and emptied regularly.
- 6) Safe, clean storage areas must be provided for workers to store personal belongings and personal protective equipment.
- 7) Workers must not be exposed to hazardous materials/substances while eating and must be provided with sheltered eating areas.

2.8.4 Alcohol and other Drugs

- 1) No alcohol and other drugs will be allowed on site without the express permission of the Principal Contractor.
- 2) No person may be under the influence of alcohol or any other drugs while on the construction site.
- 3) Any person on prescription drugs must inform his/her Employer, who shall in turn report this to the Principal Contractor forthwith.
- 4) Any person suffering from any illness/condition that may have a negative effect on his/her safety performance must report this to his/her Employer, who in turn must report this to the Principal Contractor forthwith.
- 5) Any person suspected of being under the influence of alcohol or other drugs must be sent home immediately, to report back the next day for a preliminary inquiry. A full disciplinary procedure must be followed by the Contractor concerned and a copy of the disciplinary action must be forwarded to the Principal Contractor for his records.

2.9 Electrical fencing.

- 1) Contractor must comply with sect 12, 13 and 14 of the Electrical Machinery Regulations.

ANNEUXRE A

The Contractor must submit proof of compliance with Annexure A with the construction phase H&S plan where applicable.

HSS Item No.	Requirement	OHS Act Requirement	Submission Date
2.3.1	Notification of Intention to Commence Construction/Building Work	Complete Annexure 2 (Construction Regulations)	Before commencement on site
2.3.2	Assignment of Responsible Persons	All relevant appointments as per OHS Act, Con Regs and Annexure B	Together with SHE Plan
2.3.3	Competence of Responsible Persons	Client Requirement & OHS Act	Together with SHE Plan
2.3.4	Compensation of Occupational Injuries and Diseases Act (COIDA) 130 of 1993	Construction Reg and Client Requirement	Together with SHE Plan
2.3.5	Occupational Health and Safety Policy	OHS Act	Together with SHE Plan
2.3.6	Health and Safety Organogram	Client Requirement	Together with SHE Plan
2.3.7	Initial Hazard Identification and Risk Assessment	Construction Regs.	Together with SHE Plan

ASSIGNMENT OF CONTRACTOR'S RESPONSIBLE PERSONS

ANNEXURE B

The Principal Contractor shall make the following appointments according to the initial risk assessment or as deemed necessary: (further appointments could become necessary as the project progresses)

Appointment	OHSA Reference	Requirement abbreviated
CEO Assignee	Section 16(2)	A competent person to assist with the on-site H&S, overall responsibility – Contractor's Responsible Person
Construction Manager	CR 8(1)	A competent person(s) to supervise and be responsible of Health & Safety related issues on site. The person is appointed to assist the CEO with his/her overall duties.
Construction Work Supervisor	CR 8(7)	A competent person(s) to supervise and be responsible of Health & Safety related issues on site. The person is appointed to assist the CEO with his/her overall duties.
Subordinate Construction Work Supervisors	CR 8(8)	A competent person to assist with daily supervision of construction work. The person assists the Construction Work Supervisor.
Health and Safety Officer	CR 8(5)	A competent Health and Safety officer in the control of all safety related aspects on site for the duration of the repair phase of this project.
Health & Safety	Section 17	A competent person(s) to inspect H&S in reference to plant, machinery and Health & Safety of persons in the workplace.
Health & Safety Committee Member(s)	Section 19	A competent person(s) representing the employer to assist with the on site Health & Safety matters.
Incident /Accident Investigator	GAR 8	A competent person(s) to investigate incidents/accidents on site and could be: • The employer • H&S Representative • Designated person • Members of the H&S Committee
Risk Assessment Co-ordinator	CR 9	A competent person(s) to co-ordinate all risk assessments on behalf of the Principal Contractor. The same applies to Contractors.
Fall Protection Plan Co-ordinator	CR 10	A competent person(s) to prepare & amend the fall protection plan.
First Aiders	GSR 3	A qualified person(s) to address all on site first aid cases.
Lifting Machine & Equipment Inspector	DMR 18	A competent person(s) to inspect lifting machines, equipment & tackle.
Scaffolding Erector	CR 16.1	A competent person(s) to erect scaffolding
Scaffolding Inspector	CR 16.2	A competent person(s) to inspect scaffolding before use and every time after bad weather etc
Temporary Works	CR 12	A competent person(s) to inspect formwork & support work

Excavation Inspector	CR 13	A competent person(s) to inspect excavation work and ensure that approved safe working procedures, are followed at all times
Ladder Inspector	GSR 13A	A competent person(s) to inspect monthly and ensure they are safe for use, keeping monthly record
Stacking Supervisor	CR 28	A competent person(s) to supervise all stacking and storage operations
Demolition Supervisor	CR 14(1)	A competent person(s) to supervise all demolition work
Explosive Powered Tools Inspector/Supervisor	CR 21	A competent person(s) to inspect & clean the tool daily and controlling all operations thereof.
Temporary Electrical Installations Supervisor	CR 24	A competent person(s) to control all temporary electrical installations.
Construction vehicles and Mobile Plant Supervisor.	CR 23(1)(k)	A competent person to inspect vehicles and plant on a daily basis prior to use and record such finding in register.
Fire-Fighting Equipment Inspector	CR 29	A competent person(s) to inspect fire-fighting equipment with required training certificate.

OTHER REQUIREMENTS

ANNEXURE C

The Principal Contractor shall comply but not be limited to the following requirements: report on these to the Client at progress meetings or at least monthly which ever is sooner.

What	When	Output	Accepted by Client & date
Induction training	Every worker before he/she starts work.	Attendance registers	
Awareness Training (Tool Box Talks)	At least weekly	Attendance registers	
Health & Safety Reports	Monthly	Report covering: - Incidents/accidents and investigations - Non conformances by employees & External H&S audit reports	
Emergency procedures	Ongoing evaluation of procedure	Table procedure in writing as well as tel. Numbers	
Risk assessment	Continuous	Documented risk assessment	
Safe work procedures	Drawn up before workers are exposed to new risks	Documented set of safe work procedures (method statements) updated and signed off.	
General Inspections	Weekly & daily	Report OHS Act compliance: - Scaffolding - Excavations - Formwork & support work - Explosive tools	
General Inspections	Monthly	- Fire fighting equipment - Portable electrical equipment - Ladders - Lifting equipment/slides	

What	When	Output	Accepted by Client & date
List of contractors	List to be updated weekly	Table list, number of workers and Company tel. Numbers	
Workman's Compensation	Ongoing	Table a list of Contractors' Workman's Compensation proof of good standing	
Construction site rules & Section 37.2 Mandatory Agreement	Ongoing	Table a report of all signed up Mandatory's	

ANNEXURE D

Project/site Specific Requirements

The following is a list of activities and considerations that have been identified for the project and site and for which the Risk Assessment, Standard Working Procedures (SWP), management and control measures and Method Statements (where necessary) have to be developed by the Principal Contractor.

- Demolition work
- Creating openings in walls
- Preparation of paint surfaces
- Painting of walls
- Working with cement products
- Dust
- Metal/Steel work
- Exposure to noise
- Establishment of site office
- Locating of existing services
- Loading and offloading of trucks
- Aggregate/sand and other material delivery
- Protection against dehydration and heat exhaustion
- Manual and mechanical handling
- Lifting and lowering operations.
- Use of Potable electrical Equipment
 - Angle grinder
 - Electric Drilling Machine
 - Skill Saw
- Use and storage of flammable liquids and other Hazardous substances
- Site works
- Excavations
- Electrical installation work
- Mechanical works
- Working in the vicinity of the public, inmates (prisoners) and staff of the client
- Working at heights
- Working with construction machinery and plant
- Persons working in close vicinity of construction machinery and plant.
- Working with asbestos products i.e. gutters, down pipes, insulation etc.
- Hot works i.e. Welding, flame cutting etc.

NOTE:

The above list is by no means exhaustive and should not be limited to these activities but must cover all activities that forms part of the said construction

work. Each activity must be split down to individual tasks and all associated hazards identified and listed in the risk assessment. This ensures that the critical tasks and subsequent critical hazards are not missed.

NB:-

Although some of the work related to health and safety work is mentioned /noted in certain measured items in the bill of quantities it is still the contractor's responsibility to allow in his tender price for all work related to health and safety and the requirements as per this Health and Safety Specification

PART C4: SITE INFORMATION

PG-03.1 (EC) SITE INFORMATION – GCC 3rd Edition (2015)

Project title:	VARIOUS CENTRES (FS) LABOUR BUILDING GROUP 8: PHUTHADITJHABA: PROVISION OF WATER TANK			
Tender no:	BL25/012	WCS no:		Reference no: 14/2/1/4/12/6835

C4 Site Information

See attached drawings and BoQ.



PORTION 1: THE WORKS

PS 1 GENERAL DESCRIPTION

This Specification does not replace, take precedence over nor detract from the Occupational Health and Safety Act or the Construction Regulations 2014. Nothing in this Specification shall relieve the Contractor of any obligations or responsibilities concerning health and safety conditions and practices on site.

This specification relates to specific works and equipment required to supply and install an elevated steel water tank (domestic and fire tank), pipe fittings, stand, and supportive components at Phuthaditjhaba Department of Employment and Labour (DoEL) Building in the Free-State Province.

The objective of the project is to provide storage on site during periods of water outages from the municipality. The water is for domestic use and fire hose reels.

Phuthaditjhaba Labour Building is currently supplied with domestic water through a municipality connection. The new reticulation of the system will include a connection pipe from the water meter to the elevated water tank, where a domestic pipe will be connected from the tank to supply the building.

Each installation requires work that may include any one or more of the activities as set out below.

- Location of existing services
- Exposure of services
- Trench excavation, pipe laying and backfill
- Connection of water supply from tank to building
- Connection of fire water from water tank to hose reel
- Supply and installation of fire hose reel
- Supply and installation of pumps
- Excavation of bases for foundation
- Casting of foundation concrete for tank support
- Installation of water tank
- Installation of a 68kVA outdoor generator set
- Construction of a generator plinth
- Trenching for cables
- Bedding and backfill of cables
- Alterations to newly installed Pillar kiosk
- Testing and commissioning of the generator

Note: Any conflicting information must be referred to the Engineer for clarification.

Note the list of activities above does not limit the contractor from performing all necessary tasks required to safely install the steel water tank and back-up generator. All the above activities are to be performed to install a steel water tank and backup generator.

PS 2 DESCRIPTIONS OF SITE AND ACCESS

An A4 size locality plan as Annexure A to the Project Specification must be included.

Table 1: GPS Coordinates of the site

Location of the building	
Latitude	Longitude
28° 32' 6.46" S	28° 48' 32.12" E

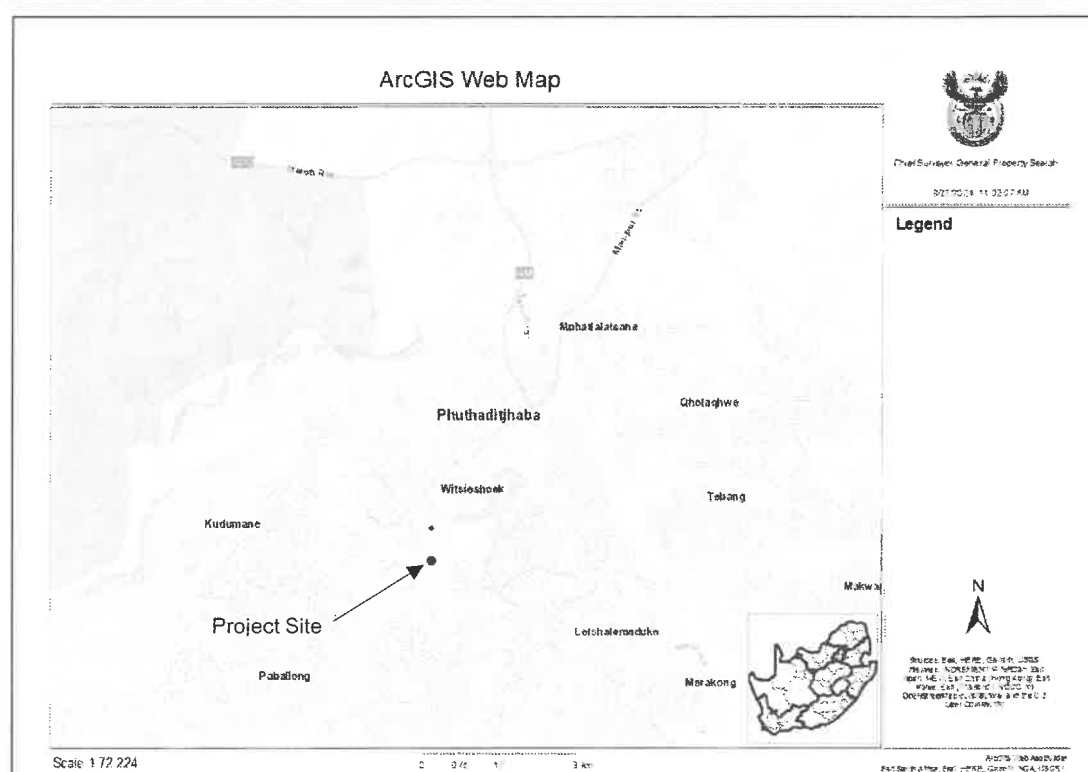


Figure 1: Locality plan for Phuthaditjhaba DoEL (1)

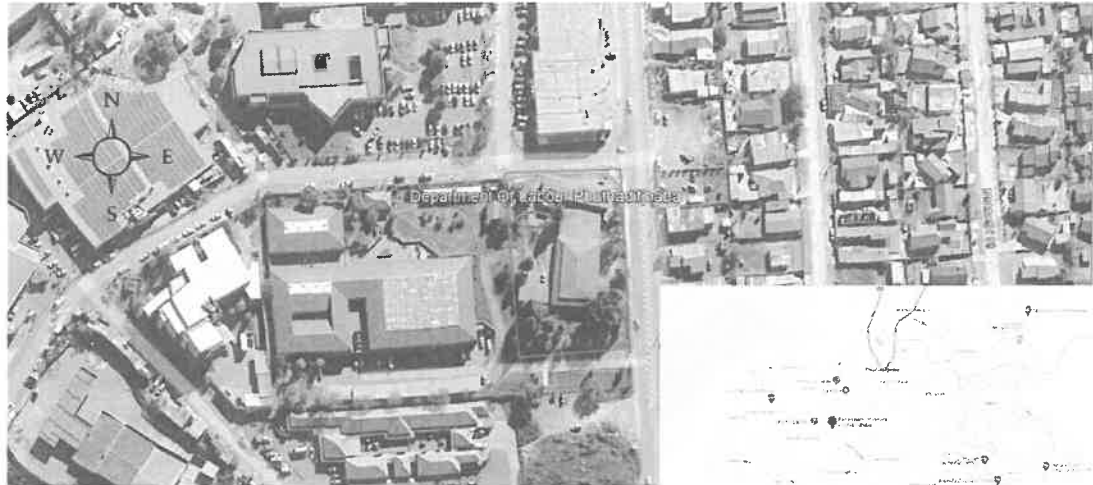


Figure 2: Locality plan for Phuthaditjhaba DoEL (2)

Take note that there are two access points to the site, both situated on the northern side of the property boundary. These access points include a pedestrian gate and a vehicle gate, clearly indicated in Figure 2 above by a red oval.

PS 3 NATURE OF GROUND AND SUBSOIL CONDITIONS

No geotechnical investigations were conducted. The contractor to undertake the investigations before any other work on site.

PS 4 DETAILS OF CONTRACT

This item is covered under the contract data.

PS 5 CONSTRUCTION PROGRAMME

This item is covered under the contract data.

PS 6 SITE FACILITIES AVAILABLE

PS 6.1 CAMP SITE AND STOREROOM

PS 6.2 WATER, ELECTRICITY AND SEWERAGE

PS 6.2.1 SOURCE OF WATER SUPPLY

Water that the Contractor may use at his own discretion is available on site. The Contractor must make the temporary connection and install a meter at his own expense at a point approved by the Engineer. The connection shall be watertight. Water will not be charged for, but consumption will be monitored in order to prevent wastage.

Where the site is located on dolomite, the Contractor shall take the necessary precautions to safeguard the use/abuse of water. If the Engineer is of opinion that the Contractor is negligent or abusing the service in such a way that the continual use of the service compromises the integrity of the underlying dolomite, the service may be discontinued. The Contractor will make his own arrangement for water in such cases.



The Department does not guarantee the sufficiency or continuity of the supply and no claims will be considered in this regard.

The Contractor will be held responsible for any wastage of water due to negligence.

PS 6.2.2 SOURCE OF POWER SUPPLY

If Single/3 Phase electric power is available on site, the Contractor may use it at his own discretion. The Contractor must make the temporary connection and install a meter at his own expense at a point approved by the Engineer. Power will be charged for at a tariff to be determined by the Regional Manager of the Department.

The Department does not guarantee the sufficiency or continuity of the electrical supply and if the supply should fail or be insufficient, the Contractor shall make his own arrangements. The Department will not be liable for any claims in this respect.

PS 6.2.3 SEWERAGE CONNECTION

The contractor shall ensure that hygienic safe and easily accessible toilet facilities are available.

If a sewerage connection is not available on site, chemical toilets shall be used.

NOTE: *The Employer shall not be held responsible for any losses or inconvenience due to a disruption in the supply of water and/or electricity.*

PS 6.3 PARKING FACILITIES

Parking facilities are available on the Site.

PS 7 SITE FACILITIES REQUIRED FOR THE ENGINEER

PS 7.1 GENERAL

PS 7.2 CONTRACT NAME BOARDS

Name boards shall be compliant with provisions of SANS 1200 AB, subclause 3.1.

PS 7.3 MOBILE PHONES

PS 7.4 ACCOMMODATION FOR ENGINEER'S REPRESENTATIVE

PS 7.5 CALL CENTRE

PS 8 FEATURES REQUIRING SPECIAL ATTENTION

PS 8.1 INSTALLATIONS AT FACILITIES

Majority of the site is paved with concrete block paving and concrete. There are three temporary tanks on site, which have a combined capacity of 25 000 litres of storage. At the time of compilation of this document, the water meter was not



reading. There were no as-built drawings available at the time of compilation of this document.

The installations at all facilities shall be carefully checked for damage and all damages shall be listed and discussed with the Engineer before commencement of repair and maintenance work. The Contractor shall present copies of all correspondence in this regard for discussion at the following site meeting.

PS 8.2 SECURITY

(a) Restrictions on movement and limited access

The Contractor's personnel, vehicles and equipment will be restricted to areas of construction only. The Contractor shall comply with any requirements that the Engineer may have in this regard and shall take note that access to some areas may be limited for security reasons.

(b) Security check on personnel

The Employer may ask the Contractor to have his personnel or a certain number of them security-classified, if required by any competent authority.

In the event of the Employer or any competent authority requiring the removal of a person/persons from the site for security reasons, the Contractor shall do so forthwith and the Contractor shall thereafter ensure that such person/persons are denied access to the site and/or to any documents or information relating to the work. In such circumstances, the Contractor shall indemnify the Employer and the Engineer and will discharge the Employer and the Engineer from any claims whatsoever.

PS 8.3 SITE TO BE KEPT CLEAN

During the progress of the work and upon completion thereof, the site of the Works shall be kept and left in a clean and orderly condition. The Contractor shall store materials and equipment for which he is responsible in an orderly manner, and shall keep the site free from debris and obstructions.

All redundant materials, rubbish and waste arising from the work must be removed from the site at the Contractor's cost and the site and buildings left clean and tidy.

PS 8.4 FACILITIES TO OTHER CONTRACTORS

The Contractor must make allowances for other Contractors on the site. This may involve adapting his programme to accommodate the work of other contractors and ensuring access to their sites along prescribed routes over the site of this Contract.



PS 8.5 SUBCONTRACTORS

The Contractor shall be responsible for work carried out by subcontractors on his behalf. The Engineer will not liaise directly with such subcontractors. Problems related to payments, programming, workmanship, etc, shall be the responsibility of the Contractor and the subcontractor. The Contractor will report payment to subcontractors to the Engineer. Payment must be declared on a monthly basis.

PS 8.6 SANS SPECIFICATIONS AND CODES OF PRACTICE

In this document all reference to South African National Standards specifications and codes of practice, or any other standard specifications or codes of practice, including National Building Regulations, shall be deemed to be references to the latest issues of such specifications and codes.

PS 8.7 MATERIALS

The monthly payment for materials brought onto the site will only be applicable for repair and replacement work, and not for maintenance work.

Unless otherwise instructed in writing by the Engineer, all proprietary materials are to be used, mixed, applied, fixed, etc, strictly in accordance with the manufacturer's recommendations.

PS 8.8 BORROW PITS

There will be no designated borrow pits. The Contractor shall utilise the material on Site or import material from commercial sources.

PS 8.9 PROTECTION OF FURNITURE AND EQUIPMENT

In the event where work is to be done inside buildings where there is furniture and other equipment involved, the Contractor will be responsible for moving the furniture and equipment in order to provide working space for his personnel. The programme shall be drawn up in such a way as to keep the movement of furniture and equipment to the very minimum and the Contractor shall be solely responsible for any damage to furniture or equipment.

PS 8.10 TESTING AND QUALITY CONTROL

The Contractor shall engage the services of an approved independent laboratory or other institution as applicable for quality testing, in order to ensure that his work complies with the specifications.

No separate payment will be made for such testing, the cost will be deemed to be included in the Contractor's rates for the items of work that require testing in accordance with the Specifications.

The onus to produce work that conforms to the requirements of the Specifications and Drawings regarding quality and accuracy of detail, rests upon the Contractor and he will, at his own expense, institute a quality-control system and provide experienced engineers, foremen, surveyors, materials technicians, other technicians and technical staff, together with all transport,



instruments and equipment to ensure adequate supervision and positive control of the Works at all times.

The cost of supervision and process control, including testing carried out by the Contractor, will be deemed to be included in the rates bid for the related items of work.

The Contractor's attention is drawn to the provisions of the various Specifications regarding the minimum frequency of testing required. The Contractor shall increase this frequency at his own discretion, to ensure adequate control where necessary.

On completion and submission of every part of the work to the Engineer for examination, the Contractor shall furnish the Engineer with the results of the relevant tests to indicate compliance with the Specifications.

PS 9 CERTIFICATES OF PAYMENT

This item is covered under the contract data.

PS 10 CONSTRUCTION IN RESTRICTED AREAS

Working space in certain areas may be restricted. The construction method used in these restricted areas largely depends on the Contractor's Plant. However, the Contractor must note that measurement and payment will be according to the specified cross-sections and dimensions irrespective of the method used, and that the rates and prices submitted will be deemed to include full compensation for difficulties encountered while working in restricted areas. Neither extra payment nor any claim for payment due to these difficulties will be considered.

PS 11 DRAWINGS

This item is covered under the contract data. However, provisions made under subclause PSH 5.1.2 are applicable, as relevant.

PS 12 LEGISLATION

This item is covered under the contract data.

PS 13 INSURANCE AMOUNTS

This item is covered under the contract data.

PS 14 TIMES FOR COMPLETION

This item is covered under the contract data.



PS 15 PRACTICAL COMPLETION

This item is covered under the contract data.

PS 16 PENALTIES

This item is covered under the contract data.

PS 17 NON-WORKING DAYS AND HOURS

This item is covered under the contract data.

PS 18 SAMPLES

This item is covered under the contract data. However, provisions made under subclause PSDB 7.5.1 and PSG 7 of this document shall be applicable, as relevant.

PS 19 WORKMANSHIP AND QUALITY CONTROL

The onus to produce work that conforms to the requirements of the Specifications and Drawings regarding quality and accuracy of detail, rests upon the Contractor and he will, at his own expense, institute a quality-control system and provide experienced engineers, foremen, surveyors, materials technicians, other technicians and technical staff, together with all transport, instruments and equipment to ensure adequate supervision and positive control of the Works at all times.

The cost of supervision and process control, including testing carried out by the Contractor, will be deemed to be included in the rates tendered for the related items of work.

The Contractor's attention is drawn to the provisions of the various Specifications regarding the minimum frequency of testing required. The Contractor shall, at his own discretion, increase this frequency to ensure adequate control where necessary.

On completion and submission of every part of the work to the Engineer for examination, the Contractor shall furnish the Engineer with the results of the relevant tests to indicate compliance with the Specifications.

PS 20 DECOMMISSIONED/DISCARDED MATERIALS

(a) Storeroom

Ownership of the material shall, however, lie with the Department of Public Works.

Material to be decommissioned by the Contractor shall be removed to this maintenance storeroom and added to the inventory. This material shall then become available to the Contractor for use in the execution of his maintenance duties.

The Contractor will apply from the Engineer for approval to dispose of any material at an approved landfill.



PS 21 APPLICABLE STANDARDISED AND PARTICULAR SPECIFICATIONS

Although not bound in nor issued with this document, the following standardized specifications shall form part of the contract document and, notwithstanding the provisions of subclause 2.2 of SANS 1200 A, the editions specified below shall apply:

a) SANS 1200 A 1986	GENERAL
b) SANS 1200 AB 1986	ENGINEER'S OFFICE
c) SANS 1200 D 1988	EARTHWORKS
d) SANS 1200 DB 1989	PIPE TRENCHES
e) SANS 1200 G 1982	CONCRETE
f) SANS 1200 H 1990	STRUCTURAL STEEL WORK
g) SANS 1200 HC 1988	CORROSION PROTECTION OF STRUCTURAL STEEL WORK
h) SANS 1200 L 1983	MEDIUM PRESSURE PIPELINES
i) SANS 1200 LB 1983	PIPE BEDDING (PIPES)
j) SANS 1200 LC 1981	CABLE DUCT
k) SANS 1200 LF 1983	ERF CONNECTIONS
l) SANS 10329 2020	THE DESIGN AND CONSTRUCTION OF SECTIONAL STEEL TANKS FOR STORAGE OF LIQUIDS AT OR ABOVE GROUND LEVEL

In addition, the following particular specifications that are bound in the document shall apply:

a) SPECIFICATION PA	MODEL TECHNICAL SPECIFICATIONS FOR THE DRILLING AND INVESTIGATION OF BOREHOLES
b) SPECIFICATION PB	GEOTECHNICAL INVESTIGATION
c) SPECIFICATION PC	SPECIFICATION FOR THE SUPPLY, INSTALLATION AND COMMISSIONING OF AN OUTDOOR EMERGENCY GENERATOR SET



PORTION 2: VARIATIONS TO STANDARDIZED/PARTICULAR SPECIFICATIONS AND ADDITIONAL CLAUSES:

SECTION 1200A: GENERAL REQUIREMENTS AND PROVISIONS

PSA 3. MATERIALS

PSA 3.1. QUALITY

Add the following:

All manufactured materials supplied shall be new unless the contrary is specified. All materials specified by SANS Specifications shall bear the SANS mark, whether so specified or not.

The contractor shall institute a quality assurance system and provide experienced personnel as well as all the necessary transport, instruments and equipment, to ensure adequate supervision and positive control of the works at all times in order to comply with the requirements.

PSA 3.2. STRUCTURES AND MATERIALS ONSITE

PSA 3.3. ORDERING OF MATERIALS

The quantities set out in the Schedule of Quantities have been carefully determined from calculations based on data available at the time and should therefore be approximate quantities only. Before ordering materials of any kind the Contractor shall check with the Engineer whether the scope of the work for which the materials are required is likely to change substantially.

No liability or responsibility whatsoever shall be attached to the Employer for materials ordered by the Contractor except when ordered by written confirmation issued by the Engineer.

PSA 5. CONSTRUCTION

PSA 5.2. WATCHING, BARRICADING, AND LIGHTING AND TRAFFIC CROSSINGS

The Contractor shall comply in all aspects with the requirements of the Occupational Health and Safety Act (Act 85 of 1993).

PSA 5.8. GROUND AND ACCESS TO THE WORKS

Add the following:

The Contractor shall further, before the commencement of any of the works, compile images and video recordings of the following:

- roads, structures,
- fences,
- gates,
- pipeline routes,
- and trees that may be affected during the works.



PSA 5.9. TRAFFIC ACCOMMODATION

The Contractor shall take note that the existing roads and tracks within and to the Sites shall remain operational throughout the contract period. To this end, the Contractor shall provide and maintain the following to ensure the safe and easy passage of all traffic:

- all temporary fences,
- security,
- barriers,
- kerb ramps,
- signs,
- markings,
- flagmen,
- drums,
- lighting,
- personnel,
- and all other incidentals necessary.

Temporary traffic signs etc. as well as all necessary markings shall be erected and maintained by the Contractor and the number and layout of the traffic signs shall comply with the Site Manual entitled "Safety at Roadworks in Urban Areas", as published by the Department of Transport. Traffic signs shall have a yellow background with either a red/black border.

No direct payment will be made for the cost of dealing with and accommodating traffic. Payment will be deemed to be covered by the rates and sums tendered and paid for the various items of work included under the contract. Further, the provision of PSA 5.2 shall apply.

PSA 5.10. SITE MEETINGS

The Contractor's authorised Site Agent and Contracts Manager will be required to attend regular site meetings. These meetings will be held twice a month on dates and at times determined by the Engineer or Project Manager. Alternatively, whenever reasonably required by the Engineer or Project Manager. Unless otherwise indicated in the Contract or instructed by the Engineer, such meetings shall be held at the Contractor's offices on the Site. At such monthly meetings, matters such as to be discussed exclude day-to-day operations. However, included the following:

- general progress on the Works,
- quality of work,
- problems,
- claims,
- payments,
- and safety.



PSA 5.10. EXISTING SERVICES

PSA 5.10.1. GENERAL

PSA 5.10.1.1. The contractor shall terminate, divert or maintain in use (either temporarily or permanently) existing services as required by the Engineer.

PSA 5.10.1.2. The contractor shall, in protecting, moving and relocating services, work in close co-operation with private owners or public authorities controlling such services.

PSA 5.10.1.3. The contractor shall be responsible for any damage to services which are

- a) known to exist within the site and shown on the drawings,
- b) pointed out to him by the employer
- c) reasonably inferred from manholes, valve boxes and the like, or
- d) specified by the Engineer

PSA 5.10.1.4. Where the probability of underground services can be inferred, the contractor shall, while taking all reasonable precautions not to damage such services, ascertain where such services exist within the relevant section of the site. The contractor shall do this by means of visual inspections, by making excavations to expose the position of services at critical points and, if required by the Engineer, by using detection apparatus. The contractor shall complete such investigations well in advance of the works commencing and shall submit a report to the Employer in time to enable whatever arrangements are necessary for the protection, removal, or diversion of the services before any construction commences.

PSA 5.10.1.5. As soon as the underground service is discovered, the contractor shall notify the employer and mark it up on a drawing. Thereafter such service shall be regarded as a known service and the contractor shall be held responsible for any damage thereto, unless he has taken all reasonable precautions and the damaged service is found to be more than 1 m from the position as may reasonably have been deducted by an experienced contractor from the investigations referred to in PSA 5.10.4.

PSA 5.10.1.6. The contractor shall take all reasonable steps to protect overhead and underground services and shall not excavate by means of mechanical equipment within 3 m of the estimated position of an underground cable.

PSA 5.10.1.7. In the event of a service becoming damaged, the contractor shall immediately notify the authority concerned and the employer and reinstate or repair (or both) such service only if instructed to do so by the authority or employer.

PSA 7. TESTING

PSA 7.1. TESTING PRINCIPLES

PSA 7.1.3. COST OF TESTING

The cost of all testing to be carried out by the Contractor in terms of the requirements of the relevant SABS 1200 standards shall be included in the rates for the various work items listed in the Schedule of Quantities. No separate payments shall be made in this regard.

The Engineer may order the Contractor to arrange special check tests to be carried out by an approved independent laboratory. The cost of special check tests ordered by the Engineer



shall be borne by the Employer if the test results indicate compliance with the specification and by the Contractor if the results indicate non-compliance with the specification.

PSA 7.2. APPROVED LABORATORIES

Unless otherwise specified in the relevant specification or elsewhere in the Project Specification, the following shall be deemed to be approved laboratories in which design work, or testing required in terms of a specification for acceptance by the Engineer of the quality of materials used and/or workmanship achieved, may be carried out.:

- (a) Any testing laboratory certified by the South African National Accreditation Systems (SANAS) in respect of the nature and type of testing to be undertaken for the purposes of the Contract;
- (b) Any testing laboratory owned, managed or operated by the Employer or the Engineer.
- (c) Any testing laboratory established and operated on the Site by or on behalf of the Contractor.
- (d) Any other laboratory that the Engineer approves in his absolute discretion.

PSA 7.3. PRESSURE LOGGING TEST

Prior to commencement of this item, a method statement must be submitted to the Engineer for review and approval. A pressure logging test is required to determine typical municipal pressure supplied into the site's erf boundary. For this test, pressure must be recorded three times a week (morning, afternoon and late afternoon) over a minimum period of two weeks. Typical equipment used is a digital logger or manual pressure gauge. It is up to the contractor which equipment to use.

PSA 8. MEASUREMENT AND PAYMENT

PSA 8.5. SUMS STATED PROVISIONALLY BY ENGINEER

PSA 8.5.1. PRESSURE LOGGING TESTSUM

The tendered rate shall include complete execution of this item, including collection of data and reporting of test results.

PSA 8.5.2. GEOTECHNICAL INVESTIGATION..... SUM

The tendered rate shall include complete execution of this item, including collection of data and reporting of test results.



SANS 1200 C: SITE CLEARANCE

PSC 3. MATERIALS

PSC 3.1. DISPOSAL OF MATERIAL

Add the following:

The contractor is responsible for arranging their material disposal sites. All transportation costs must be included in the tendered rates for site clearance items.

PSC 5. CONSTRUCTION

PSC 5.2. CUTTING OF TREES

PSC 5.2.3 PRESERVATION OF TREES

PSC 5.2.3.1. INDIVIDUAL TREES

Individual trees that, are stated by the Engineer, are identified to be conserved, shall be left standing, uninjured and protected against damage from all construction activities.

An amount as indicated in the Environmental Specification and or applicable legislation, will be deducted from money due to the Contractor as a penalty for every tree that is damaged or removed without consent of the Engineer.

PSC 5.3. CLEARING

PSC 5.3.1. Clearing shall consist of any of the activities described in Table 2 below.

PSC 5.3.2. The work associated with activities 2 and 3 (see Table 2 below) shall include

- (a) Excavation to expose the obstruction, including the measures required to stabilize the sides of the excavation, and
- (b) The breaking out, removal and disposal of the material causing the obstruction.

PSC 5.3.3. All incoming and outgoing pipes of abandoned underground structures or obstructions shall be sealed with

- (a) Grade 15 concrete which complies with the requirements of SANS 2001-CC1 or SANS 2001-CC2, or
- (e) 230 mm thick masonry, using masonry units with a minimum compressive strength of 10MPa, in accordance with the requirements of SANS 2001-CM1.

PSC 5.3.4. The work associated with activity 11 (see Table 2 below) shall include

- (a) The breaking up of pavements and excavation to expose the sewer, drain or water main, including the measures required to stabilize the sides of the excavation;
- (b) Either the reclamation of the pipe or the breaking up and disposal of the pipe together with any bedding and concrete haunching to such pipe(s) as specified by the Engineer
- (c) Backfilling trenches in accordance with requirements of SANS 2001-DP1
- (d) The disposal of surplus and unusable material; and
- (e) The sealing of ends of sewers and drains in with the requirements of PSC 5.3.3.



Note: The moving of a certain amount of soil or gravel might be inherent in, or unavoidable during, the processes of clearing.

Table 2: Site clearing activities

1	2
Activity number	Description of activity
1	The removal and disposal of all trees and bushes (complete with roots), other vegetation, rubbish, hedges, fences, and all other material that might interfere with the construction of other works.
2	The demolition, breaking up and removal of buildings, walls, structures and all superficial obstructions on the site affected by the works down to original ground level.
3	The demolition, breaking up and removal of underground structures, such as foundations and chambers of masonry or concrete construction to a depth specified in the drawings or instructed by the Engineer.
4	The demolition, breaking up and removal of underground structures, such as septic tanks and soak pits.
5	The removal of all litter, building rubble, rocks and boulders that are lying on the surface to be cleared, or exposed during the clearing operations.
6	The removal and stacking of reusable material as specified on the drawing or instructed by the Engineer.
7	The breaking up and complete removal of all pavement layers and concrete haunching, which would normally entail the use of mechanical break-out equipment.
8	The breaking up and complete removal of sidewalks, ramps, parapets, paving slabs, blocks, slate paving, brick paving, and the like.
9	The breaking up and removal of kerbs and channels or haunching (or both).
10	The scarifying, loosening and breaking up of hardened areas by ripping or excavation to a depth specified in the drawings, such that the maximum dimension of any residual block is not greater than 200 mm.
11	The removal of discussed foul water and stormwater sewers, drains and water mains.

PSC 5.4. GRUBBING

PSC 5.4.1. All stumps and roots larger than 75 mm in diameter shall be removed to a depth of at least 600 mm below the finished level, and at least 100 mm below the original ground



level. Where a roadbed or other area has to be compacted, all stumps and roots, including matted roots, shall be removed to a depth of at least 200 mm below the cleared surface.

PSC 5.4.2. Except in borrow areas, cavities resulting from grubbing shall be backfilled with suitable material and compacted to a density of 90% of the modified AASHTO maximum dry density or that of the surrounding ground, whichever is lesser.



SANS 1200 D: EARTHWORKS

PSD 2. INTERPRETATIONS

PSD 2.3 DEFINITIONS

Borrow material: Material, other than material obtained from excavations required for the works, obtained from sources such as borrow pits or the authorized widening of excavations. 'Borrow' shall have a corresponding meaning.

Specified density: The specified dry density expressed as a percentage of modified AASHTO dry density.

Stockpile (verb): The process of selecting and, when necessary, loading, transporting and off-loading material in a designated area for later use for a specific purpose

Commercial source: A source of material provided by the Contractor, not the Employer, and including any borrow pit, provided by the Contractor.

Fill: An embankment or terrace constructed of material obtained from excavations or borrow pits. In roads it includes the earthworks up to the underside of the selected subgrade level.

Fill (material): Material used for the construction of an embankment or terrace Roadbed: The natural in situ material on which the fill or, in the absence of fill, the pavement layers are constructed

PSD 3. MATERIALS

PSD 3.1. CLASSIFICATION FOR EXCAVATION PURPOSES

PSD 3.1.1. METHOD OF CLASSIFYING

Excavation shall be classified in accordance with the requirements of labour-intensive projects. Thus, all earthworks activities shall be performed by hand. The classification of material other than 'soft' excavation shall be agreed upon before excavation may commence. The Contractor shall immediately inform the Engineer if the nature of the material being excavated changes. Failure on the part of the Contractor to advise the Engineer in good time shall entitle the Engineer to reclassify, at his discretion, such excavated material.

PSD 3.1.2. CLASSES OF EXCAVATION

Classification must be made in terms of consistency and shear strength. All soft classes of excavated materials can be removed by means of hand implements and may be classified in accordance with the provisions of Table 3 & Table 4 below. Trench excavation rates shall be as estimated on Table 5 below.

Table 3: Classification of excavated materials

1	2
Classification	Description



Soft Class 1	Material which can be excavated by means of a suitable shovel without the use of a pick or other hand-swung tool
Soft Class 2	Material which can be readily excavated with the aid of a pick or other hand-swung tool
Soft Class 3	Material which can be excavated with difficulty with the aid of a hand swung tool
Intermediate	Material which is difficult to excavate by hand even with the aid of a crowbar and requires the assistance of pneumatic tools for economic removal
Rock	Material which cannot be economically fragmented and loosened by hand implements and pneumatic tools except by drilling and blasting or the use of rock-breaking equipment

Table 4: Classification of materials in terms of consistency and shear strength

1	2	3	4	5
Material Classification	Consistency (as defined in table 1)		Number of dcp blows to penetrate 100mm ^a	
	Granular soil	Cohesive Soil	Granular soil	Cohesive Soil
Soft Class 1	Very loose to loose	Very soft to soft	≤ 2	≤ 1
Soft Class 2	Loose to medium dense	Soft to stiff	2 – 6	1 – 5
Soft Class 3	Dense	Stiff to very stiff	7 – 15	6 – 8
Intermediate	-	Very stiff	>15	>8
Rock	-	-	-	-

^a Only applicable to materials comprising not more than 10 % gravel of size less than 10 mm and materials containing no cobbles or isolated small boulders.

Table 5: Approximate trench excavation rates

1	2	3	4	5
Excavation type	Typical production per 6 h task m ³			
	Depth range			
	0 m – 1.0 m	1.0 m – 1.5 m	1.5 m – 2.0 m	2.0 m – 2.5 m
Soft class 1	3.5	3.0	2.4	1.6
Soft class 2	2.8	2.4	1.9	1.3
Soft class 3	1.7	1.5	1.2	0.8

PSD 3.2.1. MATERIAL SUITABLE FOR EMBANKMENTS AND TERRACES

The following materials shall, unless otherwise instructed by the Engineer, be suitable for embankments and terraces:

- a) Material with a CBR of at least 3% at the minimum specified density (compacted at OMC) and a PI not exceeding 18; or
- b) Hard material or rock material with a maximum dimension of 300mm; or
- c) Both clay or clayey material of a liquid limit that exceeds 40, or PI that exceeds 18 (or both), and rocks or boulders that have a maximum dimension greater than 300 mm, provided that they
 - 1) Are not placed against structures, and
 - 2) Are placed in predetermined quantities and in specified parts of the fill, in accordance with the requirements of PSDB 5.6.1.1; or
- d) Materials that can be compacted so as to avoid settlement that exceeds 2 mm/m of depth excavation, and that contain no more than 10% rock or hard fragments retained on a sieve of nominal aperture size 50 mm and that contain no large clay lumps that break up under the action of compaction equipment used

PSD 3.2.2. MATERIAL SUITABLE FOR REPLACING OVERBREAK IN EXCAVATIONS FOR FOUNDATIONS

PSD 3.2.2.1. The backfill in overbreak for foundations shall be capable of sufficient compaction to avoid settlement and shall be capable of placement without significant voids.

PSD 3.2.2.2. The backfill shall not contain appreciable quantities of organic matter or stones of average dimension exceeding the lesser of 150 mm or two-thirds of the thickness of the layer being compacted. In addition, the backfill shall be graded material that has a PI not exceeding 10 and a CBR of at least 10% at the minimum specified density compacted at OMC.

PSD 3.2.3. MATERIAL SUITABLE FOR BACKFILL OR FILL AGAINST STRUCTURES

Material used for backfill behind structures shall generally be the material excavated, subject to the following conditions:



- a) The material shall not contain an excessive number of stones retained on a 50 mm sieve; and
- b) The material shall not contain large clay lumps that do not break up under the action of the compaction equipment; and
- c) The liquid limit of the material shall not exceed 40, neither shall the PI exceed 18.
- d) The minimum compaction shall be 93% of modified AASHTO maximum density.

The material placed as backfill or as fill within 500 mm of structures shall comply with PSDB 3.3 except that it shall not contain more than 10% rock or hard fragments retained on a sieve of a nominal aperture size 50 mm.

PSD 3.3. SELECTION

PSD 3.3.1. GENERAL

Replace the second paragraph with the following:

The Contractor shall deal selectively with materials from all excavations to ensure that no acceptable backfill or bedding material is contaminated by material unfit for use. No additional payment shall be made in this regard and all costs related to the above selection process shall be included in the applicable payment items. Should useful material be contaminated to such an extent that it is regarded as unfit for use, the Contractor shall at his own cost dispose of this material and replace it with the material of an equivalent standard to the acceptable in situ material.

PSD 3.3. SELECTION OF MATERIALS

PSD 3.3.2. BACKFILLING, EMBANKMENTS AND FILLS

Sufficient material arising from excavations for foundations, footings, cuttings, etc, and that is suitable for backfilling, filling against the finished structures, or placements in embankments and fills shall be stockpiled in the vicinity of the structures, or if it cannot be placed directly in the embankment or fill, in the vicinity of the embankment or fill. All other material from excavations and cuttings shall be disposed of on the site, or in accordance with the scope of work, in such a manner that material can be placed with confidence in the correct position in embankments. Any material that is below the finished level of an excavation that is unsuitable, shall be excavated and disposed of. The resultant space shall be refilled with backfill and compacted.

PSD 3.3.3. CONSERVATION OF TOPSOIL

Where, as instructed by the Engineer, the topsoil is required for later use on the site, the topsoil shall be selected and stockpiled

PSD 4 PLANT

PSD 4.2 COMPACTION

Where it is required that the work be carried out using labour intensive methods, the Contractor shall not use compaction plant larger than a walk-behind compactor.

PSD 5. CONSTRUCTION

PSD 5.1.2 EXISTING SERVICES



PSD 5.1.2.2. DETECTION, LOCATION AND EXPOSURE

The exposure by the Contractor of underground services, as required in terms of subclause 5.4 of SANS 1200 A (as amended) shall be carried out by careful hand excavation at such positions and to such dimensions as are agreed to by the Engineer. Subclause PSDB 5.1.5 is also applicable.

Unless otherwise instructed or agreed by the Engineer, no service shall be left exposed after its exact position has been determined. All excavations carried out to expose underground services shall be promptly backfilled and compacted to the following densities:

- (a) In roadways: 93% modified AASHTO density; and
- (b) In all other areas: 93% modified AASHTO density.

Where hand excavations to expose underground services must be carried out in roadways, the Contractor shall reinstate the road layerworks following the provisions of subclause 5.9 of SANS 1200 DB.

Payment in respect of exposing the services employing hand excavation as described above, will be made following subclause 8.3.8.1 (c) of SANS 1200 D.

Payment in respect of reinstating layerworks in roadways and all paved surfaces will be made following subclause 8.3.6.1 of SANS 1200 DB (as amended).

PSD 5.1.2.3. PROTECTION DURING CONSTRUCTION

As per subclause 5.4.2 of SANS 1200 A (as amended), major excavating equipment and other plant must not be operated dangerously close to known services. If necessary, excavation near known services must be carefully carried out using suitable hand tools, excluding picks when their use could damage the services. No extra payment will be made for such more difficult work.

If the contractor discovers or encounters any unidentified service during the contract, they must promptly notify the engineer and take immediate measures to prevent any damage to the service. If any damage has occurred, the contractor must minimize any further damage.

PSD 5.2. METHOD AND PROCEDURES

PSD 5.2.1. SITE PREPARATION

PSD 5.2.1.1. CLEARING OR CLEARING AND STRIPPING OF SITES

All areas in which excavation is to take place or that are to be covered by terraces, banks or structures shall be

- a) Cleared in accordance with the requirements of SANS 2001-BS1, or
- b) Cleared as specified in (a) and also stripped of all remaining vegetation and surface soil to a depth up to 150 mm. Unsuitable material shall be disposed of as on the drawings.

PSD 5.2.1.2. CONSERVATION OF TOPSOIL

When so required by the Engineer, and when there is suitable topsoil within the limits of the area to be cleared, the topsoil, together with any grass or other suitable vegetation that is removed, shall be conserved. If it is not used immediately or if it is not stockpiled in windrows clear of the working areas, the topsoil shall be conserved for later use in the manner specified in this document. Topsoil shall not be removed from any area in which the average depth of soil is less than 150 mm.



PSD 5.2.1.3. STRIPPING OR REMOVAL OF OVERBURDEN

Except as required in terms of PSDB 5.2, where stripping as specified in PSD 5.2.1.1(a) is required to include the removal of overburden and unsuitable material to depths exceeding 150 mm, the details will be shown on the drawings.

PSD 5.2.2. EXCAVATION

PSD 5.2.2.1. EXCAVATIONS FOR GENERAL EARTHWORKS AND FOR STRUCTURES

PSD 5.2.2.1.1. Excavation work shall be so executed that material:

- a) Excavated and placed in accordance with the requirements of subclause PSDB 3 and materials from excavations shall be used in preference to materials from borrow pits or other sources;
- b) Shall be transported directly to its final position without being stockpiled, and if stockpiling is unavoidable, materials intended for different uses shall be stockpiled separately.

PSD 5.2.2.1.2. After an area has been stripped, excavation shall be carried out first to any general levels to which the ground has to be reduced and then for foundations, fittings, etc., to the depths indicated in the drawings or to such greater depths as may be required to reach a suitable founding stratum.

PSD 5.2.2.1.3. Except where otherwise shown in the construction drawings, required in terms of the specification data or dictated by the requirements for safeguarding excavations, excavation shall be so carried out and the excavated surfaces so prepared by trimming to the outline of the concrete work shown in the drawings, that the excavated surfaces will act as formwork for the concrete works.

PSD 5.2.2.1.4. Except where provision for working space has been made in the scope of work, each excavated surface on which, or against which, a permanent concrete structure will be placed shall be prepared by trimming to ensure that there is no projection outside the specified tolerance into the excavation profile. Such surface shall be cleared by hand or by air or by other effective means to remove all loose material.

PSD 5.2.2.1.5. Immediately before any permanent construction is commenced, the bottom of each excavation shall be cleaned of all loose material, and soft material shall be rammed or removed, as required.

PSD 5.2.2.1.6. Excavated surfaces that will remain permanently exposed shall be trimmed in a neat and workmanlike manner and shall be graded to provide suitable drainage, as shown in the drawings.

PSD 5.2.2.1.7. Cuts shall be made and trimmed neatly to the side slopes, widths, levels, grades and sections shown in the construction drawings.

PSD 5.2.2.1.8. Unless otherwise specified in this document, the finished formation width of private sidings shall be at least that shown in figure 1, appropriate to the layout.

PSD 5.2.2.1.9. Where required in the specification data, the slopes of cuttings shall not be trimmed to a smooth surface but left as cut by a bulldozer or scraper to provide ledges to retain topsoil.

PSD 5.2.2.3. DISPOSAL



The contractor must arrange for suitable sites to dispose of any extra or unsuitable materials. Furthermore, the contractor is responsible for planning with the site owner, covering any necessary fees, and complying with any applicable regulations.

Every spoil site provided by the Contractor shall be approved by the local authority in whose area it is located, and the spoiling shall comply with the applicable statutory and municipal regulations as well as the requirements of the owner of the spoil site.

PDS 5.2.3. PLACING AND COMPACTION

PSD 5.2.3.1. EMBANKMENTS

PSD 5.2.3.1.1. Where material from excavations is insufficient to form designated embankments, additional material shall be obtained from borrow pits.

PSD 5.2.3.1.2. Only material that

- a) Has been obtained from excavations or borrow pits (or both), and
- b) Is free of stumps, tress, rubbish and other deleterious materials,

Shall be placed in the lower layers of an embankment. Only material of the same or better quality (see PSDB 3.3) shall be placed in the upper portion of an embankment.

PSD 5.2.3.1.3. Where it is necessary to use clay or clayey material that complies with the requirements of 4.1.1, such material shall be placed not less than 1 m and not more than 6 m below the finished surface.

PSD 5.2.3.1.4. Rocks with a maximum dimension exceeding 600 mm shall not be placed at the base of an embankment.

PSD 5.2.3.1.5. Before compaction, the material of each embankment shall be deposited in layers of thickness not exceeding 30 mm. The material shall be spread to form a layer that is of approximately uniform thickness, and graded over the whole area of the embankment.

PSD 5.2.3.1.6. Unless otherwise specified in this document, each layer shall be compacted at OMC to a density of at least 90% of modified AASHTO maximum dry density in the case of cohesive soil, or 98% in the case of non-cohesive soil. Should the material be too wet, owing to rain or any other cause, it shall be harrowed and allowed to dry out to the correct moisture content before compaction is undertaken.

PSD 5.2.4. FINISHING

PSD 5.2.4.1. FINAL GRADING

On completion of earthworks to the finished level and of backfilling of all holes, tranches, etc, etc., the whole surface shall be graded, shaped and compacted to final grades and levels.

PSD 5.2.4.2. TOPSOILING

Where required in terms of the specification data, topsoil shall be placed on level and slightly.

PSD 5.2.4.3. Grass or other vegetation

Where required in terms of the specification data, grass or other vegetation shall be planted after the topsoiling has been completed. On completion of planting, the planted area shall be neatly trimmed and well-watered and not allowed to dry out until it is established, or for the period required in the scope of work.



PSD 5.2.4.4. Reinstatement and maintenance of roads

Roadways through which trenches or other excavations have been made shall be reinstated and maintained. The road surface shall be restored to its correct level without any subsidence occurring at the site of such trench or other excavation.

NOTE: Where immediate restoration is impracticable, barricading, lighting and other safeguards shall be provided until restoration is complete.

PSD 6. TOLERANCES

PSD 6.1 Positions, dimensions, levels, etc.

The earthworks shall be finished to within the limits given in Table 6 for the degree of accuracy required in terms of the specification data.

Table 6: Permissible deviations in respect of position, dimensions and levels

1	2	3	4
Item	Permissible deviation (pd)		
	III	II	I
Excavation for structural foundations			
a) Position on plan Pd in plan of any point measured from the nearest grid line	±50 mm	±35 mm	±25 mm
b) Dimensions on plan Pd from the design dimensions	±75 mm	±50 mm	±25 mm
c) Foundation level (i.e level of underside of concrete except floor slab) Pd in level of surface of excavation trimmed to receive concrete	±75 mm	±50 mm	±25 mm
d) Level Pd from designed level with reference to the nearest transferred benchmark of any floor slab	±20 mm	±15 mm	±10 mm
Terraces and embankments			
a) Position of top edge of terrace ^a	±450 mm	±300 mm	±150 mm



Pd from designated position of any point, measured from nearest grid line			
b) Alignment of top edge of terrace ^a Pd from a line joining any two points 30 m apart on top of terrace	±200 mm	±100 mm	±50 mm
c) Finished levels Pd from a line joining any two points 30 m apart on top edge of terrace	±150 mm	±50 mm	±50 mm
d) Slopes of top surfaces Pd from direction of slope	zero	zero	zero
Pd from rate of fall 1 in 100 to 1 in 300	20%	10%	5%
1 in 400 and flatter	10%	5.5%	2%
Bulk earthworks for railway sidings			
Cut slope surface (batters) parallel to centre line: a) Other than rock cuttings Pd from designated batter line measured normal to slope	±300 mm	±200 mm	±100 mm
b) Rock cuttings only Pd from designated batter line measured normal to slope	±400 mm	±300 mm	^b
Fill slope surfaces parallel to centre line Pd from designated batter	Not less than designated value		
Width of formation Pd from specified width measured from centre line	0, +300 mm	0, -200 mm	^b
Pd from specified total width	0, +400 mm	0, +300 mm	^b
Formation level Pd from designated levels	±50 mm	±30 mm	^b
^a Subject to the break line between intersecting slopes being visually and suitably straight			
^b As specified in the specification data, if required.			



PSD 6.2. MOISTURE CONTENT AND DENSITY

Moisture content and density during compaction shall be within the limits given in Table 7 below, appropriate to the degree of accuracy required or as instructed by the Engineer.

Table 7: Permissible deviations in respect of moisture content and density

1	2	3	4
Item	Permissible deviation (pd) %		
	III	II	I
Moisture content Pd in moisture content in field during compaction from OMC	+2, - 2	+1, - 2	+0, - 2
Density Pd in density from specified density	No top limit, 0	No top limit, 0	No top limit, 0

SANS 1200DB EARTHWORKS (Pipe trenches)

PSDB 2. INTERPRETATIONS

PSDB 2.3. DEFINITIONS

For the purpose of this document, the definitions given in SANS 10403 and the following shall apply.

PSDB 2.3.1. BACKFILL

Material placed and compacted on top of the fill blanket to reinstate the excavated trench to the original level.

PSDB 2.3.2. BASE

Layer of specified material of designated thickness that is placed immediately below the surfacing of a road or paved area.

PSDB 2.3.3 BEDDING

Material placed and compacted around or over a pipe or prefabricated culvert in the manner specified.

PSDB 3. MATERIALS

PSDB 3.1. CLASSES OF EXCAVATION

DELETE THE CONTENTS OF CLAUSE 3.1 AND REPLACE WITH THE FOLLOWING: "The classification shall be as described in PSD 3.1".

PSDB 3.3. SELECTED GRANULAR MATERIAL

Selected granular material shall, unless otherwise instructed by the Engineer, be material of a granular, non-cohesive nature that is free-draining, has a maximum aggregate size of 20mm and has a compaction fraction that does not exceed 0.3.

PSDB 3.4. SELECTED FILL MATERIAL

Selected fill material shall, unless otherwise instructed by the Engineer, be material that has a PI that does not exceed 6 and that is free of vegetation, lumps and stones the largest dimension of which does not exceed 30 mm.

PSDB 3.5. BACKFILL MATERIAL

PSDB 3.5.1. Except as specified in PSDB 3.5.2, material excavated from trenches and used as backfill shall

- a) Contain little or no organic material
- b) Exclude stone the average dimension of which exceeds 150 mm, and
- c) Be able to be placed without significant voids and be so compacted as to avoid significant settlement

Such material shall contain not more than 10% of rock or hard fragments that are retained on a sieve of nominal aperture size of 50 mm, and shall contain a large clay lumps that do not break up under the action of compaction equipment.



PSDB 3.5.2. In areas subjected to loads from road traffic and in other areas identified by the Engineer, backfill shall have a PI that does not exceed 12 and a minimum of CBR of 15% at specified density if the backfill is to be placed in the upper 150 mm of the subgrade, and a minimum CBR of 7% if the backfill is to be placed lower in the subgrade.

PSDB 3.5.3. Cement stabilized backfill, where required, shall comprise 100 kg of common cement, that complies with the requirements of SANS 50197, to one cubic metre of loose backfill.

PSDB 3.6. MATERIAL FOR REINSTATEMENT OF ROADS AND PAVED AREAS

PSDB 3.6.1. MATERIALS FOR THE SUB-BASE AND BASE

Where trenches cross or run along surfaced roads and paved areas of which the surfaces to be reinstated, sub-base and base materials that might be required to supplement such materials lost during excavation shall comply with the requirements for the sub-base and base required in terms of the scope of work or, if no such requirements are specified, with at least the quality of the material which it replaces.

PSDB 3.6.2. GRAVEL

Where trenches cross or run along gravel roads of which the surfaces are to be reinstated, the top 300 mm of the material excavated shall be separately stored for the purpose of reinstatement.

PSDB 3.6.3. MATERIALS FOR BITUMINOUS CONSTRUCTION

Materials for bituminous construction shall comply with the applicable requirements of the appropriate of the following standards:

- | | |
|-----------------------------------|---|
| a) Prime type: | SANS 749 |
| b) Cutback bitumens or emulsions | SANS 308 or SANS 309 |
| c) Coarse aggregate (stone chips) | Freshly crushed rock other than argillaceous rock and pedocretes that comply with the requirements of SANS 1083 |

PSDB 3.6.4. ASPHALT SURFACING

Asphalt surfacing shall consist of either of the following mixes:

- 100 parts of 6,7 mm coarse aggregate (stone chips) by mass, plus 7 parts of RC 250 cutback bitumen by mass of emulsion; or
- 100 parts 6,7 mm coarse aggregate (stone chips) by mass, plus 8 parts of premix-grade 60 bitumen emulsion by mass of emulsion.

PSDB 3.7. SELECTION

REPLACE THE WORDS "if he so wishes" IN THE FIRST LINE OF THE SECOND PARAGRAPH WITH THE WORDS "at his own cost".

PSDB 5. CONSTRUCTION

PSDB 5.1. PRECAUTIONS



PSDB 5.1.2. STORMWATER, SEEPAGE AND DEWATERING OF EXCAVATION

PSDB 5.1.2.3. SLOPING GROUND

ADD THE FOLLOWING SENTENCE AT THE END OF THE PARAGRAPH:

All trench excavations on sloping embankments shall be backfilled following subclause 5.6.2 over the full extent of the actual trench excavation and to the original embankment ground level.

PSDB 5.1.3. ACCOMMODATION OF TRAFFIC AND ACCESS TO PROPERTIES

REPLACE ITEM (b) WITH THE FOLLOWING:

(b) Where necessary to achieve compliance by the Contractor with his obligations to provide and maintain pedestrian and vehicular access to properties affected by the works, the contractor shall construct and maintain to the satisfaction of the Engineer, such temporary access roads around, and/or steel or timber bridges over excavations in roads, pavements, entrances or accesses to properties.

The Contractor shall always make available on site a sufficient number of steel plates at least 2.0m x 2.0m x 8mm thick to be laid across open trenches to provide access to private properties. The cost of providing, placing and removing the steel plates shall be included in the rates for trench excavation.

On completion of the work, the Contractor shall dismantle and remove all such temporary constructions and reinstate these areas to their former condition if not better condition. Except only where the Engineer has included in the Schedule of Quantities, the Contractor will not be paid directly for the construction and maintenance of temporary access roads and/or the provision and maintenance of bridges as aforementioned, and the costs thereof shall be deemed included in the Contractor's tendered rates for excavation.

PSDB 5.1.5. REMOVAL OF EXISTING PIPELINES

Where existing pipes have to be removed, they shall be carefully opened up by machine excavation to 300 mm above the pipes after which the whole pipe shall be fully exposed using hand excavation. The excavation width shall comply with subclause 8.2.3 of SANS 1200 DB and/or requirements in subclause PSDB 5.2 of this document.

The pipes shall be removed from the trench as approved by the Engineer and brought to the surface for inspection by the Engineer.

Pipes declared suitable for reuse and pipes declared unfit for reuse shall be dealt with in an applicable manner described in the specifications, or on the Drawings, or on the Engineer's instructions, as relevant.

PSDB 5.2. MINIMUM BASE WIDTHS

PSDB 5.2.1. The width of excavations shall be sufficient to allow the proper laying, bedding and backfilling of pipelines and prefabricated culverts.

PSDB 5.2.2. Unless instructed by the Engineer, the base width of a trench shall not be less than the external diameter of the pipe barrel plus twice the side allowance determined from Table 8 below.

PSDB 5.2.3. Where two or more pipes are placed in one trench, the base width of the trench shall not be less than the sum of the external diameters of the pipe barrels plus the side



allowance for each outer pipe plus, between each pair of adjacent pipes, the average of the side allowance for each pipe.

PSDB 5.2.4. The minimum base width for pipes of external diameter that does not exceed 125 mm and laid at a depth that does not exceed 1.5 m may be less than 600 mm for flexible continuous piping that requires no bedding or jointing in the trench.

Table 8: Side allowances

1	2
External diameter of pipe barrel (D) (mm)	Side allowance on either side (mm)
≤700	300
701 – 1000	400
1001 – 2000	500
>2000	600

PSDB 5.4. EXCAVATION

Except where otherwise specified, trenches shall be of such a depth that the minimum cover over the pipes shall be 700 mm, except at road crossings, where the minimum cover shall be 1000 mm. No trench may be left open over the period 16 December to 8 January inclusive.

Where trenches have to be excavated under this Contract adjacent to live services / other services laid under other contracts, it may be necessary to shore trenches to prevent damage to the live services / other services. It will be the responsibility of the Contractor to ensure that services constructed under other contracts of live services are not damaged by his operations during the Contract.

Should the Contractor detect areas where the cover is doubtful, he shall report this immediately in writing to the Engineer, before any pipes are laid, so that remedial steps can be taken.

The Contractor shall exert maximum caution in excavating alongside or near existing services, pipelines, buildings, or structures. The Contractor shall use non-explosive methods for the excavation of hard rock in these cases and, where instructed by the Engineer.

PSDB 5.6. BACKFILL

PSDB 5.6.1. GENERAL

Backfilling of pipe trenches may only commence after the pipe has been laid, firmly bedded in the specified cradle, the blanket placed and compacted as specified and after the pipe has been tested in terms of Clause 7 of SANS 1200 L. Measures shall be taken at the discretion of the safety of his staff and avoidance of harm to anyone near the site at the time of testing.

PSDB 5.6.1.1. Backfilling of trenches shall commence after the pipe has been and firmly bedded in the specified cradle and the blanket has placed and suitably compacted at OMC



around and over the top of the pipe to the height of the blanket cover as indicated on the drawings.

PSDB 5.6.1.2. Backfilling shall be carried out over the full extent of the actual trench excavation and to original ground level. No filling shall be placed in water.

PSDB 5.6.2. MATERIAL FOR BACKFILLING

Material for backfilling above the bedding (cradle and blanket) shall be obtained from trench excavations. Hard material and rock material shall not be incorporated in the backfill unless suitably mixed with backfill material.

PSDB 5.6.3. DISPOSAL OF SOFT EXCAVATION MATERIAL

Excavation material from the trench, which is unsuitable or has become surplus, shall be disposed of along the trench servitude or as instructed by the Engineer.

PSDB 5.6.4. DISPOSAL OF HARD MATERIAL AND ROCK MATERIAL

Where the quantity of hard material or rock material exceeds that which can be or is required to be incorporated in the backfill, the surplus shall be disposed of as specified in PSDB 5.6.3 or removed to sites as instructed by the Engineer.

PSDB 5.6.5. Deficiency of backfill material

Any deficiency of backfill material from trench excavations because of the removal of excessive quantities of organic material or clay, unsuitable parts of the trench bottom, or excessive quantities of hard rock material, shall be made up from suitable surplus material from other excavations on the site or from imported material.

PSDB 5.6.6. COMPLETION OF BACKFILLING

Backfilling of trenches shall be completed expeditiously and in reasonable lengths.

PSDB 5.6.9. BACKFILLING AROUND STRUCTURES

Backfilling around a structure shall not commence before it has been approved by the Engineer. Granular material shall be used as backfill material around structures as shown on the drawings and shall be placed in layers not exceeding 150 mm compacted thickness. Each layer must be compacted as scheduled or specified in the drawings or this document.

PSDB 5.7. COMPACTION

The degree of compaction attained for bedding (other than concrete and the material over the top of the pipeline) shall be 90% of modified AASHTO maximum dry density.

PSDB 5.7.1. AREAS NOT SUBJECTED TO TRAFFIC LOADS

Except as specified in PSDB 5.6.2 each trench shall be backfilled in layers of thickness (after compaction) that do not exceed 150 mm and the material shall be compacted to the same density as that of the undisturbed surrounding ground, or to 90% of modified AASHTO maximum dry density, whichever is the higher.

PSDB 5.7.2. AREAS SUBJECTED TO TRAFFIC LOADS

In areas subjected to road traffic loads and in such other areas as shown on the drawings, trenches shall be backfilled in layers of thickness (after compaction) that do not exceed 150 mm and the material shall be compacted to 93% of modified AASHTO maximum dry density in the case of cohesive soil, or 98% in the case of non-cohesive soil.



NOTE: *It is extremely difficult to compact a layer in excess of 100 mm to the required density with walk-behind rollers. Where a 150 mm layer is required, it should be compacted in two 75 mm layers.*

PSDB 5.7.3. CEMENT STABILIZED BACKFILL

PSDB 5.7.3.1. Where cement stabilization is required, loose backfill and common cement shall be mixed by hand or by means of a suitable mixer in the proportions stated in PSDB 3.5.3 to produce a homogenous mixture soil and cement before being placed in the trench. Sufficient water shall be added, without saturating the mixture, to achieve uniform mixing and compact.

PSDB 5.7.3.2. The processing, placing and compaction shall be completed within 6 h from the time that the common cement is first added to the material.

PSDB 5.7.3.3. Cement stabilized backfill shall be compacted to 93% of modified AASHTO maximum dry density.

PSDB 5.9.5. BITUMEN ROADS – SURFACING

PSDB 5.9.5.1. GENERAL

The surface of a bitumen road shall be reinstated with asphalt of the thickness specified in this document.

PSDB 5.9.5.3. BASE MATERIAL

The base material shall be graded to a level sufficiently below the final road surface to allow the bitumen surfacing to be accommodated, and the edges of the existing bitumen wearing course shall be cut back vertically to a straight line. Before the bituminous construction is commenced, all loose materials and dust shall have been removed with brooms.

PSDB 5.9.5.4. ASPHALT SURFACE

PSDB 5.9.5.4.1. Unless otherwise specified in this document, a prime coat consisting of a suitable primer shall be sprayed at an appropriate rate and temperature. The cut edges of the existing wearing course shall also be prepared with a suitable primer. A suitable tack coat shall be applied after the prime coat.

PSDB 5.9.5.4.2. A compacted asphalt surface of the thickness specified in the scope work shall be laid, using either of the mixes specified in PSDB 3.6.4. The materials shall be thoroughly mixed in a suitable mechanically operated mixer for at least 1,5 min before being spread evenly over the surface to obtain the specified compacted thickness and then compacted with a suitable roller to a surface matching the existing surface in line and level.

PSDB 5.9.7. SEGMENTED PAVING

Segmented paved surfaces shall be reinstated using paving units that have the same shape, dimensions and properties as the existing surface, in accordance with the relevant requirements of SANS 1200 MJ.

PSDB 7. TESTING

PSDB 7.2. MATERIAL PROPERTIES OF BEDDING AND FILL MATERIAL

The material properties of bedding and fill materials shall be determined in accordance with the requirements of SANS 3001-GR10, SANS 3001-GR30 and SANS 3001-GR40, as relevant.



PSDB 7.3. IN-PLACED DRY DENSITY AND MOISTURE CONTENT

PSDB 7.3.1. The in-place dry density of the bedding and fill shall be determined in accordance with the requirements of TMH1-A10(a) by means of the sand replacement method, or where appropriate, by nuclear methods in accordance with the requirements of TMH1-A10(b).

PSDB 7.3.2. The moisture content shall be determined in accordance with the requirements of SANS 3001-GR30 where the sand replacement method is used and TMH1-A10(b) where nuclear methods are used.

PSDB 7.4. TESTING BY MEANS OF A DYNAMIC CONE PENETROMETER

As an alternative to PSDB 7.3, unless otherwise specified in the specification data and provided that the bedding or fill does not comprise more than 10% gravel of size less than 10 mm and contains no isolated boulder, the fill shall be deemed to comply with the requirements where the rates of penetration determined in accordance with TMH6-ST6 are in accordance with the requirements of Table 9 below.

WARNING: A DCP shall be used with care so as not damage the pipe coatings or the pipes themselves.

Table 9: Rates of penetration

1	2
Material	Maximum dcp penetration mm/blow
Bedding	14
Selected fill blanket	14
Backfill (areas not subjected to traffic loads)	14
Backfill (areas subjected to traffic loads)	17

PSDB 7.5. COMPACTION FRACTION

PSDB 7.5.1. The compaction fraction shall be determined, using a 250 mm long open-ended cylinder with a bore of a diameter approximately 150 mm long, a metal rammer 40 mm in diameter and weighing 1 kg, and a measuring rule graduated in millimetres, in the following manner:

- Obtain a representative sample more than sufficient to fill the cylinder.
- Place the cylinder on a firm, flat surface and put the sample into the cylinder, loosely and without tamping, until overfilled.



- c) Strike off the top surface of the material level with the top of the cylinder and remove the surplus material.
- d) Lift the cylinder clear of its contents and place on a clean area of the work surface.
- e) Place about one quarter of the material into the cylinder and tamp until no further compaction is obtained.
- f) Repeat for the remaining quarters, ensuring that the final surface is as level as possible.
- g) Measure down from the top to the compacted material and express this measurement as a fraction of 250 mm to give the compaction fraction.

PSDB 7.5.2. The compaction fraction for selected granular material may be less than, but shall not exceed, the nominated value.

PSDB 7.6. TOLERANCES

PSDB 7.6.1. ALIGNMENT AND GRADE

The deviation from the specified level of the trench invert and base dimensions up to a height equal to at least the diameter of the pipe or duct, as applicable, shall be such that the pipe may be laid and bedded in the trench within the tolerances specified for the pipeline.

PSDB 7.6.2. MOISTURE CONTENT AND DENSITY

PSDB 7.6.2.1. The permissible deviation from OMC and density in the construction of the pipe bedding material shall, except where otherwise instructed by the Engineer, be as given in Table 10 below.

PSDB 7.6.2.2. The permissible deviations from OMC and density in the backfill shall, except where otherwise instructed by the Engineer, be as given in Table 11.

Table 10: Permissible deviations in the placement of pipe bedding

1	2
Item	Permissible deviation, pd %
OMC in field during compaction	-2, +1
Specified density when bedding rigid pipes	0, +5
Specified density when bedding flexible pipes	0, +3

Table 11: Permissible deviations in respect of moisture content and density

1	2
Item	Permissible deviation, pd %
OMC in fill during compaction	+2, -2
Specified density	No top limit, 0

PSDB 7.7. INSPECTION AT INTERMEDIATE STAGES OF CONSTRUCTION

The Contractor shall call the Engineer, giving him reasonable notice, to inspect the works at the following intermediate stages of construction:



- a) After completion of the trench excavation,
- b) At preparation of the trench bottom, before any pipe is laid,
- c) After the selected backfill material has been placed around the pipe before the remainder of the trench is backfilled, and
- d) Before placing premix on roads or any final surfacing on constructed footways or driveways

Work shall not progress through the specified stages without the approval of the Engineer or his representative on site.

Note: *Failure to comply with the provision of this clause shall result in the suspension of the backfilling work until the testing of work has been approved by the Engineer.*



SANS 1200G: CONCRETE (STRUCTURAL)

PSG 3. MATERIALS

PSG 3.2. CEMENT

PSG 3.2.1. APPLICABLE SPECIFICATION

Portland cement (unless stated otherwise by the engineer) shall be used for all concrete works and shall comply with requirements set out in SANS 50197.

PSG 3.4. AGGREGATES

PSG 3.4.1. APPLICABLE SPECIFICATION

The coarse aggregate (stone) and the fine aggregate (sand) shall comply with the relevant requirements of SANS 1083 and SANS 794 as applicable. Bulking of fine aggregates shall be in accordance with SANS 5863.

PSG 3.6. REINFORCEMENT

All reinforcement shall comply with SANS 282, SANS 920, and SANS 1024 provisions.

PSG 5. CONSTRUCTION

PSG 5.5. CONCRETE

PSG 5.5.1.5. DURABILITY

The maximum water/cement ratio applicable to concrete slabs laid on the ground under moderate and severe exposure conditions are 0.53 and 0.48 respectively. Concrete that has an air-dry density in the range of 2000 kg/m³ to 2600 kg/m³ shall contain entrained air and conform to the air-content limits given in Table 12 below, as determined in accordance with SANS 6252.

Concrete made to have an air-dry density that does not exceed 2000 kg/m³ shall contain 6% $\pm$ 2% total air when the nominal maximum size of aggregate exceeds 9.5mm, or 7% $\pm$ 2% total air when the nominal size is 9.5mm or less. Proportions shall be so selected that a characteristic strength 20 MPa or more is attained.

Table 12: Total air content for various sizes of coarse aggregate for normal-density concrete

1	2
Nominal maximum size of coarse aggregate	Total air content as a volume fraction
mm	%
9.5	6 to 10
13.2	5 to 9
19	4 to 8
37.5	3 to 6



PSG 5.5.3.2. READY-MIXED CONCRETE

Ready-mix concrete must follow provisions of SANS 878 as applicable. The engineer will review and approve all test results before casting the concrete on site. Hand-mixed concrete is strictly prohibited for use onsite.

PSG 6. TOLERANCES

PSG 6.2. PERMISSIBLE DEVIATION

PSG 6.2.1. GENERAL

All permissible deviations for concrete shall comply with provisions under SANS 10155.

PSG 7. TESTS

PSG 7.1. FACILITIES AND FREQUENCY OF SAMPLING

PSG 7.1.2. FREQUENCY OF SAMPLING

PSG 7.1.2.1. Subject to the requirements of PSG 7.1.2.3., while concrete of a particular grade and in sufficient quantity is being placed under the same conditions, sets of samples of concrete (each sample being sufficient for three cubes, beams, cylinders or prisms, as relevant) shall be taken for each testing age.

PSG 7.1.2.2. Unless otherwise instructed by the Engineer, at least one set of samples of concrete shall be taken from each day's casting and from at least every 50 m³ of concrete of each grade placed.

PSG 7.1.2.3. Only one sample of concrete shall be drawn from any one batch of concrete and no sample of concrete shall be taken of any grade until at least three batches of such grade have been mixed and discharged.

PSG 7.2. TESTING

PSG 7.2.1. GENERAL

PSG 7.2.1.1. When concrete of a particular grade is being placed, samples of concrete shall be taken in accordance with SANS 5861-2, as close as is practicable to the start of placing and at appropriate intervals thereafter, or from one particular batch and then from subsequent batches chosen at appropriate intervals.

PSG 7.2.1.2. Slump shall be cast and cured in accordance with SANS 5861-3. Flow shall be measured in accordance with SANS 5862-2.

PSG 7.2.1.3. Concrete cubes shall be cast and cured in accordance with SANS 5861-3. Cubes cured on site shall be cured in water at a temperature between 22°C and 25°C.

PSG 7.2.1.4. Cubes shall be tested in accordance to SANS 5863 to obtain valid test results. Three cubes shall be tested to obtain valid results.

PSG 7.2.1.5. Site testing shall be carried out by a person who is qualified by virtue of his experience and training to perform such a task. Laboratory testing shall be carried out by an accredited testing laboratory.

PSG 7.2.1.6. The relevant test methods given in BS 5896 and BS 4486 shall apply to steel wire, strand and bars used for stressing.



PSG 7.3.4. PROCEDURE OF EXAMINATION OF CONCRETE

Replace “SABS 0100” with “SANS 10100”.

PSG 7.3.6. FREQUENCY OF SAMPLING

PSG 7.3.6.1. Subject to the requirements of PSG 7.1.2.3, while concrete of a particular grade and in sufficient quantity is being placed under the same conditions, sets of samples of concrete (each sample being sufficient for three cubes, beam, cylinder or prisms, as relevant) shall be taken for each testing age.

PSG 7.3.6.2. Unless otherwise specified in the specification data, at least one set of samples of concrete shall be taken from each day's casting and from at least every 50m³ of concrete of each grade placed.

PSG 7.3.6.3. Only one sample of concrete shall be drawn from any one batch of concrete and no sample of concrete shall be taken of any grade until at least three batches of such grade have been mixed and discharged.

PSG 7.3.7. TESTS ON GROUT

PSG 7.3.7.1 BLEEDING

Place a sample of the grout in a covered graduated cylinder of diameter approximately 100 mm and fitted with a thermometer. Ensure that the height of the grout in the cylinder is 100 mm. Keep the temperature of the grout at 20°C ± 2°C and check the bleeding for compliance with PSG 7.3.7.3.

PSG 7.3.7.2. COMPRESSIVE STRENGTH

Take a sample of the grout in accordance with SANS 5816-2. Test the grout in accordance with SANS 5863. Check compressive strength for compliance with subclause PSG 7.3.7.3.

PSG 7.3.7.3. COMPRESSIVE STRENGTH OF GROUT

Cubes (of sides 100mm) made of the grout should be used, and cured at a temperature of 22°C to 25°C and a relevant humidity of at least 90% for the first 24 h, and then kept in water at 22°C to 25°C, shall have a compressive strength that exceeds 20MPa at 7 d.

PSG 9. GROUTING TO MACHINE AND STRUCTURAL BEDPLATES

PSG 9.1. MATERIALS

- a) Water. Water for grout shall comply with the requirements given in subclause 3.3 of SANS 1200 G.
- b) Aggregates. Notwithstanding the requirements of subclause 3.4.1 of SANS 1200 G, the grading of fine aggregate (sand) and coarse aggregate (stone or pea gravel) shall conform to the gradings given in Table 13 and Table 14, respectively, below.
- c) Cement. Cement shall be ordinary Portland cement complying with SANS 50197.
- d) Admixtures. Admixtures shall comply with the requirements of subclause 3.5 of SANS 1200 G and shall have a proven record of satisfactory performance under conditions encountered in the Republic of South Africa.
- e) Proprietary grouting materials. Unless otherwise approved by the Engineer, proprietary grouting materials shall be obtained ready mixed in sealed pockets as supplied by the manufacturer.



Table 13: Sand

1	2
Test sieve nominal aperture size, mm	% Passing (by mass)
9.5	100
4.75	95-100
1.18	45-65
0.3	5-15
0.15	0-5

Table 14: Stone or pea gravel

1	2
Test sieve nominal aperture size, mm	% Passing (by mass)
9.5	100
4.74	95-100
2.36	0-5



SANS 1200 H 1990: Structural steelwork

PSH 2. INTERPRETATIONS

PSH 2.4. REPLACEMENT OF SPECIFICATIONS REFERRED TO IN THIS SPECIFICATION

The following specifications have been replaced as follows:

Table 15: Old standards replaced by new standards.

Old Standards	New Standards
SABS 1431	SANS 50025 & EN 10025
SABS 657	SANS 657
SABS 455	SANS 455
SABS 135	SANS 1700-14 (relevant parts)
SABS 136	SANS 1700-14 (relevant parts)

PSH 3. MATERIALS

PSH 3.1. STRUCTURAL STEEL

PSH 3.1.1. STRUCTURAL STEEL (NEW CLAUSE)

Steel used in the fabrication of structural steelwork shall comply with the requirements of SANS 50025-1 and those of SANS 50025-2, unless otherwise specified in this document or in the drawings.

The dimensions and permissible deviations of all steel profiles shall comply with the requirements if the standards listed in Table 16.

Table 16: Standards governing dimensional and permissible deviations

1	2
Profile	Applicable standard
Angles	EN 10056-2
Hollow sections cold formed	SANS 657-1
Hollow sections hot formed	EN 10210-2
I, IPE and H sections	EN 10034
Imperial channels	BS 4-1
Metric channels	DIN 1026-1
Plates, flats and bars	ASTM A 6/A 6Mb
Taper flange I-sections	EN 10024

PSH 3.1.2. TEST CERTIFICATE

The chemical composition and mechanical properties of all steel incorporated into structures shall be stated in a mill test certificate.

PSH 3.1.3. SURFACE CONDITION

Steel surfaces shall not be more heavily pitted or rusted than rust grade C of ISO 8501-1. Surface defects in hot-rolled sections, plates and wide flats revealed during surface



preparation, and which are not in accordance with the requirements of SANS 50025-1 and those of the SANS 50025-2, shall be rectified to comply with such requirements.

Surface defects in hot-rolled sections revealed during surface preparation and which are not in accordance with the requirements of EN 10210-1, shall be rectified to comply with such requirements.

PSH 3.1.4. WELDING CONSUMABLES

PSH 3.1.4.1. STANDARDS

Consumables for use in the metal arc welding shall comply with the appropriate standards listed in Table 17 below.

PSH 3.1.4.2. STORAGE

Consumables shall be stored in accordance with the manufacturer's recommendations. Any drying or baking of consumables before use shall be carried out in accordance with the manufacturer's recommendations.

Table 17: Approved parent metal-filler weld metal combinations for steels acceptance for prequalified welding procedures standards

1	2	3	4	5	6
Parent Material		Process	Filler weld metal		
Minimum yield strength	Minimum ultimate tensile strength		Electrode	Minimum yield strength	Minimum ultimate tensile strength
MPa	MPa			MPa	MPa
300	450	SMAW (Shielded metal arc welding)	AWS A5.1 E70XX	365	480
		SAW (Submerged arc welding)	AWS A5.17 F7XX-EXXX	400	480/650
		GMAW (Gas metal arc welding)	AWS A5.18 ER70S – X	400	480
		FCAW (Flux-cored arc welding)	AWS A5.20 E7XT – X	400	480
350 or 355	480	SMAW (Shielded metal arc welding)	AWS A5.1 E7015, E7016, E7018, E7028	400	480
		SAW (Submerged arc welding)	AWS A5.17 F7XX – EXXX	400	480



		GMAW (Gas metal arc welding)	AWS A5.18 ER70S – X	400	480
		FCAW (Flux-cored arc welding)	AWS A5.20 E7XT – X	400	480
		(except – 2, – 3, – 10, – 13, – 14, GS)			

PSH 3.1.5. STRUCTURAL FASTENERS

PSH 3.1.5.1. ORDINARY BOLT ASSEMBLIES

The mechanical properties of bolts, screws and nuts shall be in accordance with the following standards, as stated in the specification data or indicated in the design drawings:

- a) Class 4.8, 8.8 and 10.9 bolts and screws: SANS 1700-5-1
- b) Class 4 to 11 nuts: SANS 1700-5-2

Bolts, screws and nuts shall comply with the following standards:

- a) Bolts: SANS 1700-7-1 or SANS 1700-7-3
- b) Screws: SANS 1700-7-4 or SANS 1700-7-5
- c) Nuts: SANS 1700-14-2 or SANS 1700-14-3

Note 1 The term “class” is used here to indicate the mechanical properties of the material of which a fastener is made. This is equivalent to the term “property class” which is used by ISO and in SANS 1700, or the term “grade” which has customarily been used in the steel construction industry.

PSH 3.1.5.2. DELETED BY AMENDMENT NO. 1

PSH 3.1.5.3. HOLDING-DOWN (HD) BOLTS

Holding-down bolts shall be fabricated from round bar that complies with the requirements of SANS 50025-1 and those of SANS 50025-2.

PSH 3.1.5.4. WASHERS

Plain material washers shall be in accordance with the provisions of SANS 1700-16-2. Through-hardened washers shall be in accordance with the provision of SANS 1700-16-3.

PSH 3.1.5.5. SHEAR STUDS

Studs used in composite construction shall be the headed type with the following properties after being formed:

- a) Minimum yield strength (0.2% offset): 345MPa.
- b) Minimum ultimate tensile strength: 415MPa.
- c) Elongation of 20% on a gauge length of $5.65 \sqrt{A}$, where A is the area of the test specimen.

PSH 3.1.6. SUBSTITUTION OF STEEL QUALITY AND SHAPE

The steel quality or shape of components may be substituted if it can be demonstrated that all the relevant performance criteria of the original design will be satisfied.

PSH 3.5. WELDING CONSUMABLES

Also see subclause PSH 3.1.4 of this specification.



PSH 3.6. BOLTS, NUTS AND WASHERS

Also see subclause PSH 3.1.5 of this specification.

PSH 3.8. NEW CLAUSE

The design and construction of sectional steel tanks for storage of liquids at or above ground level shall be in accordance with SANS 10329.

PSH 5. CONSTRUCTION

PSH 5.1. DRAWINGS AND SHOP DETAILS

PSH 5.1.2. CONTRACTOR PROVIDES SHOP DETAILS

The contractor shall provide shop drawings prepared in accordance with the Southern African Structural Steel Works Detailing Manual published by the Southern African Institute of Steel Construction (see SANS 2001 CS 1 clause 4.2).

PSH 5.2. FABRICATION

PSH 5.2.2. IDENTIFICATION

The material grades of all steel shall be positively identifiable (see SANS 2001 CS 1 clause 4.3.1).

PSH 5.6. GROUTING OF SUPPORTS

Grouting is to be carried out by others, following provisions made in under SANS 1200 G subclause 5.5.13 and 8.7 (Also see PSG 7.4 and PSG 9.0 of this project specification).

PSH 5.7. SUNDRY ITEMS

PSH 5.7.1. HANDRAILS

All hand railing shall comply with SANS 10104, and/or as indicated on the shop-drawings.

PSH 5.7.3. OPEN GRID FLOORS

This shall be as shown on the drawings.

PSH 7. TESTING

PSH 7.1. TEST CERTIFICATES

The contractor must provide test certificates and cast analysis certificates, pertaining to the steel to be used shall be supplied to the engineer by the contractor.

PSH 7.3.7. TESTS ON GROUT

PSH 7.3.7.1 BLEEDING

Place a sample of the grout in a covered graduated cylinder of diameter approximately 100 mm and fitted with a thermometer. Ensure that the height of the grout in the cylinder is 100 mm. Keep the temperature of the grout at $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$ and check the bleeding for compliance with PSH 7.3.7.3.



PSH 7.3.7.2. COMPRESSIVE STRENGTH

Take a sample of the grout in accordance with SANS 5816-2. Test the grout in accordance with SANS 5863. Check compressive strength for compliance with subclause PSH 7.3.7.3.

PSH 7.3.7.3. COMPRESSIVE STRENGTH OF GROUT

Cubes (of sides 100mm) made of the grout should be used, and cured at a temperature of 22°C to 25°C and a relevant humidity of at least 90% for the first 24 h, and then kept in water at 22°C to 25°C, shall have a compressive strength that exceeds 20MPa at 7 d.

PSH 9. GROUTING TO MACHINE AND STRUCTURAL BEDPLATES

PSH 9.1. MATERIALS

- a) Water. Water for grout shall comply with the requirements given in subclause 3.3 of SANS 1200 G.
- b) Aggregates. Notwithstanding the requirements of subclause 3.4.1 of SANS 1200 G, the grading of fine aggregate (sand) and coarse aggregate (stone or pea gravel) shall conform to the gradings given in Table 18 and Table 19 below, respectively.
- c) Cement. Cement shall be ordinary Portland cement complying with SANS 50197.
- d) Admixtures. Admixtures shall comply with the requirements of subclause 3.5 of SANS 1200 G and shall have a proven record of satisfactory performance under conditions encountered in the Republic of South Africa.
- e) Proprietary grouting materials. Unless otherwise approved by the Engineer, proprietary grouting materials shall be obtained ready-mixed in sealed pockets as supplied by the manufacturer.

Table 18: Sand

1	2
Test sieve nominal aperture size, mm	% Passing (by mass)
9.5	100
4.75	95-100
1.18	45-65
0.3	5-15
0.15	0-5

Table 19: Stone or pea gravel

1	2
Test sieve nominal aperture size, mm	% Passing (by mass)
9.5	100
4.74	95-100
2.36	0-5



SANS 1200L: MEDIUM-PRESSURE PIPELINES

PSL 1. SCOPE

PSL 1.2. NEW CLAUSE

This specification shall also cover the supply and installation of all pipework for water service.

PSL 2. INTERPRETATIONS

PSL 2.3. DEFINITIONS

For the purpose of this document, the definitions given SANS 10403 also apply.

PSL 2.4. Abbreviations

- HDPE: High density polyethylene.
- uPVC: Unplasticized Polyvinyl Chloride.

PSL 3. MATERIAL

PSL 3.1 GENERAL

Each type of pipe delivered to the site must have a standard length corresponding to the standard lengths offered by the pipe manufacturer in their catalogue, with a maximum permissible variation in length of $\pm 2\%$.

A pipe that is shorter or longer than the defined standard will be rejected by the Engineer, except when such non-standard lengths are required in terms of the Contract and have been specifically manufactured or cut as such by the pipe manufacturer or supplier.

PSL 3.1.1. Pipes and pipe fittings shall be of the types and sizes specified in the scope of work and, unless otherwise specified in the specification data, they and their couplings shall be capable of withstanding the applicable test pressure in subclause PSL 7.3.1.4.

PSL 3.1.2. Pipes shall be handled and stored in accordance with the manufacturer's instructions.

PSL 3.1.3. Suitable temporary end covers shall be provided for the protection of threads, flanges, and the prepared ends of plain-ended pipes and fittings, and to prevent damage to the internal lining during transportation and during handling on site.

PSL 3.1.4. Pipeline materials shall be so transported, stored, and handled that pipes are not overstressed at any time and fittings are not damaged in any way. All thin-walled, flexible, and soft-coated pipes shall be handled with particular care and shall be so stored that they are not subject to concentrated pressure from stones or other objects.

PSL 3.1.5. Pipe repair clamps shall, where relevant, comply with the requirements of SANS 1808-45 and shall have a pressure rating not less than that of the pipes which are repaired.

PSL 3.4. STEEL PIPES, FITTINGS, AND SPECIALS

PSL 3.4.2. PIPES OF NOMINAL BORE UP TO 150 mm

PSL 3.4.2.1. Steel pipes and fittings of nominal bore up to 150 mm shall comply with requirements of SANS 62-1 for a medium duty pipe. Such pipes shall be supplied in a galvanized condition and with plastic caps



PSL 3.4.2.2. Screwed pieces and fittings shall be medium class fittings that comply with the requirements of SANS 62-2, and shall be galvanized inside and outside.

PSL 3.4.2.3. A certificate stating that each consignment complies with the requirements of SANS 62-1 or SANS 62-2 shall be provided where specified in the specification data.

PSL 3.4.3. PIPES OF NOMINAL BORE OVER 150 mm

PSL 3.4.3.1. Steel pipes of nominal bore over 150 mm shall comply with the applicable requirements of SANS 719 and shall have the attributes as specified in the scope of work.

PSL 3.4.3.2. A steel maker's certificate that covers all the steel used in the manufacture of the pipes shall be provided where specified in the specification data.

PSL 3.4.3.3. Steel pipe fittings and specials shall be fabricated in accordance with requirements of EN 10311 using a pipe that complies with the requirements of SANS 719. In addition, all pipe specials shall be free of weld splatter and all sharp corners and edges shall be ground smooth and round before painting.

PSL 3.4.3.4. All shop welding of slip-on and other couplings for steel pipes and specials shall be carried out by welders who are competent in terms of the approval test in API STD 1104, except where another competence test is specified in the specification data.

PSL 3.4.5. FABRICATED FLANGED STEEL PIPES

Fabricated flanged steel pipes shall comply with the requirements of SANS 1476 and those specified in the scope of works.

PSL 3.5. CONCRETE PRESSURE PIPES

Replace "SABS 676" with "SANS 676".

PSL 3.6. PRESTRESSED CONCRETE PIPES

Replace "SABS 975" with "SANS 975".

PSL 3.7. OTHER TYPES OF PIPES

PSL 3.7.1. uPVC PIPES

PSL 3.7.1.1. U-PVC pipes shall comply with the requirements of SANS 966-1 and shall have attributes as specified in the scope of works or as scheduled.

PSL 3.7.1.2. Fittings shall either comply with requirements of SANS 966-1 or SANS 52842.

PSL 3.7.2. POLYETHYLENE PIPES

PSL 3.7.2.1. UNREINFORCED PE PIPES

PSL 3.7.2.1.1. Unreinforced PE pipes shall comply with the requirements of SANS 4427-1, SANS 4427-2, SANS 4427-3 or SANS 4427-5, and shall have the attributes specified in the scope of work. Unless otherwise specified in the scope of work, any of the following shall be used to joint pipes together:

- a) mechanical joint compression fittings that comply with the requirements of SANS 14236;
- b) suitable push-fit fittings recommended by the pipe manufacturer;
- c) heated-tool socket weld or electrofusion fittings that comply with the requirements of SANS 4427-3;



- d) butt fusion;
- e) ductile iron fittings that comply with the requirements of SANS 52842; or
- f) mechanical jointing systems that comply with the requirements of SANS 4427-3

PSL 3.7.2.1.2. PE pipes may be supplied and stored in coils, provided that the diameter of the coil is the greater of 24 times the pipe diameter and 600 mm.

PSL 3.7.2.2. STEEL-MESH-REINFORCEMENT PE PIPES

Steel-mesh-reinforced PE pipes shall comply with the requirements of SANS 370 and shall have the attributes specified in the scope of work. Such pipes shall be joined by means of either an electrofusion coupling or flanged fitting that complies with the requirements of SANS 371, unless otherwise specified in the scope of works.

PSL 3.8. JOINTING MATERIAL

PSL 3.8.2. FLEXIBLE COUPLINGS

PSL 3.8.2.1. Flexible joints for the plain-ended steel pipes shall be of the slip-on type with a centre register that complies with the relevant requirements of EN 10311, and shall be able to withstand, without any sign of failure, hydrostatic test pressures of twice the working pressures specified for the pipes for which they are required.

PSL 3.8.2.2. Coupling flanges shall be capable of withstanding, without any sign of damage, all stresses caused by the proper tightening of bolts.

PSL 3.8.2.3. Rubber rings shall comply with the relevant requirements of SANS 4633 and shall have a hardness of (66 to 75), IRHD (international rubber hardness degree).

PSL 3.8.3. FLANGES AND ACCESSORIES

PSL 3.8.3.1. Each flanged pipe and fitting shall be supplied complete with one set of flange bolts, nuts and washers, and one joint insertion piece made of material suitable for the maximum test pressure. The drilling of steel and cast iron (CI) flanges shall comply with the requirements of SANS 1123 or EN 1092-1, as applicable, appropriate to the class of pipe, except that

- a) in the case of flanges for hydrant and air valve matching tees, the drilling shall match the drilling of the valves supplied; and
- b) in the case of CI flanges, where M27 and M33 bolts are specified in EN 1092-1, M24 and M30 bolts, respectively shall be used as specified in SANS 1123.

PSL 3.8.3.2. Loose flanges for welding onto steel pipes on site shall be manufactured from the same steel as is specified for the pipes and shall be in accordance with SANS 1123. Bolt holes shall not be reamed to oversize dimensions in order to make a fit.

PSL 3.8.3.3. Bolts and nuts shall comply with the relevant requirements of SANS 1700-7-1 or SANS 1700-7-3 or SANS 1700-14-2 or SANS 1700-14-3. The lengths of the bolts shall be such that, after the nuts have been tightened, the ends of the bolts are flush with the ends of the nut, or project beyond the nuts by not more than two threads.



PSL 3.8.7. SCREW-ENDED PIPES

Screw-ended pipes shall comply with the relevant requirements of SANS 1109-1. Male ends shall be taper-screwed and female ends shall have parallel threads.

PSL 3.9. CORROSION PROTECTION

PSL 3.9.2. STEEL PIPES

PSL 3.9.2.1 STEEL PIPES OF NOMINAL BORE UP TO 150 mm

All steel pipes shall be protected following provisions made in SANS 10329. The hot dip galvanizing process must adhere to the standards set by SANS 121:200/ISO 1461:1999 for fabricated articles and pipes.

PSL 3.9.3. PROTECTION AGAINST ELECTROLYTIC CORROSION

Provisions made under SANS 1117, SANS 135 and SANS 136 are applicable.

PSL 3.9.5. JOINTS, BOLTS, NUTS AND WASHERS

Joints, bolts, nuts, and washers shall be hot-dip bitumen coated, if not otherwise specified on drawings.

PSL 3.9.7. NEW CLAUSE

PSL 3.9.7.1. All flanges, valves, flexible couplings and other items not protected from corrosion shall, be cleaned with wire brushing and painted with a suitable epoxy primer, followed by one or more coats of a suitable high-build epoxy material to give a total dry film thickness of at least 250µm. Each coat shall have a different colour from its predecessor and be applied not less than 6 h and not more than 24 h after its predecessor. Care shall be taken to ensure that the previous coat has dried sufficiently to prevent solvent entrapment.

***Note:** Steel or ductile iron fittings and joints that are to be subjected to corrosive soil should be treated with a compatible primer, packed with a suitable bitumen-based mastic, and wrapped with plastic tape.*

PSL 3.10. VALVES

PSL 3.10.1. On reticulation pipelines of nominal diameter 200 mm or less, each valve shall be housed in a chamber as detailed in the drawings or as instructed by the engineer, as applicable. On pipelines of nominal diameter up to and including 275mm, chambers shall be constructed around all gate and scour valves, hydrants and air valves.

PSL 3.10.2. Diaphragm valves shall comply with the requirements of SANS 1808-13.

PSL 3.10.3. PVC-U gate valves shall comply with the requirements of SANS 1808-18.

PSL 3.10.4. Float valves (equilibrium type) shall comply with the requirements of SANS 1808-32.

PSL 3.10.5. Automatic control valves shall comply with the requirements of SANS 191.

PSL 3.10.6. Cast steel gate valves shall comply with the requirements of SANS 191.

PSL 3.10.7. Cast iron gate valves shall comply with the requirements of relevant parts of SANS 664.

PSL 3.10.8. Mechanical backflow-prevention devices shall comply with the requirements of SANS 1808-15 as applicable.



PSL 5. CONSTRUCTION

PSL 5.1.1. GENERAL

uPVC pipes shall be laid, cut and jointed strictly following the manufacturer's instructions. A pipeline shall further be laid continuously; the leaving of gaps for fittings will not be permitted.

Where applicable, pipes to be laid in a combined trench shall further be laid so that their joints are directly opposite one another and so that all pipe markings printed on the pipes are positioned at the top.

PSL 7. TESTING

PSL 7.3. STANDARD HYDRAULIC PIPE TEST

PSL 7.3.1. TEST PRESSURE AND TIME OF TEST

PSL 7.3.1.4. The field test pressure shall not exceed the appropriate of the following values in Table 20 below:

Table 20: Maximum field test pressures

1	2	3
Type of pipe	Applicable materials standard	Maximum field pressure at any point in the pipeline
Steel	SANS 62-1, SANS 62-2, SANS 719	50% of the hydraulic test pressure
Ductile iron	SANS 505445	Allowable site test pressure (PEA)
Reinforced concrete	SANS 676	75% of the hydraulic test pressure
Prestressed concrete	SANS 975	75% of the hydraulic test pressure
Fibre cement	SANS 1223	75% of the test for permeability
GRP	SANS 1748-1	1.5 times the rated pressure class
Polyethylene	SANS 4427-1, SANS 4427-2, SANS 4427-3 and SANS 4427-5	1.5 times the rated pressure of the pipe



Steel-mesh-reinforced PE	SANS 370	1.5 times the rated pressure of the pipe
Polypropylene	SANS 15874-2 and SANS 15874-3	1.5 times the rated pressure of the pipe
uPVC	SANS 966-1	1.5 times the rated pressure of the pipe
mPVC	SANS 966-2 and SANS 1283	1.5 times the rated pressure of the pipe
oPVC	SANS 16422	1.5 times the rated pressure of the pipe

PSL 7.3.3. PERMISSIBLE LEAKAGE RATES

PSL 7.3.3.1. Maintain the test pressure for a further period of 1 h after completion of the test period state in (above clause), during which time measure the volume of water required to be pumped into the pipeline for maintenance of the pressure. Check that no additional water is required in the case of continuously welded steel pipes, and in other cases that the volume does not exceed the value, in litres, calculated from the applicable of the formulae given in Table 21 below:

Table 21: Formulae to calculate permissible volume of make-up water

1	2
Type of pipe	Formulae to calculate permissible volume of make-up water L
Fibre cement and concrete-lined steel	$0.105 \times PD \times TS \times STP$
Jointed pipes in steel, ductile iron, GRP, PE, PP and PVC	$0.010 \times PD \times TS \times STP$
Reinforced and concrete pipes	$0.630 \times PD \times TS \times STP$
<i>PD = Pipe diameter, in millimetres</i> <i>STP = Square root of the test pressure, in megapascals</i> <i>TS = Test section, in kilometres</i>	



PORTION 3: PARTICULAR SPECIFICATIONS

PA - MODEL TECHNICAL SPECIFICATIONS FOR THE DRILLING AND INVESTIGATION OF BOREHOLES

PA 1.1. DOCUMENTS

This Specification shall be read in conjunction with the Invitation of Tender, Conditions of Contract, the Bill of Estimated Quantities and Rates, and other relevant documents and the whole be deemed to constitute one document.

PA 1.2. DRAWINGS

The following drawings accompanying and referred to in these specifications shall consist of:

- (i) Locality Map (Fig)
- (iii) Construction of boreholes - Open hole hard rock design (Drawing No)
- (iii) Construction of boreholes - Slotted casing hard rock design (Drawing No)
- (iv) Jetting tool (Drawing No)
- (v) Typical slotted casing (Drawing No)

PA 1.3. LOCALITY

The works are required in situated as illustrated on Locality Map (Fig.)

PA 1.4. SCOPE OF CONTRACT

The Works comprise the construction of XX boreholes. The actual number of boreholes will be decided by the Client but no guarantee is given as to the actual number finally ordered. Additional boreholes could be required under the specifications contained herein, and if so will be paid at the rates tendered.

PA 1.5. GEOLOGICAL AND HYDROGEOLOGICAL DATA

Hydrogeological data may be inspected at the offices of the Catchment Management Agency. The Contractor shall form his own assessment of the anticipated drilling conditions from the available data and no claims for misinterpretation will be entertained.

No claims for extra payment for such variations will be entertained nor do such variations relieve the Contractor from any responsibility hereunder nor from fulfilling any or all of the terms and requirements of this Contract.

PA 1.6. NATURE OF CONTRACT

The specifications are for a Schedule of Quantities and Rates Contract for the drilling, construction and development of boreholes.

The Contractor shall provide all labour, transport, plant, tools, materials and appurtenances, and shall perform all work necessary to satisfactorily construct and complete the boreholes in accordance with this Specification. The borehole depths will be dependent on results and the strata intersected.



The Contractor shall employ only competent workmen for the execution of his/her work, and all work shall be performed under direct supervision of an experienced water well driller.

PA 1.7. CONTRACTOR'S PLANT

The Contractor shall specify in the Schedule of Plant and Equipment the type of plant to be used and the method of operation. Its capacity shall be sufficient to cope with the work within the contract time. It shall be kept at all times in full working order and good repair.

No extra payment shall be made for Contractor's plant, labour or equipment to complete the work specified, nor for any incidentals thereto, the cost being deemed to be included in the Contractor's prices.

It is noted that drilling rig(s) equipped for air percussion, including foam, is (are) required on site.

PA 1.8. ASSIGNMENT

The Contractor may not assign this Contract not sub-let any part of this Contract or any of its obligations hereunder without the prior written consent of the Client.

PA 1.9. TIME SCHEDULE

The contractor shall position and start operation on site within 7 calendar days after written communication to proceed with the Works have been received from the Client.

PA 1.10. SAFETY STANDARDS

The Contractor shall adhere to applicable safety regulations at all times.

PA 1.11. DRILLING POSITIONS AND ACCESS

The drilling positions will be marked on the ground and pointed out to the Contractor by the Client or his representative. Should access to site prove to be difficult the onus is on the Contractor to make a genuine attempt in reaching the site.

PA 1.12. MATERIAL

The used materials shall be new and undamaged. The materials used shall be paid for at the rates tendered by the Contractor in the Schedule of Quantities and Rates.

PA 1.13. CASING

PA 1.13.1. STEEL CASING - PLAIN

The plain casing will be of an approved standard and shall be as specified in the Schedule of Estimated Quantities and Rates. All casing will have a minimum wall thickness of 4mm and shall be bevel edged with lugs or threaded to accomplish positive mechanical interlocking.

PA 1.13.2. STEEL OR PVC CASING - SLOTTED

Where collapsing conditions are present at the water bearing horizon, slotted steel or PVC casing shall be installed over the affected zone. The manner in which the slots are to be cut is shown in Drawing No: The width of the slots shall be 3mm minimum and 4mm maximum. Wall thickness shall be 4mm minimum. The slots shall be of uniform width with no resultant protrusions and shall be clear of debris.

PA 1.14. EQUIPMENT AND CHEMICALS



It will be the responsibility of the contractor to bring on site with all equipment and chemicals required to complete the Work without interruption.

PA 1.15. OTHER MATERIALS

Casing clamps and all other such items as are required in the construction of the boreholes shall be constructed in accordance with normal groundwater engineering practice.

PA 1.16. FORMATION STABILISER

Gravel pack material shall be well rounded, uniform and clean quartzitic gravel with a grain size varying between 6 and 10 mm. Sieved and washed river gravel can also be accepted. Samples of the gravel pack must be submitted to the Client approval before placement.

PA 1.17. BOREHOLE CONSTRUCTION

PA 1.17.1. DESIGN AND DEPTH

Two separate designs, one requiring the installation of plain casings and the second requiring the installation of both plain and slotted casing and formation stabiliser may be used. Borehole designs are shown schematically on drawing Nos.and

The anticipated depth is unlikely to exceedm.

PA 1.17.2. DIAMETER

Drilling diameters may vary from 165mm to 420mm. Anticipated drilling diameters are those indicated on Drawing Nos. and

PA 1.17.3. DRILLING TECHNIQUE(S)

The drilling technique will be air percussion. Provision must be made for the use of foam, as required. A stabiliser of a minimum length of 6m must be used to ensure the straightness and verticality of the borehole. The stabiliser forms the first drilling rod and is attached immediately above the hammer.

PA 1.17.4. DRILLING MEDIA

The Contractor may not use drilling media which may cause hole erosion or involve the use of clay, oil, salt or any lost circulation agent, sawdust, cement, or any form of plugging that could affect the production capacity of the water bearing strata intersected or contaminate groundwater. The use of foam may be required. It will be the responsibility of the driller to use a foam mix compatible with and suitable for the geological conditions being experienced.

PA 1.17.5. SANITARY SEAL

Each borehole shall be completed with 3m of cement grout extending from ground level to the top of the gravel pack.

The sanitary seal shall be mixed in the following ratio, 30 litres of water to 50kg cement.
Concrete Slab

Each borehole shall, be completed with a concrete slab of dimensions 1m x 1m x 0,5m, sunk into the ground for 0,3m. The slab will be made of aggregate, river sand and cement in the ratio 3:2:1. The strength must be 20KPA minimum after 28 days.

PA 1.17.6. SAMPLING



Representative samples of the strata intersected shall be collected every one metre and at geological contacts. The Contractor will take every possible precaution to guard against sample contamination due to poor circulation, hole erosion, or caving.

PA 1.18. DRILLING AND CONSTRUCTION OF BOREHOLES

The drilling shall be carried out with the least possible delay in order to run the casing as required, and to remove any drilling fluid from the borehole in the shortest possible time.

All boreholes shall be presented for testing free of all bridging and obstructions to bottom. Any time spent in conditioning holes or removing obstructions shall be at the contractor's expense.

PA 1.19. STRAIGHTNESS AND VERTICALITY

All boreholes shall be drilled and cased straight and vertical and all casings liners shall be set round, plumb and true to line. The Client shall have the right to reject any or all casing which fails to meet the requirements of this Specification, and the casing rejected will be replaced at the Contractor's expense.

Any delays encountered in running casing considered to be due to poor hole alignment, shall be at the Contractor's expense.

To demonstrate the compliance of his work with this requirement the Contractor, when called upon to do so, shall furnish all labour, tools and equipment and shall make the tests described herein in the manner prescribed by, and to the satisfaction of the Client. Tests for plumbness and alignment will be made after the complete construction of the borehole before its acceptance.

Plumbness and alignment shall be tested by lowering into the borehole to a depth as directed by the Client, a section of pipe 12m long. The outer diameter of the plumb shall not be greater than 15mm smaller than the diameter of the cased/screened hole to be tested. Should the plumb fail to move freely throughout the length of the casing to the required depth, or should the well vary from the vertical in excess of two-thirds of the smallest inside diameter of that part of the borehole being tested per 30m of depth, or beyond limitations of this test, the plumbness and diameter of the well shall be corrected by the contractor at his own expense. Should the contractor fail to correct such faulty straightness or plumbness, the Client may refuse to accept the borehole and no payment of the work and materials shall be made.

PA 1.20. PROTECTION

During the contract period when work is not in progress, the boreholes shall be kept capped in such a manner as to prevent the entrance of foreign material. The Contractor shall remove any foreign matter at his own expense. On completion of each borehole, the Contractor shall supply and fit an approved permanent cap as per drawing No.

PA 1.21. EXPERTISE

The Contractor under this Contract is considered to be an expert water well driller and is expected to organise and carry out the work specified hereunder in an expert manner. Drilling problems encountered will be overcome entirely within the framework of this Specification and Schedule of Estimated Quantities and rates, and no claim for extra payments will be entertained for problems foreshadowed in the Specification or due to limitations placed by this Specification.



PA 1.22. ABANDONMENT

The Client shall have the right at any time during the progress of the work to order the abandonment of the borehole. The Contractor thereupon shall remove the plant, withdraw the casing, if applicable, and salvage or attempt to salvage all such materials as the Client shall direct and/or up until the Client revokes such direction, and shall fill or leave the borehole to the satisfaction of the Client.

Payment shall be made for such abandoned borehole at the appropriate rates as detailed in the Schedule Estimated Quantities and Rates.

PA 1.23. LOST BOREHOLE

Should accident to the plant, behaviour of the ground, jamming of the tools or casing, or any other cause, prevent the satisfactory completion of the works, the borehole shall be deemed to be lost and no payment shall be made for the drilling costs nor for any materials not recovered in good order therefrom, nor for any time.

In the event of a lost borehole, the Contractor shall construct a new borehole adjacent to the lost borehole, on a site indicated by the Client. The option of declaring any borehole lost shall rest with the Contractor, subject to directions from the Client.

PA 1.24. DEVELOPMENT

On completion the borehole shall be developed to a maximum yield of water, free of suspended materials. Development will be carried out using air lift pumping, jetting and block surging, or such other standard techniques as may be directed by the Client. The standard jetting tool is shown on Drawing No.

Development will be continued for the period directed by the Client.

PA 1.25. DISINFECTION

On completion of development the screen area will be disinfected by pumping a solution of 5 kg of HTH in 200 litres of water through the jetting tool.

PA 1.26. REPORTS

At the end of the Works, the Contractor shall provide all information necessary to complete the data form.

PA 1.27. ALLOWABLE PAYMENT

PA 1.27.1. ESTABLISHMENT AND SUBSEQUENT REMOVAL THEREOF

This is payment to cover the establishment of all the required drilling equipment, personnel, camping and general equipment necessary to carry out and complete the Works described in this specification and any extensions, and to cover the removal of all plant, equipment and personnel permanently from the project and the restoration of the sites to a level and reasonably tidy stage. This rate can be either a lump sum or a Km rate.

PA 1.27.2. DRILLING

The rates for drilling are based on diameter and are to cover all the costs involved in drilling, including mud and foam mixing, injection mixers, bit sharpening, conditioning of the drilling



mud for logging, tripping in and out of hole and all other such works as are associated with the drilling, and are not covered under other allowable payments.

PA 1.27.3. SUPPLY AND DELIVERY OF MATERIALS ON SITE

The rates for materials are to cover purchase cost, transport and safe storage on site of all materials required for drilling, construction, development and use in the boreholes, ref. to letter of invitation. Payment will be made only for materials used and shall be calculated for each completed hole. No claim for extra payment will be entertained by reason of remoteness, wharfage, insurance etc. or by reason of omission in calculating the quoted rate. No payment will be made for those materials which may be provided by the Client.

PA 1.27.4. STANDBY TIME

This time rate, which is provisional and estimated in the Bill of Quantities, is to cover only those items when the rig and crew are idle waiting for decisions by the Client, where those decisions or whose presence is required before further work is possible. Under no circumstances will standby be payable for any other delays or hold ups other than those incurred by the Client's decision.

PA 1.27.5. DEVELOPMENT TIME

The borehole development time rate is to cover all the time effectively spent on borehole development, except where included under other time rates. Contractors will note that time rates do not allow for building standard development tools on site.

PA 1.27.6. WORK TIME

The work time rate which is provisional and estimated in the Bill of Quantities, is to cover time spent where the rig is held up waiting for on site manufacture of special non-standard tools as requested, or any other directive by the Client for non-standard work which requires the use of the rig and is not included in the Specification or covered under any other rate. It does not include mud mixing time or fishing time.

PA 1.27.7. CASING INSTALLATION

This rate covers the installation of permanent casing into production or abandoned boreholes and the pulling of temporary casing and casing from abandoned boreholes. It does not cover the running and pulling of casing in boreholes declared lost or in which the casing cannot be set in position due to misalignment or other operational problems.

PA 1.27.8. MOVING BETWEEN BOREHOLE SITES

This item is to cover the movement of the rig and ancillary equipment from one borehole site to the next. Payment may be claimed per site move after the initial site establishment to the first borehole.

PA 1.27.9. PAYMENTS

All payments will be made on the basis of measured quantities only.

PA 1.28. SUPERVISION OF WORKS

The Contractor shall have a senior tool pusher on site at all times to manage and organise the contract and to liaise with the Client.



PA 1.29. SITE CLEARING

The Contractor is responsible to clean and restore the site as far as possible to the natural state by:-levelling drilling cuttings; cleaning up rubbish, waste materials, debris and oil spills.



PB: GEOTECHNICAL INVESTIGATION

A number of phases are normally included in the investigation. The phases include a desk study, site reconnaissance, preliminary fieldwork, detailed investigation and verification of conditions during construction. The process may be iterative in certain instances, with some phases being repeated prior to final site selection and commencement of detailed investigation. See PW344 regarding dolomite. A dolomite Certificate is required to confirm if the site is underlined by dolomite or not. The following serves as a guide to the information, which is obtained in the various phases:

PB 1.1. SITE INVESTIGATION GOOD PRACTICE

This section of the report emphasizes the importance of a phased investigation approach, which is crucial for investigations of almost any size. It is strongly advised that geotechnical practitioners avoid conducting a single-phase ground investigation, as the need for further probing can only be assessed as the investigation progresses. This approach is not about unlimited spending, but rather about recognizing the possibility and likelihood of requiring additional investigation. Any variations can be addressed by agreeing on upfront rates and costs for different investigation techniques. Without this phased approach, as depicted in Figure 3, investigations and reports may remain incomplete and fail to provide proper conclusions. It is imperative for the geotechnical designer to have accurate parameters rather than making guesses. Sufficient investigation and testing must be conducted to determine design parameters with a reasonable degree of confidence. If direct testing methods are unavailable, correlations from reliable indirect methods should be used. Any assumptions made should be clearly stated, and provision should be made for verification within the construction budget.

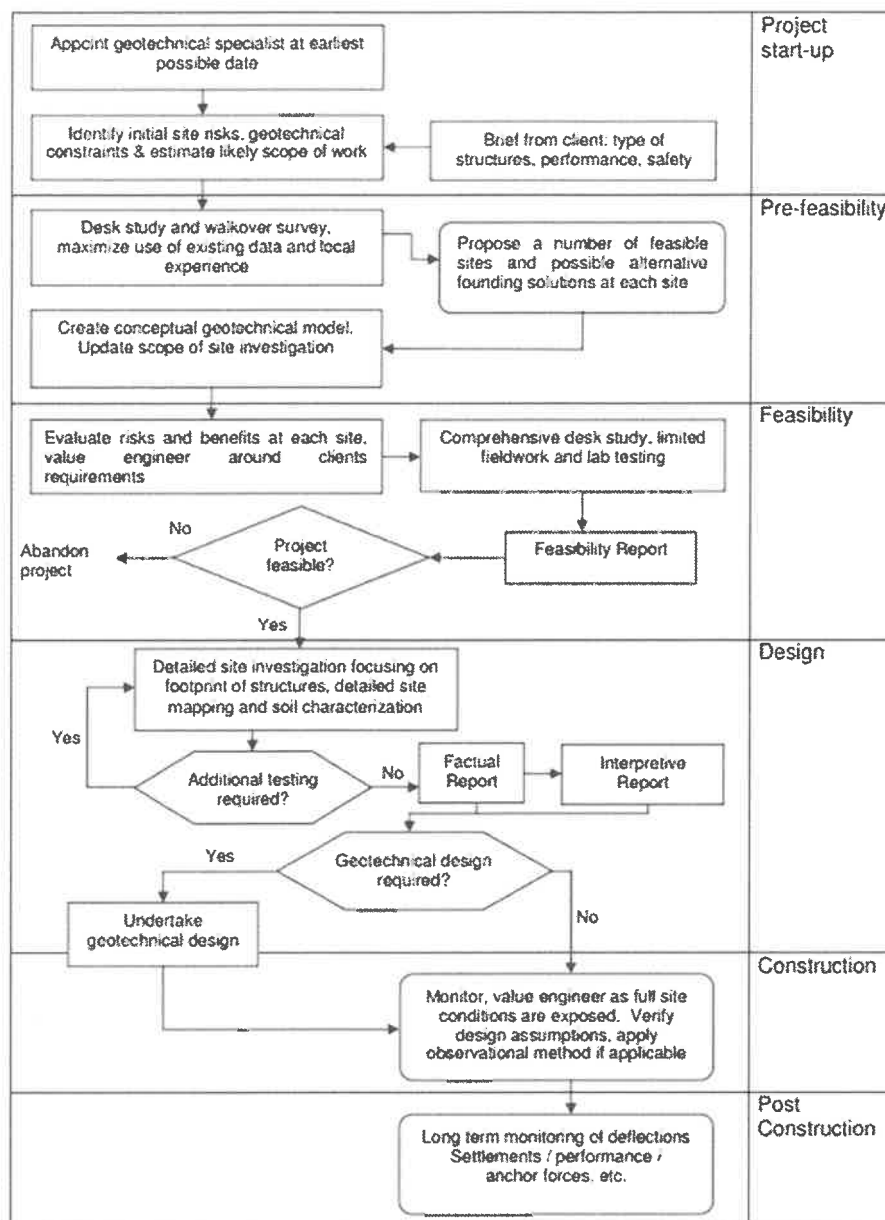


Figure 3: Site investigation good practice (SAICE, GEOTECHNICAL DIVISION, 2010)

PB 1.2. DESK STUDY

Topographical maps and aerial photographs should be consulted to gain information on the general topography and prominent features.

Geological maps should be consulted to gain information on the basic geology and possible dolomite areas.

Local authorities and other organizations should be approached to establish whether they know about and/or have records available on investigations conducted in the area.

The government mining engineer should be approached for information on mining operations where such operations are known to have been undertaken.



The study of overlapping aerial photographs through a stereoscope may be of value in identifying geological features such as faults, dykes, geological boundaries, dolomite, etc. as well as soil types and drainage patterns. These features are often not apparent in the field.

PB 1.3. SITE RECONNAISSANCE

A site reconnaissance should be undertaken in order to gain geotechnical information from visible features, establish the suitability of various geophysical testing methods and investigate accessibility for drilling equipment.

PB 1.4. GEOPHYSICAL INVESTIGATIONS

Wherever practicable, a geophysical investigation will be undertaken. This investigation will comprise a seismic/resistivity/gravimetric/electromagnetic evaluation of the subsurface conditions of sufficient extent and depth in order to assist in the selection of the most economic detailed investigation as well as in the placing of foundations.

It should be noted that a proper geophysical investigation could substantially reduce the number of boreholes required at any site.

Drilling will only be required if the footprint of the structure is fixed.

PB 1.5. DETAILED INVESTIGATIONS – EXPLORATORY HOLES

The purpose of exploratory holes is to permit visual examination, testing of the in-situ material and for the recovery of samples.

Hand or machine (back actor) excavated test pits should generally be put down first, followed by large diameter auger holes and finally small diameter cored holes. Planning should be flexible in such a way that when receiving new/additional information, the work can be varied as necessary.

Adequate direction and supervision of the work by competent staff with appropriate knowledge and experience as well as the authority to decide on variations to the investigation when required, is essential in order to obtain the greatest benefit from the investigation.

PB 1.6. LOGGING AND PROFILING

This work will be carried out in accordance with the following:

- a. A guide to soil profiling for civil engineering purposes.
- b. A guide to core logging for civil engineering purposes.
- c. A guide to percussion borehole logging.
- d. Produced by the South African Institute for Engineering and Environmental Geologists (SAIEG), South African Institute of Civil Engineers (SAICE) Geotechnical Division and Association of Engineering Geologists (AEG) (1993), edited by ABA Brink and RM Bruin.

PB 1.7. FORMAT OF REPORT

The geotechnical report will provide clear guidance to the engineer, enabling him to select the most appropriate solutions and foundation types. The report should quantify the parameters required for the design of the proposed foundation and embankments.



The report, together with the inspection of the site, will provide the contractor with sufficient information to reasonably anticipate any problems that may occur during the execution of the works. This will enable the contractor to tender a realistic price for the construction of the work and to select the most appropriate equipment and techniques.

The report will be compiled under the following headings and will include - but not be limited to the following, as relevant:

1. Introduction

- a. Terms of reference;
- b. Description of the planning stage, and the purpose for which the investigation was conducted.

2. Description of the site(s)

- a. Location of the site(s);
- b. Accessibility of the site(s);
- c. Traffic ability of the site for construction equipment;
- d. Listing of sources where data is available or was obtained from;
- e. Description of regional geology, vegetation, drainage and other general features of importance.

3. Investigations carried out

- a. Name(s) of firm(s) responsible for the field work (consultant, contractor);
- b. Name(s) of person(s) responsible for the interpretation of the geophysical work and for the profiling;
- c. Dates when the work was conducted;
- d. Description of the types of field work undertaken and equipment used.

4. Investigation results

- a. Description of the soils encountered - identifying their stability or potential problems they may present, e.g. tendency to heave, collapse, settle, etc;
- b. Description of hard rock geology - identifying the type, quality, degree of weathering, fracturing, etc;
- c. Description when potential for boulders and/or other obstructions to deep seated foundations;
- d. Description of the problems experienced or to be expected;
- e. Description of ground water and expected variations;
- f. Field and laboratory testing carried out i.e.:
- g. Types of tests conducted on the respective materials;
- h. Results obtained and their reliability.

5. Recommendations

- a. Type of foundation best suited;
- b. Expected bearing capacity and settlement for the respective materials on which founding could be considered;
- c. Friction values and rock socket parameters for the design of piles;
- d. Precautionary measures;
- e. Construction sequences.



6. References

- a. Listing of standards used for the classification of materials in respect of soil condition and rock hardness.

7. Annexure

- a. Locality plan to appropriate scale;
- b. Results of geophysical investigations;
- c. Borehole, auger hole and test pit logs;
- d. Photographs of borehole cores recovered;
- e. Laboratory test results;
- f. Drawings to scale showing the location - including levels of all positions investigated physical features of the site and setting out points.

Design of reinforced concrete base

References:

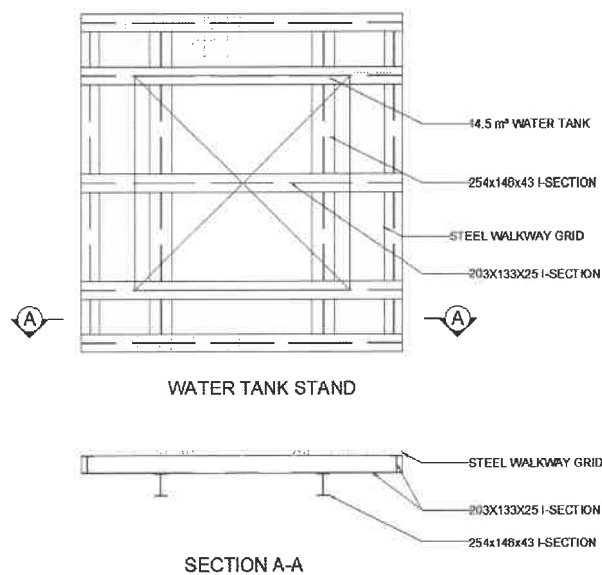
1. The process and design of the reinforced concrete base is as follows.

The elevated water tank consists of the following structural elements that will be analysed and designed individually.

1.1 Stand below the water tank.

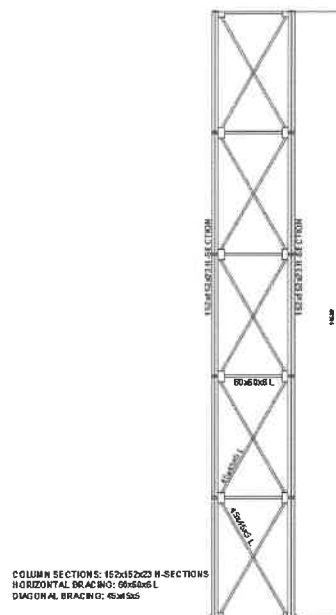
The section members are trial sections that were analysed to resist the applied loadings.

The steel walkway grid is a stainless steel grating.



1.2 15 m structural steel support structure.

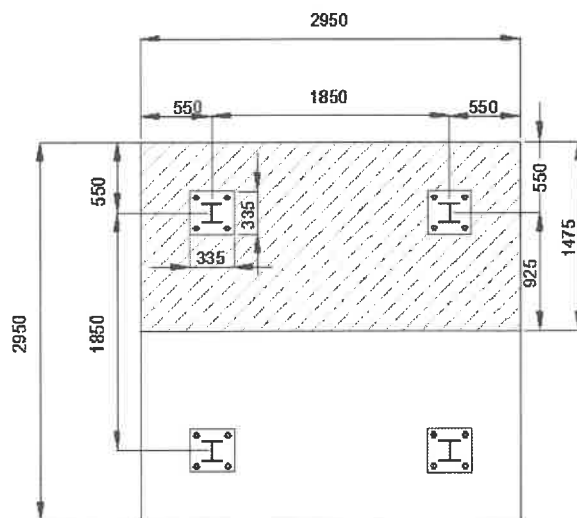
The section members of the steel support structure were trial sections analysed to resist the applied loadings.



1.3 Reinforced concrete base.

The foundation area was sized based on the column spacing of the steel support structure that carries the water tank, which is 1850 mm, and the edge distance from the base plates of 550 mm. This size will be later checked during the foundation stability checks to see if it complies.

To design the base, design of combined footing with two column loads was used. Therefore half the proposed area of 2950 mm x 2950 mm of the base will be analysed as a combined footing with area, which will be 2950 mm x 1475 mm.



2. Analysis of the water tank stand on Prokon

Loadings on the stand:

- Weight of the steel tank (W_{TANK})

Dimensions of the specified tank is: 2.44 m(B) x 2.44 m(W) x 2.44 m(H), from the Civil Engineering Report.

According to Steel tank Specifications, for 1.35 bar pressure (from Civil Engineering report), panel thickness to be used is 3 mm.

$$\begin{aligned} W_{\text{TANK}} &= \text{Area side of tank} \times \text{thickness of panel} \times 6 \text{ sides} \times \text{density} \\ &= (2.44\text{m} \times 2.44\text{m}) \times 0.003\text{m} \times 6 \times 7850 \text{ kg/m}^3 \\ &= 841.3 \text{ kg} \\ &= 8.3 \text{ kN} / 4 \text{ point loads} \\ &= \underline{\underline{2.08 \text{ kN per point load}}} \end{aligned}$$

- Weight of the typical stainless steel grating (W_{WALKWAY})

Unit weight of stainless steel grating = 26 kg/m²

$$\begin{aligned} W_{\text{WALKWAY}} &= \text{Unit weigh} \times \text{width of walkway} \\ &= 26 \text{ kg/m}^2 \times 0.6 \text{ m} \\ &= 15.6 \text{ kg/m} \\ &= \underline{\underline{0.153 \text{ kN/m}}} \end{aligned}$$

- Weight of the water in the tank (W_{WATER})

Density of fresh water = 10 kN/m³

Volume of the tank = 2.44 m x 2.44 m x 2.44 m = 14.53 m³

$$\begin{aligned} W_{\text{WATER}} &= \text{Volume of tank} \times \text{density of fresh water} \\ &= 14.53 \text{ m}^3 \times 10 \text{ kN/m}^3 \\ &= 145.3 \text{ kN} / 4 \text{ point loads} \\ &= \underline{\underline{36.33 \text{ kN per point load}}} \end{aligned}$$

- Imposed loading on the steel grid walkway (IL)

Imposed loading on walkway = 1.5 kN/m²

$$\begin{aligned} \text{IL} &= \text{Imposed loading} \times \text{width of walkway} \\ &= 1.5 \text{ kN/m}^2 \times 0.6 \text{ m} \\ &= \underline{\underline{0.3 \text{ kN/m}}} \end{aligned}$$

- Wind loading on the water tank

SANS 10160-2
(Table A.7)

SANS 1060-2:2011
(Table 2; A4)

Calculating the wind pressure on the water tank.

Phuthaditjhaba is in the Free State Province with a basic wind speed of 40 m/s. Which is the fundamental value of basic wind speed, $v_{b,0}$.

Basic wind speed, $v_b = C_{prob} \times v_{b,0}$

$$C_{prob} = \left[\frac{1 - K \times \ln \{-\ln(1-p)\}}{1 - K \times \ln \{-\ln 0.98\}} \right]^n$$

$K = 0.2$

$n = 0.5$

$p = 0.02$

$\therefore C_{prop} = 1.0$

$\therefore v_b = 1.0 \times 40 \text{ m/s}$

$= 40 \text{ m/s}$

Peak wind speed, $v_p(z)$

$v_p(z) = C_r(z) \times C_o(z) \times v_{b, peak}$

$v_{b, peak} = 1.0 \times v_b = 40 \text{ m/s}$

$C_o(z) = 1.0$

$$C_r(z) = 1.36 \left(\frac{z - z_o}{z_g - z_o} \right)^\alpha$$

With: Terrain category C

1	2	3	4	5
Terrain category	Height z_g	Height z_o	Height z_c	Exponent α
A	250	0	1	0,070
B	300	0	2	0,095
C	350	3	5	0,120
D	400	5	10	0,150

$\therefore C_r(z) = 0.91$

$\therefore v_p(z) = 0.91 \times 1.0 \times 40$

$= 36.4 \text{ m/s}$

Peak wind speed, $q_p(z)$

$q_p(z) = 0.5 \times \rho \times v_p(z)^2$

$\rho = 0.977 \text{ kg/m}^3$

$\therefore q_p(z) = 0.5 \times 0.977 \times 36.4^2$

$= 647.24 \text{ Pa}$

$= 0.647 \text{ kPa}$

SANS 10160-3:
2019 - Figure 1
SANS 10160-3.
7.2.2
SANS 10160-3.
7.2.3

SANS 10160-3.
7.3.1.1

SANS 10160-3.
7.3.2.1

SANS 10160-3.
Table 1

SANS 10160-3.
Table 4 with
HASL: 1693m

Wind pressure on the water tank: w

Internal wind pressure:

$$W_i = q_p(z_e) \times C_{pi}$$

External wind pressure:

$$W_e = q_p(z_e) \times C_{pe}$$

External pressure coefficients, C_{pe} for walls

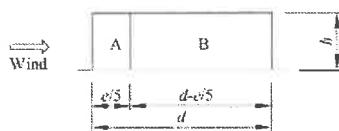
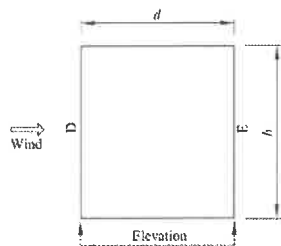
$d = 2.44 \text{ m}$

$b = 2.44 \text{ m} = D = E$

$h = 2.44 \text{ m}$

e is the smaller of b or $2h$

$\therefore e = 2.44 \text{ m}$



for $e \geq d$

$A = e/5 = 0.488 \text{ m}$

$B = d - e/5 = 1.952 \text{ m}$

$h/d = 2.44 / 2.44 = 1$

Table 6 — Values of external pressure coefficients
for vertical walls of rectangular plan buildings

1	2	3	4	5	6	7	8	9	10	11
h/d	Zone									
	A		B		C		D		E	
	External pressure coefficients									
	C _{pe,10}	C _{pe,1}	C _{pe,10}	C _{pe,1}	C _{pe,10}	C _{pe,1}	C _{pe,10}	C _{pe,1}	C _{pe,10}	C _{pe,1}
5	-1.2	-1.4	-0.8	-1.1	-0.5	-0.5	-0.8	-1.0	-0.7	-0.7
1	-1.2	-1.4	-0.8	-1.1	-0.5	-0.5	-0.8	-1.0	-0.5	-0.5
≤0.25	-1.2	-1.4	-0.8	-1.1	-0.5	-0.5	-0.7	-1.0	-0.5	-0.5
NOTE For buildings with h/d > 5, with rectangular, polygonal or circular cross-section, the total wind loading may be based on the provisions given in 8.7.5 to 8.9 and 8.10.2.										

NOTE: For buildings with $h/d > 5$, with rectangular, polygonal or circular cross-section, the total wind loading may be based on the provisions given in § 7 to § 9 and § 10.2

$C_{pe,10}$ for overall coefficient.

$A = -1.2$

$B = -0.8$

$D = +0.8$

$E = -0.5$

SANS 10160-3.
7.5.2.3

SANS 10160-3.
7.5.2.4

SANS 10160-3.
8.3.2

SANS 10160-3.
8.3.2.2 Figure 8

SANS 10160-3.
8.3.2.3 Table 6

SANS 10160-3.
8.3.1.1

$c_{pi} = -0.4$ of vented tanks with small openings	SANS 10160-3. 8.3.9.9
Net pressure, c_p is the difference between the pressures on the opposite surfaces taking into account their signs. <u>$\therefore C_p$:</u> $A = -1.2 - (-0.4) = -0.8$ $B = -0.8 - (-0.4) = -0.4$ $D = +0.8 - (-0.4) = +1.2$ $E = -0.5 - (-0.4) = -0.1$ Wind pressure, $w = q_p(z) \times c_p$ $w_{A+B} = 0.647 \text{ kPa} \times -0.8 = 0.52 \text{ kPa}$ (Applied the largest pressure coefficient of -0.8 over A and B) $w_D = 0.647 \text{ kPa} \times 1.2 = 0.776 \text{ kPa}$ $w_E = 0.647 \text{ kPa} \times -0.1 = -0.065 \text{ kPa}$ $w_D + w_E = 0.776 - (-0.065)$ $= 0.841 \text{ kPa} \times 0.85$ $= 0.715 \text{ kPa}$ The force acting on the face of the tank $F = 0.715 \text{ kPa} \times (2.44\text{m} \times 2.44\text{m})$ $= 4.26 \text{ kN} / 4 \text{ point loads}$ $= \underline{\underline{1.06 \text{ kN per point load.}}}$ Upward wind load: Design as a canopy structure with opening at the bottom. Blockage $\phi = 0$ Upward wind pressure coefficients, $c_{p,net}$, shall be used in the design of roofing elements and fixings only. Overall force coefficient for a 0 degree pitched "roof", $c_f = -0.5$	SANS 10160-3. 7.5.2.5 SANS 10160-3. 8.3.2.4 (b) SANS 10160-3. 8.4 8.4.5; Table 13
$F = c_s \times c_d \times c_f \times q_p(z) \times \text{Area}$ $= 1.0 \times (-0.5) \times 0.647 \text{ kPa} \times (2.44\text{m} \times 2.44\text{m})$ $= -1.925 \text{ kN} / 4 \text{ point loads}$ $= \underline{\underline{-0.48 \text{ kN}}}$	SANS 10160-3. 7.5.3.2

Summary of all input loads on water tank stand in Prokon:

$W_{TANK} = 2.08 \text{ kN per 4 point loads}$

$W_{WALKWAY} = 0.153 \text{ kN/m around the stand}$

$W_{WATER} = 36.33 \text{ kN per 4 point loads}$

$IL = 0.3 \text{ kN/m around stand}$

Wind load 0° and $90^\circ = 1.06 \text{ kN per 4 point loads}$

Wind load upwards $= -0.48 \text{ kN per 4 point loads}$

Load combinations:

C1: $1.5W_{TANK} + 1.5W_{WATER}$

C2: $0.9W_{TANK} + 1.3\text{Wind load } 0^\circ$

C3: $0.9W_{TANK} + 1.3\text{Wind load } 0^\circ$

C4: $0.9W_{TANK} + 1.3\text{Wind load } 0^\circ$

C5: $1.2(W_{TANK} + W_{WATER}) + 1.6IL$

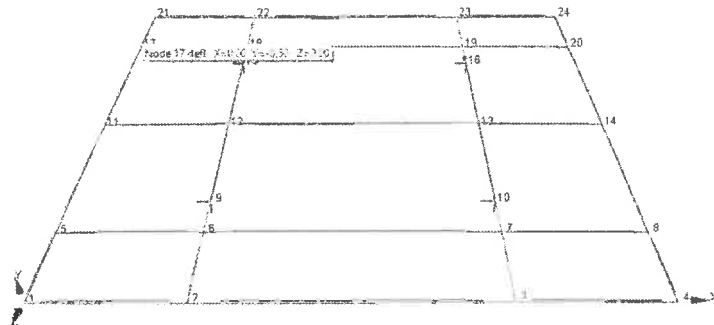
SANS 10160-1

Table 3

Output reactions: Factored

Maximum Deflections for Load Combination C5:

Y $-0.92 \text{ mm at node 22}$



REACTIONS AT ULS							
(In rotated axes where applicable)							
Node	Lcase	x-force kN	Y-force kN	Z-force kN	x-moment kNm	Y-moment kNm	Z-moment kNm
9	C1	0.00	61.96	0.00	0.00	0.00	0.00
	C2	-1.38	4.48	0.19	0.00	0.00	0.00
	C3	-0.01	4.48	1.38	0.00	0.00	0.00
	C4	0.00	3.85	0.00	0.00	0.00	0.00
	C5	0.00	51.31	0.00	0.00	0.00	0.00
10	C1	0.00	61.96	0.00	0.00	0.00	0.00
	C2	-1.38	4.48	0.00	0.00	0.00	0.00
	C3	0.00	4.48	2.75	0.00	0.00	0.00
	C4	0.00	3.85	0.00	0.00	0.00	0.00
	C5	0.00	51.31	0.00	0.00	0.00	0.00
15	C1	0.00	61.97	0.00	0.00	0.00	0.00
	C2	-1.38	4.48	-0.19	0.00	0.00	0.00
	C3	0.00	4.48	1.38	0.00	0.00	0.00
	C4	0.00	3.86	0.00	0.00	0.00	0.00
	C5	0.00	51.33	0.00	0.00	0.00	0.00
16	C1	0.00	61.94	0.00	0.00	0.00	0.02
	C2	-1.38	4.47	0.00	0.00	0.00	0.01
	C3	0.01	4.47	0.00	0.00	0.00	0.01
	C4	0.00	3.85	0.00	0.00	0.00	0.01
	C5	0.00	51.30	0.00	0.00	0.00	0.03

Choosing worst case load combination reactions: Y – direction (C1): 61.97 kN per column leg of the tower X – direction (C2): -1.38 kN per column leg of the tower Z – direction (C3): 1.38 kN per column leg of the tower NOTE: Load combination C2 and C3 are the same, with different wind directions, 0° and 90°. Therefore the loading should be the same just on different axis.	
3. Analysis of the water tank tower on Prokon <u>Unfactored loads on the tower from the reactions of the tower stand:</u> Y – direction: 61.97 kN / 1.5 = 41.31 kN on each column leg X – direction: -1.38 kN / 1.1 = -1.25 kN on each column leg Z – direction: 1.38 kN / 1.1 = 1.25 kN on each column leg <u>Wind loading on the water tank support structure</u> Wind loading calculation on lattice structure $C_f = C_{f0} \times W_z$ Finding C_f as a function of ϕ $\phi = A / A_c$ $A_c = b \times h$ of the tower = 1.84 m x 15 m = 27 m² $A = \sum_i b_i \times L_i + \sum_k A_{gk} \quad (39)$ where b_i and L_i are the width and length of the individual member, i (see figure 34), projected normal to the face; A_{gk} is the area of the gusset plate, k (see figure 34); <u>Lattice elements:</u> The following lattice elements for the water tank structural support steel structure are for the benefit of the analysis and the contractor would need to confirm the members from the supplier with the structural engineer.	SANS 10160-3: 8.12.1 SANS 10160-3 8.12.2

Column legs: 152 x 152 x 23 H-Section

Horizontal bracing: 60 x 60 x 3 Equal angle section

Diagonal bracing: 45 x 45 x 3 Equal angle section

Gusset plates: 12 % of the steel structure area

$$= 6.646 \text{ m}^2 \times 0.12 = 0.8 \text{ m}^2$$

Total area of elements wind facing:

Columns: $0.152 \text{ m} \times 15 \text{ m} \times 2 \text{ legs} = 4.56 \text{ m}^2$

Horizontal bracing: $+ 0.06 \text{ m} \times 1.84 \text{ m} \times 5 \text{ members} = 0.552 \text{ m}^2$

Diagonal bracing: $+ 0.045 \text{ m} \times 3.41 \text{ m} \times 10 \text{ members} = 1.534 \text{ m}^2$

Area of gusset plates: $+ 0.81 \text{ m}^2$

Total area of elements wind facing, $A = 7.456 \text{ m}^2$

$$\phi = A / A_c$$

$$= 7.456 \text{ m}^2 / 27 \text{ m}^2$$

$$= 0.28$$

SANS 10160-3.

8.12.1

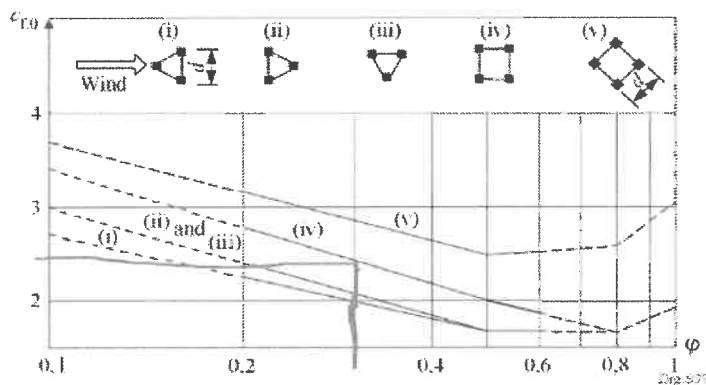


Figure 36 — Force coefficient $c_{f,0}$ for a spatial lattice structure with members of non-circular cross-section as a function of solidity ratio, ϕ

$$c_{f,0} = 2.5$$

Determining ψ_λ as a function of λ

$$\text{For } L < 15 \text{ m, } \lambda = 2L/b = (2 \times 15\text{m}) / 1.84 \text{ m} = 16.6$$

SANS 10160-3.

8.13.1; Table 22,

No.1

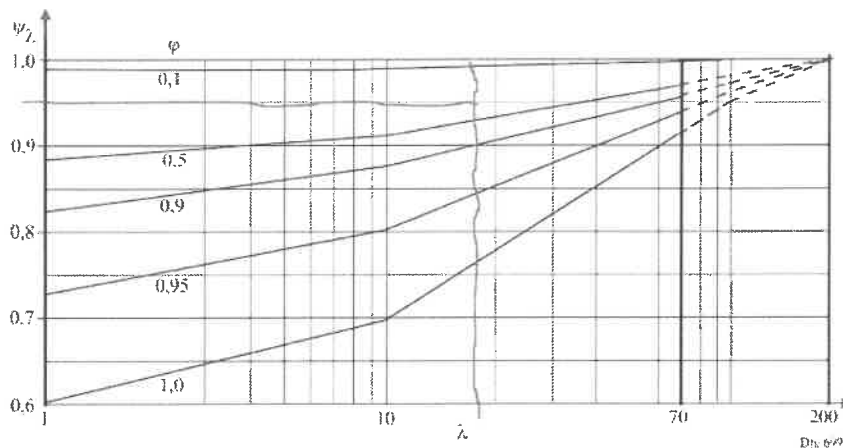


Figure 38 — Indicative values of the end-effect factor, ψ_λ , as a function of solidity ratio, ϕ versus slenderness, λ

$$\psi_\lambda = 0.95$$

$$\begin{aligned} \therefore C_f &= C_{f,0} \times \psi_\lambda \\ &= 2.5 \times 0.95 \\ &= 2.375 \end{aligned}$$

SANS 10160-3.
8.13.2

$$\begin{aligned} \text{Wind force, } F &= C_s \times C_d \times C_f \times q_p(z) \times A \\ &= 1.0 \times 2.375 \times 0.647 \text{ kPa} \times 7.456 \text{ m}^2 \\ &= 11.46 \text{ kN over 15m height} \\ &= 0.76 \text{ kN/m} / 2 \text{ column legs} \\ &= 0.38 \text{ kN/m} \end{aligned}$$

SANS 10160-3.
7.5.3.2
 $C_s \times C_d = 1.0$
7.5.3.3

Summary of all input loads on water tank support structure in Prokon:

Reaction point loads

- Y – direction: -41.31 kN on each column
- X – direction: 1.25 kN on each column
- Z – direction: -1.25 kN on each column

Uniformly distributed wind loading on each face of the support structure

- X – direction: 0.38 kN/m per column
- Z – direction: -0.38 kN/m per column

Load combinations:

- LC1: 1.5 Y-direction load
- LC2: 0.9 Y-direction load + 1.3 X-direction load
- LC3: 0.9 Y-direction load + 1.3 Z-direction load

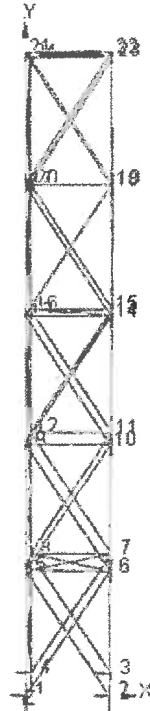
Output reactions: Factored

Maximum Deflections for Load Combination LC3:

X :-0.04 mm at node 12

Y :-1.29 mm at node 24

Z :-5.79 mm at node 23



REACTIONS AT ULS							
(In rotated axes where applicable)							
Node	Lcase	x-force kN	y-force kN	z-force kN	x-moment kNm	y-moment kNm	z-moment kNm
1	LC1	3.14	69.61	-3.14	0.00	0.00	0.00
	LC2	-3.54	-10.95	0.27	0.00	0.00	0.00
	LC3	-0.27	-10.95	3.54	0.00	0.00	0.00
2	LC1	-3.14	69.61	-3.14	0.00	0.00	0.00
	LC2	-6.77	94.48	-4.02	0.00	0.00	0.00
	LC3	0.27	-10.95	3.54	0.00	0.00	0.00
3	LC1	-3.14	69.61	3.14	0.00	0.00	0.00
	LC2	-6.77	94.48	4.02	0.00	0.00	0.00
	LC3	-4.03	94.48	6.77	0.00	0.00	0.00
4	LC1	3.14	69.61	3.14	0.00	0.00	0.00
	LC2	-3.54	-10.95	-0.27	0.00	0.00	0.00
	LC3	4.03	94.48	6.77	0.00	0.00	0.00

Load combination 1 (LC1):

	Column Leg 1	Column Leg 2	Column Leg 3	Column Leg 4
Y- direction	69.61 kN	69.61 kN	69.61 kN	69.61 kN
X- direction	3.14 kN	-3.14 kN	-3.14 kN	3.14 kN
Z- direction	-3.14 kN	-3.14 kN	3.14 kN	3.14 kN

Load combination 2 (LC2):

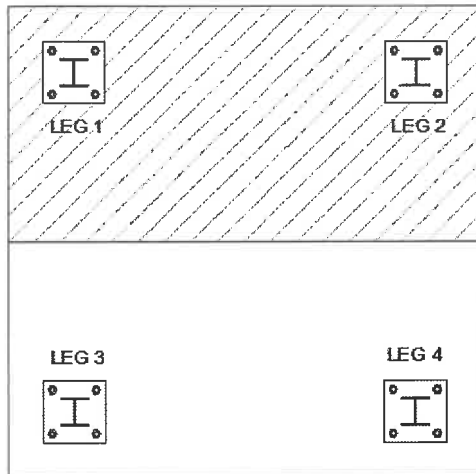
	Column Leg 1	Column Leg 2	Column Leg 3	Column Leg 4
Y- direction	-10.95 kN	94.48 kN	94.48 kN	-10.95 kN
X- direction	-3.54 kN	-6.77 kN	-6.77 kN	-3.54 kN
Z- direction	0.27 kN	-4.02 kN	4.02 kN	-0.27 kN

Load combination 3 (LC3):

	Column Leg 1	Column Leg 2	Column Leg 3	Column Leg 4
Y- direction	-10.95 kN	-10.95 kN	94.48 kN	94.48 kN
X- direction	-0.27 kN	0.27 kN	-4.03 kN	4.03 kN
Z- direction	3.54 kN	3.54 kN	6.77 kN	6.77 kN

Combined footing design

Designing for worst case load combination: LC2 and LC3



Scenario 1: Load combination 2 (LC2) Leg 1 and Leg 2

Leg 1: $N_{u1} = 94.48 \text{ kN}$ and $V_{u1} = -6.77 \text{ kN}$

Leg 2: $N_{u2} = -10.95 \text{ kN}$ and $V_{u2} = -3.54 \text{ kN}$

Scenario 2: Load combination 3 (LC3) Leg 3 and Leg 4

Leg 3: $N_{u1} = 94.48 \text{ kN}$ and $V_{u1} = 6.77 \text{ kN}$

Leg 4: $N_{u2} = 94.48 \text{ kN}$ and $V_{u2} = 6.77 \text{ kN}$

Scenario 1:

Unfactored Leg 1 nominal load, $N_1 = 94.48 \text{ kN} / 1.5 = 62.99 \text{ kN}$

Unfactored Leg 2 nominal load, $N_2 = -10.95 \text{ kN} / 1.5 = -7.3 \text{ kN}$

Unfactored shear force, $V_1 = -6.77 \text{ kN} / 1.1 = -6.15 \text{ kN}$

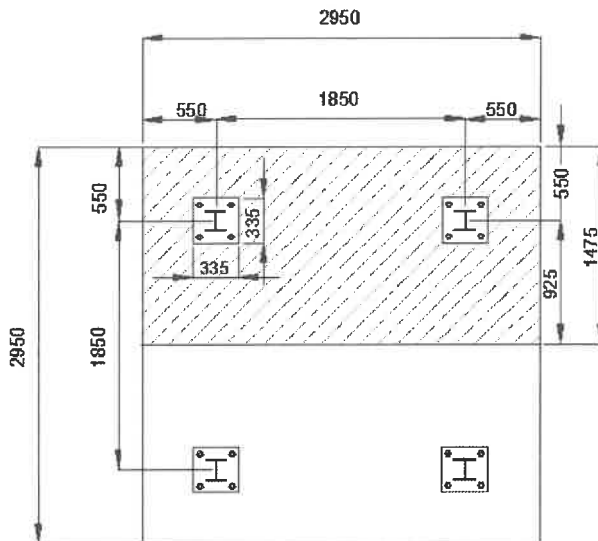
Unfactored shear force, $V_2 = -3.54 \text{ kN} / 1.1 = -3.22 \text{ kN}$

Assume base thickness of 350 mm.

Permissible soil pressure of 75 kPa

Area of base in consideration: $2.95 \text{ m} \times 1.475 \text{ m} = 4.35 \text{ m}^2$

This area is half the size of the actual base of $2.95 \text{ m} \times 2.95 \text{ m}$, which was determined from the structural steel support structure with



SANS 10100-1.
3.2.2.2

Greg Parrott,
Reinforced
Concrete, 8.6

Stability checks:

i) Check for overturning

$$\begin{aligned}\text{Self-weight of concrete base} &= \text{Area} \times \text{thickness} \times \text{concrete density} \\ &= 4.35 \text{ m}^2 \times 0.35 \text{ m} \times 25 \text{ kN/m}^3 \\ &= 38.06 \text{ kN}\end{aligned}$$

$$\text{Stabalising moment: Self-weight} \times \text{lever arm} = 38.06 \text{ kN} \times 1.475 \text{ m}$$

$$\text{Leg 1} \times \text{lever arm} = 62.99 \text{ kN} \times 2.4 \text{ m}$$

$$\text{Total Moment} = \underline{\underline{207.31 \text{ kN.m}}}$$

Stability effects of destabilising moments;

The translational load effects produced by notional lateral loads, applied at each storey, equal to (0,005 x factored gravity loads contributed by that storey), shall be added to the sway effects for all load combinations.

Factored gravity loads at the top of the support structure:

$$W = W_{\text{WATER}} + W_{\text{TANK}} + W_{\text{WALKWAY}} = 145.3 \text{ kN} + 8.3 \text{ kN} + 1.86 \text{ kN} = 155.46 \text{ kN}$$

$$W_f = 1.5 \times 155.46 \times 0.005 = 1.166 \text{ kN}$$

$$\text{Destabalising moment: Leg 2} \times \text{lever arm} = -7.3 \text{ kN} \times 0.55 \text{ m}$$

$$W \times 15 \text{ m (height of support)} = 1.166 \text{ kN} \times 15 \text{ m}$$

$$= \underline{\underline{21.51 \text{ kN.m}}}$$

$$\text{F.O.S}_{\text{OVERTURNING}} = 207.31 \text{ kN.m} / 21.51 \text{ kN.m}$$

$$= 9.64 > 1.5 \therefore \text{OK}$$

ii) Check for sliding

Soil friction coefficient = 0.4

$$\text{Weight on the base} + \text{base} = 62.99 \text{ kN} + 39.16 \text{ kN} = 102.15 \text{ kN}$$

SANS 10162-1.
8.7

$$\text{Weight against sliding} = 102.15 \text{ kN} \times 0.4 = \underline{\underline{40.86 \text{ kN}}}$$

$$\text{Horizontal loads} = 6.15 \text{ kN} + 3.22 \text{ kN} = 9.37 \text{ kN}$$

$$\text{Notional load} = 1.166 \text{ kN}$$

$$\text{Total horizontal loads} = 9.37 \text{ kN} + 1.166 \text{ kN} = \underline{\underline{10.54 \text{ kN}}}$$

$$\text{F.O.S}_{\text{SLIDING}} = 40.86 \text{ kN} / 10.54 \text{ kN}$$

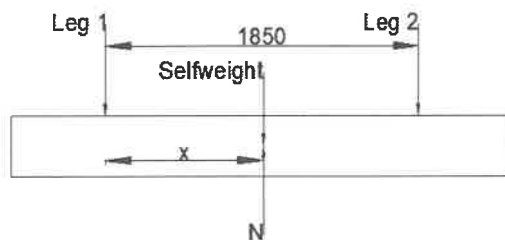
$$= 3.88 > 1.5 \therefore \text{OK}$$

iii) Soil bearing pressure

Resultant force acting on the base, N = self-weight + Leg1 + Leg 2

$$N = 39.16 \text{ kN} + 62.99 \text{ kN} + (-7.3 \text{ kN}) = 94.85 \text{ kN}$$

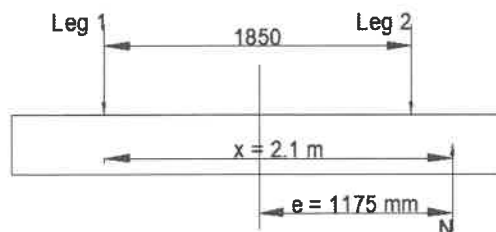
Taking moments about Leg 1 to find distance x where the centroid of the bearing pressure and base coincide;



$$N \cdot x = (62.99 \text{ kN} \times 1.85) + (\text{Selfweight} \times x)$$

$$94.85x = 116.53 + 39.16x$$

$$x = 2.1 \text{ m}$$



$$e = 1.175 \text{ m}$$

$$D = 2.95 \text{ m}$$

$$D/6 = 0.492 \text{ m} < e$$

$$\therefore p_{\text{max}} = 2 \cdot N / 3 \cdot B (D/2 - e)$$

$$= (2 \times 94.85) / 3 \times (1.475) \times (2.95/2 - 1.175)$$

$$= \underline{\underline{143.35 \text{ kPa}}} > 75 \text{ kPa}$$

∴ Increase size of the base

Robert & Marshall,
Analysis and
design of concrete
structures. Eq.
12.3-9

Try base 3.5 m x 3.5 m x 0.35 m

For combined footing, half of the base; 3.5 m x 1.75 m x 0.35 m

Area = 3.5 m x 1.75 m = 6.125 m²

Self-weight (SW) = 6.125 m² x 0.35 m x 25 kN/m³
= 53.59 kN

Resultant force acting on the base, N = SW + Leg1 + Leg 2

N = 53.59 kN + 62.99 kN + (-7.3 kN) = 109.28 kN

Taking moments about Leg 1 to find distance x where the centroid of the bearing pressure and base coincide;

N.x = (62.99 kN x 1.85) + (Selfweight x x)

109.28x = 116.53 + 53.59x

x = 2.1 m

∴ e = 1.175

D = 3.5 m

D/6 = 0.58 m < e

∴ p_{max} = 2.N / 3.B (D/2 - e)

= (2x110.815) / 3 x (1.75) x (3.5/2 - 1.175)

= **73.42 kPa** < 75 kPa

∴ **3.5 m x 1.75 m base is fine. As well as for overturning and sliding due to the increase load of the base.**

Design loads at ULS:

N_{u1} = 62.99 kN x 1.5 = 94.49 kN

N_{u2} = -7.3 kN x 1.5 = -10.95 kN

Factored resultant force, N_u = 94.49 kN + (-10.95 kN) = 83.54 kN

Centroid of the resultant force, x_u

N_u.x_u = N_{u1} x 1.85 m

83.54 kN x x_u = 94.49 kN x 1.85 m

x_u = 2.1 m

x_u = x at ULS

Check for punching shear at base plate edge:

H = 350 mm

d = 350 - cover - rebar diameter

= 350 - 50 - 16

Robert & Marshall,
Analysis and
design of concrete
structures. Eq.
12.3-9

SANS 10100-1.
4.4.5.2

$$= 284 \text{ mm}$$

$$\text{Base plate} = 335 \text{ mm} \times 335 \text{ mm}$$

$$u_1 = u_2 = 4 \times 335 \text{ mm} = 1340 \text{ mm}$$

$$v_{\max,2} = N_{u2} / u_2 \times d$$

$$= 94.49 \text{ kN} / 1.34 \text{ m} \times 0.284 \text{ m}$$

$$= 0.25 \text{ MPa}$$

$$0.75 \text{ MPa} \cdot (f_{cu} / \text{MPa})^{0.5}$$

$$= 0.75 \cdot (30)^{0.5}$$

$$= 4.1 \text{ MPa} > v_{\max,2} \therefore \text{OK. No shear reinforcement required}$$

Moment and shear forces:

In the long direction; $B = 1.75 \text{ m}$

Bearing pressure at ULS;

$$\therefore p_{u,\max} = 2 \cdot N_u / 3 \cdot B (D/2 - e)$$

$$= (2 \times 83.54 \text{ kN}) / 3 \times (1.75) \times (3.5/2 - 1.175)$$

$$= 55.35 \text{ kPa}$$

Length of the bearing pressure under the base

$$Y = 3 (D/2 - e)$$

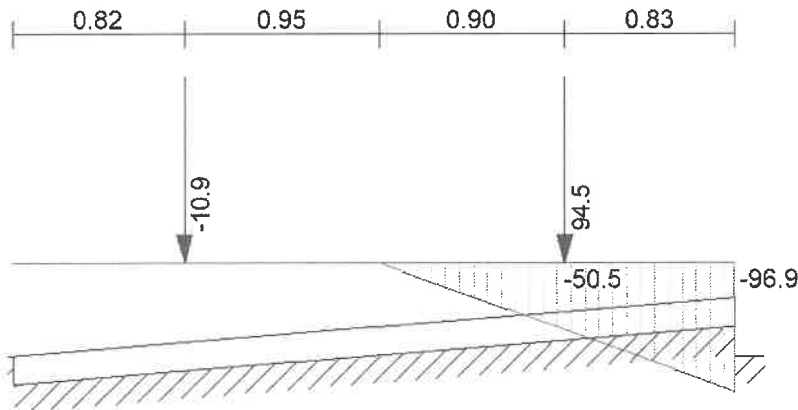
$$= 3 (3.5/2 - 1.175)$$

$$= 1.725 \text{ m}$$

$$w_u = p_{u,\max} \times B$$

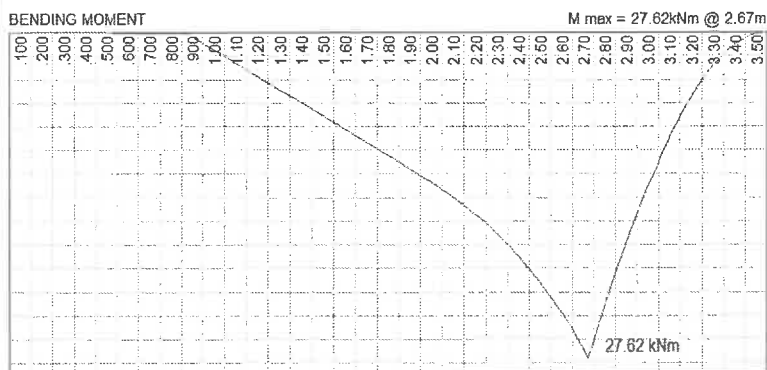
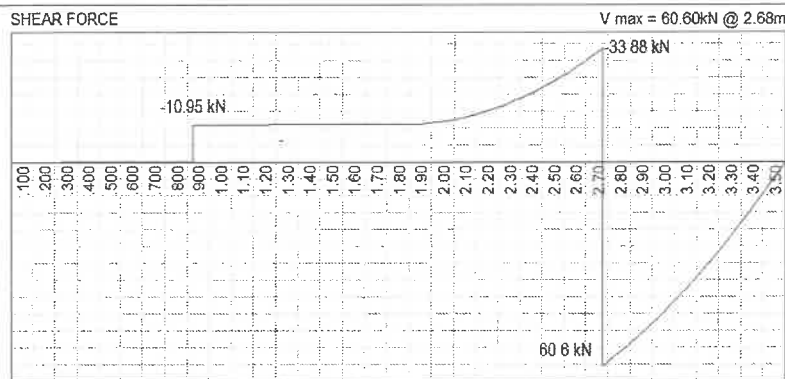
$$= 55.35 \text{ kPa} \times 1.75 \text{ m}$$

$$= 96.86 \text{ kN/m over } 1.725 \text{ m of the base.}$$



SANS 10100-1.
4.4.5.2.2

Robert & Marshall,
Analysis and
design of concrete
structures. Eq.
12.3-9



Check for compression reinforcement:

$$d = 350 - 50 - 16/2$$

$$= 292 \text{ mm}$$

$$K = M_{\max} / (B \cdot d^2 \cdot f_{cu})$$

$$= 27.62 \text{ kNm} / (1.75 \text{ m} \times 0.292^2 \text{ m} \times 30 \text{ MPa})$$

$$= 0.0058 < 0.156 \therefore \text{No compression steel required}$$

Area steel required:

$$z = 0.95d = 0.95 \times 292 = 277 \text{ mm}$$

$$A_{s, \text{req}} = M_{\max} / (0.87 \times f_y \times z)$$

$$= 27.62 \text{ kNm} / (0.87 \times 450 \text{ MPa} \times 0.277 \text{ m})$$

$$= 254.69 \text{ mm}^2$$

Minimum area steel required:

$$A_{s, \text{min}} = 0.13/100 \times (B \times h)$$

$$= 0.0013 \times (1750 \times 360)$$

$$= 819 \text{ mm}^2 > A_{s, \text{req}} \therefore \text{Use minimum steel.}$$

Detailing of reinforcement over column area when;

$$D/2 > 1.5 (c + 3d)$$

SANS 10100-1.

4.3.3.4.1

SANS 10100-1.

Table 23

SANS 10100-1.

4.10.3.2

$$D/2 = 1.75 \text{ m}$$

$$1.5 (c + 3d) = 1.5 (335 + 3 \times 302) = 1861.5 \text{ mm} > D/2$$

∴ Distribute reinforcement evenly over base

$$A_{s,\min} \text{ over } 1.75 \text{ m width} = 819 \text{ mm}^2 / 1.75 \text{ m} = 468 \text{ mm}^2/\text{m}$$

Steel required is Y12 @ 200 c/c (565 mm²/m)

Check for shear;

$$\text{Max shear, } V = 60.6 \text{ kN}$$

Shear at distance d from perimeter of base plate @ 3.15 m

$$V = 30.36 \text{ kN}$$

$$v = V / B.d$$

$$= 30.36 \text{ kN} / (1.75 \text{ m} \times 0.306 \text{ m})$$

$$= 0.057 \text{ MPa}$$

$$100. A_{s,\text{prov}} / (B.d)$$

$$= (100 \times 988.75) / (1750 \times 306)$$

$$= 0.185$$

From

$$d = 292 \text{ mm, } v_c = 0.3447 \text{ MPa} > v$$

∴ No shear reinforcement required

Check for punching shear:

$$\text{Perimeter of punching shear, } u = 4 \times (2 \times 1.5d + c)$$

$$= 4 \times (2 \times 1.5 \times 306 + 335)$$

$$= 4 \times 1253 \text{ mm}$$

$$= 5012 \text{ mm}$$

Calculating shear at perimeter of shear block failure;

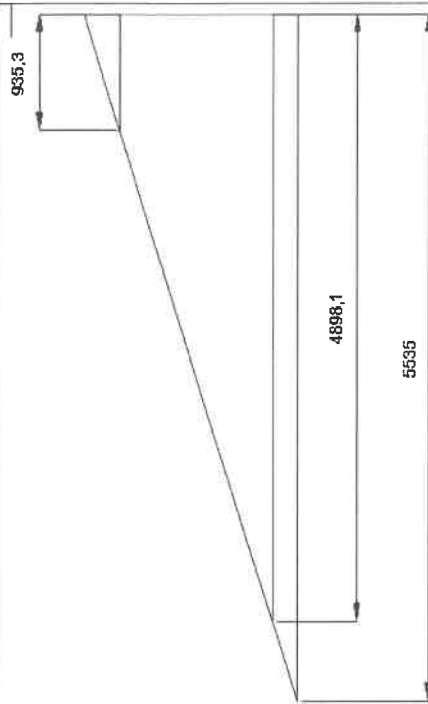
Volume of bearing pressure under the base – Volume of shear block.

$$V_1 = \text{Volume of bearing pressure}$$

$$= 0.5 \times Y \times p_{u,\max} \times B$$

$$= 0.5 \times 1.725 \text{ m} \times 55.35 \text{ kPa} \times 1.75 \text{ m}$$

$$= 83.54 \text{ kN}$$



$$h_1 = 48.98 \text{ kPa}$$

$$h_2 = 9.35 \text{ kPa}$$

$$b = 1.253 \text{ m}$$

$$d = 1.253 \text{ m}$$

V_2 = Volume of shear block

$$= (h_2 \times b \times d) + (0.5(h_1 - h_2) \times b \times d)$$

$$= (9.35 \text{ kPa} \times 1.253^2 \text{ m}) + (0.5(48.98 \text{ kPa} - 9.35 \text{ kPa}) \times 1.253^2 \text{ m})$$

$$= 14.68 \text{ kN} + 31.11 \text{ kN}$$

$$= 45.79 \text{ kN}$$

$$V = V_1 - V_2$$

$$= 83.54 \text{ kN} - 45.79 \text{ kN}$$

$$= 37.75 \text{ kN}$$

$$v = V / u \times d$$

$$= 37.75 \text{ kN} / (5.012 \text{ m} \times 0.292 \text{ m})$$

$$= 0.0258 \text{ MPa} < v_c$$

$\therefore$ No punching shear reinforcement required

Scenario 2:

Unfactored Leg 2 nominal load, $N_1 = 94.48 \text{ kN} / 1.5 = 62.99 \text{ kN}$

Unfactored Leg 3 nominal load, $N_2 = 94.48 \text{ kN} / 1.5 = 62.99 \text{ kN}$

Unfactored shear force, $V_1 = 6.77 \text{ kN} / 1.1 = 6.15 \text{ kN}$

Unfactored shear force, $V_2 = 6.77 \text{ kN} / 1.1 = 6.15 \text{ kN}$

Assume base thickness of 350 mm.

Permissible soil pressure of 75 kPa

Area of base in consideration: $3.5 \text{ m} \times 1.75 \text{ m} = 6.125 \text{ m}^2$

Stability checks:

i) Check for overturning

$$\begin{aligned}\text{Self-weight of concrete base} &= \text{Area} \times \text{thickness} \times \text{concrete density} \\ &= 6.125 \text{ m}^2 \times 0.35 \text{ m} \times 25 \text{ kN/m}^3 \\ &= 53.55 \text{ kN}\end{aligned}$$

$$\begin{aligned}\text{Stabilising moment: Self-weight} \times \text{lever arm} &= 53.55 \text{ kN} \times 1.75 \text{ m} \\ \text{Leg 2} \times \text{lever arm} &= 62.99 \text{ kN} \times 2.675 \text{ m} \\ \text{Leg 3} \times \text{lever arm} &= 62.99 \text{ kN} \times 0.825 \text{ m} \\ \text{Total Moment} &= \underline{\underline{314.18 \text{ kN.m}}}\end{aligned}$$

Stability effects of destabilising moments;

The translational load effects produced by notional lateral loads, applied at each storey, equal to $(0.005 \times \text{factored gravity loads contributed by that storey})$, shall be added to the sway effects for all load combinations.

Factored gravity loads at the top of the support structure:

$$W = W_{\text{WATER}} + W_{\text{TANK}} + W_{\text{WALKWAY}} = 145.3 \text{ kN} + 8.3 \text{ kN} + 1.86 \text{ kN} = 155.46 \text{ kN}$$

$$W_f = 1.5 \times 155.46 \times 0.005 = 1.166 \text{ kN}$$

$$\begin{aligned}\text{Destabilising moment: } W_f \times 15 \text{ m (height of support)} &= 1.166 \text{ kN} \times 15 \text{ m} \\ &= \underline{\underline{17.49 \text{ kN.m}}}\end{aligned}$$

$$\begin{aligned}\text{F.O.S}_{\text{OVERTURNING}} &= 314.18 \text{ kN.m} / 17.49 \text{ kN.m} \\ &= \underline{\underline{17.96 > 1.5 \therefore \text{OK}}}\end{aligned}$$

ii) Check for sliding

Soil friction coefficient = 0.4

$$\begin{aligned}\text{Weight on the base} + \text{base} &= 62.99 \text{ kN} + 62.99 \text{ kN} + 53.55 \text{ kN} \\ &= 179.53 \text{ kN}\end{aligned}$$

$$\text{Weight against sliding} = 179.53 \text{ kN} \times 0.4 = \underline{\underline{71.81 \text{ kN}}}$$

Horizontal loads = 6.15 kN + 6.15 kN = **12.3 kN**

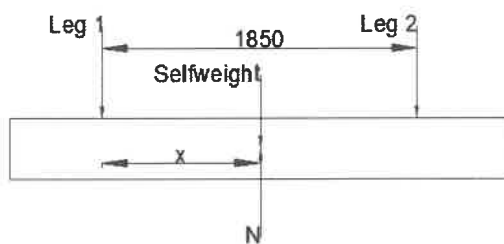
$$\text{F.O.S}_{\text{SLIDING}} = 71.81 \text{ kN} / 12.3 \text{ kN} \\ = \mathbf{5.84 > 1.5 \therefore \text{OK}}$$

iii) Soil bearing pressure

Resultant force acting on the base, N = self-weight + Leg1 + Leg 2

$$N = 53.55 \text{ kN} + 62.99 \text{ kN} + 62.99 \text{ kN} = 179.53 \text{ kN}$$

Taking moments about Leg 1 to find distance x where the centroid of the bearing pressure and base coincide;



$$N \cdot x = (62.99 \text{ kN} \times 1.85) + (\text{Selfweight} \times x)$$

$$179.53x = 116.53 + 53.55x$$

$$x = 0.925 \text{ m}$$

x is in the centre of the base $\therefore$ soil pressure is uniformly distributed

$$\therefore p_{\text{max}} = N / A \\ = 179.53 \text{ kN} / 6.125 \text{ m}^2 \\ = \mathbf{29.31 \text{ kPa} < 75 \text{ kPa}}$$

$\therefore$ **3.5 m x 1.75 m base is fine.**

Design loads at ULS:

$$N_{u1} = N_{u2} = 62.99 \text{ kN} \times 1.5 = 94.49 \text{ kN}$$

$$\text{Factored resultant force, } N_u = 94.49 \text{ kN} + 94.49 \text{ kN} = 188.98 \text{ kN}$$

Centroid of the resultant force, x_u

$$N_u \cdot x_u = N_{u1} \times 1.85 \text{ m}$$

$$188.98 \text{ kN} \times x_u = 94.49 \text{ kN} \times 1.85 \text{ m}$$

$$x_u = 0.925 \text{ m}$$

$x_u = x$ at ULS and soil pressure is uniformly distributed

Check for punching shear at base plate edge:

$$H = 350 \text{ mm}$$

$$d = 350 - \text{cover} - \text{rebar diameter}$$

$$= 350 - 50 - 16$$

$$= 284 \text{ mm}$$

Base plate = 335 mm x 335 mm

$$u_1 = u_2 = 4 \times 335 \text{ mm} = 1340 \text{ mm}$$

$$v_{\max,1} = N_{u1} / u_1 \times d$$

$$= 94.49 \text{ kN} / 1.34 \text{ m} \times 0.284 \text{ m}$$

$$= 0.25 \text{ MPa}$$

$$0.75 \text{ MPa} \cdot (f_{cu} / \text{MPa})^{0.5}$$

$$= 0.75 \cdot (30)^{0.5}$$

$$= 4.1 \text{ MPa} > v_{\max,2} \therefore \text{OK. No shear reinforcement}$$

Moment and shear forces:

In the long direction; $B = 1.75 \text{ m}$

Bearing pressure at ULS;

$$\therefore p_{u,\max} = N_u / A$$

$$= 188.98 \text{ kN} / 6.125 \text{ m}^2$$

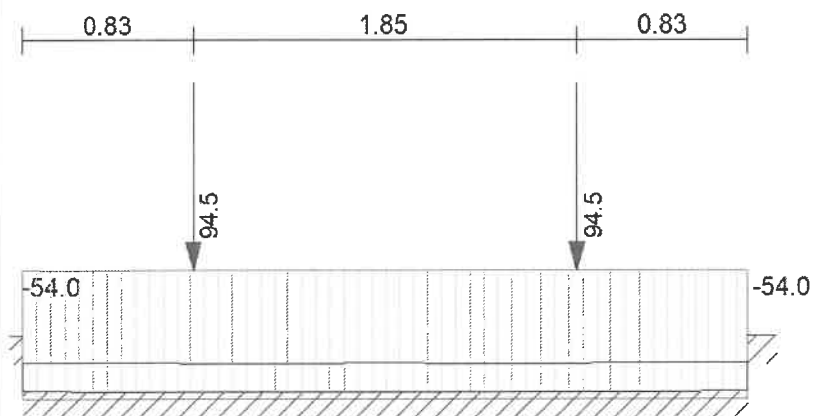
$$= \mathbf{30.85 \text{ kPa}}$$

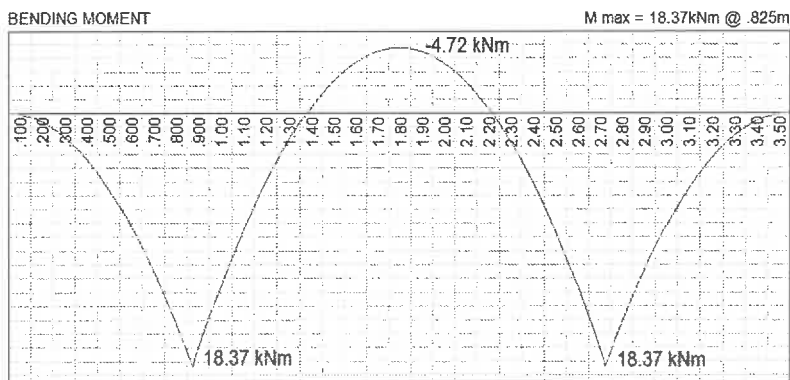
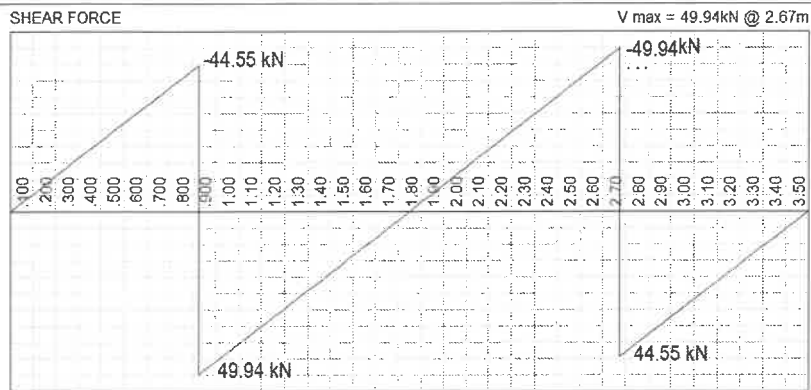
Uniformly distributed

$$w_u = p_{u,\max} \times B$$

$$= 30.85 \text{ kPa} \times 1.75 \text{ m}$$

$$= 53.99 \text{ kN/m}$$





Scenario 2 Moments and Shear forces are less than those of Scenario 1;

Therefore it is concluded that all the checks from Scenario 1 will apply to Scenario 2 and the steel required is;

$$A_{s,min} \text{ over } 1.75 \text{ m width} = 819 \text{ mm}^2 / 1.75 \text{ m} = 468 \text{ mm}^2/\text{m}$$

Steel required is Y12 @ 200 c/c (565 mm²/m) for both top and bottom.

Finally apply the required area steel to the base 3.5 m x 3.5 m.



public works
& infrastructure

Department:
Public Works and Infrastructure
REPUBLIC OF SOUTH AFRICA

NATIONAL DEPARTMENT OF PUBLIC WORKS AND INFRASTRUCTURE

ELECTRICAL ENGINEERING SERVICES

SPECIFICATION FOR THE SUPPLY, INSTALLATION AND COMMISSIONING OF AN OUTDOOR EMERGENCY GENERATOR SET

PHUTHADITJHABA LABOUR CENTRE

Date: JULY 2021

Engineering Services Chief Directorate
Electrical Engineering Directorate
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SECTION 1 – GENERAL

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1. SECTION 1 – GENERAL

1.1. Intent of Specification

The specification is intended to cover the complete installation and commissioning of the generator plant. The minimum equipment requirements are outlined, but do not cover all the details of design and construction. Such details are recognised as being the exclusive responsibility of the contractor.

For the purposes of this document the following applies:

- Generator Contractor shall be referred to as the Generator Contractor or simply Contractor;
- The masculine includes the feminine;
- The singular includes the plural.

1.2. Standards and Codes

All standards referenced shall be the latest editions.

SANS 10142-1	the wiring of premises: Low Voltage Installations
SANS 8528	Reciprocating internal combustion engine driven alternating current generating sets.
SANS 60034	Rotating electrical Machines
SANS IEC 60947	Low Voltage Switchgear
OHSACT	Occupational Health and Safety Act.
Department of Public Works	Quality Specification Parts A, B and C.
Local municipality by-laws	for generator installations. (To be obtained from local municipality)

1.3. Compliance with Regulations

The installation shall be erected and tested in accordance with the following Acts and regulations:

- a) The Occupational Health and Safety Act, 1993 (Act 85 of 1993) as amended,
- b) The Local Government Ordinance 1939 (Ordinance 17 of 1939) as amended and the municipal by-laws and any special requirements of the local supply authority,
- c) The Fire Brigade services Act 1987 (Act 99 of 1987) as amended,
- d) The National Building Regulations and Building Standards Act 1977 (Act 103 of 1977) as amended,
- e) The Electricity Act 1984 (Act 41 of 1984) as amended.
- f) The environmental Act and regulations

1.4. Scope of Work

Included in this Outdoor Generator Specification

Supply, delivery, installation and commissioning of the complete outdoor emergency generator inside an IP65 canopy/container set on a concrete plinth as specified in this document.

The successful tenderer shall supply, deliver and install a complete single enclosed diesel driven standby generator set in a position that will be determined on site. The machine shall be totally enclosed in a 3CR12 stainless steel housing powder coated or within 50km from the coast with grade 316 steel housing powder coated. The exhaust shall be manufactured from stainless steel.

The housing is to be provided on galvanized 3CR12 stainless steel skids so that the generator set can be transported to site and placed in position on a concrete plinth, casted by the successful tenderer. The skids must be of sufficient height to allow for the passage of storm water under the set.

1.5. Co-ordinating

The Contractor shall familiarise himself with the requirements of the other professional disciplines and shall examine the plans and specifications covering each of these sections.

The generator space, noise and vibration requirements shall be carefully checked with other professional disciplines to ensure that the equipment can be installed in the proper sequence in the space allotted.

1.6. Tests Certificates and Inspections

The following tests are to be carried out:

- a) At the supplier's premises, before the generating set will be delivered to site Representatives of the Department must be present during the test to satisfy themselves that the generating set complies with the specification and delivers the specified output. The test must be carried out in accordance with SANS 8528. The Representative/Agent must be timeously advised of the date for the test.
- b) After completion of the works and before practical completion is taken, a full test will be carried out on the installation for a period of sufficient duration to determine the satisfactory working thereof. During this period the installation will be inspected and the contractor shall make good, to the satisfaction of the Representative/Agent, any defects which may arise.
- c) The Contractor shall provide all instruments and equipment required for testing and any water, power and fuel required for the commissioning and testing of the installation at completion.
- d) Test reports of both tests as specified under (a) and (b) are to be submitted to the Representative/Agent.

The total costs for these test shall be included in the tendered amount.

In the event of the plant, equipment or installation not passing the test, the Representative/Agent shall be at liberty to deduct from the Contract amount all reasonable expenses incurred by the Employer and/or the Representative/Agent attending the test.

1.7. Operating and Maintenance Manuals

The Contractor shall be responsible for the compilation of a complete set of Operating and Maintenance manuals.

This shall be done in accordance with Section 4 – Operating and Maintenance manuals.

All information shall be recorded and reproduced in electronic format as well as supplying the Representative/Agent with three sets of hard copies.

Approval of the final Operating and Maintenance Manuals shall be a prerequisite for issuing of a Certificate of Practical Completion of the installation.

1.8. Guarantee

After works completion of the installation have been achieved, there will follow a 12-month free maintenance period.

During this period the generator contractor shall maintain the generator installation as per the requirements of the Occupational Health and Safety Act. This maintenance shall include systematic examinations, adjustments and lubrication of all generator equipment. Electrical and mechanical parts shall be repaired or replaced whenever it is required to maintain optimum performance without additional cost to the Department, unless the condition was caused by misuse or vandalism of the generator equipment or natural hazards/force majeure.

The work under this section shall be performed by competent, qualified accredited personnel under the supervision and in the direct employment of the Generator Contractor and shall not be transferred to any non-affiliated agent. Contract maintenance and repair work shall be done during normal working hours and shall further provide emergency call-back service twenty-four (24) hours a day, seven (7) days a week.

During the guarantee/maintenance period the Department will invite tenders for the comprehensive maintenance of the generator, which will commence after the final completion has taken place, i.e. after the twelfth month guarantee period is over and all defects are corrected.

1.9. Materials and Workmanship

- a) The work throughout shall be executed to the highest standards and to the entire satisfaction of the Representative/Agent who shall interpret the meaning of the Contract Document and shall have the authority to reject any work and materials, which, in his judgement, are not in full accordance therewith. All condemned material and workmanship shall be replaced or rectified as directed and approved by the Representative/Agent.
- b) All work shall be executed in a first-class manner by qualified accredited tradesman.
- c) The Contractor shall be fully responsible for his work and shall replace any of the work which may be damaged, lost or stolen. The Contractor shall protect the building and its contents against damage by him, his employees or sub-contractors and shall make good any damage thereto.
- d) The Contractor shall indemnify the Employer of all liability for damages arising from injuries or disabilities to persons or damage to property occasioned by any act or omission of the Contractor or any of his sub-contractors, including any and all expenses, legal or otherwise, which may be incurred by the Employer or Representative/Agent in the defence of any claim, action or suit.
- e) The Contractor shall warrant that the materials and workmanship shall be of the highest grade, that the equipment shall be installed in a practical and first-class manner in accordance with the best practices and ready and complete for full operation. It is specifically intended that all material or labour which is usually provided as part of such equipment as is called for and which is necessary for its proper completion and operation shall be provided without additional cost whether or not shown or described in the Contract Document.
- f) The Contractor shall thoroughly acquaint himself with the work involved and shall verify on site all measurements necessary for proper installation and commissioning work. The Contractor shall also be prepared to promptly furnish any information relating to his own work as may be necessary for the proper installation work and shall co-operate with and co-ordinate the work of others as may be applicable.
- g) The Contractor shall inspect and verify that the existing power feeder system is compatible with the equipment offered and any changes or upgrading of the electrical supply shall be brought to the attention of the Representative/Agent.
- h) Material and equipment damaged in transit shall be replaced with undamaged material without additional cost to the Department.
- i) All components and their respective adjustment, which do not form part of the equipment installation work, but influence the optimum and safe operation of the equipment shall be considered to form part of, and shall be included in the Contractor's scope of works.
- j) All control equipment and serviceable items shall be installed and positioned such that they will be accessible and maintainable.
- k) The Contractor shall make sure that all safety regulations and measures and environmental regulations are applied and enforced during the installation and guarantee period to ensure the safety of the public and the User Client.

1.10. Brochures

Detailed brochures of all equipment offered shall be presented together with the tender documents.

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2. SECTION 2 – EQUIPMENT REQUIREMENTS

2.1. Engine

2.1.1. General

The engine must comply with the requirements laid down in SANS 8528 and must be of the atomized injection, compression ignition type, running at a speed not exceeding 1500 r.p.m. The engine must be amply rated for the required electrical output of the set, when running under the site conditions. The starting period for either manual or automatic switching-on until the taking over by the generating set, in one step, of a load equal to the specified site electrical output, shall not exceed 15 seconds. This must be guaranteed by the Tenderer.

Turbo-charged engines will only be accepted if the Tenderer submits a written guarantee that the engine can deliver full load within the specified starting period.

Curves furnished by the engine makers, showing the output of the engine offered against the speed, for both intermittent and continuous operation as well as fuel consumption curves when the engine is used for electric generation, must be submitted with the Tender.

2.1.2. Rating

The set shall be capable of delivering the specified output continuously under the site Conditions, without overheating. The engine shall be capable of delivering an output of 110% of the specified output for one hour in any period of 12 hours consecutive running in accordance with SANS 8528.

2.1.3. De-Rating

The engine must be de-rated for the site conditions as set out in the Technical Specification, Section 3 of this document.

The de-rating of the engine for site conditions shall be strictly in accordance with SANS 8528 as amended to date. Any other methods of de-rating must have the approval of the Department and must be motivated in detail. Such de-rating must be guaranteed in writing and proved by the successful Tenderer at the site test.

2.1.4. Starting and Stopping

The engine shall be fitted with an electric starter motor and be easily started from cold, without the use of any special ignition devices under summer as well as winter conditions.

Tenderers must state what arrangements are provided to ensure easy starting in cold weather. Full details of this equipment must be submitted. In the case of water cooled engines, any electrical heaters shall be thermostatically controlled. The electrical circuit for such heaters shall be taken from the control panel, and must be protected by a suitable circuit breaker.

2.1.5. Starter Battery

The set must be supplied a fully charged lead-acid type or maintenance free type battery, complete with necessary electrolyte. The battery must have sufficient capacity to provide the starting torque stipulated by the engine manufacturer. The battery capacity shall not be less than 120 Ah and shall be capable of providing three consecutive start attempts from cold and thereafter a fourth attempt under manual control of not less than 20 seconds duration each. The battery must be of the heavy duty "low maintenance" type, housed in a suitable battery box.

2.1.6. Cooling

The engine may be either of the air or water cooled type. In the case of water-cooling, a built-on heavy duty, tropical type pressurised radiator must be fitted. Only stand-by sets that are water cooled shall have electric heaters.

For either method of cooling, protection must be provided against running at excessive temperatures. The operation of this protective device must give a visual and audible indication on the switchboard. Water-cooled engines shall in addition be fitted with a low water cut-out switch, installed in the radiator, to switch the set off in the event of a loss of coolant. The protection shall operate in the same way as the other cut-outs (e.g. low oil pressure). All air ducts for the cooling of the engine are to be allowed for. The air shall be supplied from the cooling fan cowling/radiator face to air outlet louvers in the enclosure.

2.1.7. Lubrication

Lubrication of the main bearings and other important moving parts shall be by forced feed system. An automatic low oil pressure cut-out must be fitted, operating the stop solenoid on the engine and giving a visible and audible indication on the switchboard.

2.1.8. Fuel Pump

The fuel injection equipment is suitable for operation with the commercial brands of diesel fuel normally available in South Africa.

2.1.9. Fuel Tank

The fuel tank shall be an integral part of the base frame of the generator set. The tank shall have sufficient capacity for standby sets to run the engine on full load for a period of 24 hours.

The diesel fuel storage system / tank which will be provided with the standby generator installation must be fitted with a fuel filtration and water separation system (filter & separator) which is entirely separate from the fuel supply line and line filter to the engine. This filtration and water separation system must be dedicated to purifying the content of the storage system / tank by way of the cleaning processes which are applied while circulating the fuel through the filter & separator unit.

The filtration system must be able to handle diesel fuel of "high" and of "low" sulphur content for an indefinite period. The suction line of the system must be connected to the lowest part of the storage system / tank. The return line must be connected in the top section of the storage system / tank in such a position and in such a way that the flow of fuel within the storage system / tank between the fuel return point and the fuel suction point will induce scouring of the bottom of the system / tank to effectively capture sediment and water in the to be filtered fuel.

The filtration unit must filter the diesel fuel, removing suspended particles of effective diameters down to 5 micron. In addition, it must separate all water from the fuel and the fuel storage system and automatically dispose of / dump such water into an open, removable receptacle for disposal at the installation or in a suitable position outside the building. Separation of the fuel and water must be sufficiently effective that the discharged water will meet the standard required for it to be disposed of into a municipal drain and sewer system.

The filter and water separator unit must draw its power from the DC batteries used to power the relevant generator set. The circulating pump shall be provided with a controller programmed to switch the pump through not more than three complete on and off cycles of equal time (i.e. 50% on; 50% off) , per hour, with a deviation of not more than 10 % $\pm$. The pump must be capable of a duty cycle of not less than 60% running time. The flow rate through the circulating pump must be between 1 L/min and 1.25 L /min.

The filter cartridge of the filter and water separator unit must be replaceable, and, in normal operational conditions, not require replacement within periods shorter than three months. The replacement units must be readily available.

The filtration & separator system may be mounted against the wall of the plant room or on the inside of a container, which may house the installation as may be specified elsewhere in this document.

The tank shall be fitted with a suitable filter, a full height gauge glass, "low fuel level" alarm, giving an audible and visible signal on the switchboard as well as a low-low fuel level cut-out.

An electrically operated pump with sufficient length of oil resistant hose to reach 2m beyond the door of the canopy/container, shall be supplied, for each set for filling the fuel tank/s from 200 litre drums.

The interconnection fuel piping shall consist of copper tubes and the connection to vibrating components shall be in flexible tubing with armoured covering.

The contractor shall allow for the supply and installation of a fuel shut off fusible link in the container. The fusible link shall shut off the fuel at a temperature of 130 degrees in an event of a fire in the self-contain enclosure. The fusible link shall be mounted above the engine and coupled to the shut off valve by means of a 2mm stainless steel cable. The cable shall be installed to the shut off valve without any possibility of kinking the cable which may cause malfunctioning of the protection device.

2.1.10. Governor

The speed of the engine shall be controlled by a governor in accordance with ECM of SANS 8528 if not otherwise specified in the Detailed Specification.

The permanent speed variation between no load and full load shall not exceed 4.5% of the nominal engine speed and the temporary speed variation shall not exceed 10%. External facilities must be provided on the engine, to adjust the nominal speed setting by $\pm 5\%$ at all loads between zero and rated load.

2.1.11. Flywheel

A suitable flywheel must be fitted, so that lights fed from the set will be free from any visible flicker.

The cyclic irregularity of the set must be within the limit laid down in SANS 8528.

2.1.12. Exhaust Silencer

It is essential to keep the noise level as low as possible. An effective exhaust silencing system of the residential type must be provided and shall be capable of providing 20 to 30 decibels of suppression.

The exhaust system shall consist of 3CR12 steel for inland areas (greater than 50km from the coast) or Grade 304 stainless steel in coastal areas.

The exhaust pipe shall be installed in such a way that the expelled exhaust fumes will not cause discomfort to the public. The exhaust pipe must be flexibly connected to the engine to take up vibrations transmitted from the engine, which may cause breakage. The exhaust piping and silencer shall be lagged and then cladded in stainless steel sheet to reduce the heat and noise transmission in the generator enclosure and shall be protected against the ingress of driving rain at 45° to the horizontal. The exhaust pipe must extend 0,5m above the canopy.

2.1.13. Accessories

The engine must be supplied complete with all accessories, air and oil filters, 3 instruction manuals, spare parts lists, the first fill of all lubricating oils, fuel, etc.

2.1.14. Exhaust emissions

The exhaust emissions shall comply with US Tier III/EU stage III standards.

2.2. Alternator

2.2.1. General

The alternator shall be of the self-excited brushless type, with enclosed ventilated drip-proof housing and must be capable of supplying the specified output continuously with a temperature rise not exceeding the limits laid down in SANS 60034-1 for rotor and stator windings.

The alternator shall be capable of delivering an output of 110% of the specified output, for one hour in any period of 12 hours consecutive running.

Both windings must be fully impregnated for tropical climate and must have an oil resisting finishing varnish.

2.2.2. Regulation

The alternator must preferably be self-regulated without the utilisation of solid state elements. The inherent voltage regulation must not exceed plus or minus 5% of the nominal voltage specified, at all loads with the power factor between unity and 0,9 lagging and within the driving speed variations of 4,5% between no-load and full load.

2.2.3. Performance

The excitation system shall be designed to promote rapid voltage recovery following the sudden application of the load. The voltage shall recover to within 5% of the steady state within 300 milliseconds following the application of full load and the transient voltage dip shall not exceed 18%.

2.2.4. Coupling

The engine and alternator must be directly coupled by means of a high quality flexible coupling, ISO 9001:2000 approved and must be designed and manufactured to this quality system.

2.3. Switchboard

2.3.1. General

A switchboard must be supplied and installed to incorporate the equipment for the control and protection of the generating set and battery charging.

The switchboard must conform the specification as set out in the following paragraphs.

2.3.2. Construction

The switchboard shall be enclosed in the steel enclosure.

All equipment, connections and terminals shall be easily accessible from the front. The front panels may be either hinged or removable and fixed with studs and chromium-plated cap nuts. Self-tapping screws shall not be used in the construction of the board.

All pushbuttons, pilot lights, control switches, instrument and control fuses, shall be mounted on hinged panels with the control wires in flexible looms.

The steelwork of the boards must be thoroughly de-rusted, primed with zinc chromate and finished with two coats of signal red quality enamel, or a baked powder epoxy coating.

Suitably rated terminals must be provided for all main circuits and the control and protection circuits. Where cable lugs are used, these shall be crimped onto the cable strands. Screw terminals shall be of the type to prevent spreading of cable strands. All terminals shall be clearly marked.

For the control wiring, each wire shall be fitted with a cable or wire marker of approved type, and numbering of these markers must be shown on the wiring diagram on the switchboard. Control wiring shall be run in PVC trunking. The trunking shall be properly fixed to the switchboard steelwork. Adhesives shall not be acceptable for the fixing of trunking or looms.

The modular generator set controller and protection equipment shall be mounted on a separate easily replaceable panel.

All equipment on the switchboard, such as contactors, isolators, busbars, etc., shall have ample current carrying capacity to handle at least 110% of the alternator full load current.

Access to the cubicle will be such that all components can be conveniently reached for testing and maintenance purposes.

The necessary bushes and a screen over the terminals will be provided where the power feeds enter and leave the cubicle.

The cubicle will be so constructed that the ac and dc components are screened from one another.

2.3.3. Protection and Alarm Devices

All switchboards shall be equipped with protection and alarm devices as described below.

A circuit breaker and an adjustable current limiting protection relay must be installed for protection of the alternator. The protection relay shall be of the type with inverse time characteristics. The relay shall cause contactor to isolate the alternator and stop the engine.

Protection must be provided for overload, high engine temperature, low lubricating oil pressure, over speed, start-failure, and low water level.

Reset push buttons are required on the modular generator set controller and a visible signal are required and the engine must stop when any of the protective devices operate. In the case of manual operation of standby sets, it shall not be possible to restart the engine.

The indication on the modular generator set controller must be in ENGLISH.

"OVERLOAD"
"TEMPERATURE HIGH"
"OIL PRESSURE LOW"
"OVERSPEED"
"START FAILURE"
"LOW WATER LEVEL"

In addition an audible and visible flashing signal shall be provided, when:

- a) The fuel level in the service tank is low. The indication on the modular generator set controller shall be "FUEL LOW".
- b) The battery charger failed. The indication on the modular generator set controller shall be "CHARGER FAIL"

A low-low level sensor must be provided. At this level the engine must stop to prevent air entering the fuel system.

This is also applicable to the engine driven generator/alternator.

All alarm conditions must operate an alarm hooter. A pushbutton must be installed in the hooter circuit to stop the audible signal, but the fault indicating light on the control panel must remain lit until the fault has been rectified.

An on/off switch is not acceptable. After the hooter has been stopped, it must be re-set automatically, ready for a further alarm.

The hooter must be of the continuous duty and low consumption type. Both hooter and protection circuits must operate from the battery.

Potential free contacts from the alarm relay must be brought down to terminals for remote indication of alarm conditions.

A test pushbutton must be provided to test all indicators lamps.

2.3.4. Modular Generator Set controller

The modular generator set controller shall be an electronic unit to match those of the other modular generator set controllers and of a high quality i.e. Levato, Deep Sea Electronics, Circom. It must be provided with IO and communication facilities.

The modular generator set controller will be supplied with all its functions and shall be mounted on a separate easily replaceable panel with plug in termination blocks for easy installation and replacement.

The modular generator set controller interface will be implemented with relays, contactors etc.

The modular generator set controller will have a mimic display of the alternator/mains/ change over contactors configuration with LED's showing the status of the mains, alternator and change over contactors.

Configuration software shall be supplied with the system. The software will be capable of the following:

- Fault management (event log)
- Configuration management (software upgrades and function changes)
- Account management (energy management)
- Performance management (generator set point changes)
- Security management (passwords)

The modular generator set controller will have a standard RS 232/485 or Ethernet interface suitable for TCP I/P transport medium. All communication including configuration management will be done through this port. Equipment connected at each end of the RS 232 or Ethernet cable shall be adequately protected against transient over-voltages, lightning effects (particularly if the set and remote alarms are in separate buildings), switching surges, power system surges or mains and alternator borne noise/interference.

The controller will incorporate the following functions:

- Mains sensing
- Alternator output-voltage sensing
- Alternator over- frequency sensing
- Control of processor unit (self-diagnostics)
- Alarm/ Status indications
- Control selector and operation
- Phase rotation monitor

A 4- position control selector on the controller will be provided to facilitate the following modes of operation:

- OFF: Diesel/ alternator generator set switched off
- MANUAL: Mains bypassed: Diesel/ alternator will not take load

- AUTO: Diesel /alternator takes load on mains failure
- TEST: Diesel /alternator takes load on mains failure
- A standby failure alarm (SF) will be given on the controller and to the output alarms when "Not in Auto" is selected.

The modular generator set controller must monitor the following

When the voltage of the incoming mains varies by more than a pre-program value (default $\pm 10\%$) from the normal voltage on any phase, the controller will signal that the incoming mains will be disconnected and the engine-starting sequence initiated.

When the frequency of the incoming mains varies by more than pre- program value (default $\pm 5\%$) from the normal frequency, the controller will signal that the incoming mains will be disconnected and the engine-starting sequence initiated.

Upon restoration of the incoming mains to the pre-program value (default $\pm 10\%$) of the normal voltage on all phases, the monitor will signal that the load will be disconnected from the alternator and reconnected to the incoming mains.

If the alternator has been disconnected from the load and the incoming mains within the voltage limits of $\pm 10\%$ on all phases, the controller will signal that the load will be reconnected to the incoming mains.

Should the incoming mains fail or not in the specified limits while the engine is running under control of the cooling-off timer, the control for the cooling –off timer in the controller will be cancelled and the load connected to the alternator.

When the output voltage of the alternator varies by more than the pre-program value (default value $\pm 10\%$) on ANY phase, the controller will signal that the load will be disconnected from the alternator and the engine stopped.

A software over and under-frequency monitor will be provided in the controller if the frequency exceeds or drop below pre-programmed values. It will meet the requirements of class G2 governing. The monitor will not be influenced by harmonics.

Note: Software monitors will include adjustable overshoot and undershoot timers to be fully compatible with Class G2 governing.

All timers will be implemented in software.

Incoming supply failure timer

It is essential that incoming supply failures, occurring at short intervals, do not cause a series of starts and stops.

A timer adjustable from 1 s to 10 s required

The timer default value will be generator set to 3 s

The signal generated by the mains voltage monitor will start the timer. If the duration of the signal is less than the generator setting on the timer, the signal is suppressed so that the switching and starting sequence is initiated. However, if the duration of the signal is more than the generator setting on the timer, the signal will be transmitted to initiate the switching and starting sequence.

Incoming supply restoration timer

It is essential that incoming supply failures, occurring at short intervals, do not cause a series of starts and stops.

A timer adjustable from 1 s to 10 s required.

The timer default value will be generator set to 3 s.

The signal generated by the mains voltage monitor will start the timer. If the duration of the signal is less than 150 sec, the signal is suppressed and the timer is regenerator set. However, if the duration of the signal is more than 150 sec, the signal will be transmitted to initiate the switching sequence.

Alternator supply/ incoming supply change-over timer

It is essential that the supply be disconnected from the load before the incoming supply is reconnected to the load. This will be software generator settable in the controller with a minimum of 5 seconds and maximum of 20 seconds.

On receipt of the switching signal, the alternator supply will be disconnected from the load and timer started. After 5 sec, the incoming supply will be reconnected to the load.

Engine cooling-off timer

After the load has been transferred to the incoming supply the engine will run without load for a period to cool off and then stop.

A timer, software adjustable in the controller from 5 to 10 min is required.

Repeat- start control

A repeat- start control is required in the controller software adjustable so that in the event of the engine failing to start on the first start attempt, the starter motor will be released and repeat the start attempt.

The repeat-start attempt will be repeated 3 times.

The duration of each start attempt will be 6 sec with a period of 15 sec between successive start attempts.

Should the engine fail to start after the third start attempt, the controller will transmit a signal for alarm purposes.

In addition to the requirement for the switchboard instruments listed elsewhere in this document metering will also form part of the modular generator set controller and must be accessible on the software.

The modular generator set controller shall display the following alarm/status indications:

- High engine temperature.
- Low Oil pressure
- High/low alternator output voltage
- Over and under speed (frequency)
- Low water level
- Emergency stop activated
- Mains fail
- Battery charger fail
- Dummy load in operation (When provided)
- Unit not in Auto
- Engine running
- Low fuel alarm
- Engine start failure

Conditions one to six above will stop the engine.

The Contractor shall provide a remote alarm mimic panel and the associated control wiring for the set. The panel shall be installed in the duty/security room at the entrance to the building approximately 70m from the generator set position.

The mimic panels must fit into furniture and blend with the design. Before manufacture, the Contractor shall submit and obtain the approval, from the Engineer, for the mimic panel.

The remote alarm must have potential free relay contacts which shall indicate the following on each set:

- 1) Mains on/off
- 2) Alternator running
- 3) Common fault alarm
- 4) Buzzer which can only be reset at the generator panel
- 5) Fuel low

The cable between the remote alarms is to be a signal cable with a screen and this option must be able to operate from a 12 / 24 V dc supply so that it can be powered from the generator set batteries.

A facility to originate a fault message should a warning or shutdown fault occur.

A facility to allow the mode of the control system to be changed to any of the four modes to allow the set to be run from a remote location.

A facility to originate a call to the control cellular and to transfer a fault message should a warning or shutdown fault occur. The alarm conditions above from the controller will be extended to four relays with a make and break contact and terminal strip to allow for remote monitoring of the following alarms:

- Mains fail
- Standby run
- Standby fail
- Low Fuel

A remote start facility must be supplied, software controllable in the controller.

All events relating to the status of the generator set shall be logged with date and time in a non-volatile memory (which can retain information for a period of 6 months in the absence of power to the controller) and the user shall be able to contain a hard copy on site.

The modular generator set controller system must be able to operate with a minimum DC supply voltage of 4 volts (without making use of either an internal or an external auxiliary battery) to allow cranking and starting under conditions of low battery capacity. Control cables between the set and the control panel shall be fitted with sockets for ease of undoing in the event the modular generator set controller has to be removed.

2.3.5. Manual Starting

Each switchboard shall be equipped with two pushbuttons marked "START" and "STOP" for manual starting and stopping of the set.

2.3.6. Battery Charging Equipment

Each switchboard shall be equipped with battery charging equipment.

The charger shall operate automatically in accordance with the state of the battery and shall generally consist of an air-cooled transformer, a full wave solid state rectifier, and the necessary automatic control equipment of the constant voltage system.

The charger must be fed from the mains. An engine driven alternator must be provided for charging the battery while the set is operational. Failure of this alternator must also activate the battery charger failure circuit.

The starter battery voltage will be software monitored by the modular generator set controller. The voltage will be digitally displayed.

2.3.7. Switchboard Instruments

Each generating set shall have a switchboard equipped as follows:

- a) One flush square dial voltmeter, reading the alternator voltage, scaled as follows:
 - (i) 0-300V for single phase generators.
 - (ii) 0-500V for three phase generator. In this case a six position and off selector switch must be installed for reading all phase and phase to neutral voltages.
- b) A flush square dial combination maximum demand and instantaneous ampere meter for each phase, with resettable pointer suitably scaled 20% higher than the alternator rating. A red arc stripe above scale markings from 0-20A and a red radial line through the scale at full-load current, shall be provided. This instruments shall be supplied complete with the necessary current transformer.
- c) One flush square dial vibrating type frequency meter, indicating the alternator frequency.
- d) A six digit running hour meter with digital counter, reading the number of hours the plant has been operating. The smallest figure on this meter must read 1/10 hour.
- e) Fuses or m.c.b.'s for the potential voltage circuits of the meters.
- f) One flush square dial ampere meter suitably scaled for the battery charging current.
- g) One flush square dial voltmeter with a spring loaded pushbutton or switch for the battery voltage.

2.3.8. Marking

All labels, markings or instructions on the switchgear shall be in English.

2.3.9. Earthing

An earth bar must be fitted in the switchboard, to which all non-current carrying metal parts shall be bonded.

The neutral point of the alternator must be solidly connected this bar by means of a removable link labelled "EARTH". Suitable terminals must be provided on the earth bar for connection of up to three earth conductors, which will be supplied and installed by others.

2.3.10. Operation Selector Switch

A four position selector switch must be provided on the switchboard marked "AUTO", "MANUAL", "and TEST" and "OFF".

With the selector on "AUTO", the set shall automatically start and stop, according to the mains supply being available or not.

With the selector on "TEST", it shall only be possible to start and stop the set with the pushbuttons, but the running set shall not be switched to the load.

With the selector on "MANUAL", the set must take the load when started with the pushbutton, but it must not be possible to switch the set on to the mains, or the mains onto the running set.

With the selector on "OFF", the set shall be completely disconnected from the automatic controls, for cleaning and maintenance of the engine.

2.3.11. Automatic Change-over System

A fully automatic change-over system must be provided to isolate the mains supply and connect the standby set to the outgoing feeder in case of a mains failure and reverse this procedure on return of the mains.

The contactors for this system must be electrically and mechanically interlocked.

2.3.12. By-pass Switch and Main Isolator

The switchboard shall be equipped with an on-load isolator to isolate the mains and a manually operated on-load 4 pole 4 position by-pass switch, which shall switch the connected loads as follows:

NORMAL: will allow for the normal connection i.e. connects the incoming mains to the Automatic control gear or directly to the outgoing feeder.

In the GEN BY-PASS position the switch will disconnect the automatic changeover control gear, and will connect the municipal mains directly the essential supply busbar which will allow for the maintenance of either or both the generator and the automatic changeover equipment.

MAINS BY-PASS switching position would allow the generator to be connected directly to the essential supply busbar. This is when there is a problem with the automatic changeover equipment and there is no municipal power available.

The final position is an OFF position which will remove all power downstream of this switch.

It is required that this by-pass switch and mains isolator be mounted away from the automatic control gear, in a separate compartment, either on the side or in the lower portion of the switchboard cubicle, and that the switches are operated from the front of the compartment.

Contractor to note: The by-pass and mains isolator switch shall also break the main neutral.

2.3.13. Start Delay

Starting shall be automatic in event of a mains failure. A 0-15 second adjustable start delay timer shall be provided to prevent start-up on power trips or very short interruptions.

2.3.14. Stop Delay

A stop delay with timer is required for the set, to keep the set on load for an adjustable period of one to sixty seconds after the return of the mains supply, before changing back to the supply. An additional timer shall keep the set running for a further adjustable cooling period of 5 to 10 minutes at no-load before stopping.

2.4. Installation

Except for the supply of the incoming mains cable and outgoing feeder cables, the tenderer must include for the complete installation and wiring of the plant in running order, including the connection of the incoming cable and outgoing feeder cables.

The connecting of the cable and control cabling to the generator and the control terminals in the LV board remains the responsibility of the tenderer.

2.5. Warning Notices

Notices, in English, must be installed on the outside of the steel enclosure.

The successful tenderer must consult the Occupational Health and Safety Act 83 of 1993 and get approval of the wording from the Department's representative, prior to ordering the notices.

The notice shall be made of a non-corrodible and non-deteriorating material, preferable plastic, and must read as follows:

DANGER: This engine will start without notice. Turn selector switch on control board to "OFF" before working on the plant.

An engraved label shall be installed next to the fuel cap that indicates the following:

- Base Tank Capacity
- Bulk Tank Capacity (if provided)
- Full load litres per hour consumption

2.6. Construction

The engine and alternator of the set shall be built together on a common frame, which must be mounted on a skid base on anti-vibration mountings. The set must be placed inside an IP65 canopy/container. A drip tray must be fitted under the engine. The tray must be large enough to catch a drip from any part of the engine.

The frame must be of the 'DUPLEX' type.

2.7. Operation

The set is required to supply the lighting and power requirements in the case of a mains power failure.

The set shall be fully automatic i.e. it shall start when any one phase of the main supply fails or get switched and shall shut down when the normal supply is re-established. In addition it shall be possible to manually start and stop the set by means of pushbuttons on the switchboard.

The automatic control shall make provision for three consecutive starting attempts. Thereafter the set must be switched off, and the start failure relay on the switchboard must give a visible and audible indication of the fault.

To prevent the alternator being electrically connected to the mains supply when the mains supply is on and vice versa, a safe and fail proof system of suitably interlocked contactors shall be supplied and fitted to the changeover switchboard.

SECTION 3 – TECHNICAL SPECIFICATION

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3. SECTION 3 – TECHNICAL SPECIFICATION

3.1. General

Supply, deliver, install, commission, test and maintain an emergency generating set at Phuthaditjha Labour Centre, Department of Labour, Qwaqwa

This installation must comply fully with all the sections and drawings of this document. This technical specification is supplementary to the Equipment Requirements, Section 2, and must be read together where they are at variance the Technical Specification shall apply.

Supply, delivery, installation and commissioning of the complete outdoor emergency generator set inside an IP65 canopy/container on a concrete plinth as specified in this document and indicated on the drawings.

Concrete plinth to be provided as per drawing P-DOL-E-01

The surface of the concrete plinth shall be 50mm higher than the existing ground level. The thickness and strength of the plinth shall be designed by the consulting engineer and are detailed on the drawings.

A tap to be provided to drain all the water that accumulates inside the bund wall. Final position of the tap will be determined on site. It is the engineer's responsibility to ensure plinth design complies with generator dimensions and weights. The bund wall shall contain 110% of the fuel, oil and water capacity of the generator. The bund wall shall not constrain the canopy doors from opening completely.

The contractor shall install an earthing system in the concrete plinth. The contractor shall install two (2) earth studs 1.8 meters long on opposite corners of the concrete plinth into the ground. The earth studs shall be connected by means of a 70mm² bare copper earth wire to the main earth bar in the control panel. The earth conductor shall be connected to the earth bar, canopy, base, skid and earth bar by means of suitably crimping lugs and brass bolts.

3.2. Site Information and Conditions

3.2.1. Location

The site is at Phuthaditjhaba Labour Centre, Qwaqwa.

3.2.2. Site Conditions

The following site conditions will be applicable and equipment shall be suitably rated to develop their assigned rating and duty at these conditions.

- | | |
|---|---------------|
| a) Height above sea level | : 1 646 Meter |
| b) Maximum ambient temperature | : 26 °C |
| c) Maximum ambient humidity at lowest temperature | : 0 % |

3.3. Output and Voltage

After the de-rating factors for the engine and generator due to site conditions have been taken into account, the set must have a site output and voltage as follows: -

No load voltage	⚡	400/230 Volt
Rating	⚡	68 kVA
Power at 0.9 power factor	⚡	61.2 kW

Frequency	50Hz
Fault Level	5kA

The generating set is required to feed the entire facility with a total load of 55.36 kVA.

3.4. Switchboard/Control Panel Unit

All switch- and control gear shall be rated for a fault current level of 6kA.

The switchboard/control panel unit shall be enclosed in the IP65 canopy/container.

3.5. Cables

The contractor will be responsible for all electrical cable connections associated with the complete generating set installation.

The following cables will be supplied, installed and terminated at the Switchboard by others. Adequate provision shall be made for the termination of these cables at the Switchboard:

DB Main	PVC/SWA/PVC Cable 4 core	25 mm ²
DB Main	BCEW	16 mm ²

3.6. Engine

A sump drainpipe must be fitted with a shut-off valve placed in a convenient position outside the base frame to facilitate drainage.

Recommended oil types must be indicated on the engine, or base frames, by means of suitable labels.

All engine instruments shall have clear markings on the faceplates, indicating the normal operating zone(s), maximum and minimum allowable values/limits and danger zone(s).

The flywheel shall be covered by approved hoods.

3.7. Alternator

The Alternator shall be of the low harmonic type.

3.8. Load Acceptance

The generator set shall be capable of accepting 75% of the specified site electrical output 10 seconds after the starter motor is energised and the remaining 25%, 5 seconds thereafter, i.e. 100% load acceptance shall not exceed 15 seconds.

3.9. Enclosure

The standby set is a free standing unit and shall be mounted in an enclosure as detailed below:-

3.9.1 General

The enclosure, shall be completely vermin-proof, powder coated and shall be constructed of 3CR12 stainless steel or within 50km from the coast with grade 316 steel housing of a minimum thickness of ± 1.5 mm.

The enclosure shall allow easy access to the engine, alternator, radiator filler cap and control cubicle for maintenance purposes.

The door shall be flush with the rest of the canopy and of the side opening type. A minimum of four doors are required i.e. two on either side.

The door hinges and locking bars shall be of a heavy duty type and be manufactured of 3CR12 stainless steel or within 50km from the coast with grade 316 steel and shall be fitted with a grease nipple.

The doors and panels shall be suitably braced and stiffened to ensure rigidity and to prevent bending and warping.

Suitable door restraints shall be fitted to all the doors, enclosure including the control panel to prevent wind damage. The restraint shall consist of a steel rod in a steel groove or slide with a spring loaded catch, which is to be manually reset to close the door.

No flexible restraints will be accepted.

The diesel fuel level indicator and alternator rating plate shall be clearly visible with the doors open.

Unless specified the silencers shall be mounted within the enclosure.

Perforated sheeting shall be fitted over all the insulating material inside the canopy of all soundproof sets.

Rubber seals on doors shall be equal to or similar to rubber pinch weld, wind lace.

9.2 Design

The enclosure shall be designed to be weather-proof and sound-proofing as specified. Rivets or self-tapping screws will under no circumstances be allowed for fixing the various sections of the enclosure. Only cadmium coated nuts and bolts are acceptable.

9.3 Roof

The roof of the enclosure shall be constructed for proper drainage of water as per the drawing.

9.4 Lamp fitting

A lamp fitting and it's associated on/off door switch shall be provided inside the enclosure for illumination of the control panel. The power for the lamp shall be obtained from the starter battery.

9.5 Sound-proofing

The sound-proofing on canopy engine sets shall be such that the maximum noise level generated by the set under any load condition shall not exceed 65 dB measured in any direction at a distance of 5m from the centre of the set with the doors closed.

The supply and discharge air paths will require separate attenuators on soundproof sets.

9.6 Padlock and keys

The contractor shall supply padlocks and keys for all the doors of the enclosure. The padlock shall be off the "Viro A82 keyed alike with stainless steel shackles" type.

Suitable brass metal plates shall be installed behind each lock for the protection of the enclosure against scratching or damaging, where the locks are hanging.

3.10. Alarms

The successful tenderer must pay particular attention to the requirements of the alarms as described in the Equipment Requirements, Section 2.

One alarm hooter and red light shall be supplied and installed on the outside of the generator container in a position as indicated by the Department's Representative.

The hooter shall consist of an electronic unit similar and equal to a "Klaxon" - type SY2/725 hooter with a continuously rated output and 110 dB at a distance of 2 metres, and shall be IP55 weatherproof rated.

The warning light shall consist of a 40W flashing red light, which shall be mounted on a galvanised steel frame together with the hooter.

The hooter and light shall be switched on or off simultaneously after initiation or cancellation of an alarm condition. The supply and installation of the wiring between the control board and the alarm unit forms part of this contract.

The successful tenderer must ensure that the hooter control circuit resets automatically after cancellation due to a low fuel condition or battery charger failure, but the visible fault indication must remain, i.e. should the operator continue to run the set, the hooter must sound, should any other condition develop.

A remote alarm panel shall be supplied and installed by the contractor in the control room. This shall be of surface mounting, enamelled sheet metal (colour to approval), minimum depth construction, and shall incorporate a flashing red pilot alarm light, adjustable electronic sounder, and a silence push button. The silence button shall not switch off the pilot light - this shall only be switched off when the alarm is reset at the Generator Panel.

A 16mm² x 4-core PVC SWA PVC cable will be supplied, installed and terminated by others between the Generator Panel and the Main DB. The Contractor shall connect this cable at both ends and shall supply and install all switch gear relays, etc. to ensure satisfactory operation of the Remote Alarm Panel.

3.11. Remote Control Generator Switch

A Remote Control Generator "ON/OFF/AUTO" switch will be supplied and installed by others in the control room, and a 16mm² x 4-core PVC SWA PVC cable will be supplied and installed by others between the control room and the Generator Panel.

The contractor shall connect this cable at both ends, and shall supply and install all switch gear, relays, etc. to ensure satisfactory operation of the remote control switch.

3.12. Fuel Drip Tray

A drip tray approximately 100mm deep shall be mounted below the generator and must be large enough to collect any fuel that drips from the generator fuel accessories. The drip tray shall be manufactured from black mild steel. The thickness of the drip tray sheet steel shall not be less than 2mm.

3.13. Completion Time

The Generator Set is required to be commissioned in conjunction with the building contract.

3.14. Inform

The successful tenderer shall inform the Engineer when the set is ready for installation.

3.15. Fuel Supply Tank

The fuel tank shall be an integral part of the base frame of the generator set. The tank shall have sufficient capacity to run the engine on full load for a period of 24 hours. The base tank shall be an open channel self-bund walled type that shall be of sufficient capacity to contain a spillage equivalent to 110% in volume of the base tank. The containment tank shall be manufactured from black mild steel with a thickness of not less than 2mm.

A float level alarm connected to the generator controller shall be incorporated into the bund area located such that the alarm will be activated when 50% of the volume of the bund area has been reached in the event of any diesel fuel leakage.

**SECTION 4 – SCHEDULES OF TECHNICAL INFORMATION
(TO BE FULLY COMPLETED BY TENDERER)**

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4. SECTION 4 – SCHEDULES OF TECHNICAL INFORMATION

4.1. Engine

NO	ITEM	REMARKS
1.	Manufacturer's Name	
2.	Country of Origin	
3.	Manufacturer's model No. and year of manufacture	
4.	Continuous sea level rating after allowing for ancillary equipment : a) In b.h.p. b) In kW	
5.	Percentage de-rating for site conditions, in accordance with SANS 8528 a) For altitude b) For temperature c) For humidity d) Total de-rating	
6.	Net output on site in kW	
7.	Nominal speed in r.p.m.	
8.	Number of cylinders	
9.	Strokes per working cycle	
10.	Stroke in mm	
11.	Cylinder bore in mm	
12.	Swept volume in cm ³	
13.	Mean piston speed in m/min	
14.	Compression ratio	
15.	Cyclic irregularity	
16.	Fuel consumption of the complete generating set on site in l/h of alternator output at : a) Full load b) $\frac{3}{4}$ load c) $\frac{1}{2}$ load NOTE : A tolerance of 5% shall be allowed above the stated value of fuel consumption.	
17.	Make of fuel injection system.	
18.	Capacity of fuel tank in litres	
19.	Is gauge glass fitted to tank?	

NO	ITEM	REMARKS
20.	Is electric pump for filling the fuel tank included?	
21.	Method of starting	
22.	Voltage of starting system	
23.	Method of cooling	
24.	Type of radiator if water-cooled	
25.	Type of heater for warming cylinder heads	
26.	Capacity of heater in kW	
27.	Method of protection against high temperature	
28.	Method of protection against low oil pressure	
29.	Type of governor	
30.	Speed variation in % a. Temporary b. Permanent	
31.	Minimum time required for as assumption of full load in seconds	
32.	Recommended interval in running hours for : a. Lubricating oil change b. Oil filter element change c. Decarbonising	
33.	Type of base	
34.	Can plant be placed on solid concrete floor?	
35.	Are all accessories and ducts included?	
36.	Is engine naturally aspirated?	
37.	Are performance curves attached?	
38.	Diameter of exhaust pipe	
39.	Noise level in plant room in dBA	N/A
40.	Noise level at tail of exhaust pipe in dBA	
41.	BMEP (4 stroke) at continuous rating (kPa)	
42.	% Load acceptance to SANS 8528, with 10% transient speed drop	

4.2. Alternator

NO	ITEM	REMARKS
1.	Maker's name and model no.	
2.	Country of Origin and year of manufacture	
3.	Type of enclosure	
4.	Nominal speed in r.p.m.	
5.	Number of bearings	
6.	Terminal voltage	
7.	Sea level rating kVA at 0,9 power factor	
8.	De-rating for site conditions	
9.	Input required in kW	
10.	Method of excitation	
11.	Efficiency at 0,9 power factor and : a) Full load b) $\frac{3}{4}$ load c) $\frac{1}{2}$ load	
12.	Maximum permanent voltage variation in %	
13.	Transient voltage dip on full load	
14.	Voltage recovery on full load application in milli-seconds	
15.	Is alternator brushless?	
16.	Class of insulation of windings	
17.	Is alternator tropicalised?	
18.	Symmetrical short circuit current at terminals n Ampere	
19.	Type of Coupling	

4.3. Switchboard

NO	ITEM	REMARKS
1.	Maker's Name	
2.	Country of Origin	
3.	Is board floor mounted?	
4.	Finish of board	
5.	Make of volt, amp, and frequency meters	
6.	Dial size of meters in mm	
7.	Scale range of voltmeter	
8.	Scale range of ammeters	
9.	Ratio of current transformers	
10.	Make of hour meter	
11.	Range of cyclometer counter	
12.	Smallest unit shown on counter (Item 11)	
13.	Make of circuit breaker	
14.	Type of circuit breaker	
15.	Rating of circuit breaker in Amp and fault level in kA	
16.	Setting range of overload trips	
17.	Setting range of instantaneous trips	
18.	Make of change-over equipment	
19.	Make of voltage relay	
20.	Is control and protection equipment mounted on a small removable panel?	
21.	Type of control equipment .	
22.	Make of mains isolator	
23.	Type of indicators for protective devices	
24.	Make of rectifier	
25.	Type of rectifier	
26.	Is battery charging	
27.	Are volt- and ammeters provided for charging circuit?	
28.	Is the alarm hooter of the continuous duty type?	
29.	Rating in Amps of : a. Change-over equipment b. Mains on load isolator c. By-pass switch d. Circuit breaker to outgoing feed	
30.	Is manufacture of switchboard/control panel to be sub-let?	

NO	ITEM	REMARKS
31.	If yes, state name and address of specialist manufacturer	

4.4. Battery

NO	ITEM	REMARKS
1.	Maker's Name	
2.	Country of Origin	
3.	Type of battery	
4.	Voltage of battery	
5.	Number of cells	
6.	Capacity in cold crank amp	

4.5. Dimensions

NO	ITEM	REMARKS
1.	Overall dimensions of set in mm	
2.	Overall mass	
3.	Is the canopy/container adequate for the installation of the set, switch board and fuel tank	

4.6. Deviation from the Specification as an Alternative (State Briefly)

NO	DESCRIPTION

4.7. Spare Parts and Maintenance Facilities

NO	ITEM	REMARKS
1	Approximate value of spares carried in stock for this particular diesel engine and alternator	
2	Where are these spares held in stock	
3	What facilities exist for the servicing of the equipment offered	
4	Where are these facilities available	

SECTION 5 – PRICE SCHEDULES

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5.2. Schedule..... 31

5.3. Summary of Schedules of Quantities 34

5. SECTION 5 – PRICE SCHEDULES

5.1. General

- 1) The conditions of contract and the application of the Contract Price Adjustment Provisions shall be as set out in Part A: Section 1: Preliminaries.
- 2) The descriptions in this Price Schedule shall be read in conjunction with the specification.
- 3) The unit rate for each item in the Price Schedules shall include for all materials, labour, profit, transport, etc., everything necessary for the execution and complete installation of the work in accordance with the description.
- 4) The Price Schedules shall not be used for ordering purposes. The Contractor shall check the lengths of cables and overhead conductors on site before ordering any of the cables. Any allowance for off-cuts shall be made in the unit rates.
- 5) The rates shall exclude Value Added Tax and the total carried over to the final summary in PART A.
- 6) All material covered by this Specification shall, wherever possible, be of South African manufacture.

5.2. Schedule

 public works & infrastructure Department: Public Works and infrastructure REPUBLIC OF SOUTH AFRICA					
PHUTHADITJHABA LABOUR CENTRE GENERATOR INSTALLATION					
ELECTRICAL ENGINEERING SERVICES					
TENDER NUMBER:					
BILL 1 - BACKUP GENERATOR FOR PHUTHADITJHABA LABOUR CENTRE					
ITEM NO	DESCRIPTION	UNIT	QTY	RATE	AMOUNT
	Backup Generator Installation				
1,1	<u>EMERGENCY STANDBY GENERATOR ENGINE</u>				
	Supply, Deliver, install and commissioning of standby generator complete in canopy as specified for the following sizes:				
	The Engine shall be a Diesel Fuelled, old starting liquid cooled, compression ignition, direct injection industrial type as complying with SANS 8528. The cooling system shall be thermostatically controlled entirely				

	self-contained and shall consist of a radiator, fan and Circulation pump as per DPWI 722 specification.				
	<u>The following from part of genset:</u> Water jacket heater, fuel level indicator, fire fuse link shut off system, drip tray, battery charger, battery charger amp meter, canopy lights, fuel filling pump, Anti vibration mounts.				
1.1.1	68kVA, 3 Phase with 3CR12 Container				
	Supply	ea	1		R -
	Install	ea	1		R -
1.2	<u>3CR12 CHANGE OVER PANEL WITH CONTROLLER</u>				
1.2.1	The control shall contain the engine, alternator management and protection system, as well as the control logistics for the remote changeover switchgear. These functions shall be controlled by a micro-processor-based programmable control and it shall be equipped with an optional GSM cellphone-type modem as per DPWI 722 specifications (modem with sim card), c/w adjustable CB, motorized c/p & by pass switch				
	Supply	ea	1		R -
	Install	ea	1		R -
	<u>LUBRICATION, OIL AND DIESEL</u>				
	Supply and fill up to 100% all required lubrications to run generator including diesel. Tank shall be a 280L capacity	item	1		R -
1.3	<u>EXHAUST SILENCER - Sound Attenuated</u>				
1.3.1	Design supply and install the stainless steel exhaust silencer for the mentioned generator, including lagging:				
	Supply	ea	1		R -
	Install	ea	1		R -

1,4	<u>STRUCTURAL - TYPICAL GENERATOR BASE</u>				
1.4.1	Supply and install a concrete plinth according to the specifications and drawing.	m3	60		R -
1.4.2	Supply and Install a barrier fence around the generator in accordance with the National Building Regulations	m	20		R -
1,5	<u>WARNING NOTICES</u>				
1.5.1	Supply and Install warning notices on the container as specified.				
	Set of Warning Notices as per SANS and OHS specifications.	Item	1		R -
1,5	<u>DOCUMENTATION</u>				
1.5.1	Compilation of Maintenance, operational and technical Manuals to the client satisfaction.				
	Supply manuals	sum	1		R -
1,6	<u>SITE TESTING, COMMISSIONING & DOCUMENTATION</u>				
1.6.1	Test and Commission to deliver a fully operational generating set to the client and engineers satisfaction:	Item	1		R -
1.6.2	At the suppliers premises, prior to delivery to site				
	On site after completion of the installation	Item	1		R -
1,7	<u>1 YEAR MAINTENANCE</u>				
1.7.1	12 Month maintenance as per the specification.				
	Quarterly (4) service of the plant as per the manufacturer's requirements	Item	4		R -
1,8	<u>PADLOCKS</u>				
1.8.1	Supply and install A82 padlocks.	Item	5		R -
				TOTAL:	R -
BILL 1 - BACKUP GENERATOR TOTAL CARRIED FORWARD TO SUMMARY PAGE:					R -

5.3. Summary of Schedules of Quantities

Schedule	Page No	Amount	
		R	c
1.			
Total Tender Price for the Supply and Installation of an Emergency Generator Set		R	